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GENERIC REQUIREMENTS
GR–303–CORE
ISSUE 1, SEPTEMBER 1995
WITH REVISION 3, DECEMBER 1997

Integrated Digital Loop Carrier System Generic Requirements, Objectives, and Interface

(A module of TSGR, FR-440)

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		Supplier Documentation for NEs, TR–TSY–000454
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		Supplier Support, TR–NWT–000840
		EMC and Electrical Safety, GR–1089
2	DLC System, UDC, and Basic Exchange Radio Systems	Digital Loop Carrier Systems, TR–NWT–000057
		Universal Digital Channel (UDC), TR–TSY–000398
		Basic Exchange Radio Systems, TR–NWT–000911
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4	ISDN Transport, Interface, and Related Requirements	ISDN Basic Access DSL, TR–NWT–000393
		ISDN Basic Access Transport, TR–NWT–000397
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5	Digital Radio Systems	Microwave Digital Radio, TR–TSY–000752
6	SONET Common Criteria	SONET Transport Systems: Common Generic Criteria, GR–253
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IDLC Generic Requirements, Objectives, and Interface

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Introduction to Revision 3

This document, GR–303–CORE, *Integrated Digital Loop Carrier System Generic Requirements, Objectives, and Interface* is a module of FR-440, *Transport Systems Generic Requirements (TSGR)*. If you have that set of documents, GR-303-CORE is in Volume 3.

Please use the following instructions to update GR–303–CORE, Issue 1, September 1995.

Remove from Issue 1	Replace with Revision sections
Section 1	Section 1
Section 3	Section 3
Section 5	Section 5
Section 6	Section 6
Section 12	Section 12
Section 13	Section 13
Requirement-Object Index	Requirement-Object Index

Reason for Revision

This document incorporates proposed changes and additions to the IDLC requirements provided in GR-303-CORE, Issue 1. Supplier and user comments, received during the early interaction phase, were also considered and used in the formulation of the criteria provided in this document. Change bars (|) highlight changes in this revision.

See Section 1.7, page 1–9, for a detailed list of changes made in this revision.

Preface

This Preface contains important information about Bellcore's GR process in general, as well as important information about this document.

Bellcore's GR Process

Generic Requirements documents (GRs) provide Bellcore's view of proposed generic criteria for telecommunications equipment, systems, or services, and involve a wide variety of factors, including interoperability, network integrity, funding participant expressed needs, and other input.

Bellcore's GR process implements Telecommunications Act of 1996 directives relative to the development of industry-wide generic requirements relating to telecommunications equipment, including integral software and customer premises equipment. Pursuant to that Act, Bellcore invites members of the industry to fund and participate in the development process for such GRs. Invitations to fund and participate are issued monthly in the *Bellcore Digest of Technical Information*, and posted on Bellcore's web site at *http://www.bellcore.com/DIGEST*. Information specific to GR-303 can be found at *http://www.bellcore.com/GR/gr303.html*.

At the conclusion of the GR development process, Bellcore publishes the GR, which is available by subscription. The subscription price entitles the purchaser to receive that issue of the GR (GR-CORE) along with any Issues List Report (GR-ILR) and Revisions, if any are released under that GR project. ILRs contain any technical issues that arise during GR development that Bellcore and the funding participants would like further industry interaction on. The ILR may present issues for discussion, with or without proposed resolutions, and may describe proposed resolutions that lead to changes to the GR. Significant changes or additional material may be released as a Revision to the GR-CORE.

Bellcore may also solicit general industry nonproprietary input regarding such GR material at the time of its publication, or through a special Industry Interaction Notice appearing in the *Bellcore Digest of Technical Information.* While unsolicited comments are welcome, any subsequent work by Bellcore regarding such comments will depend on funding support for such GR work. Bellcore will acknowledge receipt of comments and will provide a status to the submitting company.

About GR–303–CORE

A. Funders of GR–303–CORE, Issue 1, Revision 3 are:

- Bell Atlantic
- BellSouth Telecommunications
- Pacific Bell
- Southwestern Bell Telephone

B. Relative Maturity Level

This is a mature technology and requirements reflect maintenance mode.

C. GR–303–CORE Plans

Issues affecting these requirements are planned to be published in future GR-303-ILRs.

To Submit Comments

When submitting comments, please include the GR document number, and cite any pertinent section and requirement number. In responding to an ILR, please identify the pertinent Issue ID number. Please provide the name and address of the contact person in your company for further discussion.

Comments should be submitted by **March 15, 1998.**

Send comments to:

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1. Introduction

1.1 Purpose

This Generic Requirements (GR) document describes Bellcore's view of the overall system functions and performance levels required when a Digital Loop Carrier System (DLC) is integrated into a Local Digital Switch (LDS). It further describes a generic interface, one particular means of interfacing a DLC Remote Digital Terminal (RDT) with the LDS.

The proposed overall system requirements for Integrated Digital Loop Carrier (IDLC) systems are expressed in terms of functions, i.e., what the combination of RDT and LDS must do when connected together. These end-to-end system requirements are grouped into functional categories dealing with (1) Customer services, (2) Digital network interfaces, (3) Operations Systems interfaces, (4) Craft interfaces, and (5) Overall system capabilities. These proposed requirements do not specify or imply any specific supplier implementation. They are, therefore, termed generic system requirements.

This GR also defines optional features that might be offered in IDLC systems tailored to meet specific applications. Where appropriate, this GR defines the application(s) for which each option is intended. However, these intended applications should only be considered as possible guidelines, and by no means are exhaustive.

The Generic IDLC Interface, between the end components of the system, is defined in a layered structure. These include the physical layer corresponding to an electrical (DS1) or optical (OC-3) signal, the data link layer as a particular communication data link protocol, and the application layer as particular message sets for both operations and call processing. This GR deals with a DS1-based interface. Section 13 (formerly TR-NWT-000303, Supplement 1) provides the generic requirements for interfacing an RDT to an LDS via the Synchronous Optical Network (SONET) format.

The Generic IDLC Interface requirements are consistent with the end-to-end system requirements and comprise one particular means of accomplishing those system requirements. The Generic IDLC Interface requirements also contain options, both in implementation and tied to optional system features. These options are described so that the decision of an RDT supplier to either offer or not offer an option does not preclude the interconnection with another supplier's LDS. While this encourages the development of RDTs tailored for specific applications, it does require the LDS interface to be broad enough to handle a variety of combinations of RDT features.

1.2 Scope and Assumptions

An **Integrated Digital Loop Carrier (IDLC)** system is a composite system (see Figure 1-1) that consists of an RDT and an Integrated Digital Terminal (IDT), which is an

integral part of the LDS. The distinguishing characteristic of IDLC systems from Universal DLC (UDLC) systems is the absence of a Central Office Terminal (COT).

This document identifies features and functions that, in Bellcore's view, should be incorporated into IDLC systems to maximize the benefits of IDLC deployment.

The requirements proposed in this GR are aimed at a forward-looking environment. Assumptions on that environment include an increased emphasis on new digital services, such as those based on Integrated Service Digital Networks (ISDNs), and a new Operations Systems (OS) environment. The new OS environment includes highly automated, centralized, and remotely located operations centers. It is assumed that these operations centers employ OSs dedicated to network performance monitoring and analysis, circuit testing of both switched and non-switched circuits, and automated remote provisioning of Network Elements (NEs).

These OSs communicate with new generation NEs using generic interfaces, protocols, and languages, as specified in other Bellcore Technical Advisories (TAs), Technical References (TRs), and GRs. However, it is also recognized that transition to such a modern service and operations environment will not be instantaneous.

While requirements proposed in this GR are “optimized” for this forward-looking operations environment, this GR also includes proposed requirements supporting today's services and OSs. This GR requires that IDLC systems provide both interim interfaces to the existing OSs, and the ability to transition from the current to the future operations interfaces.

Further, the Generic IDLC Interface between the RDT and the LDS will allow the flexibility of deploying an LDS from one supplier and RDTs from the same **or different** suppliers. Thus, the proposed requirements in this GR on the Generic IDLC Interface apply to this “multiple-supplier system.”

Another major expectation is that the supplier of an IDLC RDT may also offer a non-integrated system, otherwise known as a UDLC, based on the same RDT hardware. UDLC systems would be installed in analog Central Offices (COs) and then later integrated when the analog switch is replaced by an LDS. This implies that the IDLC RDT should ideally be, from the user perspective, functionally and operationally equivalent to the universal configuration. That is, the COT of a UDLC system may be replaced with a direct digital interface to an LDS without perceptible change in features, function, or performance.

The underlying assumption that motivates this document is that there are economic benefits to integration as opposed to UDLC. Experience with currently available IDLC systems that are based on the requirements and interface described in TR-TSY-000008, indicates that the magnitude of these benefits and, ultimately, the decision to integrate a DLC system, depend heavily on the operations features and service handling capability offered with the integrated system. For example, if the integrated system does not support all services currently provided by a universal system, the decision to integrate may depend on the cost to provide such services by alternate means. These costs include not only the additional

equipment required, but also the administrative costs of segregating services by facility type. If IDLC systems require operations markedly different from other facilities, especially if IDLC operations require manual intervention in an otherwise automated operation, IDLC benefits will not be realized. This stresses that the benefits of integration depend on the IDLC system meeting the service and operations related requirements of this GR.

1.3 A Summary of System and Generic IDLC Interface Requirements

This section provides a brief summary of some of the new functions specified in this GR and some of the key attributes of the Generic IDLC Interface.

1.3.1 End-to-End System Requirements Summary

An IDLC system must be able to interface to other digital transmission systems in the CO. This GR includes requirements and options on signal frame formats, signaling, performance, and operations to ensure connectivity and consistent operations across the digital network.

This GR calls for the use of modern OS-NE interfaces, based on International Telecommunication Union - Telecommunication Standardization Sector (ITU-T)[1] protocols and language standards. These protocol and language standards are described in a series of Bellcore TAs, TRs, and GRs. Use of these standards will, for example, allow for standard means of (1) remote circuit provisioning, (2) remote testing of both POTS and special services, (3) performance monitoring of each DS1 facility, and (4) a consistent set of alarms. Because of its remote location, the RDT will use the LDS as a “gateway” to the OS network.

In addition, this GR calls for system features aimed at providing a functional equivalence of DS0 subscriber main frame access. Included in this category are features to (1) terminate and redirect DS0 channels to the interoffice transmission network (non-locally switched and non-switched services), (2) provide for equivalent CO bridging (party lines, secretarial services, dual service, cable transfers), and (3) provide for improved traffic load management.

Because the requirements for an RDT to interface to customer access lines to support customer services are common between UDLC and IDLC systems, requirements in this GR are consistent with those in TR-NWT-000057. Requirements in this GR apply to the line units of RDTs only, however, because the COT requirements of TR-NWT-000057 do not apply to IDLC systems.

1. Formerly known as the International Telephone and Telegraph Consultative Committee (CCITT).

Finally, this GR recognizes the need for compatibility with ISDN (see Figure 1-2). This GR supports features required to transport ISDN *Basic Access* services from one end of an IDLC system to the other. DS1-based IDLC systems are not required to support ISDN *Primary Rate Access*, other than to transparently transport customer DS1 lines meeting Primary Rate standards.

1.3.2 Generic IDLC Interface Requirements Summary

The physical layer of the Generic IDLC Interface is based on DS1 rate modularity. Across the Generic IDLC Interface, an IDLC system may range in size from 1 to 28 DS1s. The lower limit, one DS1, allows IDLC systems to meet the needs of small line size applications that do not require the ability to back-up critical operations data links. Support of two DS1s allows IDLC systems to meet the needs of small line size applications, while also providing the ability to back up critical operations data-links. The maximum limit, 28 DS1s, allows IDLC systems to meet the needs of large line size applications. The maximum size is limited to 28 DS1s to promote consistency with higher-rate facilities with DS3 modularity.

The DS1 line uses the Extended Super Frame (ESF) format. This frame format uses the channel derived from the 193rd bit of a DS1 frame for several functions, including synchronization, error detection, and for a derived 4 kb/s channel. Performance monitoring of each DS1 facility is accomplished by using the CRC-6 code. The 4-kb/s derived channel can be used to transmit performance-report messages between the RDT and the LDS, or can be preempted as a bit oriented channel to transmit alarm codes and protection line switch commands.

A separate DS0 data link, called the Embedded Operations Channel (EOC), is used to transmit operations messages between RDT and LDS. The EOC is based on the LAPD protocol and CMISE/ASN.1 messages described in Supplement 3 of TR-TSY-000303 and GR-2833-CORE. An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is discussed in SR-3581.

The Generic IDLC Interface also uses a separate 64-kb/s data link (DS0-channel) to perform per-call time-slot assignments and, on an option basis, to transmit call processing messages between the RDT and the LDS. A 16-state robbed-bit signaling is another option for transmitting call processing messages between the RDT and the LDS. The call processing data link is based on the LAPD protocol, which is the same protocol used on ISDN D channels. Call processing messages are based on the CCITT Q.931 message standard.

For ISDN Basic Access capability, requirements are described that specify the mapping of B and D channels onto DS1 facilities at the RDT. This ensures that the LDS can find and properly process all B and D channels. Two methods are described, one (called the 3DS0 method) is simple but bandwidth-inefficient, the other (called the 4:1 TDM method) is more bandwidth-efficient, but relies on the presence in the RDT of several other feature and interface options.

One prominent application of the Generic Interface involves its use as the basis for defining an open interface for integrated Fiber In The Loop (FITL) systems, as defined in TA-NWT-000909.

1.3.3 Miscellaneous Items

1.3.3.1 IDLC/Integrated Network Access Requirements

When a circuit or facility directly connects to the network without going through the local switch (fabric), this architecture is called an Integrated Network Access architecture. In Integrated Network Access applications, the generic interface between the IDLC system and an OS is expected to be through the Operations Interface Module (OIM) of the LDS . The IDLC system interface to an OS is specified to be through the LDS because, generally, Digital Cross-connect Systems (DCSs) and byte-synchronous Add-Drop Multiplexes (ADMs) do not have the capability to provide an IDLC-system-to-OS interface. In the absence of an OIM, alternate means (such as dedicated lines, dial-up lines, etc.) could be used.

1.3.3.2 RSU/RDT Requirements

When an IDLC system is terminated on a Remote Switch Unit (RSU), the RSU must provide all the functions that have been allocated to an IDT in GR-303-CORE, or allow access to them, as well as meet the IDLC Generic Interface requirements. At the present time, the link between the RSU and host is supplier-specific and not the subject of these requirements, but the length of this link does have a significant impact on some delay related criteria for IDLC systems.

1.3.3.3 Integrated RTU/RDT Requirements

The interface between the integrated Remote Testing Unit (RTU) and its Test System Controller (TSC) is assumed to be supplier-specific because it is assumed that both ends of the test system will be provided by the same supplier.[2] In addition, the method used to exchange control and test data messages between the integrated RTU and its TSC, whether by dedicated DS0 channels, messages over embedded communications channels, or any other means, is also supplier specific at this time and not subject to these requirements.

2. This is not meant to discourage the supplier(s) of the Integrated RTU and the supplier(s) of the RDT and LDS from making whatever contractual arrangements, or exchange of interface specifications they deem necessary, to allow their respective products to work together.

When an RTU is performing circuit testing at sites with multiple RDTs, it may be desirable for an integrated RTU in just one of the co-located RDTs to be used for circuit testing in the other co-located RDTs. There may also be situations where it is economical to devote an integrated RTU to a single RDT. In the case of an integrated RTU serving multiple RDTs at a site, it will be necessary for suppliers to provide - as an option - external taps to access the Metallic Test Access Units (MTAUs) of co-located RDTs, including those from other suppliers.

1.4 Key Bellcore Documents Related to this GR

This section lists some key Bellcore documents that are referenced in this GR. A complete list of all referenced documents in numerical order, plus ordering information, is in the References section that follows the Appendixes.

TR-TSY-000303, Supplement 3, *IDLC System Generic Requirements, Objectives, and Interface: Operations (ROS/CMIS/ASN.1) Messages Release 1.0,* defines the operations messages for the Embedded Operations Channel.

SR-NWT-002411, *MCS and MOCS Proformas for IDLC TR-TSY-000303 Issue 1 Supplement 3 Revision 1,* provides a mechanism for a vendor to formally specify conformance information, which will be useful for achieving “mix and match.” This SR is a companion document of Supplement 3.

SR-NWT-002166, *Guidelines for Supervisory Systems that Manage TR-TSY-000303 Remote Digital Terminals,* provides guidelines to RDT vendors on the operations support capabilities of their Supervisory Systems to support their RDTs.

SR-OPT-002344, *TR-303 IDLC Network and Operations Plan,* provides an overview of the impact of TR-303 features on the major operations processes, i.e., network capacity provisioning, service activation, and service assurance.

SR-NWT-002139, *Feature Management Survey for Products Based on TR-TSY-000303,* provides a snapshot of the TR-303 products being planned and built by various vendors.

TR-NWT-000057, *Functional Criteria for Digital Loop Carrier Systems,* describes the functional requirements of UDLC systems consisting of COTs and RDTs. Since one objective of the IDLC requirements is to facilitate transition from UDLC to IDLC, many requirements on the RDTs are the same. As a result, this GR refers to TR-NWT-000057 for those functions that are common to both. In particular, IDLC RDT interfaces to metallic pairs (and customer service and signaling requirements) at the DS0 or VF rate, IDLC RDT physical and environmental requirements, and IDLC RDT human factors requirements are as described in TR-NWT-000057.

GR-2833-CORE, *Generic Interfaces Using OSI Tools: Information Model for Integrated Digital Loop Carrier and Fiber in the Loop Systems,* defines an

information model that provides a common frame of reference for operations communications between a managing system and an IDLC system

SR-3581, *GR-303 Operations Migration Strategy*, proposes an operations migration strategy for GR-303 products and their managing systems.

TR-NWT-000397, *ISDN Basic Access Transport System Requirements,* contains detailed implementation requirements for transporting Basic Access lines across the Generic IDLC Interface.

TA-NWT-000909, *Generic Requirements and Objectives for Fiber In The Loop Systems,* contains additional generic requirements that must be supported to integrate FITL systems into a LDS.

It is suggested that documents referenced in this GR be obtained to develop a complete understanding of the requirements in this document. References to TAs are made with the understanding that these are preliminary documents more likely to change than subsequent TRs or GRs. The reader, in referring to a TA, should make sure of having the most recent version by calling the number listed in the References section of this document. GRs that replace TAs or TRs have the same number. See the Preface for a description of Bellcore's new generic requirements process.

1.5 Applications of IDLC Systems

The use of DLC systems as an alternative to copper feeder cable pairs accounts for most DLC system deployments. DLC systems also support a wide range of special services. The overall system is very attractive because, in addition to substantial first cost savings, it provides a flexible means to offer many types of services. Of particular importance are the potential operational simplifications possible with DLC system transport of special services, especially when the Carrier Serving Area (CSA) concept is employed. Costs may be further reduced with remote provisioning of special service circuits. Moreover, DLC systems will provide ISDN Basic Access to a large number of lines otherwise inaccessible due to loop length limitations. The concurrent development of digital switching technology led naturally to the concept of IDLC systems.

Within the feeder cable substitution application, a wide range of physical and customer service environments must be accommodated. For example, IDLC systems must be able to serve both small and large line sizes of customers, requiring both basic switched services (i.e., POTS) and private line special services (including digital). IDLC systems must interface with transmission media ranging from T1 metallic cables to fiber optic systems. While it is unreasonable to expect any one RDT design to be able to optimize over all these environments, they all may occur in the same wire center area. Thus, while RDTs may be customized to fit individual application environments, the LDS must be capable of operating in all such environments.

1.6 Differences from TR-NWT-000303, Issue 2

The more significant differences are listed below.

1. The format of presenting generic criteria has been changed. See Sections 1.8 and 1.9 for a description. This has resulted in the changing of all requirement numbers from TR-NWT-000303, Issue 2. However, the original section numbers have been retained whenever possible.
2. All changes from TR-NWT-000303, Issue 2, Revisions 1 and 2, have been included in GR-303-CORE.
3. TR-NWT-000303, Issue 2, Supplement 1 is now Section 13 of this GR. Although the section numbering has changed, a cross-reference to the section numbers used in Supplement 1 is provided in each heading used in Section 13.
4. TR-NWT-000303, Issue 2, Supplement 2 has been integrated into Section 5. Many of the operations requirements throughout TR-NWT-000303, Issue 2, have also been integrated into Section 5 of this GR; especially from Sections 6 through 9 and 12.7. Section 5 of this GR has undergone a major reorganization.
5. All changes specified in Technical Bulletins 1 and 2 have been included in this GR. Also included in this GR are the changes in Technical Bulletin 3, except for the changes impacting Supplement 3 of TR-TSY-000303.
6. Twenty-seven issues of SR-3371, *TR-303 Issues List Report*, Issue 3 have been closed because the identified changes have been included in this GR. GR-303-ILR, Issue 1A replaces SR-3371 as of September 1995 and identifies the specific sections of this GR that have changed.
7. All dated objectives in TR-NWT-000303, Issue 2 that have 1995 included with the letter O (e.g., O_{1995} - 625) have been changed to requirements in this GR.
8. Criteria that had been flagged in previous iterations as too ambiguous has been clarified, and differences have been resolved between GR-303-CORE and Family of Requirements sets such as the *Transport Systems Generic Requirements* (*TSGR*, FR-440), the *LATA Switching Systems Generic Requirements* (*LSSGR*, FR-64), and the *Operations Technology Generic Requirements* (*OTGR*, FR-439).
9. A TR-NWT-000303 operations migration strategy has been proposed by Bellcore in SR-3581, *TR-NWT-000303 Operations Migration Strategy*. In this GR, it is now required that the services and information model of GR-2833-CORE, *Generic Interfaces Using OSI Tools: Information Model for Integrated Digital Loop Carrier and Fiber in the Loop Systems*, be used to support the functional requirements of this GR. On an interim basis, however, the services and information model defined in Supplement 3 of TR-TSY-000303 may continue to be used to support management functions between the IDT and RDT.

1.7 Reasons for Revision

Revision 3 to GR-303-CORE, Issue 1, *IDLC System Generic Requirements, Objectives and Interface* and its Revisions 1 and 2, incorporates proposed changes and additions to the IDLC requirements. Supplier and user comments, received during early industry interaction, were also considered and used in the formulation of the criteria provided in this document.

Changes or additions were incorporated in each of the sections listed below. Additional criteria and changes are denoted by a change-bar located in the outside margin. Deletion of criteria is denoted by a single * in the outside margin. Previously a revision only provided those pages that included changes within a section of the GR document. This current revision, as well as any future Bellcore revisions, shall provide the entire section if a change or addition was incorporated within the section. Therefore this revision includes replacements for the following sections of GR-303-CORE:

- Section 1, *Introduction*
- Section 3, *Requirements and Options for Customer Services*
- Section 5, *Operations System Interfaces*
- Section 6, *IDLC System Capabilities: Requirements and Options*
- Section 12, *LDS-RDT Generic Interface - Requirements and Options*
- Section 13, *Feature Set C - SONET Interface*
- Requirement-Object Index

Throughout this document, references to criteria cited both in this revision of GR-303-CORE or past revisions of GR-303-CORE are needed. When referencing criteria that are present in this revision of GR-303-CORE, only the criterion's local number will be referenced (see Section 1.10, "Requirement Labeling Conventions" for the definition of "local number"). When referring to criteria not cited in this revision, the criterion's absolute number (see Section 1.10 "Requirement Labeling Conventions" for the definition of "absolute number") along with its local number will be referenced.

Specific additions, deletions, or changes include:

- Section 3, *Requirements and Options for Customer Services*
  - — New text was added to Section 3.2.1.5 to indicate that the Total Loss requirements in do not include any network loss that may be inserted by the IDLC system to control echo performance.
  - — New text was added to Section 3.2.2.1.10 that defines the meaning of a Showering Line and describes possible faults that may result in a Showering Line. R3-41 [41] was modified to indicate the proper reference.

— Requirements in Section 4.9 of TR-NWT-000057 were migrated into Section 3.2.2.1.12 of GR-303-CORE to apply to an IDLC application. They were originally proposed as part of GR-303-ILR Issue 1D, under issue 303-174 and have now been explicitly included in GR-303-CORE.

— It was identified that GR-303-CORE was missing Open Switching Interval Distortion requirements. Thus, new requirements were included in Section 3.2.2.4.4. These requirements were originally proposed as part of GR-303-ILR Issue 1D, under issue 303-174 and have now been explicitly included in GR-303.

— It was identified that GR-303-CORE was missing DTMF requirements. Thus, new requirements were included in Section 3.2.2.4.9 to address DTMF Signaling. These requirements were originally proposed as part of GR-303-ILR Issue 1D, under issue 303-174 and have now been explicitly included in GR-303.

— It was identified that GR-303-CORE was missing TR-NWT-000057 Signaling and Supervision cross-references. Thus, new cross-references were included in Section 3.3.2 to address this concern.

— Additional references to specific TR-NWT-000057 section numbers have been added.

- Section 5, *Operations System Interfaces*

  — New requirements were added in Section 5.4.2.2 to allow for RDT restoration from a remote backup. Recovery from a remote back-up is needed during catastrophic failures of the RDT where the RDT has to be totally re-provisioned. The new requirements apply to the target operations environment where an EMS manages the RDT and the LDS manages a small portion of RDT data.

  — New requirements were added in Section 5.4.2.3 to allow technicians to verify that DS1 lines between the RDT and LDS are accurately connected during network activation.

  — Section 5.4.3.1.3 was modified to allow the IDLC Interface to support a single DS1. An interface that supports one DS1 is not required to support data link protection. IDLC Interfaces that support more than one DS1 are still required to provide data link protection.

  — Section 5.4.3.2.3 Part C (Circuit Testing - Digital Test Access) was modified to clarify that using no-test trunks to initiate the PGTC test capability is a requirement if the LDS does not support digital test access to individual circuits at the IDT.

- Section 6, *IDLC System Capabilities: Requirements and Options*

  — Section 6.1.4 was modified to allow the IDLC Interface to support a single DS1. An interface that supports one DS1 is not required to support data link protection. IDLC Interfaces that support more than one DS1 are still required to provide data link protection.

- Section 12, *LDS-RDT Generic Interface - Requirements and Options*
  - — Sections 12.2, 12.3, and 12.6.3 were modified to allow the IDLC Interface to support a single DS1. An interface that supports one DS1 is not required to support data link protection. IDLC Interfaces that support more than one DS1 are required to provide data link protection.
  - — Section 12.5.8.5.1 *Network Loss* has been revised to better align with TR-NWT-000507 loss plan requirements. Requirement R12-485 [1354] has been completely revised to align with the current wording for switch loss insertion requirements stated in TR-NWT-000507. Additional motivation for moving network loss to the RDT is also provided in Section 12.5.8.5.1.
  - — Editorial changes were made throughout Section 12 to help readers better comprehend GR-303-CORE criteria.
- Section 13, *Feature Set C - SONET Interface*
  - — Section 13.1.3.3.2 was modified to allow the IDLC Interface to support a single DS1. An interface that supports one DS1 is not required to support data link protection. IDLC Interfaces that support more than one DS1 are still required to provide data link protection.

1.8 Organization of Document

Following this introduction, Section 2 discusses the individual components of an IDLC system. Section 2 introduces some new terms and definitions. The distinction between Requirements, Conditional Requirements and Objectives is also explained.

Sections 3 through 11 describe the end-to-end system requirements and options for an IDLC system. Requirements are placed on both RDT and LDS ends of the system. Included are requirements on interfaces to customer services, Operations Systems, and the digital network. **Section 5 also contains most of the material that was originally published as TR-NWT-000303, Issue 2, Supplement 2**. Section 11 discusses requirements on IDLC systems stimulated by the need to operate in both the forward-looking operations environment and today's operations environment.

Section 12 describes the requirements for the Generic IDLC Interface. These requirements will allow one supplier's RDT to interconnect with another supplier's LDS to meet the End-to-End system requirements of the remainder of the GR. Section 12 is organized in a structure parallel to the End-to-End requirements where appropriate. Section 12 also includes a transition section, which describes migration from UDLC systems to IDLC systems meeting the Generic IDLC Interface.

Section 13 was formerly TR-NWT-000303, Issue 2, Supplement 1 and provides the generic requirements for interfacing an RDT to an LDS via the SONET format.

Appendix A discusses some traffic load balancing implementation scenarios. Appendix B gives a checklist of requirements and objectives. The References section lists all documents referenced in this GR, and the Glossary defines all acronyms used in this document.

1.9 Requirements Terminology

The following requirements terminology is used throughout this document.

- Requirement - Feature or function that, in Bellcore's view, is necessary to satisfy the needs of a typical BCC. Failure to meet a requirement may cause application restrictions, result in improper functioning of the product, or hinder operations. A Requirement contains the words shall or must and is flagged by the letter “R.”
- Conditional Requirement - Feature or function that, in Bellcore's view, is necessary in specific BCC applications. If a BCC identifies a Conditional Requirement as necessary, it shall be treated as a requirement for the application(s). Conditions that may cause the Conditional Requirement to apply include, but are not limited to, certain BCC application environments, elements, or other requirements, etc. A Conditional Requirement is flagged by the letters “CR.”
- Objective - Feature or function that, in Bellcore's view, is desirable and may be required by a BCC. An Objective represents a goal to be achieved. An Objective may be reclassified as a Requirement at a specified date. An objective is flagged by the letter “O” and includes the words it is desirable or it is an objective. Conditional Objective - Feature or function that, in Bellcore's view, is desirable in specific BCC applications and may be required by a BCC. It represents a goal to be achieved in the specified Condition(s). If a BCC identifies a Conditional Objective as necessary, it shall be treated as a requirement for the application(s). A Conditional Objective is flagged by the letters “CO.”
- Condition - The circumstances that, in Bellcore's view, will cause a Conditional Requirement or Conditional Objective to apply. A Condition is flagged by the letters “Cn.”

1.10 Requirement Labeling Conventions

As part of Bellcore's new GR Process, proposed requirements and objectives are labeled using conventions that are explained in the following two sections.

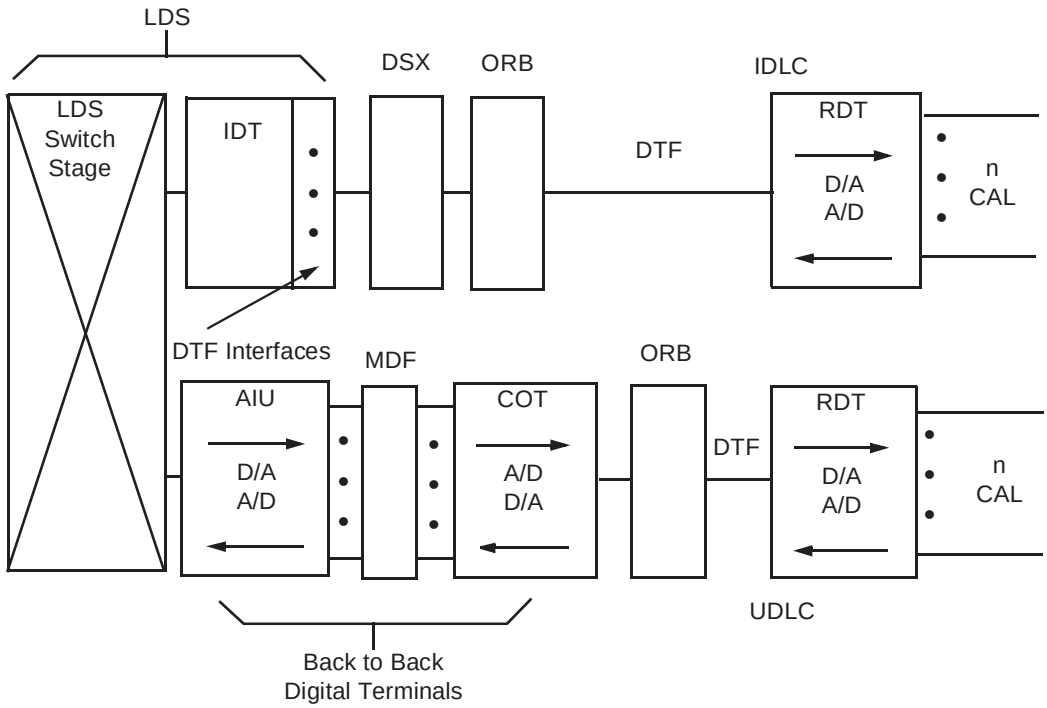
1.10.1 Numbering of Requirement and Related Objects

Each Requirement, Objective, Condition, Conditional Requirement, and Conditional Objective object is identified by both a local and an absolute number. The local number

consists of the object's document section number and its sequence number in the section (e.g., R3-1 is the first Requirement in Section 3). The local number appears in the margin to the left of the Requirement. A Requirement object's local number may change in subsequent issues of a document if other Requirements are added to the section or deleted. The absolute number is a permanently assigned number that will remain for the life of the Requirement; it will not change with new issues of the document. The absolute number is presented in brackets (e.g., [2]) at the beginning of the requirement text. Neither the local nor the absolute number of a Conditional Requirement or Conditional Objective depends on the number of the related Condition(s). If there is any ambiguity about which Conditions apply, the specific Condition(s) will be referred to by number in the text of the Conditional Requirement or Conditional Objective. References to Requirements, Objectives, or Conditions published in other Generic Requirements documents will include both the document number and the Requirement object's absolute number. For example, R2345-12 refers to Requirement [12] in GR-2345.

1.10.2 Requirement, Conditional Requirement, and Objective Object Identification

A Requirement object may have numerous elements (paragraphs, lists, tables, equations, etc.). To aid the reader in identifying each part of the requirement, an ellipsis character (...) appears in the margin to the left of all elements of the Requirement.



LEGEND
DTF - Digital Transmission Facility
AIU - Analog Interface Unit
ORB - Office Repeater Bay
DSX - Digital Signal Cross-Connect
CAL - Customer Access Line
D/A - Digital to Analog*
A/D - Analog to Digital*

* Arrow indicates direction of function

Figure 1-1. IDLC vs. UDLC

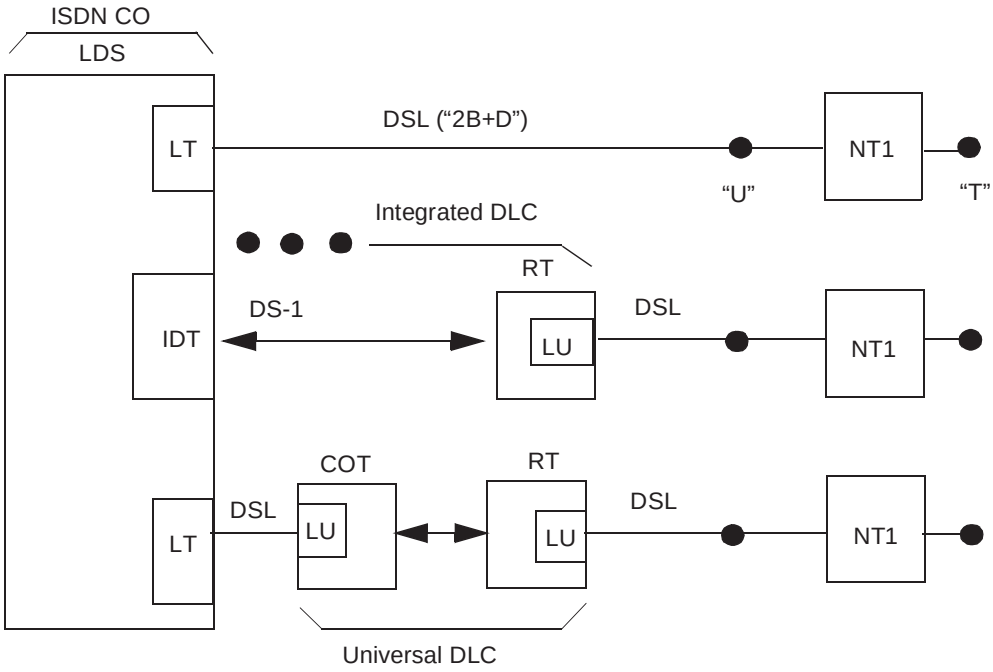


Figure 1-2. ISDN Basic Access Capability

2. Definition of Terms

2.1 Network Architecture and Definitions

Figure 2-1 illustrates a generic IDLC system network architecture. Figure 2-1 includes a physical cross-connect device for DS1 signals commonly known as a DSX-1 frame. This architecture will be used to provide functional descriptions of the various components.

2.1.1 The Remote Digital Terminal (RDT)

The RDT is an intelligent network element that interfaces between customer access lines and DS1 rate facilities. Figure 2-2 provides a functional block diagram of the RDT. The RDT may be functionally divided into three parts: line interface functions, common system functions, and Digital Transmission Facility (DTF) Interface functions. Line interface functions include A/D and D/A conversions, 2-wire to 4-wire transmission conversion, power feed, over voltage protection, signaling including ringing, signaling detection and test access.[1] Common system functions include signaling insertion and extraction, multiplexing and demultiplexing, concentration, time-slot interchange, channel tests, and frame alignment. At the RDT, the line interface functions (or some select group of these functions) may be configured on a per customer access line basis, while any remaining line interface functions may be provided as common equipment.

The RDT requires operations interfaces for provisioning. This GR defines this collection of dedicated per customer access line functions as Line Terminal Equipment (LTE). Throughout this GR this equipment is also referred to as line units. Specific requirements for line interface functions are provided in this GR, but specific requirements for what a dedicated per customer LTE must provide are not defined since these are design rather than functional criteria.

In addition, transmission facility interface functions as described in the next section may be included in the RDT.

The RDT requires operations interfaces for provisioning, maintenance, and testing. These are provided via one or more of the following; an operations channel through the switch, a supervisory system, and a local craft interface. More details are provided in later sections.

1. Because RDT line interface functions are almost totally common for both UDLC and IDLC systems, this GR will not place requirements on this part of the RDT. Such requirements can be found in TR-NWT-000057.

2.1.2 Digital Transmission Facility (DTF) Interface

The DTF interface is defined to be part of the LDS and the RDT. A DTF interface terminates one DS1 facility and provides generic digital terminal functions. These functions include frame alignment, multiplexing and de-multiplexing, and signaling insertion and extraction.

Digital transmission facility interface functions include power feed, regeneration and fault location (e.g., loop back); these latter functions are Line Terminal Equipment (LTE) functions that can be incorporated into the LDS or RDT. Alternately, these LTE functions can be provided by external equipment such as Office Repeater Bays (ORBs) located at the CO or RDT site.

The ORB is a part of the DTF, but it is a separate equipment bay located in the CO or located at the RDT site that houses Office Regenerators (ORs). The ORs provide the necessary signal characteristics for connection of the DTF to the DSX frame. The ORB functions include:

1. Impedance matching and metallic pair termination
2. DC powering for the line regenerators
3. End section build-out, equalization, and signal regeneration
4. DSX-1 transmission interface

An ORB, however, cannot provide digital line protection switching, alarms to indicate trouble conditions, or maintenance access.

2.1.3 Integrated Digital Terminal (IDT)

The IDT is that part (or parts) of the LDS that replicates the functions of a UDLC system's COT, with the exception of D/A and A/D conversions. An IDT is the logical resource of an LDS that is associated with a single RDT. The IDT provides a common basis of operation, management, or administration for an RDT. An IDT is composed of a set of DTF interfaces and all LDS common equipment (including software) interfaces and functions necessary to support the operation of an RDT. There is a one to one correspondence between an RDT and an IDT. However, it is not necessary for an IDT to be a single, self-contained physical unit. Rather, the IDT is a **logical entity** that may (or may not) be implemented as distributed physical resources within the LDS.

The IDT mirrors the functions of the RDT with the exclusion of customer line interface functions and D/A and A/D conversion. Figure 2-3 is a functional block diagram of the IDT arrangement. The functions of the IDT include, aside from those of the DTF interfaces, switching network interface functions. Code/rate conversion of the DS1 signal to an internal format may be required before entry to the switching network. Such conversion is not part of the functionality of the IDT because it is a matter of individual LDS design.

The IDT, like the RDT, requires operations interfaces for provisioning, maintenance, and testing. Maintenance functions include alarm reporting and performance monitoring. For the RDT, these interfaces are provided through the LDS and IDT and also locally, e.g., via Craft Interface Devices (CIDs). Only the IDT needs a synchronization network interface; the RDT obtains timing from its incoming DS1 signals. The IDT's interfaces are provided by the common equipment of the LDS and also include an interface to the switching network.

Within this functional architecture, the overall IDLC system control will reside with the LDS. The RDT controller will provide local control functions and will handle terminal communications but will, in general, be under the control of the LDS for call processing. The IDT may have a certain level of autonomous control, i.e., separate from the controlling processor of the LDS, but it too will be overall controlled by the LDS. The relationship between the RDT and IDT controllers is, at least for the general requirements, undefined; this relationship forms the greater part, however, of the Generic IDLC Interface described in Section 12.

All OS interfaces to the RDT will be through the LDS. The CO where the LDS is located is likely to be equipped with interfaces to OSs to support operations for the network elements contained in that CO. This would include all RDTs terminated on the LDS.

2.1.4 Integrated Network Access

Integrated Network Access is a network architecture that provides direct digital connectivity between digital facilities in the loop and digital interoffice facilities. GR-303-CORE supports some forms of Integrated Network Access as described below. Non-switched and non-locally switched services benefit from Integrated Network Access. For Integrated Network Access, the distribution digital circuit is extended to the interoffice facilities without an analog interface between the distribution and interoffice facilities. Traditionally, the direct digital interface has been made in a DCS, ADM with DS0 cross-connect capabilities, channel bank, multiplex, or directly to the interoffice facilities at the DSX-1 frame. With the advent of a DS0 cross-connect capability (nail-up feature, see TR-TSY-000679) in LDSs, the interface between the distribution and interoffice facilities may be through the LDS. Also a DS0 cross-connect capability in the RDT can groom the interoffice circuits at the RDT without using LDS resources.

Three forms of Integrated Network Access are suggested for use in a GR-303 system. They include field grooming at the RDT, sidedoor routing of Integrated Network Access circuits at the IDT, and nailup of circuits through the LDS to a trunk port. These are shown in Figure 2-4. Choice of one or more of these architectures is likely to be based on the economics of the application and the complexity of administering the designs.

Field grooming provides a DS0 flexibility point at the RDT, taking advantage of a Time Slot Interchange (TSI) capability to groom DS0s to one or more DS1 ports on the RDT. These DS1 facilities are connected to interoffice facilities at the CO without connection to

the LDS. Interoffice routing choices include connection to a DCS, connection to a digital terminal for conversion to an analog circuit, or direct interoffice facility connection.

Sidedoor grooming requires that the IDT have the capability to collect and route DS0s from any DS1 on the RDT to a DS1 port on the IDT for interoffice connection as in the field groomed case. This architecture requires the IDT to have a TSI capability.

LDS nailup supports Integrated Network Access by connecting the interoffice DS0s through the LDS to trunk ports on the LDS. The trunk ports can connect to the interoffice as described for the other forms of Integrated Network Access. This form of Integrated Network Access requires switch resources to be committed semi-permanently to the DS0s circuits, but saves IDT complexity if sidedoor capability is not required.

A form of Integrated Network Access that is not suggested is the use of a DS0 cross-connect in a DCS between the LDS and the RDT. This form of Integrated Network Access creates operational complexities that cannot be justified when compared to the other Integrated Network Access architectures.

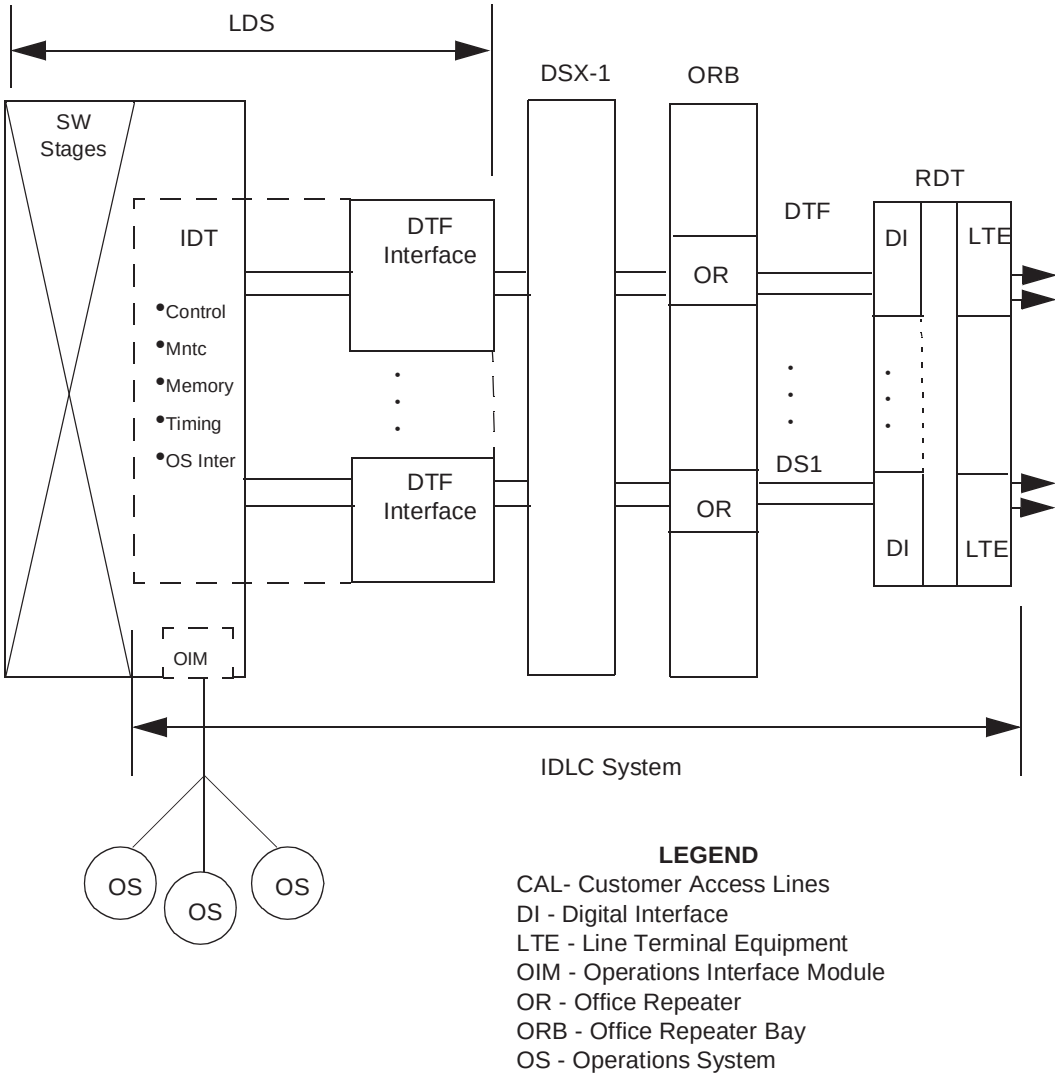


Figure 2-1. IDLC Network Architecture

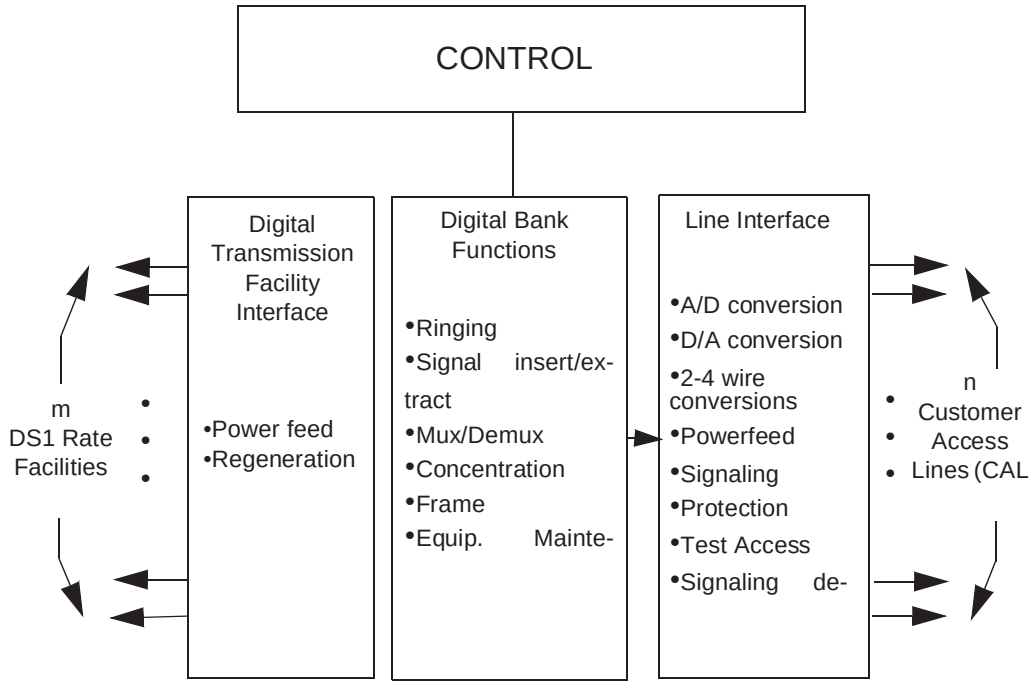


Figure 2-2. RDT Functional Diagram

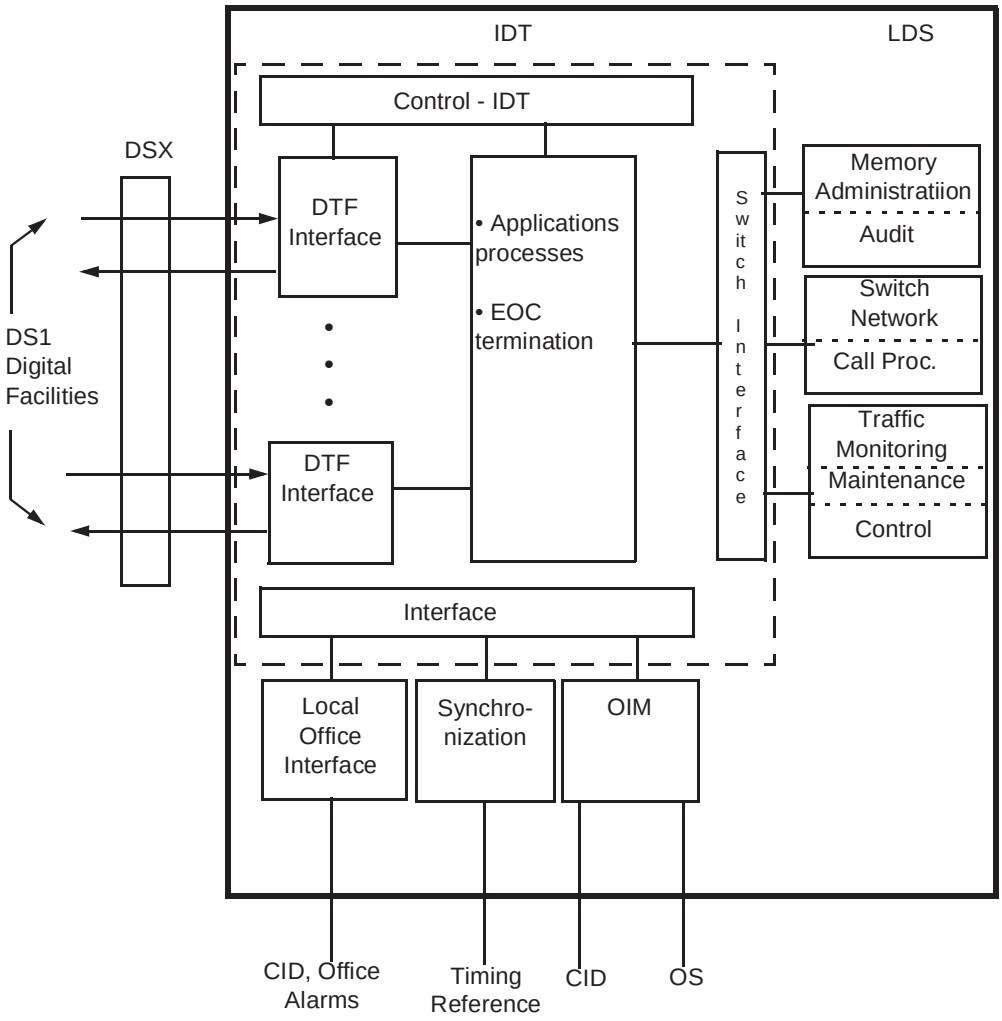


Figure 2-3. IDT Functional Diagram

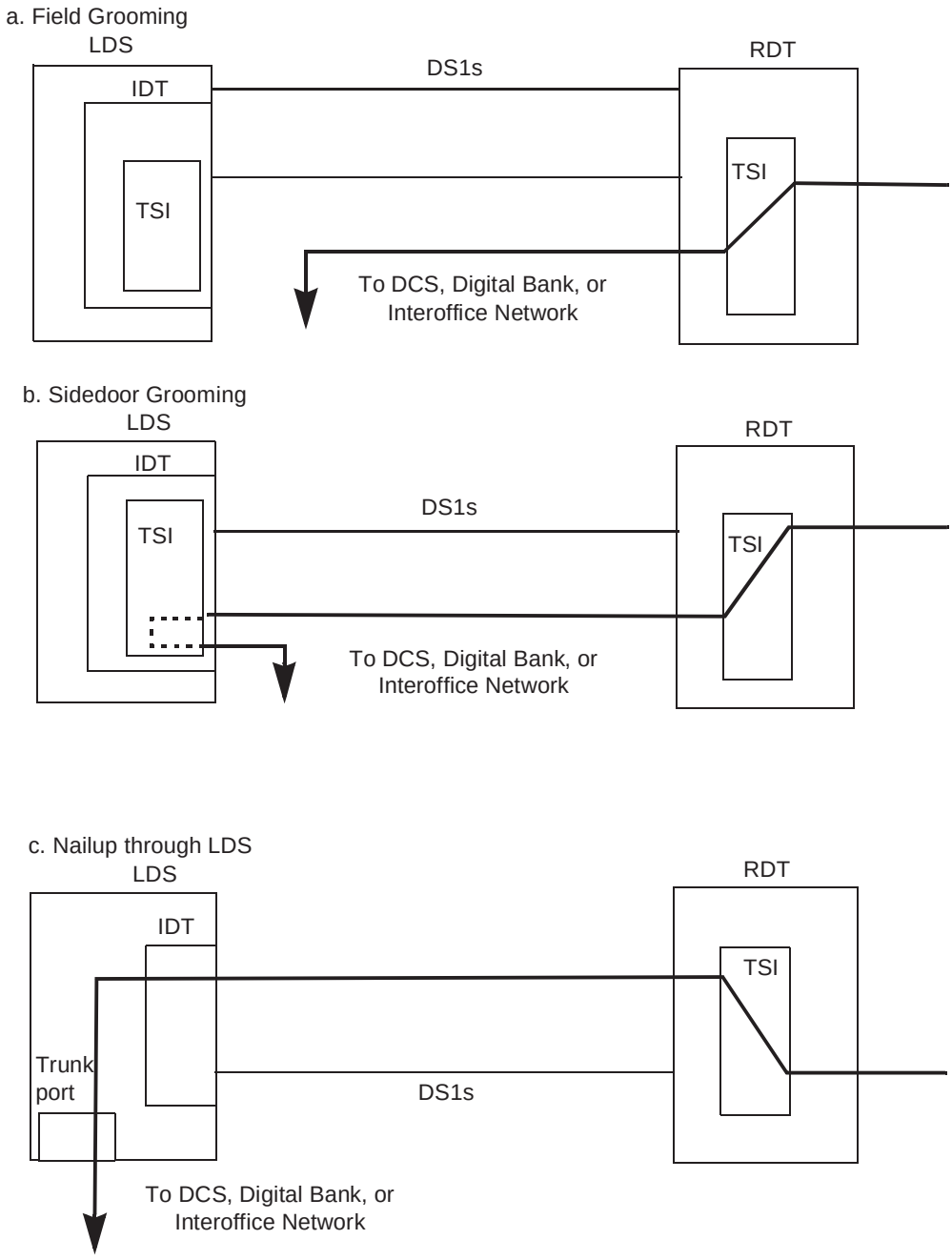


Figure 2-4. Integrated Network Access

3. Requirements and Options for Customer Services

3.1 Summary of Required and Optional Service Capabilities

This section summarizes the customer service requirements and options for IDLC systems. The following sections provide specific service or service capability characteristics, transmission, signaling, and/or loop interface requirements for IDLC systems.

As a goal, all DLC systems should provide the same types of services as metallic cables. If this is achieved, assignment of customer service orders can be simplified, and engineering and planning groups can avoid the need to provision expensive alternate facilities. However, it may not be technically or economically feasible to provide fully equivalent service capability over all DLC systems.

Locally switched loop-start, ground-start, and loop-reverse-battery signaling services must be provided on all IDLC systems. These services are collectively referred to as VF services. However, many additional service capabilities are described as options. Within each of these optional capabilities, however, specific technical requirements must be met if the capability is offered by the supplier of IDLC systems.

It is desirable that the IDLC system also support coin, non-locally/non-switched services, and digital data services, and have ISDN and DS1 extension capabilities.

These optional capabilities are:

a. Coin - Both dial-tone first and pre-pay dial-tone coin service requirements are described. Transmission requirements are similar to those for VF services; however, signaling requirements are different.

b. Non-locally/Non-switched Services - These services include all analog services that are not switched in the local CO. They include both 2-wire and 4-wire services. Because these services are not switched in the LDS host, provision must be made to segregate (or groom) these services from switched services. This segregation can occur at either the RDT or LDS by means of an integrated DS0 cross-connect capability, controlled by OS messages. Requirements on this integrated cross-connect capability are described.

c. Digital Data Services - These include private-line data services carrying digital signals at 2.4 kb/s, 4.8 kb/s, 9.6 kb/s and 56 kb/s. Specific requirements on code conversion requirements, and special requirements to segregate these private line services at either the RDT or LDS, are described.

d. Basic Rate Access (BRA) ISDN Capability - IDLC systems will be the second-choice facility to provide ISDN Basic Access, after metallic pairs. IDLC systems will be the first-choice in areas where the practical reach of metallic pair Digital Subscriber Line (DSL) systems is exceeded. This GR provides requirements on performance for this capability. Specific line interface requirements for RDT line units are also presented,

but rely heavily on requirements published in other TRs, TAs, and GRs, and on the findings of standards groups.

e. DS1 Extension Capability - IDLC system applications may require RDTs to extend DS1 signals beyond the RDT site, possibly to a customer. This capability may be used for both channelized and dedicated DS1 service categories. In the first instance, individual DS0 channels on extended DS1s must be separable before reaching the LDS' switch matrix. This will allow mixing of both switched and non-switched channels on extended DS1s, with grooming capabilities similar to those needed for other non-switched services. In the second instance, an entire DS1 path is dedicated to the remote (extended) location and the corresponding DS1 is available for routing at the CO's DSX-1.

Several requirements of IDLC systems span multiple service categories. The additional service related requirements, in this section, are necessary to ensure that services offered on IDLC systems are truly equivalent to the same services offered on metallic pairs. For example, requirements to allow the LDS to bridge IDLC system lines with other lines ensures that all service arrangements are equivalent. Likewise, requirements to support on-hook transmission capabilities on switched services allow all customers the opportunity to avail themselves of new service capabilities, independent of the type of facility serving them.

R3-1 **[1]** The functional requirements in this section shall be implemented using the services and information model defined in GR-2833-CORE.

CR3-2 **[2]** On an interim basis, the services and information model defined in Supplement 3 of TR-TSY-000303 may be used to support management functions between the IDT and RDT.

An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.

3.2 VF Services

The following subsections reference, and sometimes modify, the signaling/supervision and transmission requirements of TR-NWT-000057 for the loop-start, ground-start, and loop-reverse-battery applications of IDLC systems. TR-NWT-000057 provides additional requirements needed for specific service applications (e.g., two-party ANI, four-party fully-selective ringing, etc.).

R3-3 **[3]** IDLC systems shall be capable of supporting locally switched services that use loop-start, ground-start, or loop-reverse-battery signaling.

CR3-4 **[4]** In some BCC applications, line side answer supervision will be required on loop-start and ground-start locally switched services. When provided, the respective reverse loop current feed requirements of TR-NWT-000057 shall be satisfied.

3.2.1 End-to-End Transmission

The transmission requirements of this subsection apply to all locally switched analog services provided by an IDLC system unless criteria elsewhere in Section 3 specifically excludes or replaces the criteria/requirements in this subsection. The criteria contained in the following subsections apply specifically to IDLC systems (IDT, RDT, and Digital Transmission Facility) as a unit. Transmission criteria for an RDT alone are specified in Section 12.

CR3-5 **[5]** Criteria for locally switched special services are provided in Section 4 of TR-NWT-000057 and shall be satisfied, if provided.

CR3-6 **[6]** Criteria for non-locally switched and non-switched special services are also provided in Section 4 of TR-NWT-000057 and shall be satisfied, if provided.

3.2.1.1 Transmission Level Point

The transmission level of any point on a transmission system is defined as the decibel value of the ratio of the power of a signal at that point to the power of the same signal at a reference point. By definition, the designated reference point is the 0 Transmission Level Point (0 TLP). The transmission level of any other point represents the loss (or gain), in dB, between that point and the reference point. Since loss is normally a function of frequency, transmission level points are defined by the loss at 1004 Hz.

The TLP of a digital switching office is defined at the center of the switch and, for a digital end office, the TLP is 0. For IDLC systems, therefore, the center of the LDS is defined as the 0 TLP.

3.2.1.2 Transmission Criteria Test Conditions

Unless otherwise specified in an individual criterion, the following conditions apply for all transmission criteria.

a. The criterion applies to both directions of transmission; IDT/LDS to RDT and RDT to IDT/LDS.

b. The IDLC line under test is off-hook except for on-hook transmission tests.

c. All RDT line units are either terminated in 900 ohms or connected to signal sources with a 900-ohm source impedance, except for Universal Voice Grade (UVG) channel units (refer to TR-NWT-000057).

d. For all tests, the IDLC channel is switched to a 4-wire, 600-ohm resistive termination at the LDS, unless specifically stated differently.

e. Transmission parameters are measured using the methods of IEEE Standard 743-1984.

f. The transmission criteria must be met over the environmental conditions specified in Section 10.1.2 and at the end of the service life of the IDLC system. Transmission criteria also apply over the full range of system power supply variations (see Section 10.2), including operation with loss of ac power.

3.2.1.3 Return Loss - RDT

R3-7 **[7]** The Echo Return Loss (ERL) and Singing Return Loss (SRL) at the RDT shall meet the following requirements (per Section B8 of MDP-326-140 [i.e., PUB 43801] without the inserted 25 ohms of loop resistance).

Parameter	Reference Impedance	Requirement
ERL	900Ω + 2.16 μF	>28 dB
SRL	900Ω + 2.16μμF	>20 dB

For this measurement, the IDLC channel is switched to a 4-wire 600-ohm resistive termination at the LDS; refer to TR-NWT-000507. The input power level of the test signal is 0 dBm0.

The nominal input impedance of the RDT should be 900 ohms in series with 2.16 microfarads.

3.2.1.4 Longitudinal Balance - RDT

R3-8 **[8]** As specified in TR-NWT-000057.

3.2.1.5 Total Loss

The following requirements apply to locally-switched voice-grade services. See TR-NWT-000057, Section 4, for total loss requirements for locally-switched voice-grade special services. These total loss requirements in this section do not include any network

loss inserted by the IDLC system to control echo performance. See **Section 12.5.8.5** for information on network loss.

R3-9 **[9]** The IDLC system shall be compatible with LDS digital-loss implementation requirements, as defined in TR-NWT-000507.

O3-10 **[10]** As an objective, the IDLC system should allow the capability to implement all loss requirements at the RDT.

For the total loss test, an IDLC channel is switched to a 4-wire, 600-ohm resistive termination at the LDS; the LDS' digital-loss pad is disabled (i.e., the LDS inserts 0 dB of loss).

R3-11 **[11]** The total loss between the 4-wire termination of the LDS and the Network Interface (NI) on the customer's premises (LDS to RDT loss plus the loss of the cable between the RDT and the NI) shall not exceed 8 dB for any application recommended by the supplier.

This measurement is made using a 0-dBm0, 1004-Hz tone and a 600-ohm signal source (or detector) at the LDS and a 600-ohm signal source (or detector) at the NI. **Additional loss requirements can be found in Section 12.5.8.5.**

3.2.1.6 IDLC System Loss and Tolerance

Minimum system losses are specified to control transmit and receive signal levels ("loudness)". This to helps to minimize "contrast" problems that occur when some of a customer's service is provided by IDLC circuits units and some by other facilities (e.g., straight cooper).

R3-12 **[12]** As specified in Section 6.1.8 of TR-NWT-000057.

3.2.1.7 IDLC System Symmetry

R3-13 **[13]** The IDLC system design loss from the LDS to the RDT shall be equal to the design loss from the RDT to the LDS.

3.2.1.8 Maximum IDLC System Loss

O3-14 **[14]** As specified in TR-NWT-000057.

3.2.1.9 Frequency Response

R3-15 **[15]** The loss between 404 Hz and 2804 Hz, of each channel, shall be within -0.4 and +0.65 dB of the loss at 1004 Hz (+ means more loss; - means less loss). This measurement shall be made with a signal level of 0 dBm0.

3.2.1.10 60-Hz Loss

R3-16 **[16]** The IDLC system shall provide a loss at 60 Hz during analog-to-digital conversion that is at least 20 dB greater than the loss at 1004 Hz.

The intent is to limit the encoding of 60 Hz into the bitstream.

3.2.1.11 Amplitude Tracking

R3-17 **[17]** As specified in Section 6.1.11 of TR-NWT-000057.

3.2.1.12 Idle Channel Noise

R3-18 **[18]** As specified in Section 6.1.13 of TR-NWT-000057, except that the requirement specified at the output of the COT should be based on a measurement made at the 600-ohm resistive output port of the LDS' 4-wire, 600-ohm termination.

3.2.1.13 Signal-to-Distortion

R3-19 **[19]** As specified in Section 6.1.14 of TR-NWT-000057.

3.2.1.14 Impulse Noise

R3-20 **[20]** As specified in Section 6.1.15 of TR-NWT-000057, except that the requirement specified at the output of the COT should be based on the measurement made at the 600-ohm resistive output port of the LDS' 4-wire, 600-ohm termination.

3.2.1.15 Intermodulation Distortion

R3-21 **[21]** The second-order intermodulation products (R_2) and third-order intermodulation products (R_3) when measured using the 4-tone method described in IEEE Standard 743-1984 shall meet the following limits:

Total Input Level (dBm0)	Intermodulation Product	Power Below Received Signal (dB)
-13	R_2	>45
-13	R_3	>47

O3-22 **[22]** The intermodulation products should meet the following limits:

Total Input Level (dBm0)	Intermodulation Product	Power Below Received Signal (dB)
-13	R_2	>50
-13	R_3	>52

3.2.1.16 Overload Compression

R3-23 **[23]** As specified in Section 6.1.12 of TR-NWT-000057.

3.2.1.17 Single Frequency Distortion

R3-24 **[24]** As specified in Section 6.1.17 of TR-NWT-000057.

3.2.1.18 System Generated Tones

R3-25 **[25]** As specified in Section 6.1.18 of TR-NWT-000057, except that the reference to the "COT" should be to the "4-wire, 600-ohm termination at the LDS."

3.2.1.19 Peak-to-Average Ratio (P/AR)

R3-26 **[26]** With a -13 dBm0 input level, the P/AR rating shall be greater than or equal to 94.

3.2.1.20 Channel Crosstalk

R3-27 **[27]** As specified in Section 6.1.20 of TR-NWT-000057, except that the reference to the "COT" should be to the "4-wire, 600-ohm termination at the LDS."

3.2.1.21 Frequency Offset

R3-28 **[28]** As specified in Section 6.1.21 of TR-NWT-000057.

3.2.1.22 On-Hook Transmission

On-hook transmission will enable provisioning of several new features, as described in Section 3.7.3. Additional on-hook transmission requirements are specified in Section 12.5.3.4, page 12–46.

R3-29 **[29]** So that IDLC systems can provide such features, the IDLC system shall be able to provide an on-hook transmission capability, via per-channel time-slots, that is compatible with the Customer Premises Equipment (CPE) data interface described in GR-30-CORE. The on-hook transmission loss can be up to 5 dB greater than the off-hook transmission loss; this is consistent with TR-NWT-000057.

3.2.1.23 Hybrid Balance

TR-NWT-000507 provides requirements for various[1] hybrid balance networks at 2-to-4 wire transmission-conversion points.

R3-30 **[30]** TR-NWT-000507 allows the hybrid-balance requirements for IDLC systems to be summarized as follows:

… a. ERL: *2* x channel 1kHz loss + weighted trans-hybrid loss (THL) ≥20 dB

… b. SRL: *2* x channel loss at any frequency +THL at same frequency ≥15 dB

O3-31 **[31]** The ERL/SRL objectives for IDLC systems are 25/20 dB, respectively.

1. Dependent on type of 2-wire interface; e.g., loaded, nonloaded, etc.

TR-NWT-000507 specifies test methods to be used.

3.2.2 Customer Signaling and Supervision Criteria

The intent of the requirements/criteria in this section are to help ensure that services provided over an IDLC system will provide a compatible interface at the Network Interface (NI) on a customer's premises, in terms of network/station-terminal interactions and electrical characteristics. The signaling/supervision requirements provided in the remainder of this section, must be satisfied for all loop-start, ground-start, and loop-reverse-battery circuits.

3.2.2.1 Loop-Start Signaling

3.2.2.1.1 RDT dc Supervisory Range

R3-32 **[32]** As specified in Section 5.1.1 of TR-NWT-000057.

3.2.2.1.2 Idle State (On-Hook) RDT Loop Voltage

R3-33 **[33]** As specified in Section 5.1.8 of TR-NWT-000057.

3.2.2.1.3 Loop Supervision Criteria

R3-34 **[34]** All criteria of Section 3.2.2.4, General Loop Supervision Criteria, shall be met.

3.2.2.1.4 RDT Loop Closure Detection

R3-35 **[35]** As specified in Section 5.1.5 of TR-NWT-000057, except that the requirement for loop closure at the COT line circuit output does not apply. Loop-closure status, however, shall be reported to the IDT/LDS.

3.2.2.1.5 RDT On-Hook Detection

R3-36 **[36]** As specified in Section 5.3.7 of TR-NWT-000057.

3.2.2.1.6 Dial Tone Delay

R3-37 **[37]** IDLC systems shall not prevent the dial tone delay Service Standards in TR-TSY-000511, with respect to the overall dial tone delay that is experienced by the subscriber, from being satisfied.

For the Generic IDLC Interface discussed in Section 12, the following criteria are specified in support of the above requirement:

a. Origination requests must be reported to the switching system within 50 ms of their occurrence.

b. A two-way transmission path must be provided within 50 ms of applying dial tone to the customer (for loop-start circuits), and within 50 ms of applying loop current feed to the customer (for ground-start circuits), except that this dial tone and loop current feed does not need to be provided any quicker than 200 ms following the occurrence of the originating request. Providing a two-way transmission path within 50 ms of receiving an acknowledgment to an origination request indicating that the switching system has connected to a DS0 time slot and is ready to proceed with the origination request, is an acceptable implementation.

   The receipt of dial tone from the switching system is an indication that the switching system is ready to accept addressing data.

3.2.2.1.7 Ringing Requirements

R3-38 **[38]** All criteria of Section 3.2.2.5, IDLC System Ringing Criteria, shall be met.

3.2.2.1.8 Reminder Ring

R3-39 **[39]** IDLC systems shall be able to generate a 500 (±50)-ms burst of ringing at the output of the RDT.

3.2.2.1.9 Distinctive Alerting

R3-40 **[40]** IDLC systems shall be able to generate alerting patterns as described in Section 5.1.12 of TR-NWT-000057, at the output of the RDT.

3.2.2.1.10 Showering Lines

A Showering Line is an oscillating off/on hook condition generated at the RDT, usually caused by an ac power fault (e.g., power line cross or by 60Hz induction caused by a phase-to-ground fault in a power line) or from low leakage resistance caused by a wet or crushed cable. See Section 12.5.9.2 for additional requirements related to preventing the occurrence of a showering line signaling condition.

R3-41 **[41]** The IDT/LDS of the IDLC system shall satisfy the requirements of Section 3.1.1 “Excessive Origination Protection” of GR-505-CORE, alleviating the effects of showering lines on IDT/LDS overloading.

3.2.2.1.11 System Failures - Trunk Conditioning

R3-42 **[42]** During an IDLC system failure or maintenance activity that prevents service from being provided to more than two lines, the lines affected by the failure or activity shall indicate a continuous on-hook status at the IDT/LDS and an idle state loop voltage at the RDT for the duration of the IDLC system’s inability to provide service.

3.2.2.1.12 Reverse Loop Current Feed

Services that provide line side answer supervision apply reverse loop current feed to the calling customer's line when the called customer answers.

CR3-43 **[43]** If line-side answer supervision is provided, All *Loop Start Signaling and Supervision* requirements of Section 3.2.2.1, page 3–9, of this document **shall** be met. In addition, the following requirements based on Section 4.9 of TR-NWT-000057 shall be satisfied.

R3-44 **[1813]** When reverse loop current feed is applied to the RDT by the switching system while the RDT is indicating loop closure, the access system line unit **shall** apply a reverse loop current feed to the customer’s access line.

R3-45 **[1814]** The access system line unit (e.g., RDT or ONU line unit) **shall** apply a reverse loop current feed to the customer’s access line in ≤ 50 ms after the switching system’s reverse loop current feed request (via the ABCD ESF bits).

R3-46 **[1815]** Temporary changes from requesting loop current feed to requesting reverse loop current feed, or vice versa, of duration “T” to the

RDT **shall** be reproduced by the access system line unit with a duration of T ± 25 ms. This requirement applies for 50 ms ≤ T ≤ 1000 ms.

R3-47 **[1816]** When reverse loop current feed is applied to the RDT by the switching system while the RDT is indicating loop closure, reverse loop current feed applied from the access system line unit **shall not** be interrupted when the RDT momentarily changes to applying loop open for ≤ 1600 milliseconds.

O3-48 **[1817]** When reverse loop current feed is applied to the RDT by the switching system while the RDT is indicating *loop open*, the corresponding access system line unit **should** apply reverse loop current feed.

R3-49 **[1818]** When sending reverse loop current feed from the access system line unit, the line unit **shall** apply a voltage between tip and ring conductors with the tip conductor negative with respect to the ring conductor.

R3-50 **[1819]** The applied voltage **shall** meet the dc loop current feed criteria of Section 5.3.8 of TR-NWT-000057, *Functional Criteria for Digital Loop Carrier Systems*.

3.2.2.1.13 Transmission Path

R3-51 **[44]** A transmission path, consistent with the off-hook transmission requirements of Section 3.2.1, shall exist in both directions of transmission between the IDT/LDS and RDT.

… • Within 50 ms of applying dial tone to the customer, on an originating call

… • Within 50 ms of transmitting an off-hook indication toward the LDS, on a terminating call.

R3-52 **[1790]** The criteria in Section 5.2.2.1.D of TR-NWT-000505 (Issue 3, May 1991) shall be satisfied by the LDS/IDT when establishing a 2-way transmission path between the calling facility and the called line (i.e., DS0) on a terminating call. Upon receiving an off-hook indication from the RDT, on a terminating call, the LDS/IDT shall establish this transmission path within 150 ms on 50 percent of all calls and within 300 ms on 95 percent of all calls.

3.2.2.2 Ground-Start Signaling

3.2.2.2.1 RDT dc Supervisory Range

R3-53 **[45]** As specified in TR-NWT-000057.

3.2.2.2.2 RDT Idle State Conditions

R3-54 **[46]** As specified in TR-NWT-000057.

3.2.2.2.3 RDT Ring Ground Detection

R3-55 **[47]** As specified in TR-NWT-000057.

3.2.2.2.4 Delay Requirements to Minimize Glare

R3-56 **[48]** Delays in reporting ring-ground detection to the IDT/LDS shall be ≤50 ms of their occurrence.

R3-57 **[49]** Delays in implementing requests for the application of a voltage between the tip and ring conductors of the RDT shall also be ≤50 ms.

The intent is to minimize the possibilities of a “glare” condition. “Glare” is the seizure of a circuit at the same time by both the switching system and the customer premises terminal equipment.

3.2.2.2.5 Transmission Path

R3-58 **[50]** A transmission path, consistent with the off-hook transmission requirements of Section 3.2.1, shall exist in both directions of transmission between the IDT/LDS and RDT.

… — Within 50 ms of when the RDT applies loop current feed between the tip and ring of the RDT line circuit to the customer, on an originating call

… — Within 50 ms of when the RDT (with the RDT applying loop current feed) sends an off-hook indication toward the LDS, on a terminating call.

R3-59 **[1791]** The criteria in Section 5.2.2.1.D of TR-NWT-000505 (Issue 3, May 1991) shall be satisfied by the LDS/IDT when establishing a 2-way transmission path between the calling facility and the called line (i.e., DS0) on a terminating call. Upon receiving an off-hook indication from the RDT, on a terminating call, the LDS/IDT shall establish this transmission path within 150 ms on 50 percent of all calls and within 300 ms on 95 percent of all calls.

3.2.2.2.6 Floating Line Feed Circuit At RDT

R3-60 **[51]** When the RDT is supplying a voltage between the tip and ring conductors, it shall also apply a ground to either tip or ring conductor (as appropriate) unless the IDLC system can ensure the following are met.

… a. A ground shall be applied to tip conductor at the RDT for at least the first 210 ms of the addressing state.

… b. If the loop closure between tip and ring conductors of the RDT is removed during the call processing or communications state, the IDLC system shall apply ground to the RDT tip conductor within 50 ms of the removal of the loop closure.

3.2.2.2.7 RDT Tip Ground Resistance

R3-61 **[52]** As specified in TR-NWT-000057.

3.2.2.2.8 Reverse Loop Current Feed

CR3-62 **[53]** If line side answer supervision is provided, the respective requirements of TR-NWT-000057 shall be satisfied.

R3-63 **[54]** If the tip conductor was grounded at the RDT, then after a battery reversal a ground shall now be applied to the ring conductor at the RDT.

CR3-64 **[55]** For compatibility with toll restriction service (i.e., toll diversion signal), the IDLC system shall be capable of generating a battery reversal interval that lasts between 75 ms and 150 ms, when commanded by the IDT/LDS.

3.2.2.2.9 RDT Loop Closure Detection

R3-65 **[56]** As specified in TR-NWT-000057.

3.2.2.2.10 Loop Supervision Criteria

R3-66 **[57]** While in any loop supervision state, the criteria of Section 3.2.2.4, General Loop Supervision Criteria, shall be met.

3.2.2.2.11 Ringing Requirements

R3-67 **[58]** The ringing criteria of Section 3.2.2.5, IDLC System Ringing Criteria, shall be met.

3.2.2.2.12 System Failures - IDT/LDS - Trunk Conditioning

R3-68 **[59]** During an IDLC system failure or maintenance activity that prevents service from being provided to more than two lines, the lines affected by the failure or activity shall be first idled to prevent false billing and shall then be marked busy (out-of-service) for the duration of the IDLC system's inability to provide service.

3.2.2.2.13 System Failures - RDT - Trunk Conditioning

R3-69 **[60]** As specified in TR-NWT-000057.

3.2.2.3 Loop Reverse Battery Signaling

3.2.2.3.1 Transmission Path

R3-70 **[61]** As specified in TR-NWT-000057.

3.2.2.3.2 RDT Idle State Conditions

R3-71 **[62]** In the idle state, an open circuit between tip and ring shall be provided at the output of the RDT line circuit. The resistance tip-to-ring, tip-to-ground, and ring-to-ground shall be greater than 100,000 ohms.

3.2.2.3.3 RDT Loop Closure Resistance

R3-72 **[63]** As specified in TR-NWT-000057.

3.2.2.3.4 RDT Detection of Voltage Polarity

R3-73 **[64]** The RDT line circuit shall detect the polarity of a voltage applied between tip and ring of the RDT line circuit (either ring negative with respect to tip, or tip negative with respect to ring) and shall uniquely report the presence of each polarity (normal battery or reverse battery, respectively) to the IDT/LDS.

CR3-74 **[65]** If the direction of current flow is used to determine the polarity of the voltage, the determination of polarity shall be accurately made with any current flow ≥15 ma.

O3-75 **[66]** If no voltage is being applied between the tip and ring conductors of the RDT line circuit, a reverse-battery indication should be reported to the IDT/LDS.

3.2.2.3.5 Voltage Polarity Reversal Delay

R3-76 **[67]** When the RDT is applying a loop closure between its tip and ring conductors, any reversal of the voltage applied between the tip and ring conductors of the RDT shall be reported to the IDT/LDS within 50 ms; the report shall indicate the new state of the voltage (i.e., reverse-battery or normal-battery).

O3-77 **[68]** It is desirable that all voltage polarity reversals be reported to the IDT/LDS within 30 ms.

R3-78 **[69]** During battery and ground reversals applied to the RDT line unit, there may be a period of transition during which the electrical state is undefined. This transition period depends on the reversal circuitry of the CPE. The tip and ring conductors may be momentarily shorted and connected to either -48 volts or ground; one conductor may be open and the other conductor connected to either -48 volts or ground, etc. The RDT line circuit shall tolerate any of the possible conditions during this transition interval.

3.2.2.3.6 Loop Dial Pulsing

R3-79 **[70]** Loop dial pulsing by the RDT shall be uniform within the range of 8 to 12 pulses per second and 42% to 76% break.

3.2.2.3.7 Dial Pulse Contact Protection

R3-80 **[71]** As specified in TR-NWT-000057.

3.2.2.3.8 IDLC Generated Open Intervals - RDT

R3-81 **[72]** Any interruptions of loop closure at the RDT shall not exceed 1 ms unless the loop-open condition is requested by the IDT/LDS.

3.2.2.3.9 System Failures - IDT/LDS - Trunk Conditioning

R3-82 **[73]** During an IDLC system failure or maintenance activity that prevents service from being provided to more than two lines, the lines affected by the failure or activity shall be first idled to prevent false billing and shall then be marked busy (out-of-service) for the duration of the IDLC system's inability to provide service.

3.2.2.3.10 System Failures - RDT - Trunk Conditioning

R3-83 **[74]** As specified in TR-NWT-000057.

3.2.2.4 General Loop Supervision Criteria

This section applies to all loop-start circuits and to all ground-start circuits after conversion to a loop supervision state.

3.2.2.4.1 RDT Off-Hook dc Voltage and Current

R3-84 **[75]** As specified in TR-NWT-000057.

3.2.2.4.2 RDT Immunity to Line Crosses

R3-85 **[76]** As specified in TR-NWT-000057.

3.2.2.4.3 IDLC Generated Open Intervals - IDT/LDS

R3-86 **[77]** With a continuous loop closure present at the output of the RDT, any interruption of loop closure status to the IDT/LDS shall not exceed 1 ms.

3.2.2.4.4 IDLC Generated Loop Current Feed Open Intervals - RDT

A Loop Current Feed Open (LCFO) condition is defined as the absence of access system-applied voltage between the tip and ring conductors of the customer's access line. Periods when a switching system is applying loop current feed open indication towards the access system are called Open Switching Intervals (OSI). LCFO conditions may be produced by the switching system in some call states (e.g., at the expiration of a timed-release interval per Section 13.7.1 of GR-506-CORE) or during transitions between call states. The application of an OSI by the switching system may be used to establish a 2-way on-hook transmission path not associated with a terminating call (e.g., to send a message waiting indicator or to perform a meter reading application). This is discussed in Alternative #2 of TR-57 Section 5.1.13.

R3-87 **[78]** With a continuous loop closure present at the output of the RDT[2], any interruptions of loop current by the access system at the RDT line unit shall not exceed 300 ms unless a disconnect is intended; see Section 3.4.7, "Loop Current Feed Open (LCFO) Intervals", of GR-506-CORE.

The following Open Switching Interval distortion requirements are based on criteria contained in Section 5.3.10 of TR-NWT-000057.

R3-88 **[1820]** While loop closure is applied to the access system line unit (e.g., RDT or ONU line unit), when a change to loop current feed open of duration T is indicated by the switching system, the line unit **shall** apply loop current feed open to the customer's access line for a duration T ± 25 ms. This requirement **shall** be met for $50 \leq T \leq 1000$ ms.

R3-89 **[1821]** While loop closure is applied to the access system line unit, the access system **shall** signal loop closure to the switching system with no interruptions greater than 1 ms before, during, and after the switching

2. Continuous Loop Closure implies the loop resistance detected by the line unit is less or equal to the DC supervisory resistance R_{DC}, per Section 3.2.2.1.1, page 3–9 (loop-start) and Section 3.2.2.2.1, page 3–13 (ground-start).

system indicates a change to loop current feed open of duration T. This requirement **shall** be met for $50 \leq T \leq 1000$ ms.

R3-90 **[1822]** While loop closure is applied to the access system line unit, the access system **shall** apply loop current feed open to the customer access line within ≤ 50 ms after the application of loop current feed open by the switching system.

For loop start circuits, loop current feed open is an interruption of loop current. For ground start circuits, loop current feed open is an interruption of tip ground.

3.2.2.4.5 Open Interval at Permanent Signal Timeout

R3-91 **[79]** Section 4.5.2.1, *Permanent Signal and Partial Dial Treatments-Analog Lines*, of GR-505-CORE shall be satisfied by all integrated access systems (e.g., IDLC systems).

3.2.2.4.6 On-Hook/Off-Hook Distortion

R3-92 **[80]** With the IDLC line off-hook caused by a loop closure at the output of the RDT, the duration of temporary changes to on-hook at the RDT shall be sent to the IDT/LDS with a tolerance of 10 ms; applies only to IDLC systems that pass on-hook/off-hook transitions to the IDT/LDS for interpretation.

The dial pulsing requirements of Section 3.2.2.4.8 may be more stringent.

3.2.2.4.7 On-Hook/Off-Hook Delay

R3-93 **[81]** With the IDLC line off-hook caused by a loop closure at the output of the RDT, transmission to the IDT/LDS of circuit-status changes between off-hook to on-hook or on-hook to off-hook detected at the RDT shall not be delayed more than 50 ms.

The on-hook to off-hook portion of this criterion applies only when the duration of the on-hook state is short enough not to be interpreted as a disconnect signal by the end office switch (<1600 ms).

The above requirement applies only to IDLC systems that pass circuit-status changes to the IDT/LDS for interpretation.

CR3-94 **[82]** If the RDT interprets these circuit-status changes, then the result of the interpretation (e.g., flashhook, disconnect) shall be sent to the IDT/LDS within 50 ms.

3.2.2.4.8 Dial Pulsing

R3-95 **[83]** As specified in TR-NWT-000057, except that the output of the COT in TR-NWT-000057 shall be interpreted as the input to the LDS.

3.2.2.4.9 DTMF Signaling Requirements

The following requirements are based on those described in Section 5.3.12 of TR-NWT-000057.

R3-96 **[1823]** Figure 24 of ANSI T1.401-1988 describes the maximum permitted DTMF signal level produced by a customer installation as a function of the dc loop current provided to the customer installation. Using this as a reference, the supplier of an integrated access (e.g., IDLC) system **shall** state the maximum expected DTMF signal level at the current-feed line unit based on the loop current characteristic provided by the access system's current-feed line unit.

R3-97 **[1824]** Integrated access (e.g., IDLC) system current-feed line units **shall not** amplitude overload at the maximum expected DTMF signal level. A line unit will be considered to amplitude overload if the output at any frequency between 0 and 12 kHz, other than the input signal frequency, is greater than -28 dBm0. The input signal **shall** be at any frequency between 600 and 1500 Hz and at a power level equal to the maximum expected DTMF per pair signal level.

Integrated access systems that meet the above requirements and transmission criteria of Section 3.2.1, page 3–3, should provide satisfactory DTMF signaling performance.

3.2.2.5 IDLC System Ringing Criteria

3.2.2.5.1 Alerting Signals

R3-98 **[84]** When a regular (i.e., non-distinctive and non-multi-party) alerting signal is required, it shall be applied to ring with tip grounded at the output

of the RDT with a nominal 6-second period consisting of a 1.7- to 2.1-second ringing interval and a 3.1- to 5.5-second silent interval.

… a. The dc component during the ringing interval shall be applied so that ring is negative with respect to tip.

… b. During the ringing interval, the criteria of Section 3.2.2.5.3 shall be met.

… c. During the silent interval, the criteria of Section 3.2.2.1.2 shall be met.

The actual alerting pattern may be controlled by either the IDT or RDT, depending on the type of call-processing signaling technique being used.

3.2.2.5.2 Ringing Delay

R3-99 **[85]** The application of a ringing signal at the RDT shall not be delayed more than 200 ms after the request for ringing is sent from the IDT/LDS.

3.2.2.5.3 RDT Ringing Source

R3-100 **[86]** As specified in TR-NWT-000057.

3.2.2.5.4 Ringing Capability

R3-101 **[87]** As specified in TR-NWT-000057.

3.2.2.5.5 Ringing Capacity

R3-102 **[88]** As specified in TR-NWT-000057.

3.2.2.5.6 Ring Trip

R3-103 **[89]** As specified in TR-NWT-000057.

R3-104 **[90]** As a safety precaution, ring trip shall be effected autonomously by the RDT, even under failure conditions.

3.2.2.5.7 Ring Trip Reporting Delay

R3-105 **[91]** Off-hook status shall be reported to the IDT/LDS within 300 ms after an off-hook is applied at the RDT.

3.2.2.5.8 Ring Trip Immunity

R3-106 **[92]** As specified in TR-NWT-000057.

3.2.2.5.9 Ringing During System Failures - Trunk Conditioning

R3-107 **[93]** As specified in TR-NWT-000057.

3.3 Coin - Option

3.3.1 General

Coin service is a service where the public is provided a means of obtaining access to the public switched telephone network. Because this access line is open to public use in many jurisdictions, methods must be defined to ensure that monies are received for services rendered.

Transactions between network and customer to arrange for the call to be charged are accomplished within the VF transmission path and are thus transparent to IDLC-system designs.

Transactions between network and customer to coordinate payment at the coin telephone site require additional signaling and supervision activities beyond those described in Section 3.2.2.

There are two types of coin circuits in use today:

a. Dial Tone First (DTF) circuits are loop-start circuits that provide dial tone, and thus will accept address information, without requiring any initial deposit by the customer.

b. Coin First (CF) circuits are ground-start circuits and require an initial deposit before any addressing information will be accepted.

CF circuits are the least likely to be found today, due in part to the need to support 911 emergency calls from pay phones.

3.3.2 Requirements

R3-108 **[94]** DTF coin service shall be supported. The access system line unit shall meet the signaling and supervision requirements specified in Section 5.6 of TR-NWT-000057

Additional DTF coin service requirements are found in Section 12.5.2.1, “ABCD Codes,” page 12–17.

CR3-109 **[95]** CF coin service may be required in some BCC applications. The access system line unit shall meet the signaling and supervision requirements specified in Section 5.7 of TR-NWT-000057.

R3-110 **[96]** For IDLC systems to offer coin capabilities, a number of coin-related functions need to be coordinated between LDS, RDT, and the coin telephone equipment.

… a. Therefore, in addition to the loop- and ground-start requirements of Section 3.2.2, the IDLC system shall satisfy requirements for:

… — Collecting coins

… — Returning coins

… — Checking for initial deposit

… — Checking for overtime deposits

… — Checking for stuck coins

… — Homing the coin station totalizer

… — Interpreting coin deposit signals

… — Ringing back the coin station.

… b. Specifics as to how to achieve these coin-related signaling/ supervision functions are left to each individual IDLC-system supplier; the coin signaling requirements in GR-528-CORE, however, shall be satisfied.

R3-111 **[97]** The transmission requirements of Section 3.2.1 shall be satisfied for both coin-first and dial-tone-first coin services.

3.4 Digital Data System (DDS) Capability - Option

3.4.1 General

The DDS is a data communications network that is integrated into the nationwide telecommunications system. Point-to-point and multipoint digital private line services can be provided. The first allows digital communication between two subscriber terminals, while the latter allows several terminals at different locations to share a common transmission channel. Several data rates are available. The DDS uses station-to-station digital transmission techniques in contrast to modulation and demodulation of digital signals to and from analog signals, which are used for transmission over telephone channels.

3.4.2 Requirements

R3-112 **[98]** For IDLC systems to offer DDS capabilities to the customers served by that IDLC system, the IDLC system must be able to provide, as a private line service, full-duplex digital-data transmission at synchronous rates of 2.4, 4.8, 9.6, and 56 kb/s.

As a private line service, there are no signaling requirements between the RDT and the IDT/LDS, but there are specific code conversion requirements. DDS control codes use bipolar violations on the loop interface to the customer. These are 7-bit codes that need to be converted to unipolar codes for carriage within the IDLC system.

R3-113 **[99]** The requirements of TA-TSY-000077 and TA-TSY-000083 shall be satisfied by IDLC systems that provide DDS capabilities.

Furthermore, because DDS is a private-line service, the requirements for a DS0 cross-connect function in either the LDS or RDT, as described in Section 3.5, need to be satisfied.

3.5 Non-locally/Nonswitched Services - Option

3.5.1 General

It is desirable that IDLC systems support non-locally switched services such as foreign exchange lines and nonswitched services such as private lines. An IDLC system can implement non-locally switched and nonswitched services by a DS0 cross-connection function at the RDT, a DS0 cross-connection function in the LDS, or a combination of both.

3.5.1.1 Cross-Connect in LDS

In the LDS, a DS0 cross-connection provides a full-duplex, semipermanent connection between specified time-slots of two terminating DS1 facilities or between a specified time-slot of a terminating DS1 facility and the switch side (DS0) of an analog line or trunk unit. This DS0 cross-connect may be part of the switching fabric or may be implemented before the switching fabric or the IDT.

For DS0 cross-connects in the LDS involving IDLC systems, the following classes of cross-connects are possible:

a. A DS0 on one IDT is cross-connected to a DS0 on another IDT (includes the case where both DS0s are from the same IDT or the same DS1).

b. A DS0 on one IDT is cross-connected to a DS0 on a DS1 terminated on the LDS where the DS1 is from a network element such as a DCS or a channel bank.

c. A DS0 on one IDT is cross-connected to a DS0 on an analog line interface unit.

d. A DS0 on one IDT is cross-connected to a DS0 on a trunk interface unit.

A digital cross-connect function in the local switching system allows a telephone company to provide both switched and non-locally/nonswitched services in the IDLC system without placing assignment restrictions on the IDLC system.

As discussed above, the DS0 cross-connect function is an integrated part of the LDS. The DS0 cross-connect function could also be provided by a stand-alone DCS in an Integrated Network Access. However, the Integrated Network Access will change the operation and maintenance requirements for IDLC systems and may require additional features in the DCS.

This GR does not support a DS0 cross-connect feature in any Network Element located between the RDT and LDS.

3.5.1.2 Cross-Connect in RDT

In the RDT, a DS0 cross-connect provides a full duplex semipermanent connection between a specified time-slot of a digital transmission facility at the RDT and a specified customer`s line at the RDT. The DS0 cross-connect function may also be used to establish a connection between a specified time-slot of a terminating facility and a specified time-slot of a DS1 extension at the RDT as discussed in Section 3.7.4, “Requirements for DS1 Extensions - Option.” The capability to make DS0 cross-connects between a terminating facility time-slot and a time-slot of a DS1 extension at the RDT allows for the grooming of circuits on the DS1 extension. A DS0 cross-connect capability in the RDT also permits the rearrangement of circuits from a failed DS1 to a good DS1 terminated on the same RDT under control of an OS.

The DS0 cross-connect function in the RDT allows the segregation of switched and non-locally/nonswitched services onto different DS1s. The DS1s carrying the switched traffic would terminate at the IDT as usual; the DS1s carrying the non-locally/nonswitched traffic would terminate on either a DCS, a channel bank, or multiplexer. The DCS can be a separate network terminating element or part of the local switching system.

For DS0 cross-connects in the RDT, the following classes of cross-connects are possible:

a. A DS0 on a digital transmission facility (DS1 between the LDS and the RDT) is cross-connected to a line unit at the RDT.

b. A DS0 on a digital transmission facility is cross-connected to a DS0 of a DS1 extension, when provided at the RDT.

For concentrated IDLC systems (see Section 6.2.2, “Concentration”), the cross-connect function is used to assign a full-duplex connection between a specified customer`s line at the RDT and a specified time-slot of a terminating facility at the RDT on a per-call basis for switched services. For non-locally/nonswitched services, the DS0 cross-connect function is implemented by allowing the connections to be semipermanently established under the control of a memory administration system or from a local user system interface to the IDLC system.

A DS0 cross-connect function in the RDT allows an operating company to provide both switched and non-locally/nonswitched services in the IDLC system without placing assignment restrictions on the RDT.

An IDLC system may implement both a DS0 cross-connect in the LDS and service segregation in the RDT using a DS0 cross-connect function. This would allow for a smaller DS0 cross-connect matrix in the LDS.

Although a DS0 cross-connect function in the RDT could be used to implement intra-RDT links, an intra-RDT link is not a required class of cross-connect for a DS0 cross-connect function in an RDT. An intra-RDT link is a connection between two customer lines terminating on the same RDT that is established when the local switching system recognizes that the two lines associated with a call are served by the same RDT and the RDT provides intra-RDT links. Using an intra-RDT link frees two time-slots on the facilities between the RDT and IDT, and the connection through the switch.

Because of the operational complications that would result from the use of intra-RDT links, intra-RDT links are not included in the IDLC specifications contained in this GR.

3.5.2 Requirements

3.5.2.1 General

Control of a DS0 cross-connect function in the LDS or RDT is through the OS-LDS interface.

When the DS0 cross-connect function is provided in the LDS, only OS-LDS communication through the switching system's operations interface is required; however, when the DS0 cross-connect function is provided in the RDT, OS control of the function is through the switching system's operation interface that provides the "Gateway Function" for the RDT (see Section 12.7.1, "OS/IDLC Communications Conventions," for a discussion of the Gateway Function). The two operation interfaces may be implemented as one physical interface or as two distinct interfaces.

3.5.2.2 DS0 Cross-Connect in the LDS

R3-114 **[100]** A DS0 cross-connect feature in an LDS shall be governed by requirements in TR-TSY-000679.

R3-115 **[101]** The LDS shall provide the capability to establish and disconnect DS0 cross-connects.

R3-116 **[103]** For non-locally switched services on the IDLC system that require robbed bit signaling, the LDS shall maintain the signaling integrity.

R3-117 **[104]** The RDT may pass the signaling information either in band using robbed bit signaling or out of band using a common signaling channel. For either method, the LDS shall insert the required signaling in the outgoing signal.

R3-118 **[105]** For the incoming signal, the LDS shall interpret the signaling information and insert either the robbed bit signaling or generate the common signaling channel messages as required for the IDLC system.

O3-119 **[106]** The LDS should support multiple DS0 services such as program services and 384-kb/s service.

… When multiple DS0 services are supported, the LDS shall maintain time-slot integrity through the LDS. For example, if IDLC DS0 time-slots 3 and 5 are cross-connected to inter-office DS0 time-slots 9 and 11, the data received in IDLC DS0 time-slots 3 and 5 in a given frame must appear in the inter-office time-slots 9 and 11 in the same frame. Also the data in

IDLC DS0 time-slot 3 must appear in inter-office time-slot 9 and the data in IDLC DS0 time-slot 5 must appear in inter-office time-slot 11.

3.5.2.3 DS0 Cross-Connect in the RDT

R3-120 **[107]** The RDT shall provide the capability to establish and disconnect the DS0 cross-connect.

R3-121 **[108]** The cross-connect capability in the RDT shall be full access and non-blocking. As used in this requirement, full access means that any time-slot on the facility side of the RDT can be connected to any line on the customer side of the RDT. Non-blocking, as used in this requirement, means a cross-connect can be established as long as there is an idle time-slot on the facility side of the RDT.

O3-122 **[109]** The RDT should support multiple DS0 services such as program services and 384-kb/s service.

3.6 Requirements for the ISDN Capability-Option

3.6.1 General

ISDN is a network architecture plan designed to facilitate provisioning of digitally based services that provide voice, data, and packet-switched capabilities. Two means of network access are described in these requirements. The first, Primary Access, provides a 1.536-Mb/s capability in a “23B+D” format. For this format, a B Channel is a 64-kb/s channel used for customer data or voice, and the D Channel is a 64-kb/s channel used for signaling and packet data. A typical application might be to provide network access to a digital PBX. The second means of network access, Basic Access, uses a “2B+D” format. For this format, B Channels are as above, and the D Channel is a 16-kb/s channel used for signaling and packet data. The customer will interface to the Primary Access via DS1 facilities and to the Basic Access via a DSL.

3.6.2 Primary Access Requirements

CR3-123 **[110]** Primary Access, if provided, can be considered a DS1 extension and, as such, all requirements specified in Section 3.7.4 shall apply.

CR3-124 **[111]** Clear Channel Capability - For Primary Access the DS1 extension must provide clear channel capability as specified in Section 4.4.7.

3.6.3 Basic Access Requirements- General

R3-125 **[112]** The 2-wire DSL (2B+D) interface standard as defined in TR-NWT-000397 shall be used for IDLC applications.

R3-126 **[113]** The LDS and RDT shall support the 4:1 TDM interface as described in TR-NWT-000397, Section 10.1.

R3-127 **[114]** The RDT shall support the 3 DS0 interface standard as described in TR-NWT-000397, Section 10.2.

R3-128 **[115]** Clear Channel Capability - For ISDN Basic Access, the IDLC system must provide clear channel capability as specified in Section 4.4.7.

DSL Embedded Operations Channel - The DSL embedded operations channel (eoc) is a 2-kb/s communications channel embedded in the DSL overhead bits. This channel will be used for communications between the Operations Support System (OSS), the Line Unit (LU), and the first network termination (NT1). This channel will support testing and maintenance operations for the DSL. The use of the eoc is shown in TR-NWT-000397 for various forms of ISDN implementation. For 4:1 TDM BRA ISDN, operations communications between the LDS and the RDT is supported by the EOC described in Section 12.

R3-129 **[116]** Maintenance - Metallic test capability as specified in Section 5 is required for ISDN BRA lines.

R3-130 **[117]** The maintenance, testing, and performance monitoring requirements described in TR-NWT-000397 shall be supported. This reference leads the reader to other significant documents in FR-439 for ISDN support.

3.6.4 Basic Rate Access- 4:1 TDM

R3-131 **[118]** Provisioning - The IDLC system shall have the capability of provisioning two B Channels and a D Channel, one B Channel and a D Channel, or just a D Channel. If dynamic time-slot allocation of B Channels on a per-call basis is provided, the system shall have the capability of dedicating one or both B Channels to fixed, full-period time-slots.

O3-132 **[119]** D-channel data should not be delayed more than 2 ms relative to its B-channel data, in each direction of transmission.

R3-133 **[120]** The OS will access the eoc at the RDT LU via the Operations Interface Module (OIM) of the LDS described in Section 5. The IDLC system EOC is used to pass the OS messages to the RDT. The RDT must perform the necessary language translation from an operations message received over the EOC to an eoc message.

3.6.5 Basic Access Extensions- 3 DS0

R3-134 **[121]** Basic Access extensions refer to ISDN Basic Access lines whose D Channels are not processed by the LDS, but instead these lines are destined for some distant switch. In this case, the IDLC system shall assemble these circuits within the DS1 format so that the Basic Access will occupy 3 DS0 time slots. Byte synchronization between the 3 DS0s is not required. Each of the DS0s may be individually assigned to the same or different DS1s.

R3-135 **[122]** Each B Channel shall use one time slot.

R3-136 **[123]** One DS0 time slot shall contain the D-Channel, overhead bits, and eoc. The time slot shall be formatted within the DS1 extended superframe as defined in Section 10.2 of TR-NWT-000397.

R3-137 **[124]** All time-slots shall be dedicated and fixed at provisioning.

3.6.6 Multipoint eoc

The ISDN BRA signal contains an embedded operations channel (eoc) that provides a path for the Line Termination (LT) unit in the LDS or the Line Unit Line Termination (LULT) in the RDT to communicate with the Network Termination Type 1 (NT1) on the ISDN subscriber's premises. There are two types of eoc configurations: the point-to-point configuration (pp-eoc) and the multipoint configuration (mp-eoc). The pp-eoc configuration is illustrated in Figure 3-1. The mp-eoc configuration, illustrated in Figure 3-2, occurs when additional nodes between end nodes also access the same eoc.

R3-138 **[125]** IDLC systems shall support the pp-eoc configuration.

CR3-139 **[126]** If needed for certain architectures, IDLC systems shall support the mp-eoc configuration. This configuration will require additional digital testing, alarms and threshold crossing alert reporting, and PM data retrieval capabilities for intermediate nodes per the criteria in TR-TSY-000821, OTGR Section 5.2: *Network Maintenance: Transport Surveillance - Additional Transport and Transport-Based Surveillance*, TR-NWT-000823, OTGR Section 6.4: *Network Maintenance; Access and*

Testing - Integrated Services Digital Network (ISDN), and TR-TSY-000829, OTGR Section 11.3: *Generic Operations Interfaces* - Embedded Operations Channels.

If the need arises in the future, mp-eoc capabilities may change to requirements.

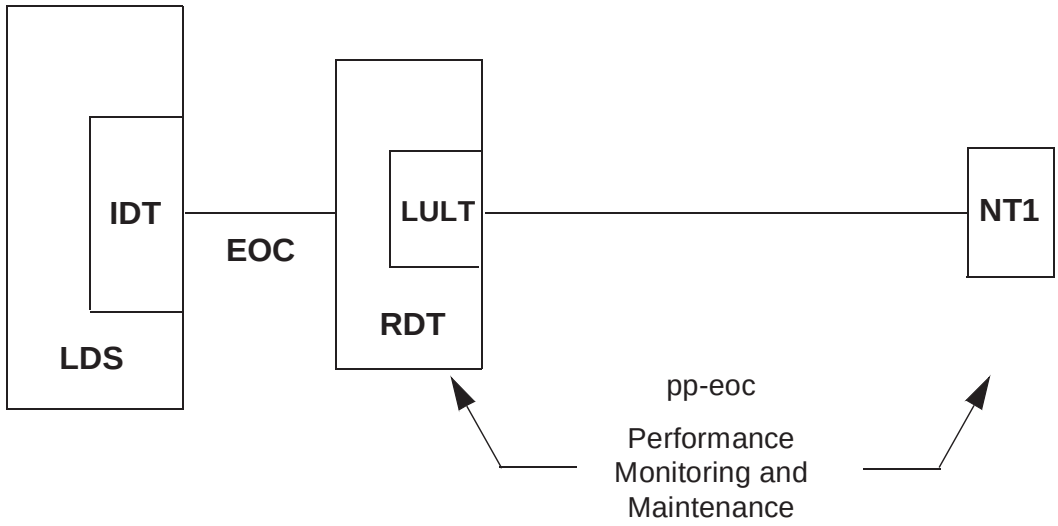


Figure 3-1. ISDN pp-eoc Configuration Example

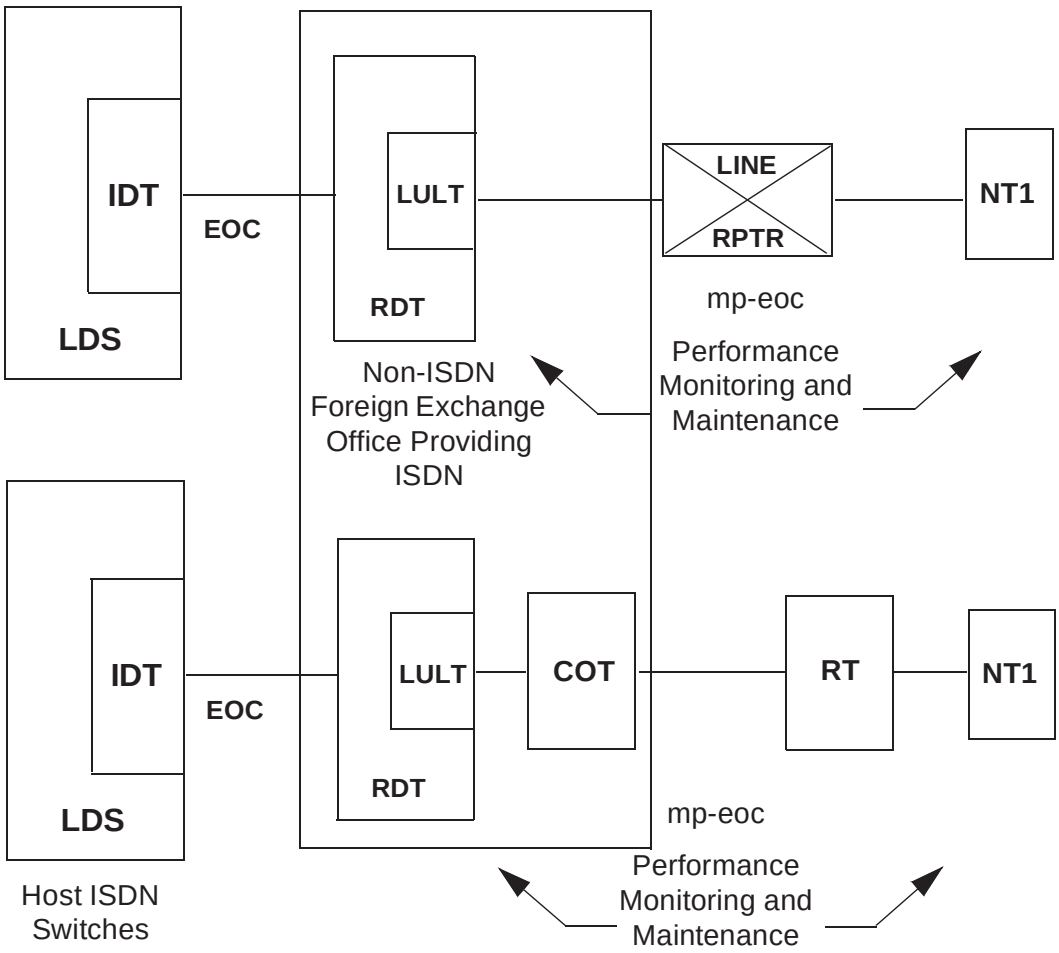


Figure 3-2. ISDN mp-eoc Configuration Example

3.7 Service Related Requirements

O3-140 **[127]** It is an objective that IDLC systems have the capability of providing all services that can be provided over metallic cable pairs.

For IDLC systems, however, access at the Main Distributing Frame (MDF) to allow the provisioning of certain customer services that require the physical manipulation of the individual customer access lines is lost. Equivalent capabilities are therefore imposed on the LDS, or on the RDT as in the case of the DS1 extension option, to facilitate these provisioning activities. Requirements on these LDS and RDT capabilities are discussed in the following sections.

3.7.1 Digital Bridging

A necessary feature for an IDLC system is to provide bridged services when one or more lines are served on an IDLC system. The elimination of the Subscriber Main Distributing Frame (SMDF) for lines terminated on IDLC eliminates the CO point of access where lines have been traditionally bridged, physically opened and electrically tested.

In the case of analog lines (in both LDS and analog switches), OSP pairs are bridged using a bridge lifter. Bridge lifters are devices that electrically isolate bridged telephone pairs at the CO to reduce the transmission losses they produce. Saturable inductors, relays, and semiconductors are sometimes used as bridge lifters. Connection between the OSP pairs and the bridge lifter is accomplished by accessing the pairs at the SMDF termination, and wiring to the bridge lifter with jumpers. For IDLC terminated lines, no such appearance exists since the lines appear as digital channels in a DS1 (or higher) bit stream in the CO. Digital bridging is a feature of the LDS that simulates standard CO bridging of two or more lines. It provides the functions of CO bridging when at least one of the lines does not have a CO analog appearance.

Offered services requiring the digital bridging feature are:

a. Party Lines (up to four lines)

b. Off-premises extension line (OP)

c. Secretarial Lines (SL)

d. Dual service.

3.7.1.1 Motivation

For all these services, assume that at least one of the lines is served by IDLC. Without digital bridging, the above services cannot be placed on IDLC systems; service orders for these services must be assigned to either metallic pairs or universal DLC systems. This

complicates the assignment process, but more importantly, it complicates the planning and design of DLC systems. This complication centers on the need to forecast the frequency of occurrence of these services in a small geographical area, the CSA, and to size IDLC and UDLC systems accordingly in the same CSA site. In addition, plans that include removing existing COTs upon the cutover to a new LDS will be modified to compensate for the need for paralleling systems that terminate on an SMDF to groom bridged services.

Additional motivation for digital bridging comes from the need to perform facility rearrangements (e.g., circuit transfers, cable throws) the details of which are defined in Section 8.2.

3.7.1.2 Requirements

The following are high-level functional requirements on the LDS. These functions do not describe the design or internal operation.

R3-141 **[128]** The LDS shall duplicate the function of a bridge lifter and a bridged connection at the SMDF when one or more lines to be bridged are terminated on an IDLC system.

Three similar features for Party Lines, circuit transfers, and Secretarial Lines are needed. Feature requirements for circuit transfers are covered in Section 8.2; the external characteristics in the other two cases are as follows:

R3-142 **[129] Secretarial Lines, Off-Premises Extensions, Dual Service:** Two lines shall be joined under a single directory number. Either line can originate a call, the other shall only be allowed to bridge onto the conversation in progress. A terminating call shall ring both lines, but shall trip ringing on both lines when either line goes off-hook. The second line shall then be able to bridge onto the conversation by going off-hook.

R3-143 **[130] Party Lines:** Two, three, or four lines are joined under different directory numbers, but the same time slot in the switch is used for all lines. This feature shall allow for any combination of analog and IDLC lines to be combined together into a party line. Call origination is the same as under Secretarial Lines, etc. A terminating call would use standard selective ringing, determined by the directory number being called.

… For two-party lines, an ANI feature shall be provided. Since two-party channel units of many DLC systems can detect Tip-Party Grounds (TPI) and return a code to their COTs in the Universal DLC case, a similar scheme shall be provided for IDLC. For the case of RDT and LDS by different suppliers, this will require coordination between the DLC RDTs and the LDS IDT to ensure consistent signaling. See Section 12.

R3-144 **[131]** Both of the above features shall be initiated via the recent change (or equivalent) system. The same syntax as used for analog lines shall be used, independent of the fact that IDLC lines are involved. The LDS shall have the capability of assigning the same TN to each line.

R3-145 **[132]** If the same line is shared by two subscribers at the RDT, then the requirements of the LSSGR Feature Specific Documents (FSDs) on Four-Party Line, Two-Party Line, and Reverting Call Service shall apply (see TR-TSY-000520, TR-TSY-000561, and TR-TSY-000677, respectively).

If the line to the RDT is not shared, yet party line service is provided, then some of the restrictions caused by line sharing (as mentioned in the above FSDs) can be relaxed. For a reverting call, the special originating and terminating treatment is not required. Also, there is no need to route toll calls to an operator because the originating station can be identified.

It is conceivable that for a 3-party or 4-party service some combination of the subscribers may share the same line into the RDT while the remaining do not. In this case, the service provided to the subscriber shall depend on whether or not the line is shared and if the call is to someone on the line.

3.7.2 Universal Channel Units-Options

TR-NWT-000057 states that it is an objective to minimize the number of types of line units needed to provide customer services in DLC systems; one way of doing this uses universal channel units. Bellcore is proposing two types of universal channel units. The first, the Universal Voice Grade (UVG) CU, would provide locally switched special service grade loop-start, ground-start, and loop reverse battery capabilities. It would be used to provide the following classes of intraLATA services on an assigned basis:

1. Centrex CO lines
2. Local PBX trunks
3. Secretarial lines
4. Off-premises extension lines
5. Direct-out-dial (DOD) lines
6. Direct-in-dial (DID) lines
7. 800 Service trunk
8. WATS line out
9. WATS trunk out
10. 800 Service line

11. WATS trunk 2-way

12. WATS line 2-way.

The requirements for UVG CUs were derived from established POTS and special services criteria and from the CSA rules. UVG CU requirements are provided in TR-NWT-000057.

The second, the Universal Digital Channel (UDC), is defined in TR-TSY-000398. The primary goal of the UDC is to economically provide existing analog and digital service capability. The UDC will depend on echo cancellation hybrid technology to allow the existing two-wire loop to function as a DSL.

3.7.2.1 Requirements

CR3-146 **[133]** For the IDLC system to support UDC, the requirements specified in Section 3.6.3 for ISDN Basic Access shall apply. In addition, for UDC, the DSL eoc must be transported to the UDC central office terminal. The eoc interface to the OSS must be at the UDC central office terminal.

CR3-147 **[134]** No requirement on the number of types of services supported by any one UVG channel unit is imposed. However, to simplify provisioning and inventory operations, a UVG CU supporting most or all of the services enumerated in Section 3.7.2 should be provided.

CR3-148 **[135]** The RDT must be capable of maintaining the proper interface (e.g., loop-start or ground-start) toward the customer. This includes IDLC systems that use dynamic time slot assignment.

CR3-149 **[136]** The classification “UVG CU” requires that no provisioning of the CU be required. If provisioning is required, the CU is considered to be a multi-function CU as described in Section 5.1.1.

3.7.3 On-Hook Transmission Capability

3.7.3.1 General

On-hook transmission capabilities are needed for IDLC systems to be compatible with new service capabilities such as those described in GR-30-CORE and TR-NWT-000031.

Per Section 3.2.2 of GR-30-CORE, on-hook transmission capabilities are to be available with single-party POTS lines, CENTREX lines, Multiline Hunt Group (MLHG) lines, and RSU lines. It is desirable that on-hook transmission capabilities be also available with PBX lines and Foreign Exchange lines. Compatibility with 2-party lines, 4- and 8-party lines,

coin lines, or Charge-A-Call lines is not required. On-hook transmission capabilities are not required on ground-start circuits.

TR-NWT-000031 allows the called CPE to receive the Directory Number (DN) of the calling party during the alerting sequence (e.g., during the first 4-second silent interval of the ringing cycle). These data transmissions are always coincident with a terminating call-processing sequence.

Meter reading applications require data transmissions that are not coincident with any terminating call-processing sequence, and in fact should only occur on an idle line.

The above criteria are partitioned into two major types of on-hook transmission requirements; those coincident with, and those not coincident with, an actual terminating call.

3.7.3.2 On-Hook Transmission Requirements Coincident with Terminating Call

R3-150 **[137]** Both non-concentrated and concentrated IDLC systems shall provide an on-hook transmission capability that allows for the transmission of data at any time (other than when the RDT is applying a ringing signal toward the CPE) during a call sequence from a terminating switch (i.e., the switch to which the called party is connected) to CPE, and from CPE to the switch, regardless of whether the CPE is on-hook or off-hook; this is consistent with Section 1.1 of GR-30-CORE.

For this discussion, a concentrated IDLC system is considered to be a system that requires a time slot to be assigned between IDT and RDT at call set-up. Data transmissions during the off-hook state are accommodated by normal voice transmission paths through the IDLC system; the requirement to break the talking connection during actual data transmissions is a switch and CPE requirement, as detailed in Section 3.10 of GR-30-CORE; thus, no additional capabilities are required of an IDLC system.

For data transmissions during the on-hook state, special coordination between the data transmission and customer alerting signals may be needed. In the on-hook state, the transmission requirements of Section 3.2.1.22 shall apply.

3.7.3.3 On-Hook Transmission Requirements Not Coincident with Terminating Call

R3-151 **[138]** A non-concentrated IDLC system shall be able to provide on-hook transmission capabilities when the data transmissions are not coincident with an actual call termination (e.g., control of message-waiting display, meter reading, autonomous customer alarm reporting, etc.).

O3-152 **[139]** A concentrated IDLC system should be able to provide on-hook transmission capabilities when the data transmissions are not coincident with an actual call termination (e.g., control of message-waiting display, meter reading, etc.).

3.7.4 Requirements for DS1 Extensions - Option

3.7.4.1 General

DS1 extensions are those DS1 interfaces at the RDT that do not terminate at the IDT. On the customer's side of the RDT, they interface to CPE. On the network side of the RDT, they interface to Digital Network Elements (DNEs); typical DNEs may be a DCS, Automated Digital Terminal System (ADTS), Channel Bank (e.g., D4-type), or a foreign exchange digital switch.

R3-153 **[140]** The applicable requirements of Section 4, “Requirements Supporting Interfacing to the Digital Network,” shall be satisfied for each DS1 extension. Differences with Section 4, specific to providing DS1-extension capabilities, are provided in the following subsections.

3.7.4.2 Synchronization

As specified in Section 4.2, the RDT is a stratum 4 node and receives a reference signal from the IDT that is traceable to a stratum 1 timing source.

R3-154 **[141]** The RDT shall use its derived internal clock, or its free-running stratum 4 clock (if all input references from the IDT are lost), to clock a DS1 signal toward a CPE, except if provisioned to provide *through timing.*

CR3-155 **[142]** DS1s from a CPE may not always be synchronous with the RDT clock; i.e., the CPE may not loop-time off of the DS1 from the RDT. The RDT shall be capable of reconciling the frequency difference between the DS1 received from the CPE and the RDT clock; e.g., controlled slips via a 125-µsec slip buffer is an acceptable implementation.

CR3-156 **[143]** If the RDT is only regenerating (i.e., all 193 bits without DS0 grooming) the DS1 interconnecting a CPE and DNE, then the RDT shall be provisionable to provide *through timing* (i.e., timing transparency) of the DS1 in both directions of transmission; i.e., from the CPE toward the DNE, and from the DNE toward the CPE.

R3-157 **[144]** The RDT shall line-time all DS1 interfaces from DNEs except when provisioned to provide through timing or loop timing.

DS1s from a DNE may not always be synchronous with the RDT clock; i.e., the DNE may be traceable to different stratum 1 source than the RDT, or maybe a reference signal fails causing either the DNE or RDT to be running at less than stratum 1 quality.

CR3-158 **[145]** If the RDT is required to loop-time a DS1 to a DNE, the RDT shall be capable of reconciling the frequency difference between

… a. The DS1 received from DNE and the RDT clock

… b. The RDT clock and the DS1 transmitted (which is loop-timed) to the DNE.

Controlled slips via a 125-µs slip buffer on both the receive and transmit is an acceptable implementation. Uncontrolled buffer overwrites/underwrites is not acceptable.

When there is a frequency difference between the DNE clock and the RDT clock, slips will occur at the RDT and the number of slips is a function of the difference in clock frequency between the DNE and RDT. To minimize slips and achieve the performance objectives of some services, both the DNE clock and the RDT clock may need to be very close in frequency; synchronization planning information is provided in TA-NPL-000436 and SR-NWT-002224.

In some applications, an RDT is expected to provide a DS1 extension to CPE for use by the CPE as its synchronization reference. The CPE expects the DS1 reference signal even when all IDT to RDT DS1s are lost.

O3-159 **[146]** It is desirable that the RDT be capable of accepting external timing from a Building Integrated Timing Supply (BITS) clock as discussed in TA-NPL-000436 and SR-NWT-002224. Specifically, the RDT should provide a DS1 timing reference to the BITS clock that is traceable to a stratum 1 source and the RDT should be capable of accepting two inputs (primary and secondary) from the BITS clock for RDT synchronization.

If the DS1s from CPE are channelized, the only channelizing schemes recognized are those defined by the SF and ESF DS1 formats (see ANSI T1.403-1989). As discussed in Section 3.5, a DCS capability satisfying the DCS requirements of TR-NWT-000170 may be provided in the RDT to groom the DS0s from the CPE onto selected DS1s destined for DNE.

CR3-160 **[147]** If DCS capabilities are provided for DS1 extensions, sufficient buffer storage shall be provided at each DS1 termination to allow for DS0 cross-connections between non-superframe-aligned DS1s.

3.7.4.3 Signal Formats

Section 4.4 specifies that IDLC systems use the ESF format defined in TR-NWT-000499. Subsection 4.4.7 describes existing techniques (ZBS and B8ZS), and the IDLC requirement (B8ZS), for satisfying the ones-density requirements between the IDT and RDT.

R3-161 **[148]** The following signal formats and ZBS/B8ZS options need to be supported at all DS1-extension interfaces at the RDT:

… a. An SF (ZBS/B8ZS) capability, where

… — The SF format and ZBS option are as defined in PUB 43801.

… — The B8ZS option is as defined in TR-NWT-000499.

… b. An ESF (ZBS/B8ZS) capability, where

… — The ESF format and B8ZS option are as defined in TR-NWT-000499.

… — The ZBS option is as defined in PUB 43801.

Accommodation of the above requirements may be automatically determined, provisionable by command messages from an OS, or plug-in selectable during service set-up.

3.7.4.4 DS1 Extension Facility Performance

R3-162 **[149]** Section 4.6 provides performance-parameter detection, accumulation, and storage requirements for the DS1s between the LDS and RDT. These requirements shall also be satisfied for all ESF DS1-extensions at an RDT.

R3-163 **[150]** Consistent accumulation and storage capabilities shall also be provided for SF DS1-extensions at the RDT; refer to GR-820-CORE for data storage requirements derived from bipolar violation (CRC-6 coding violations are not available for the SF format).

R3-164 **[151]** Section 4.9.4 provides the requirements for generation, interpretation, storage, and thresholding of Performance Report Messages (PRMs), which are carried on the Facility Data-Link (FDL) of ESF DS1s. These requirements shall also be satisfied for all ESF DS1-extensions at an RDT.

3.7.4.5 Facility Data-Links

R3-165 **[152]** All DS1-extension facility data-links shall terminate at the RDT, except if the RDT is only regenerating the DS1.

Customer and network use of these FDLs may require unique accommodations at the RDT.

3.7.4.6 DS1 Extension Facility Alarms

CR3-166 **[153]** When the RDT is acting as an intermediate DS1 node (i.e., no grooming at the RDT), the following facility-alarm requirements need to be satisfied:

… a. Upon detection of an AIS (see Section 4.9.2), the RDT shall generate an AIS toward the downstream[3] termination (DNE or CPE).

… b. A detected LOS (see Section 4.6.1) on any DS1 extension shall cause an AIS to be generated in the downstream direction.

… c. If the DS1 path exhibiting a trouble condition is protection switched (see Section 6.2.1), AIS processing/generation is suspended as soon as a valid DS1 signal can be transmitted downstream.

The facility alarms discussed above are defined as follows for the various signal formats:

- SF
  - — AIS is defined in TR-TSY-000191 (unframed, all ones).
  - — YELLOW is defined in PUB 43801 (bit 2 = 0, for each DS0).
- ESF
  - — AIS is defined in TR-TSY-000191 (unframed, all ones).
  - — YELLOW is defined in TR-NWT-000499 (coded, over data-link).

3.7.4.7 DS1 Extension Loopbacks

R3-167 **[154]** The two methods (via operations messages and 16-bit codes in the ESF data link) of controlling digital-line loopback, that are specified in Section 6.1.5.4, shall be supported on all RDT-DNE DS1 extensions.

3. In the same bitstream direction as the detected AIS signal.

R3-168 **[155]** The loopback control methods that must be supported on all RDT-CPE DS1 extensions are via operation messages (same as the above requirement) and the methods defined in TR-NWT-000819.

4. Requirements Supporting Interfacing to the Digital Network

4.1 Physical Interface

This section describes Bellcore's view of the proposed requirements for the physical interface between the IDT and the digital transmission facility, and the RDT and the digital transmission facility. Physical interface requirements are defined for both ends of the digital transmission facility used to interconnect the IDT and RDT to allow transmission systems and terminating equipment to be deployed and changed independently. A DS1 signal transmitted by T1-type repeaters over metallic cable pairs is the most common digital facility used in a typical Bellcore Client Company (BCC) loop plant.

R4-1 **[156]** IDTs and RDTs shall be compatible with DS1-rate interfaces to digital transmission facilities.

R4-2 **[157]** The physical interface in the central office between an IDT and a digital transmission facility shall be a DSX-1 cross-connect. Accordingly, the IDT shall send and receive electrical signals that meet the DSX-1 interconnection specification of TR-NWT-000499 with 0 to 655 feet of cabling between the IDT and the DSX-1.

Two means of implementing the physical interface between an RDT and a digital transmission facility from the central office, need to be supported - i.e., via a DSX-1 cross-connect and a direct interconnection to metallic cable pairs.

CR4-3 **[158]** If the RDT interconnection is at a DSX-1 specified cross-connect, the RDT shall send and receive electrical signals that meet the DSX-1 interconnection specification of TR-NWT-000499 with 0 to 655 feet of cabling between the RDT and the DSX-1.

CR4-4 **[159]** If the RDT interconnection is directly to metallic cable pairs, the following interface requirements shall be met:

… a. The RDT shall produce an output signal meeting the specifications of CB-113 and meeting the minimum ones density specification of TR-NWT-000499.

… b. The RDT shall operate properly with an input signal at the cable interface equivalent to a signal that meets the specifications of CB-113 that has been transmitted through a cable pair that has a loss ≤25 dB at 772 kHz.

… c. The RDT shall provide the capability to attenuate the output signal at its cable interface. Attenuation capabilities shall be 0, 7.5, 15, and 22.5 dB at 772 kHz; no need to be remotely settable.

… d. If the RDT cable interface supplies power to a T1-type digital line, the applicable line-powering requirements of TR-NWT-000057 shall be satisfied. An RDT cable interface that does not supply power to the line shall loop the T1-type line simplex powering current.

CO4-5 **[160]** If the RDT interconnection is directly to metallic cable pairs, the RDT should operate properly through a cable pair that has a loss ≤34 dB at 772 kHz. If the RDT cannot meet this objective, the supplier shall state the maximum loss at 772 kHz that will ensure proper operation.

CR4-6 **[161]** For interfaces to digital transmission facilities at higher than DS1-rates, the physical interface shall be the appropriate DSX; e.g., for a DS3-rate interface, the DSX-3 specifications in TR-NWT-000499 shall be satisfied. IDLC system architectures, however, shall be such that these higher-order digital interfaces could be provided over n DS1-rate facilities (where n ≥1); e.g., a DS3-rate interface is viewed by the IDLC architecture as a digital pipe having 28 DS1 constituent bitstreams. This Conditional Requirement also addresses SONET-based physical interfaces where the IDLC system DS1s are asynchronously mapped into SONET Virtual Tributaries (i.e., VT1.5s).

R4-7 **[162]** IDTs and RDTs shall support operations strategies and provide operations features on a DS1 basis, even if the transmission facility interface is at a rate higher than DS1.

4.2 Synchronization

The IDT and RDT of an IDLC system communicate via a synchronous DS1-based interface and, therefore, must conform to the requirements of TA-NPL-000436. Under this plan, the RDT is a stratum 4 node and receives synchronization from the LDS (a stratum 3 node) via a 1.544-Mb/s digital interface signal (a traceable[1] synchronization signal) from the IDT.

The purpose of the following synchronization plan is to prevent data loss by ensuring that both ends of the IDLC system derive timing either directly or indirectly from one master clock.

1. A traceable reference is one that can be traced back through some number of clocks to a stratum 1 timing source, and as such is locked in frequency with that source.

R4-8 **[163]** The IDT shall acquire synchronization from its associated local digital switch, which is a stratum 3 node traceable to a stratum 1 timing source. If all input references to the LDS are lost, the LDS/IDT shall be capable of free-running with a minimum accuracy of a stratum 3 source.

R4-9 **[164]** The RDT shall acquire synchronization from its DS1 interfaces from the IDT. If all input references to the RDT are lost, the RDT shall be capable of free-running with a minimum clock accuracy of a stratum 4 source; as defined in TR-NWT-001244.

R4-10 **[165]** The RDT shall be tolerant to clock synchronization source impairments on its DS1 interfaces, per the requirements in Section 4 of TR-NWT-001244.

R4-11 **[166]** The RDT shall line-time all DS1 interfaces between the RDT and IDT; i.e., lock the frequency of the outgoing DS1 signals to the long-term average[2] of the incoming DS1 reference signal.

Additional synchronization requirements for DS1 extensions are defined in Section 3.7.4.

R4-12 **[167]** Automatic switching, consistent with the criteria in Section 3.5 of TR-NWT-001244, between DS1 reference signals from the IDT is required whenever the selected input reference signal is lost. The RDT shall be capable of obtaining synchronization from any operational DS1 reference signal from the IDT as long as the IDLC system is capable of providing any service whatsoever.

4.3 Jitter

Timing variations in digital bitstreams are referred to as “jitter” and are caused by terminal equipment, multiplexes, and repeatered digital lines. Restrictions on jitter generation and requirements on jitter accommodation are placed on both the IDT and RDT to permit satisfactory IDLC system performance, particularly when IDTs and RDTs interface with other digital transmission equipment such as optical multiplexers.

R4-13 **[168]** To permit the IDT and RDT to perform satisfactorily in the presence of jitter encountered in the network, and to maintain a reasonably small contribution to total jitter, both the IDT and RDT shall comply (on IDT-RDT interfaces) with the *Category II* digital equipment timing jitter requirements of Section 7.3 of TR-NWT-000499.

2. One-second is an acceptable averaging interval.

4.4 Signal Format

4.4.1 DS1 Framing Format

R4-14 **[169]** IDTs and RDTs shall use the ESF format for overall digital transmission.

The ESF format is listed as a system requirement to enable IDLC systems to interface with higher-rate digital transmission systems between the IDT and RDT; Section 3.7.4 identifies other DS1 formats if the "DS1 extension" option is provided. Interface specifications for ESF can be found in Section 10.2.4 of TR-NWT-000499. The use of the ESF provides the following:

- Compatibility with most existing asynchronous multiplexers (see TR-TSY-000009) and the new synchronous add-drop multiplexers (see TR-NWT-000496), particularly when used in byte-synchronous modes.
- Timing and frame recognition necessary to enable 16-state, robbed-bit signaling within the 24-frame superframe structure.
- Improved error detection capability and false framing protection, using 2 kb/s of the 8-kb/s framing bits to transmit a CRC-6 error detection code.
- Data Link (DL) capabilities derived from the use of 4 kb/s of the 8-kb/s framing bits. Some applications of the data link are protection switching, alarms, far-end line performance, equipment testing, and maintenance information.

Two distinct formats are defined for use on the ESF data link. The first format is a scheduled message that uses a 15-byte packet to send facility performance information; generic criteria for this format is in Section 10.2.4.3.B of TR-NWT-000499 and IDLC-specific criteria is in Section 4.9.4 of this GR. The second format is a group of unscheduled messages that use repeated 16-bit codewords to send alarms, commands, and responses; generic criteria for this format is in Section 10.2.4.3.C of TR-NWT-000499. The IDLC-specific criteria for unscheduled messages can be summarized as follows:

R4-15 **[170]** Specific 16-bit codewords shall be used for various IDLC applications supported in this GR, as defined in Table 4-3.

… a. Throughout this GR, a valid code is defined as any of the codes defined in Table 4-3. (TR-NWT-000499 defines additional codes but these codes are not used for IDLC applications.)

… b. IDLE is a valid code and is considered a 16-bit code for IDLC applications; note this is different from TR-NWT-000499 where IDLE is considered an 8-bit code.

… c. Throughout this GR, an unrecognized code is defined as any 16-bit pattern not defined in Table 4-3.

… d. Unlike GR-499-CORE, for the DS1 protection switching applications supported in this GR, an ESF 16-bit coded message is continuously sent and it is removed only after a response has been received or a time-out occurs. Other applications in this GR follow GR-499 criteria; e.g., DS1 loopback command messages consist of ten repetitions of the appropriate codeword.

R4-16 **[171]** The IDT and RDT shall be capable of detecting 16-bit codes in the ESF data link of a DS1 for which an Out-of-Frame (OOF) or Loss-of-Signal (LOS) condition has not been declared (see Section 4.6.1).

O4-17 **[172]** It is desirable that the IDT and RDT be capable of detecting 16-bit codes in the ESF data link of a DS1 during intermittent OOF conditions.

Detection requirements have been specified in Section 12.6.2 of this GR to allow for accurate detection of codewords in the presence of a 10^{-3} Bit Error Ratio (BER) while satisfying the overall timing needs of the DS1 facility protection switching procedures for the Generic IDLC Interface. These detection requirements are applicable to the codewords of Table 4-3 that are used in the facility protection switch procedures. A supplier may use these requirements for the detection of other codewords in Table 4-3 or choose to implement different detection criteria. It is an objective that the same criteria be used for the detection of the 16-bit codes used for DS1 loopback control (see Section 6.1.5.4).

The actions to be taken following the detection of a codeword in Table 4-3 are application-dependent and given in the applicable sections of this GR. Requirements for the detection of a codeword are different than the timing requirements to act on the detected codeword. For example, trunk conditioning must begin between 335 and 1000 ms following the receipt of the YELLOW codeword (see Section 4.7).

R4-18 **[173]** For IDT-RDT configurations to interact with an intermediate transmission system, the following DS1-maintenance functions must be supported in both the IDT and RDT:

… a. Compatibility with the Carrier Group Alarm (CGA) requirements defined in Section 4.7; including Trunk Conditioning in response to detection of DS0 AIS (the replacement terminology for UNICODE), as specified therein.

… b. Capability to transmit and receive the yellow alarm signal per the requirements of Section 4.9.1.

… c. Capability to transmit and receive the Alarm Indication Signal (AIS) per the requirements of Section 4.9.2.

4.4.2 Frame Organization

IDTs and RDTs use the standard DS1 frame consisting of 193 bits. The frame is composed of 24 consecutively numbered (1-24) time-slots synchronized by a framing (F) bit. Each time-slot consists of eight consecutively numbered (1-8) bits, bit 8 being the least significant. The frame repetition rate is 8000 frames/sec. The nominal DS1 line rate is 1.544 Mb/s. Figure 4-1 illustrates the frame format.

4.4.3 Delay

To ensure adequate transmission performance, specifically with regard to listener echo concerns, the round-trip delay on a 4-wire digital path must be limited. TR-NWT-000507 identifies maximum echo-path-delay[3] requirements for various call connections. For RDT-to-RDT connections, where the connection path is in the LDS, 99% of such connections need to have delays ≤6.5 ms. See Section 12.6.1.1 for IDLC system component delay allocations.

R4-19 **[174]** The echo-path-delay of an IDLC system shall be ≤3.25 ms from the center of the LDS to the 2-wire line terminations at the RDT.

R4-20 **[175]** The supplier shall provide delay characteristics for the IDLC system. These characteristics shall be in the form of tables/graphs that indicate maximum achievable T1-line distances versus quantities of delay being contributed by other transmission-related equipment (e.g., multiplexers). A round-trip delay of 16 μsec per mile[4] shall be used to calculate these maximum achievable T1-line distances; 16 μsec per mile shall also be used to calculate the maximum distances for fiber facilities.

4.4.4 Reframe Time

R4-21 **[176]** For IDTs and RDTs, the maximum average reframe time shall be less than 50 ms in the absence of bit errors.

Reframe time is defined as the time that elapses between the moment a valid frame alignment signal becomes available at the receive terminal and the moment frame alignment is established. Maximum average reframe time is the average time required to reframe when the maximum number of bit positions must be examined for the framing pattern.[5] The intent of limiting the allowable reframe time for IDTs and RDTs is to minimize, (1) impairments to customer signals, (2) the impact on supervision (disconnects),

3. Echo path delay is twice the 1-way transit time delay of a signal through an end office connection path.

4. Assumes 19, 22, 24, or 26 gauge standard capacitance (83 nF/mile) cable. (See TR-TSY-000008.)

and (3) the impact on signaling (wrong numbers), to levels currently found acceptable during reframe conditions.

4.4.5 False Framing

R4-22 **[177]** An IDLC system shall not frame on a framing pattern that may be present within the channel time-slots of the DS1 signal.

With ESF DS1s, CRC-6 errors should be indicated for all potential false framing situations.

4.4.6 Compression Law

R4-23 **[178]** An IDLC system shall use a piecewise linear approximation to a μ=255 compression law, as indicated in TR-NWT-000507; i.e., Codecs shall comply with CCITT Blue Book Recommendation G.711.

4.4.7 Clear Channel Capability

R4-24 **[179]** IDTs and RDTs shall provide a DS0 clear channel capability (DS0 CCC). This used to be called 64-kb/s CCC but now DS0 CCC is the preferred terminology.

To accomplish this, an IDLC system may[6] need to overcome the following historical obstacles.

a. The predominant technique of accomplishing IDT-RDT per channel signaling today is by robbing a transmission bit from each channel time-slot, every six frames; clearly, this does not allow a clear channel capability.

CR4-25 **[180]** Where per-channel signaling is required, an IDLC system will need to utilize a non-robbed-bit out-of-slot method of satisfying the signaling needs of the channel if DS0 CCC is to be provided.

For Generic IDLC Interfaces, both the robbed-bit and the out-of-slot (e.g., message-oriented) methods of signaling are defined in Section 12.

5. For the “maximum average reframe time,” the average time is the average of 193 attempts to find the framing pattern. Some attempts will be abandoned at the second bit check while others may not be able to be abandoned until the sixth bit check. This assumes that 1s and 0s in the bitstream are statistically independent and equally likely.

6. DS0 CCC on network-switched channels will require that both items “a” and “b” be satisfied. DS0 CCC on private-line channels will only require that item “b” be satisfied; because signaling is not needed, the ESF signaling-bit positions can be used to transport bit-8 data during the signaling frame.

b. Regenerators on T1 digital lines, and loop-timed DS1 terminations, require a specific density of pulses to retain clock synchronization. Thus the requirement at the DSX-1 to assure a minimum ones density in all DS1 rate signals applies. The predominant method of ensuring adequate ones density at the DS1 output of digital channel terminating equipment today is to check each voice PCM data byte for an all-zeroes condition and if it occurs, to force bit 7 of the PCM data byte to a logic "1." This is called Zero Byte Suppression (ZBS) and clearly precludes a DS0 clear channel capability. To provide DS0 CCC, an IDLC system will need to employ a different method of assuring that ones-density requirements are satisfied.

R4-26 **[181]** A "bipolar with eight zero substitution" (B8ZS) (see TR-NWT-000499) capability shall be available at both the IDT and RDT to ensure a minimum ones-density on DS1 facilities.

R4-27 **[182]** B8ZS introduces additional delay into the 4-wire digital path and shall be considered in satisfying the delay requirements of Section 4.4.3.

4.4.8 Channel Signaling

R4-28 **[183]** IDTs and RDTs shall provide per-channel signaling capabilities.

In Section 12, both an in-slot (robbed-bit) and an out-of-slot (message-oriented) method of signaling are described for the Generic IDLC Interface.

R4-29 **[184]** The IDLC system shall allow any DS0 to be used as a DS0 clear channel, when needed, to satisfy service requirements.

Channel signaling requirements for non-locally switched services are defined in Section 3.5.

4.4.9 Channel Freezing for Detected Defects

4.4.9.1 Channel Signalling Freezing

In-slot (robbed-bit) signaling states are continually refreshed by the signaling-bit configurations received in the DS1 digital bitstream.

CR4-30 **[185]** If TMC is provided, then during a declared Out-Of-Frame (OOF) or Loss-Of-Signal (LOS), IDTs and RDTs shall maintain the on-hook and off-hook signaling states that existed before initial declaration of the condition; ringing codes shall be inhibited (i.e., maintain the idle signaling

state rather than ringing). This requires buffering of the signaling information.

CR4-31 **[186]** If TMC is provided, then the probability of freezing in the wrong signaling state, for a 50% ones-density OOF condition, shall not exceed 5%. [7]

CR4-32 **[187]** If TMC is provided, then the signaling states shall not be changed until the fault conditions cease and the IDT/RDT regains synchronization, the IDT/RDT declares a Carrier Failure Alarm (CFA) (see Section 4.7), or the facility is declared Out Of Service (OOS).

In some digital-transmission-facility arrangements, the DS1-rate interface between the LDS/IDT and RDT may be implemented via higher-order synchronous transmission systems such as SONET equipment (see Section 13). In such an arrangement, equipment other than the IDT or RDT may detect DS1 out-of-frame or loss-of-signal conditions and are required to take action to freeze per-channel signaling states. The DS0 AIS code (replacement terminology for UNICODE), as defined in Section 4.7, is the technique being used by evolving synchronous-transmission-systems to accomplish per-channel freezing and subsequent trunk conditioning at a downstream terminal.

CR4-33 **[188]** If TMC is provided, then the IDT and RDT shall monitor each terminating DS0 that utilizes robbed-bit signaling for the presence of DS0 AIS.

CR4-34 **[189]** If TMC is provided, then upon detection of two consecutive DS0 AIS bit-patterns, the signaling state of the affected DS0 shall be frozen to a valid signaling state detected within the window of three-to-six signaling-state cycles immediately before the first detected DS0 AIS bit-pattern. (This window of three-to-six signaling-state cycles also applies to freezing on SF-type DS1 extensions, an IDLC option discussed in Section 3.7.4.)

A signaling-state cycle is an extended superframe (3 ms), i.e., the time needed to acquire an entire ABCD signaling bit-pattern. As previously stated, freezing in the ringing state is inhibited (i.e., maintain the idle signaling state rather than ringing).

CR4-35 **[190]** If TMC is provided, then the signaling state shall remain frozen as long as DS0 AIS is detected

… a. until trunk conditioning begins (refer to Section 4.7 for information on DS0 AIS trunk conditioning), or

7. This probability can be verified by replacing a functional DS1 with a DS1 without framing, and having a 50% ones-density; no more than 5% of the channels being carried by the functional DS1 can be frozen in the wrong signaling state.

… b. until DS0 AIS is not observed for four consecutive signaling-state cycles and a valid signaling code is detected.

When a signaling method is used that does not depend on signaling-bit configurations received in the DS1 digital bitstream to determine per-channel signaling states (e.g., an out-of-band message-oriented signaling channel), the channel-signaling-freezing requirements of this section are unnecessary.

4.4.9.2 Channel Replacement Data

The criteria below applies to both the IDT and RDT and shall be applied only in the downstream DS0 direction from where the defect condition exists.

R4-36 **[1792]** For detected defects (i.e., LOS, OOF, and AIS), the IDT and RDT shall replace the outgoing DS0 data with an idle PCM word compliant with the criteria in R4-39 [192].

O4-37 **[1793]** For detected defects (i.e., LOS, OOF, AIS), it is desirable to immediately replace the content of each DS0 associated with a detected defect with all ones. All ones is consistent with the AIS philosophy of replacing payloads with all ones, as defined in TR-TSY-000191 and GR-253-CORE, and is needed to minimize annoying audio disturbances to customers during trouble conditions.

4.4.10 Line-to-Time-Slot Numbering

CR4-38 **[191]** IDTs and RDTs without DS0 cross-connect capabilities shall use the sequential numbering scheme for assigning line numbers to time-slots. Line numbers 1 through 24 are assigned to time-slots 1 through 24, respectively, of DS1 facility 1, line numbers 25 through 48 are assigned to time-slots one through 24 of DS1 facility 2, and so forth, up to the maximum number of lines the IDLC system can provide.

As described in Section 3.6, “ISDN Compatibility,” ISDN Basic Access will require more than one DS0 channel. Other services that require more than one DS0 channel are program channels (5 kHz, 8 kHz, and 15 kHz) and 56-kb/s DDS (with error correction capabilities). For systems with DS0 cross-connect capabilities, the assignment of line numbers to time slots may be a dynamic relationship.

4.4.11 Idle Channel Requirements

The following channel conditions are considered idle-channel states for IDLC systems:

- **Unequipped:** denoting that per-channel equipment has been removed or never installed.
- **Equipped but not provisioned:**[8] denoting that all necessary per-channel equipment is in place but necessary provisioning activities have not been completed. A unit that doesn't require provisioning is assumed to be provisioned.
- **Equipped, provisioned, but OOS:** denotes that a channel has been equipped and provisioned for a specific service but has not been turned up for service at the LDS; or that a channel has been taken OOS for administrative and operational concerns; this state may be different than an OOS state that a channel is put into as a result of major alarms, such as a Carrier Failure Alarm (CFA), where trunk conditioning requirements (see Section 4.7) must also be satisfied.
- **Equipped, provisioned, but unassigned:** denotes that a channel has been equipped and provisioned for a specific service but is presently not assigned (only applicable for concentrated systems) a time slot on the digital transmission facility. Also denotes those time slots that do not have a channel assigned to them. Both, the unassigned time slots as well as the unassigned channel units, are considered in this condition and all idle channel requirements apply to both.
- **Equipped, provisioned, assigned, but on-hook:** denotes that a channel has been equipped, provisioned, assigned a time slot on the digital transmission facility (only applicable for channels not involved in dynamic time slot assignment), but the channel is idle because the customer is on-hook.

R4-39 **[192]** For the above channel conditions, the IDLC system shall ensure[9] that the following idle-channel requirements are satisfied:

… a. A high ones-density content on all affected facility time slots

… b. A minimum analog power output (i.e., near-zero voltage signal) at the decoder of all affected channel units

… c. No false seizures or alerting of customers

… d. No performance degradations of customer service requirements of Section 3.

4.5 Digital Transmission Facility Maintenance

IDTs and RDTs must be capable of maintaining the facilities between the IDT and RDT on a DS1 basis. If the facilities between the IDT and RDT contain systems operating at rates

8. Circuit provisioning is defined in Section 5.1.1.

9. Refer to Sections 5.5 and 5.6 of MDP-326-140 (formerly known as PUB 43801) for an example of an idle PCM-code-word strategy that works.

above the DS1 level (e.g., a multiplex or fiber optic system), the higher-rate system will form a maintenance span.[10] The maintenance span or tandem maintenance spans will satisfy trouble detection and related requirements within the maintenance span. The IDLC system must be capable of detecting and acting on AISs as specified in Section 4.9.2, generated by the higher-rate systems, within its DS1 signals.

The capabilities of the IDLC system needed to maintain a DS1 facility include the following:

a. **Single-Ended Fault Location**

Once a fault has been determined to be in the DS1 facility, the IDLC system shall provide the capability to locate the fault on the DS1 facility by tests performed from one end of the DS1 facility. Requirements for single-ended fault location on T1-type digital lines are specified in Section 6.1.5.

b. **Test Access**

R4-40 **[193]** A physical (not managed) test access to the DS1 facility shall

… a. Be provided at each end of the DS1 facility

… b. Be provided to both the transmit and receive paths of the DS1 facility

… c. Provide both breaking and bridging accesses. Breaking access shall permit connection of external test equipment to the DS1 facility and disconnection of the DS1 facility from the system. Bridging test access shall permit connection of external test equipment to an in-service DS1 facility without disrupting the operation of the DS1 facility.

c. **Order Wire**

R4-41 **[194]** The IDLC system shall provide access to an order wire circuit at the RDT and the central office end of the DS1 facility. The order wire will permit technicians to establish a talk path between the RDT and the central office during total system failures.

d. **Manual Control**

R4-42 **[195]** The IDLC system shall provide the capability to remove any DS1 facility from service. The capability to activate these manual controls locally and remotely shall be provided.

10. A group of equipment maintained as a single entity (e.g., a DS3 multiplex facility, a fiber optic system, a T-1 carrier span).

When DS1 protection facilities are provided, the capability to inhibit switching of any DS1 facility to a protection DS1 facility and to manually initiate a switch of any DS1 facility to a protection DS1 facility, shall be provided as specified in Section 6.2.1.

4.6 Digital Transmission Facility Performance

In the following subsections, CRC-6 violations (as defined in TR-NWT-000499) will be a basic parameter used to derive other digital signal parameters required of IDTs and RDTs to be compatible with the centralized surveillance strategies of GR-820-CORE. As defined in GR-820-CORE, digital signal parameters are numerical counts of impairments on a transmission system that are detectable by observing the transmitted digital signal alone, and for IDTs and RDTs are defined in Section 4.6.1.

4.6.1 Parameters and Data Storage Requirements

Surveillance data parameters for all DS1-based network elements are defined in Section 4 of GR-820-CORE.

R4-43 **[196]** The parameter definitions, data accumulation requirements (during both normal and unavailable periods), and data storage requirements in Section 4 of GR-820-CORE shall be met at the IDT and RDT for all incoming DS1s, for the following parameters:

… a. Code Violation-Path (CV-P).

… b. Errored Second-Path (ES-P)

… c. Severely Errored Second-Path (SES-P)

… d. Controlled Slip Second-Path (CSS-P): only applies to the DS1 Extension Option, Section 3.7.4, and the Multiple Interface Group Feature, Section 12.5.10.

… e. Severely Errored Frame/Alarm Indication Signal-Path (SAS-P)

… f. Unavailable Second-Path (UAS-P)

… g. Near-end Failure Count-Path (FC-P)

… h. Errored Second-Line (ES-L).

R4-44 **[197]** When the continuous accumulation of occurrences of a condition is inhibited during periods of unavailability, the contents of all inhibited data registers shall be flagged as being corrupted.

R4-45 **[198]** The data storage scheme[11] shall allow retrievable access, via the requirements of Section 5, to all 15-minute and daily registers.

R4-46 **[199]** Data registers shall be of sufficient size to store performance monitoring data on DS1s, as indicated in Table 3-1 of GR-820-CORE. When any register capacity is exceeded, the register shall not roll over but shall be pegged at the maximum value.

4.6.2 Alert-Declaration and Protection-Switching Threshold Requirements

Specific thresholds need to be set for the current 15-minute period and current day of the ES-P, SES-P, and CSS parameters to provide for threshold-crossing alert declarations that enable IDLC system performance objectives to be satisfied. Threshold-crossing alerts reported, via the requirements of Section 5, to an OS may result in further OS activity depending on OS priority-of-action classification for the DS1 involved.

R4-47 **[200]** All threshold levels shall be user settable on a DS1 basis and retrievable, both locally at the IDT/RDT and remotely by an OS. Default values for all thresholds are provided in Table 4-1.

R4-48 **[201]** The IDT/RDT shall report all occurrences of threshold-crossings to a surveillance operations system.

GR-820-CORE should be consulted for additional information on threshold levels and default values. The default values for the “performance alarm thresholds” are tighter than the tightest daily service objective of all circuits carried by an IDLC system and well below the expected performance of most transmission lines. Approximate Bit-Error-Ratios (BERs) are provided in Table 4-1, as benchmarks to previously used BER thresholds.

R4-49 **[202]** Default values are also indicated in Table 4-1 for initiating a protection switch (124 CRC CVs within any 1-second interval).

O4-50 **[203]** It is desirable that a protection switch also be initiated on excessive BPVs. Table 4-1 indicates a default of 154 BPV CVs within any 1-second interval as sufficient to initiate a protection switch.

R4-51 **[204]** DS1s shall be taken OOS (i.e., declare a CFA) after 10 consecutive path SESs, if no protection switch has taken place.

11. Refer to Section 3 of GR-820-CORE for common criteria associated with data storage.

R4-52 **[205]** Thresholds for initiating a protection switch shall be user settable at BERs from 10^{-4} to 10^{-7}, and retrievable, both locally at the IDT/RDT and remotely by an OS.

Default values are given in Table 4-1 for initiating a protection switch at a BER of 10^{-4} or worse. A maximum decision interval of 1-second is allowed for BERs of 10^{-4} or worse, because of the possible IDLC service degradation at such performance levels. Maximum decision intervals at BERs of 10^{-5} and better, need to be longer to allow robust decision algorithms to be implemented as indicated in the following.

DS1 Performance (BER)	Max Time for Switching Decision	CRC CVs	BPV CVs	Min Time for Restoral Decision
$\geq 10^{-4}$	1 sec	124	154	10 sec
10^{-5}	10 sec	150	154	10 sec
10^{-6}	100 sec	154	154	100 sec
10^{-7}	1000 sec	154	154	1000 sec

The default CV counts and timing intervals in the above table were derived from an assumption that errors on a DS1 path are single-bit errors, randomly distributed, and have a mean equal to the BER; i.e., the error distribution is a Poisson probability distribution. For ESF DS1s, which use CRC-6 checks to detect bit errors within a block, the probability that there was at least one error in a block is defined as follows:

$$P(n \geq 1) = 1-(1-BER)^K$$

where, P is the probability of having n bits in error,
BER is the Bit Error Ratio of the DS1 path, and
K is the number of bits in the block being checked.

And the expression for calculating the expected number of Code Violations (CVs) per second, at a given BER on an ESF DS1 path, is as follows:

$$[1-(1-BER)^K]\left[\frac{1CV-check}{3\ ms}\right]$$

where, K = 193x24 = 4632 for an ESF DS1 block

R4-53 **[206]** The probability of BER threshold detection, within the indicated "Maximum Time for Switching Decision," should be greater than 0.95 when an error rate (a Poisson distribution of bit errors is assumed) on the DS1 exceeds the selected threshold.

R4-54 **[207]** The probability of BER threshold detection shall be less than 0.05 when the error rate on the DS1 equals one-half the selected threshold.

R4-55 **[208]** A DS1 shall not be restored to service until its error rate has improved to at least one-half the selected BER threshold for the "Minimum Time for Restoral Decision"; e.g., if selected threshold is 10^{-5}, then the DS1 can be restored at $5x10^{-6}$.

R4-56 **[209]** The maximum time window for the switching decision applies to actual DS1 performance at or below the selected BER switching threshold; e.g., if a BER switching threshold is set at 10^{-6} and the DS1 performance drops to 10^{-4}, the decision to protection switch shall be made within one second of the onset of the 10^{-4} performance.

4.7 Carrier Group Alarm

The combination of a Carrier Failure Alarm (CFA)[12] and Trunk Conditioning (TC)[13] is defined as a Carrier Group Alarm (CGA) system.

R4-57 **[210]** A CGA capability shall be provided by the IDT and RDT.

As specified in Section 4.4.1, IDTs and RDTs use an ESF signal format that satisfies interface specification TR-NWT-000499. In some Digital Transmission Facility (DTF) configurations, the DS1-rate interface between LDS/IDT and RDT may be implemented via higher-order byte-synchronous[14] transmission systems comprised of equipment such as SONET Add-Drop Multiplexers (ADMs). To provide compatibility with such DTF arrangements, a generic IDLC implementation of CGA is defined in this section.

CGA operation must be coordinated with the terminal equipment at the other end of the DS1 path. In many cases this will be an IDT coordinating smooth channel-service tear-down (part of CGA operations) with an RDT, but in other cases there will be intervening terminal equipment that is part of a synchronous transmission system (e.g., SONET ADMs). The CGA strategy implemented in IDTs and RDTs, therefore, needs to be compatible with both the strategy defined in MDP-326-140 (formerly known as PUB 43801) and GR-253-CORE, and is described in the remainder of this section. Section 4.7.1 provides the CGA requirements for equipment that terminates DS0s while Section 4.7.2 provides additional requirements for equipment that cross-connects DS0s from DS1s into other DS1s (i.e., provides an Integrated Network Access capability via the DS0 Cross-Connect option discussed in Section 3.5) for eventual downstream termination.

4.7.1 CGA at DS0 Terminations

CFA Declaration

R4-58 **[211]** Detection of continuous LOS or OOF within the IDT or RDT for 2.5 (±0.5) seconds shall initiate a red alarm (CFA)[15] at the detecting terminal. An operations message reporting the CGA-RED alarm condition shall be sent, via the requirements of Section 5, to the appropriate OS.

12. A carrier failure alarm defines the beginning and end of a carrier system outage.

13. TC is per-channel signaling upon CFA declaration to release the connection, stop billing, and if a trunk circuit is involved, to remove the trunk from service (i.e., make the trunk appear busy). TC forces a channel associated with a carrier failure into a defined service-specific state.

14. Byte-synchronous are the key words for this concern in that only byte-synchronous transmission systems will frame on incoming DS1s to interpret/generate alarm- or performance-related data.

15. A red alarm is defined as a locally detected failure and a yellow alarm is defined as a remotely detected failure. Either a red or yellow alarm starts a CFA and the CFA controls the TC process.

R4-59 **[212]** Detection of 10 consecutive path SESs (see Section 4.6), without an associated protection switch, shall also initiate a red alarm (CFA) at the detecting terminal.

R4-60 **[213]** A red alarm (CFA) shall cause a yellow alarm signal to be transmitted to the far end, via the outgoing bitstream, as described in Section 4.9.1.

The terminal at the other end of the facility may recognize the yellow alarm signal in less than 335 ms (and declare a CFA) but must start the TC process within 335 to 1000 ms after the terminal detecting the outage began sending the yellow alarm signal. The needed coordination for removal and restoral of services is achieved by the timing sequences illustrated in Figure 4-2. IDLC equipment requirements for generation and receipt of the yellow alarm signal are in Section 4.9.1.

R4-61 **[214]** An IDT/RDT subjected to intermittent OOF or LOS shall initiate a red alarm (CFA) after a period of integration of the short outages. On detection of an OOF or LOS condition, an integration of time shall start that produces a red alarm after 2.5 (±0.5) seconds of continuous OOF or LOS. If the terminal starts to detect an incoming signal and regains frame synchronization, the integrator shall decay at a slope from 1/4 to 1/15 of the rise slope.

Trunk Conditioning

Upon declaration of a CFA, the channels inter-connecting the LDS and RDT need to be conditioned to achieve the following (more detail is given in the “Trunk Conditioning” subsections of Section 3.2.2):

a. Minimize the chance of a false billing and prevent attempts to use IDT-RDT channels for new calls by giving appropriate signaling indications to the LDS/RDT.

b. Automatically restore IDT-RDT channels to service in a coordinated manner after the trouble is cleared.

The LDS/IDT and RDT also need to initiate per-channel trunk conditioning, as specified in “Trunk Conditioning” subsections of Section 3.2.2, when a DS0 AIS code (replacement terminology for UNICODE) of sufficient duration is detected. DS0 AIS is a per-DS0 alarm signaling state supported by SONET-based DS0-processing equipment (refer to GR-253-CORE for more information). The advantage of implementing DS0 AIS in a network is to relieve the transmission facilities, multiplexers, and digital cross-connects from the burden of performing service-specific trunk conditioning in case of a carrier failure, thus simplifying both the hardware and software design of these equipment. With respect to DS0-AIS detection, Section 4.4.9 provides the requirements for the initial reaction to a detected DS0 AIS; i.e., freeze the signaling for that channel.

Removal from Service

R4-62 **[215]** IDTs and RDTs shall remove from service all DS0 channel terminations associated with a DS1 that is in CFA. However, if service channels are switched to a protection DS1 (refer to Section 6.2.1), then those channels are now associated with the DS0 channel terminations of the protection DS1 and are not removed from service.

Removal from service includes disconnecting the call, stopping billing, and marking the line unavailable in the LDS. This is accomplished via service-specific signaling procedures and is covered in Section 3.2.2.

R4-63 **[216]** The initiation of the trunk conditioning process, at both ends of the DS1, shall be timed in accordance with Figure 4-2.

R4-64 **[217]** Trunk conditioning shall also be performed on individual DS0 channels with DS0 AIS detected continuously for a period of 3.25 (±0.25) seconds.

… a. Service-specific trunk conditioning shall be performed on the locally terminated DS0s.

… b. Service-specific trunk conditioning via service-specific ABCD signaling codes shall be transmitted toward the far-end termination in the upstream direction.

R4-65 **[218]** When local trunk conditioning is started due to a received DS0 AIS, the capability to send a DS0 Yellow (as defined in Section 4.9.1 and illustrated in Figure 4-3) via the ABCD signaling bits of the DS0 channel in the upstream direction, instead of the service-specific trunk conditioning codes, shall be provided and shall be selectable on a per-DS0 basis.

R4-66 **[219]** If DS0 AIS is intermittently present, the timer (3.25 [± 0.25] seconds) shall be reset to zero seconds when DS0 AIS is not observed for four consecutive signaling-state cycles (i.e., ABCD bit-patterns).

Trunk conditioning also takes place at terminals detecting incoming yellow alarm signals, both “DS1 Yellow” and “DS0 Yellow,” as specified in Section 4.9.1.

Service Restoral

R4-67 **[220]** When the terminal detecting the carrier outage experiences 15 (±5) seconds of continuous in-frame operation and 10 consecutive seconds without a path SES, it shall start restoral at its end and stop transmission of the yellow alarm signal.

R4-68 **[221]** A terminal receiving a yellow signal shall not start its service restoral if the yellow signal can no longer be detected due to a loss of synchronization.

R4-69 **[222]** The termination of the trunk conditioning process, at both ends of the DS1, shall be timed in accordance with Figure 4-2.

R4-70 **[223]** Trunk conditioning shall also be released when DS0 AIS is not observed for four consecutive signaling-state cycles and a valid signaling code is detected.

4.7.2 CGA at DS0 Cross-Connects

In Integrated Network Access applications, DS0s from DS1s are cross-connected into other DS1s for eventual downstream termination. For DS0s using in-band (robbed-bit) signaling, all equipment providing such DS0 cross-connects must be capable of controlling per-DS0 in-band signaling during DS1 failure conditions. This includes freezing the signaling on initial DS1 trouble detection and subsequent trunk-conditioning if a CFA is declared. In the future, it is expected that equipment that does not terminate a DS0 (i.e.,the DS0 is re-transmitted on an outgoing DS1) associated with a DS1 in trouble, will use DS0 AIS to both freeze that DS0's signaling state and to initiate trunk-conditioning on that remotely terminated DS0. Most of the DS0-terminating equipment today, however, does not recognize DS0 AIS; for those DS0s, the “Signaling Freezing” and “DCS CGA Plan” requirements of TR-NWT-000170 (Sections 3.4.2 and 3.5.3, respectively) must be satisfied. For IDLC/Integrated Network Access interfaces, the IDT and RDT must meet the following DS0 AIS generation/detection requirements.

CR4-71 **[224]** For an IDT/RDT providing the DS0 cross-connect option, where the downstream DS0 termination supports DS0 AIS, the following shall be provided.

… a. When an OOF or LOS condition is detected, DS0 AIS shall be immediately inserted (i.e., all ones shall be inserted into affected DS0s and if the DS0 utilizes Robbed-bit Signalling, the DS0 AIS (UNICODE) code shall be inserted in the ABCD signalling bits) into all DS0 channels derived from the failed/failing DS1 that are cross-connected to outgoing DS1s.

… This is especially important on DS0 clear-channel access circuits that do not use ABCD signalling and may not have an opportunity to see the DS0 AIS code

… b. DS0 AIS insertion shall end when the OOF/LOS condition ends, unless a CFA has been declared.

… c. If a CFA has been declared, DS0 AIS shall be continuously inserted until the CFA is cleared.

The above criteria applies to both the IDT and RDT and shall be applied only in the downstream DS0 direction from where the defect/failure condition exists.

CR4-72 **[225]** For an IDT/RDT providing the DS0 cross-connect option, DS0 channels not supporting DS0 AIS shall be treated in accordance with the "Signaling Freezing" and "DCS CGA Plan" requirements of TR-NWT-000170.

Therefore, for declared failures, it is required to immediately replace the DS0 data with an idle PCM word compliant with the criteria in R4-39 [192] and Section 2.5.5 DCS CGA Plan of TR-NWT-000170 (Issue 2). Specifically, as stated in R-75 of TR-170, the insertion of Trunk Conditioning signaling codes shall be accompanied by the insertion of an 8-bit idle or multiplex out of service (MUX-OOS) code; Table 2-3 of TR-170 identifies the entire Trunk Conditioning signal (signaling and 8-bit code) for various types of access circuits. The above criteria applies to both the IDT and RDT, and shall be applied only in the downstream DS0 direction from where the defect/failure condition exists.

4.8 ESF Data Link For Facility Maintenance

As specified in Section 4.4.1, IDTs and RDTs must use a DS1 signal format based on the ESF interface specification in TR-NWT-000499. As illustrated in Table 4-2, the 24 F-bits[16] of the ESF format are distributed into 3 subchannels, as follows:

a. 6 F-bits (designated FPS-bits) per ESF, which make up a terminal synchronization channel; the effective bandwidth of this channel is 2 kb/s.

b. 6 F-bits (designated CRC-bits) per ESF, which make up a cyclic redundancy check channel; the effective bandwidth of this channel is 2 kb/s.

c. 12 F-bits (designated FDL-bits) per ESF, which make up an end-to-end data channel; the effective bandwidth of this channel is 4 kb/s.

The ESF specification (see TR-NWT-000499) specifies that the 4-kb/s FDL-bits be usable as both a message-oriented (i.e., 15-byte packet) data link, and as a bit-oriented data link using the bit-code-assignments of Table 4-3.

R4-73 **[226]** The appearance of any of the bit codes of Table 4-3, except for IDLE and PROTECTION SWITCH COMPLETE (see Section 12.6.2 for application specifics), shall pre-empt any message-oriented use of the FDL-bits.

16. Where an F-bit is defined as the 193rd bit of each frame.

CR4-74 **[227]** If a vendor wishes to use the FDL-bits in a proprietary manner, only the 16-bit codes of TR-NWT-000499 shall be used. Other codes may create operational problems with intermediate equipment.

R4-75 **[228]** Transmission and reception/interpretation of 16-bit codes shall be as specified in TR-NWT-000499, except as follows:

… a. For loopback codes, the requirements in Section 6.1.5 shall apply for all IDLC system loopbacks.

… b. Across the Generic IDLC Interface, the requirements in Section 12.6.2 shall dictate the use of the protection-switching codes if a DS1 Facility Protection Switch option is provided.

4.9 Facility Alarm/Performance Indications Via DS1

This section defines the use of the FDL-bits of the ESF specification to help achieve per-DS1 facility-alarm reporting between the RDT and IDT.

R4-76 **[229]** Alarms shall be reported from the RDT/IDT detecting a fault to the appropriate OSs, via the requirements of Section 5.

R4-77 **[230]** An operations message shall also be sent, from the RDT/IDT that detected the fault to the appropriate OSs, when the alarm condition has cleared, via the requirements of Section 5.

4.9.1 Yellow Alarm - Remote Alarm Indication (RAI)

The yellow alarm signal or Remote Alarm Indication (RAI) is used to indicate to the far end of a DS1 facility that a local CFA has been declared. The “Yellow” terminology is still used throughout this GR and should be considered equivalent to the “RAI” terminology in GR-820-CORE.

R4-78 **[231]** IDTs and RDTs shall be capable of generating and interpreting (even in the presence of a BER of 10^{-3}) the YELLOW code of Table 4-3.

R4-79 **[232]** IDTs and RDTs shall be capable of generating and interpreting the DS0 Yellow (RAI) code, as specified in GR-253-CORE.

… a. DS0 Yellow is defined as ABCD=0111.

… b. DS0 Yellow shall be detected as two consecutive sets of ABCD bits set to the “0111” code.

…

c. Removal of DS0 Yellow shall be detected as four consecutive sets of ABCD bits set to any other code than the "0111" code; the same code must persist for 12 ms.

R4-80 **[233]** The FDL-bits of the ESF specification shall be used for transmission of the YELLOW code between the IDT and RDT.

R4-81 **[234]** IDTs and RDTs shall generate a YELLOW code, and transmit it in the outgoing direction on the DS1 facility, when a local CFA is declared, in accordance with Figure 4-2.

R4-82 **[235]** The YELLOW code, as illustrated in Figure 4-2, shall be transmitted by IDTs and RDTs continuously (the only permitted interruptions are for a maximum of 100 ms per interruption with a minimum interval of one second between interruptions, per Section 10.2.4.3.C of TR-NWT-000499) for the duration of the local CFA.

R4-83 **[236]** IDTs and RDTs shall interpret receipt of YELLOW codes in accordance with the yellow-alarm recognition/timing requirements of Section 4.7 and Figure 4-2.

R4-84 **[237]** A valid yellow alarm signal shall cause the detecting IDT/RDT to declare a CFA and to begin trunk conditioning. The operations message (see Section 4.9) shall indicate a CGA-YEL condition.

4.9.2 Alarm Indication Signal (AIS)

The AIS indicates to the receiving terminal that a trouble condition exists in the DS1 path between DS1-terminating equipment, but that the trouble is not located in the adjacent link (i.e., equipment between the IDT and RDT has detected a DS1 failure and replaced the failed DS1 with an AIS).

R4-85 **[238]** IDTs and RDTs shall be capable of interpreting an AIS signal format where the DS1 is unframed and all 1s. Per Section 5.4.1 of TR-TSY-000191, an incoming signal that does not have framing but does have a ones density of at least 99.9% (to allow for a BER of 10^{-3}) shall be identified as a DS1 AIS.

R4-86 **[239]** If a CFA is declared (see Section 4.7) and a valid AIS condition has been detected, then a CGA-AIS shall be declared instead of CGA-RED; the operations message (see Section 4.9) shall indicate a CGA-AIS condition.

R4-87 **[240]** IDTs and RDTs shall also transmit an AIS toward the other end of the DS1 facility, during any near-end loop back of the transmit section to the receive section of any DS1 line interface circuit; a far-end protection switching inhibit may be needed during such testing operations to preclude unintentional facility protection switching (see Section 6.2.1).

4.9.3 Yellow Response to CGA-AIS

R4-88 **[241]** IDTs and RDTs shall transmit a YELLOW code (as defined in Section 4.9.1), upon declaration of a CGA-AIS condition (as specified in Section 4.9.2), in the direction of the incoming AIS.

4.9.4 Far-End Performance Data

IDTs and RDTs need to be capable of reporting DS1-path performance data back to the near-end terminating equipment (IDT, RDT, or equipment terminating a DS1 Extension[17]) to satisfy the ESF interface requirements of TR-NWT-000499. Parameters similar to the ones defined in Section 4.6.1 can be accumulated from information received, once each second, via the 15-byte Performance Report Message (PRM) on the ESF FDL of each DS1. Definitions and criteria for using the PRM are in Section 10.2.4.3.B of TR-NWT-000499.

R4-89 **[242]** All DS1 interfaces at the IDT and RDT shall generate and transmit, at 1-second intervals, PRM information on the FDL of each DS1.

CR4-90 **[243]** In some applications, it may be required that the IDT/RDT interpret, store, and threshold PRM information.

CR4-91 **[244]** If not required to interpret PRM messages, the IDT/RDT shall be capable of ignoring them.

When provided, the following requirements on parameter interpretation, storage, and thresholding must be satisfied:

CR4-92 **[245]** For PRM interpretation, the C/R bit value in octet 2 of the PRM shall be ignored.

CR4-93 **[246]** Far-end performance parameters similar to those accumulated in Section 4.6.1 are defined in Section 4 of GR-820-CORE and shall be accumulated from information in the PRM on the FDL of each DS1 for each of the following parameters:

17. Refer to Section 3.7.4 for requirements related to the “DS1 Extension” Option.

… a. CV-PFE

… b. ES-PFE

… c. SES-PFE

… d. CSS-PFE

… e. SEFS-PFE

… f. UAS-PFE

… g. FC-PFE

… h. ES-LFE.

CR4-94 **[247]** The data storage requirements for the above far-end parameters shall be the same as for similar near-end parameters of Section 4.6.1.

CR4-95 **[248]** The threshold setting requirements for generation of Threshold-Crossing Alert messages shall be the same for the above far-end parameters as for similar near-end parameters of Section 4.6.2.

4.10 Data Link

4.10.1 General

A data link is a communication path between two or more control circuits. Because of the single-ended attributes[18] of the IDLC-system architectures described in this GR, one or more IDT-RDT data links (DLs) will be required. These DLs will allow IDTs and RDTs to be compatible with network operational strategies for alarm surveillance, performance monitoring, maintenance (including test access), and memory administration (provisioning). Also realizable via these DLs will be intra-IDLC-system opportunities for concentration mappings, data audits, call processing, and bandwidth management.[19]

As Section 4.4.1 describes, a 4-kb/s data link is available in each ESF DS1 between the IDT and RDT. DS0 channels may also be used as data links.

The following subsection specifies general requirements for data links that apply to any data-link implementation. To meet the Generic IDLC Interface, the requirements of Section 12 shall be satisfied.

18. Specifically with respect to operational strategies and call-processing intelligence.

19. ISDN provides some unique bandwidth-management challenges to IDTs and RDTs, as described in Section 3.6.

4.10.2 Requirements

For IDLC applications, any implementation of data-linking capabilities between the IDT and RDT requires the following:

R4-96 **[249]** Data-link connections shall be within the bandwidth of the interconnecting DS1-rate signal.

R4-97 **[250]** Sequence control, to maintain the sequential order of messages between the IDT and RDT, shall be provided, irrespective of the number of DLs implemented between the IDT and RDT, and the traffic handling strategies.

R4-98 **[251]** Transmission, format, and operational errors on the data link, shall be detected and recovery strategies from detected transmission, format, and operational errors, shall be implemented.

… a. If the data-link control circuits cannot recover from the detected errors, a “DL Failure” condition shall be declared and the appropriate application process of the IDLC system shall be notified.

… b. Upon declaration of a “DL Failure,” the IDLC system shall notify the opposite end, and each end shall take steps to effect a coordinated switch-over, re-arrangement, or whatever is necessary to satisfy the IDT-RDT communications criteria of Section 4.10.1; refer to Section 6.1.4 for Data Link Protection strategies and timing requirements. In summary, some method of maintaining DL communications shall be provided if a primary DL fails.

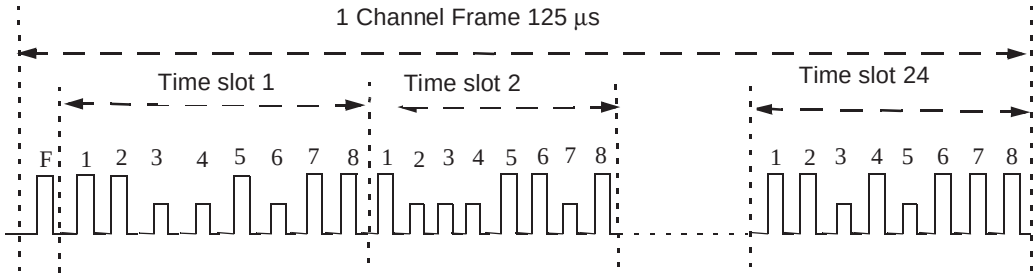
… c. In reporting DL failures to OSs, IDTs and RDTs shall report a minor alarm when the system successfully maintains DL capabilities during the “DL Failure” condition. If the system cannot maintain DL capabilities during the “DL Failure” condition, the report shall be the highest alarm the system is allowed to report (usually dependent on the number of lines supported).[20]

… d. The IDLC system shall continue to monitor any failed DLs. A DL shall be declared in-service when it is detected to be without error,

20. No services may be affected, but because all operational communications between the RDT and IDT have been lost, a service-affecting alarm at the RDT would not be detectable, this is viewed as the highest alarm situation available to the system.

and the system shall automatically restore the DL as specified in Section 6.1.4.

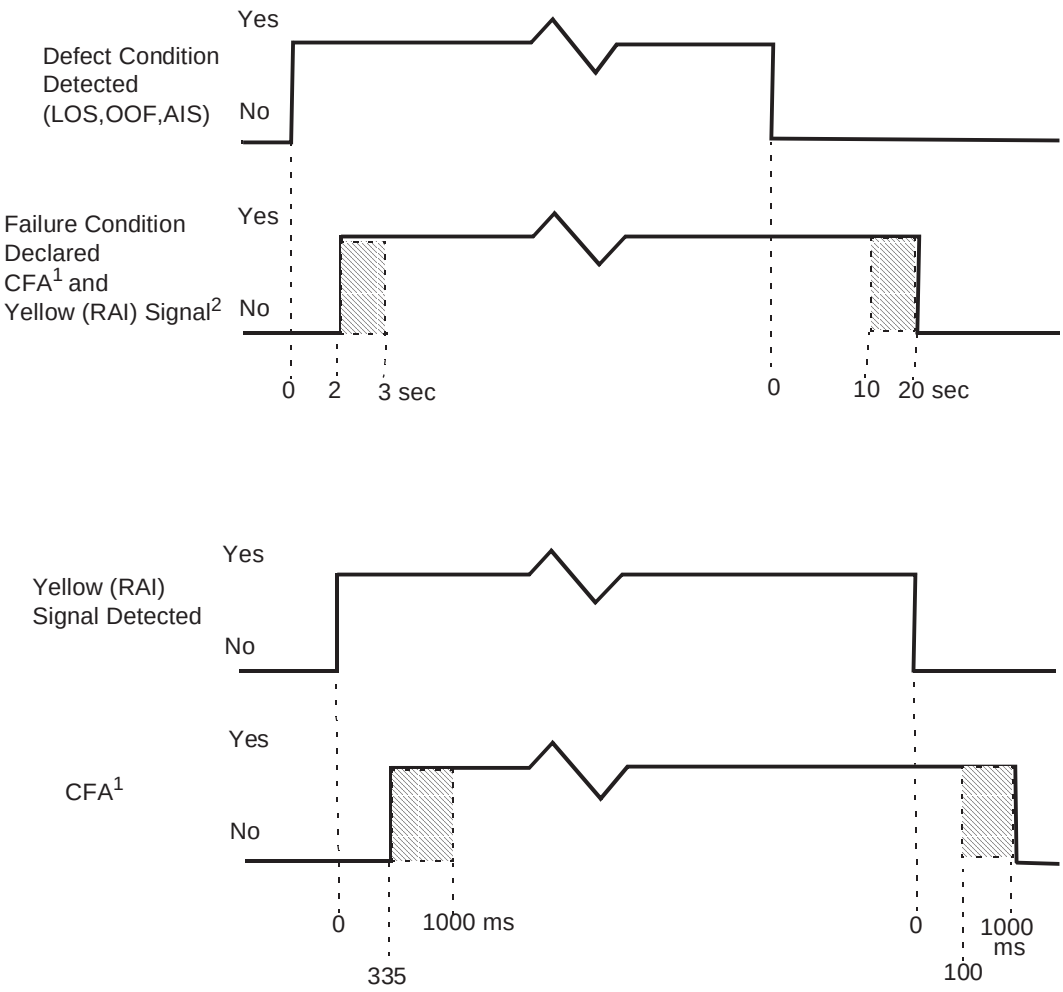
R4-99 **[252]** Flow control[21] of information transfer between the ends of the data link shall be provided.



Sampling frequency	8000 Hertz
Output bit rate	1.544 mbps
Bits/channel frame	193
Time slots/channel frame	24
Signaling	Eighth bit every sixth frame

Figure 4-1. Channel Frame Organization

21. Flow control is the means by which the receiving end of the data link controls the rate at which data is transmitted from the source.



1. CFA controls the Trunk Conditioning process.
2. CFA and Yellow (RAI) Signal are also activated after ten consecutive path SESs and deactivated after ten consecutive seconds without a path SES. No additional delays are required for these actions.

Figure 4-2. DS1 CFA Timing

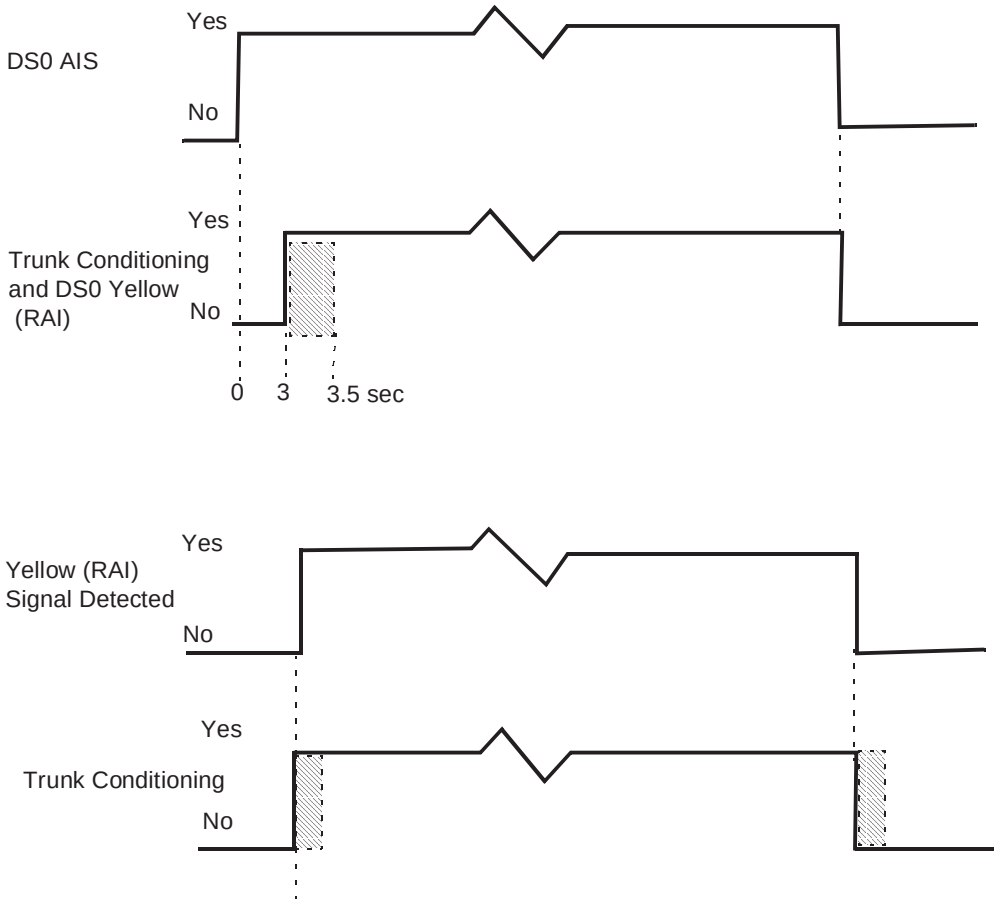


Figure 4-3. DS0 AIS/Yellow (RAI) Timing

Table 4-1. Default Values for DS1 Alert Declarations

	PERFORMANCE ALERT THRESHOLDS			ACTION	TO INITIATE PROT. SWITCH	
	#/ day	#/15-min.	BER BENCHMARK		CVs/sec.	BER BENCHMARK
CV-P	N/R	N/R			124 CRCs	10^{-4}
CV-L	N/R	N/R			154 BPVs	
CSS (DS1 Ext. & Multihosting)	**4**	**1**	PERFORMANCE OBJECTIVE	TC ALERT --> OS		
ES-P	648	65	SERVICE OBJECTIVE	TC ALERT --> OS		
SES-P	100	10	10^{-3}	May have protection switched before these thresholds are reached: **TC** ALERT --> OS		
UAS-P	10	10	10^{-3}	Should have protection switched (if supported) before these thresholds are reached: **TC** ALERT --> OS		

TC = Threshold Crossing
BER = Bit Error Ratio
OS = Operations System
N/R = Not Required

Table 4-2. Extended Superframe (ESF) Format

ESF		F BITS			BIT USE IN EACH CHANNEL TIME SLOT		SIGNALING BIT USE OPTIONS			
FRAME NO.	BIT NO.	FPS	FDL	CRC	TRAFFIC	SIGNAL-ING	T	2	4	16
1	0	-	m	-	BITS 1-8					
2	193	-	-	C1	BITS 1-8					
3	386	-	m	-	BITS 1-8					
4	579	0	-	-	BITS 1-8					
5	772	-	m	-	BITS 1-8					
6	965	-	-	C2	BITS 1-7	BIT 8	-	A	A	A
7	1158	-	m	-	BITS 1-8					
8	1351	0	-	-	BITS 1-8					
9	1544	-	m	-	BITS 1-8					
10	1737	-	-	C3	BITS 1-8					
11	1930	-	m	-	BITS 1-8					
12	2123	1	-	-	BITS 1-7	BIT 8	-	A	B	B
13	2316	-	m	-	BITS 1-8					
14	2509	-	-	C4	BITS 1-8					
15	2702	-	m	-	BITS 1-8					
16	2895	0	-	-	BITS 1-8					
17	3088	-	m	-	BITS 1-8					
18	3281	-	-	C5	BITS 1-7	BIT 8	-	A	A	C
19	3474	-	m	-	BITS 1-8					
20	3667	1	-	-	BITS 1-8					
21	3860	-	m	-	BITS 1-8					
22	4053	-	-	C6	BITS 1-8					
23	4246	-	m	-	BITS 1-8					
24	4439	1	-	-	BITS 1-7	BIT 8	-	A	B	D

NOTES

FPS - Framing Pattern Sequence (...001011...)
FDL - 4 kb/s Facility Data Link (message bits m)
CRC - CRC-6 Cyclic Redundancy Check (bits C1-C6)
Option T - Transparent (bit 8 for traffic)
Option 2 - 2-State Signaling (channel A)
Option 4 - 4-State Signaling (channels A and B)
Option 16 - 16-State Signaling (channels A, B, C and D)

Table 4-3. ESF Data Link Bit Code Assignments

FUNCTION	16-BIT CODE ASSIGNMENT
IDLE	0 111111 0 01111110
YELLOW (RAI)	0 000000 0 11111111
LINE LOOPBACK ACTIVATE*	0 000111 0 11111111
LINE LOOPBACK DEACTIVATE*	0 011100 0 11111111
PAYLOAD LOOPBACK ACTIVATE*	0 001010 0 11111111
PAYLOAD LOOPBACK DEACTIVATE*	0 011001 0 11111111
NETWORK LOOPBACK ACTIVATE**	0 001001 0 11111111
UNIVERSAL LOOPBACK DEACTIVATE**	0 010010 0 11111111
PROTECTION SWITCH LINE 1+	0 100001 0 11111111
PROTECTION SWITCH LINE 2	0 100010 0 11111111
PROTECTION SWITCH LINE 3	0 100011 0 11111111
|	|
|	|
|	|
PROTECTION SWITCH LINE 26	0 111010 0 11111111
PROTECTION SWITCH LINE 27	0 111011 0 11111111
PROTECTION SWITCH LINE 28	0 111100 0 11111111
PROTECTION SWITCH ACKNOWLEDGE	0 001100 0 11111111
PROTECTION SWITCH COMPLETE	0 010101 0 11111111
PROTECTION SWITCH RELEASE	0 010011 0 11111111
FORCED PROTECTION SWITCH RELEASE	0 001101 0 11111111

The rightmost bit of the above 16-bit codes is transmitted first.

* For RDT-CPE (DS1 Extension) loopbacks.
** For RDT-IDT (IDLC) and RDT-DNE (DS1 Extension) loopbacks.
+ The “PROTECTION SWITCH LINE” codes of the form 01xxxxx0 11111111 use the 5 “x” bits to indicate the number of the line, 1 through 28, to be switched to a protection line, with the least significant bit of the line number (rightmost “x” bit) transmitted first.

This table does not identify all current code assignments, but only those assignments that may apply to IDTs and RDTs.

5. Operations System Interfaces

From an operations point of view, the IDT of an IDLC system will be treated as part of the local switching system and the Remote Digital Terminal (RDT) of an IDLC system will be treated as a separate Network Element (NE). For IDLC systems with a proprietary interface between the IDT and RDT, operations messages for the RDT may be processed in the LDS or routed to the RDT for processing; the supplier determines how this will be done. However, for IDLC systems using the Generic IDLC Interface defined in Section 12 between the IDT and RDT, operations messages for the RDT are processed in the RDT. The OSs will generate all operations messages for the RDT as if they were to be processed in the RDT, i.e., the message will contain the information required to route the message to the RDT.

CR5-1 **[253]** If the LDS generates operation message responses or autonomous messages (e.g., alarm messages) as an agent for the RDT, the following requirements shall be met:

… a. The LDS shall NOT send an operation message response to the OS until the LDS has determined the RDT's response to the given operations message.

… b. The operation message response sent to the OS shall reflect the RDT's response to the given operations message.

… c. The operation message responses and autonomous messages shall be identified as coming from the RDT.

R5-2 **[254]** The interface between an IDLC system and an OS shall be through the Operations Interface Module (OIM) of the LDS containing the IDLC system's IDT.

R5-3 **[255]** The OIM interface in the LDS shall include an operations interface to OSs that meets the physical, data link, and network layer protocol requirements described in TR-TSY-000827.

R5-4 **[256]** The OIM interface in the LDS shall include an operations interface to OSs that meet the requirements described in GR-828-CORE.

The interface described in TR-TSY-000827 is used when a non-OSI communications architecture is implemented. This architecture is used by Test System Controller/Remote Test Unit (TSC/RTU) systems to communicate with Metallic Test Access Units (MTAUs) and Digital Test Access Units (DTAUs). It is expected that these systems will continue to use the non-OSI communications architecture for several years. This architecture is also suitable for use by Mediation Devices (MDs) or Supervisory Systems (SSs) during the transition to a full-function OS environment.

The interface described in GR-828-CORE is used when the communications architecture is based on the Open System Interconnection (OSI) reference model. The requirements are applicable to operations interfaces that support transaction (interactive) and/or file oriented applications. At this time, the OIM for IDLC applications is only required to support transaction oriented applications for an IDLC RDT, although it may be required to support file-oriented applications in the future. This architecture will find use in OS-to-LDS and OS-to-RDT communications as the OS environment migrates to the OSI architecture. Therefore, an OIM needs to support both the non-OSI and the OSI interfaces to cover all the remote operation needs of an IDLC system during the transition to an OSI communications architecture.

Requirements for memory administration, maintenance, and circuit testing are discussed in the remainder of Section 5.

R5-5 **[257]** The functional requirements in this section shall be implemented using the services and information model defined in GR-2833-CORE.

CR5-6 **[258]** On an interim basis, the services and information model defined in Supplement 3 of TR-TSY-000303 may be used to support management functions between the IDT and the RDT.

An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.

5.1 Memory Administration

Memory administration requirements have been included in Section 5.4.

5.1.1 Circuit Provisioning

Circuit provisioning requirements have been included in Section 5.4.

5.2 System Maintenance

System maintenance requirements have been included in Section 5.4.

5.2.1 Maintenance Operations System Interfaces

Requirements associated with maintenance functions have been included in Section 5.4.

5.2.2 Interfacing Existing Operations Systems

During the transition period, OSs supporting the generic OS/NE interfaces between an OS and a NE described in TR-TSY-000827 and GR-828-CORE may not be available in each place an IDLC system is installed. In these situations, the LDS will interface one of the existing OSs.

Stored Program Control Systems (SPCSs) report their alarms and other maintenance information to a Maintenance Control Center (MCC). The interface between the switching system and the maintenance center OS varies by switching system and OS. Generally, MCCs have two interfaces to a LDS: (1) a message oriented interface for maintenance and administrative data, and (2) a telemetry oriented interface for alarms, status, and control points for emergency service protection. TA-TSY-000387 contains the generic requirements for a widely deployed OS used in the MCCs.

CR5-7 **[259]** When the generic OS/NE interface to the network monitoring and maintenance (surveillance) OS(s) is not available, the IDLC system's maintenance and administrative messages shall be sent to the MCC using the LDS's interface to the OS used in the MCCs.

A second interface that is generally available between the LDS and MCC is one of the telemetry oriented interfaces described in MDP-326-600 (also known as PUB 4900).

The same interfaces are used by other NEs to interface existing OSs. MDP-326-600 describes the following two interfaces:

a. An interface compatible with E2A Telemetry Status and Command (SAC) remote that requires scan-point inputs (contact closures) for alarm surveillance and control-point outputs (relay closures) for control operations, and

b. An interface compatible with E2A Alarm Processing Remote (APR) Section 3 of MDP-326-600.

R5-8 **[260]** The IDLC system shall provide the E2A Telemetry Status and Command interface.

O5-9 **[261]** It is desirable that the IDLC system also offer the E2A Alarm Processing Remote as an option.

Additional information on the compatibility requirements of telecommunications equipment with surveillance and control systems can be found in MDP-326-600.

The message oriented interface between the LDS and its network and monitoring OS may carry all the surveillance and maintenance data required, but the E2A telemetry interface is still needed by those telephone companies that want to route the alarms, status, and control information to other work centers and OSs.

R5-10 **[262]** The IDLC system shall provide the capability to upgrade from either one of the above two interfaces to the interface described in TR-TSY-000827 or the interface described in GR-828-CORE.

O5-11 **[263]** Capabilities to implement this upgrade without service interruption or generic updates of the IDLC software should be provided.

R5-12 **[264]** The alarms to be reported through the E2A telemetry interface shall stay active for a minimum of 20 seconds even if the trouble clears, to allow time for detection by systems that periodically scan for activity.

R5-13 **[265]** Short duration alarms reported through the E2A telemetry interface shall not be kept active or stretched beyond the 20 seconds needed to accommodate periodic scanning for activity.

The alarm severity classifications are defined in Section 6.1.3.2. Performance monitoring requirements of Section 4.6 do not apply to the E2A telemetry interfaces.

5.2.3 Guidelines for Supervisory Systems

If the desired remote OSs or their functions are not available, an interim alternative is to provide some or all remote operations capabilities such as the capability to provision plug-ins for service activation, provide surveillance of alarms and performance data, provide test access, and provide inventory of the equipment and software present in the IDT and RDT. This functionality can be provided by a supplier specific supervisory system.

CO5-14 **[266]** When the generic OS/NE interface to OSs that manage the IDT are not available, or the OSs do not provide the required functionality, the switching system should provide the capability to manage the IDT through the OSs that manage the switching system.

CO5-15 **[267]** When the generic OS/NE interface to OSs that manage the RDT are not available, or the OSs do not provide the required functionality, a supervisory system should be provided that conforms to the requirements and objectives in SR-NWT-002166 to provide or supplement the functionality of the OSs.

5.3 Circuit Test Capability

Circuit testing requirements have been included in Section 5.4.

5.4 IDLC Operations Requirements

5.4.1 Introduction

An IDLC system offers various features, capabilities, and functionality that enhance a conventional DLC system to provide flexibility and potential operation cost savings. Some of these features include ISDN service support, grooming special services, dynamic Time Slot Interchanger (TSI), and remote operations over an open interface.

One of the features offered by a GR-303 compliant IDLC system is remote provisioning and flow-through maintenance capabilities. These remote operations aim to reduce dispatch activities and operations cost. In addition, these operations capabilities are to be provided over generic open (external) interfaces enabling generic control of systems involving different supplier products. The objective is to interwork any GR-303 compliant RDT with any switch supplier's GR-303 compliant IDT and any managing system such as an Operations System (OS) that supports the GR-303 operations requirements using a common managing system-NE interface.

A remote management system, as specified in the criteria throughout this section, can be an OS, EM, or LDS, if that OS, EM, or LDS satisfies all the TMN operations criteria associated with the operations function being provided.

This section provides a collection of operations requirements for external communication to an IDLC system. In particular, this section addresses the detailed operations needs across the following three common external interfaces: IDT-RDT, managing system-RDT, and managing system-IDT. These operations interface requirements also apply to craft interfaces which are not explicitly described here. The requirements in this section also support relevant generic operations requirements described in GR-472-CORE and GR-820-CORE. The operations requirements are message language independent (i.e., apply to CMISE or TL1 message sets). They may be used for operations planning, prioritizing, and customizing according to each network provider's specific operations needs and environment. The requirements also serve as a base for NE operations conformance testing and OS (managing system) development to achieve remote operations capabilities of the IDLC system and integration of multi-supplier systems.

It is emphasized that the requirements in this section serve as a basic guideline for operations exchanges over the common interfaces for the IDLC system. An individual network provider is likely to modify these requirements according to specific operations environments and needs. Suppliers should respond to the Request for Proposal (RFP) from each network provider to meet specific needs of that network provider.

The requirements in this section cover network capacity activation, inventory assignment, service activation, and service assurance.

Using Telecommunications Management Network (TMN) standards terminology, the requirements cover three of the five TMN management categories: configuration

management, performance management, and fault management. Accounting management is outside the scope of IDLC operations and is not included, while security management over external interfaces for the IDLC system is still under study. Thus, no detailed interface requirement on security is provided in this section.

Network capacity activation and service activation share many operations such as provisioning the termination points and cross connections. In network capacity activation, resources are usually pre-provisioned, i.e., the resource is given all the data it needs but set to an out-of-service or lock state. Compared to service activation, a resource may need to be provisioned if no available pre-provisioned resource is available and immediately be assigned to fulfill a service order. That is, the resource is given all the data it needs and is set to an in-service state assigned to a customer. The operations message for providing a resource with the needed data is the same for network capacity activation and service activation, and thus does not need separate requirements.

In addition, most of the operations carried out for inventory assignment are needed to complete capacity activation and service activation. For example, assignment and keeping track of available termination points of an IDT (Interface Group [IG]) is information needed during provisioning and pre-provisioning operations performed during capacity and service activation. Thus, Section 5.4.2 combines the operations for network capacity activation, service activation, and inventory assignment together as configuration management operations.

Besides provisioning for service activation, additional provisioning operations functions for setting up maintenance capabilities such as setting threshold values, provisioning for protection switching, and provisioning for collecting performance monitoring data are needed. These operations are presented with the maintenance operations in Section 5.4.3 to preserve an orderly operations flow. A managing system engineer concerned with configuration management should read Section 5.4.2 and parts of Section 5.4.3.

Service assurance involves performance and fault management. Section 5.4.3 presents the service assurance operations interface requirements and their respective provisioning requirements. A managing system engineer concerned with maintenance functions should read Section 5.4. 3 and refer to Section 5.4.2 for control and status requirements that are likely to be used when setting a resource out-of-service to perform a test or maintenance.

5.4.2 Configuration Management

Configuration Management involves setting up or provisioning resources and administrating data in the NE to enable proper performance of the NE functions.

For an IDLC system, provisioning resources include assignment of the DS1 facilities, EOC, TMC/CSC, customer access termination points, cross connections, and equipment such as plug-in slots and plug-ins. These provisioning operations are mostly performed during capacity activation and service activation.

Relevant administrative operations for the IDLC system include adding, deleting, querying, and modifying system-dependent data such as date, time, system code or ID, receiving reports, scheduling reports of status or value changes, and memory backup and restoration.

The RDT also needs to be provisioned to perform maintenance functions such as performance monitoring, threshold setting, alarm reports, protection switching, and metallic test access. The provisioning operations for these functions are usually performed during capacity activation and service activation along with configuration management functions. However, the provisioning for maintenance capabilities is not included in this section. It is presented in Section 5.4.3 along with the detailed operations functions for maintenance.

5.4.2.1 NE Data Administration

For management purposes, the RDT and the IDT are identified as two distinct managed resources, while only the termination points of the digital transmission facility (DTF) are identified and managed as resources, not the DTF itself. Managed resources have distinct names referenced by the managing system during operations message exchanges. Specific characteristics of each of the managed resources are also identified and made accessible for operations exchanges.

This subsection provides the requirements for adding, deleting, modifying, and querying the system-dependent data of the RDT and the IDT by a managing system (e.g. OS). The requirements for provisioning the termination points of the DTF and the EOC and TMC/CSC are in the Provisioning DTF subsection.

System-dependent data is information that affects the NE as a whole. It is the basic set of information about the NE and is loaded or initialized during installation with little or no changes required on a daily basis.

R5-16 **[268]** An RDT shall receive from a remote managing system and process requests to configure and to retrieve the following information about the RDT:

… a. System physical location code/ID

… b. System software version

… c. System time of day.

R5-17 **[269]** An RDT shall receive from a remote managing system and process requests to retrieve its system ID. The identification is entered at the RDT by the user. For example, it may be entered by switch or thumb-wheel settings.

R5-18 **[270]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve synchronization timing sources with an indication of which DS1s are used:

… a. Primary system timing source (internal-RDT clock, remote-Building Integrated Timing Supply, or slaved-DS1)

… b. Secondary system timing source (internal, remote, or slaved).

CR5-19 **[271]** If needed by a network provider, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following RDT system information:

… a. User-assigned system name (user friendly name)

… b. System vendor name

… c. System model information.

The following requirements on status and control of the overall RDT and IDT may also be used during service assurance (e.g., placing out-of-service for maintenance purposes). Placing an RDT out-of-service means stopping it from providing access services to the customers. It does not mean cutting off communication with a managing system that controls the RDT.

R5-20 **[272]** An RDT shall receive from a remote managing system and process requests to place the RDT out-of-service or in-service. An RDT shall confirm with the managing system before executing the request to place the system out-of-service.

R5-21 **[273]** An RDT shall receive from an LDS and remote managing system and process requests to retrieve the service status of the RDT (in or out of service).

R5-22 **[274]** Upon request by a remote managing system, an RDT shall provide a managing system with the RDT operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-23 **[275]** Upon request by a remote managing system, an RDT shall provide a managing system with the RDT operating capacity status indicating whether it is operating at maximum or minimum capacity or has spare capacity to accept more users.

R5-24 **[276]** Upon request by a remote managing system or an LDS, an RDT shall provide the LDS or the managing system with the RDT overall alarm status indicating whether it is under repair, has one or more critical alarms,

one or more major alarms, one or more minor alarms, or one or more alarms still outstanding.

R5-25 **[277]** Upon request by a remote managing system, an RDT shall provide a managing system with the set of current problems still outstanding in the RDT indicating the probable cause of the problem and the severity of each problem.

5.4.2.2 Provisioning NE Equipment

This subsection contains the requirements for provisioning equipment components in the RDT that provide support to termination points or circuits. These managed hardware resources include plug-in slots, plug-ins, and memory devices.

- Memory Device

  The requirements on memory devices are based on Section 6.1.2 of this document, and partially on the generic functional requirements in GR-472-CORE.

  A memory device is the physical storage medium such as a hard disk or a tape used for storage of software or a database including binary images. Management of the storage device should not be confused with management of the individual software files or database files stored in the device. Messages for managing individual files are listed under software control in Section 5.4.2.5.

R5-26 **[278]** An RDT shall receive from a remote managing system and process requests to restore the RDT's volatile memory from the non-volatile memory.

R5-27 **[279]** An RDT shall receive from a remote managing system and process requests to assign and retrieve the capability to inhibit/allow automatic memory restoration from memory backups stored at the RDT.

R5-28 **[280]** An RDT shall receive from a remote managing system and process requests to allocate and to retrieve the RDT memory capacity (e.g., CPU, disk space, memory, etc.).

R5-29 **[281]** An RDT shall receive from a remote managing system and process requests to retrieve the RDT memory size usage.

R5-30 **[282]** An RDT shall receive from a remote managing system and process requests to retrieve the available memory size in the RDT.

R5-31 **[283]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the role of the RDT memory. The role of a memory device includes a working memory, a primary local backup memory, or a secondary local backup memory.

R5-32 **[284]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the number of memory modifications made or time interval as a threshold to trigger automatic backup of the memory.

R5-33 **[285]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the write-count threshold for a memory device before the device loses its restorability.

R5-34 **[286]** An RDT shall autonomously notify a remote managing system when the write cycle count of a backup memory exceeds the threshold.

O5-35 **[287]** An RDT should receive from a remote managing system and process requests to assign and to retrieve the destination for automatic memory backup.

O5-36 **[288]** An RDT should receive from a remote managing system and process requests to assign and to retrieve the availability of the automatic restoration of memory capability (enable or disable).

O5-37 **[289]** An RDT should receive from a remote managing system and process requests to assign and to retrieve the source for automatic memory restoration.

The following status and control operations for memory devices may also be used during service assurance (e.g., to restore a corrupted memory device).

O5-38 **[290]** An RDT should receive from a remote managing system and process requests to place the RDT memory device out-of-service or in-service.

O5-39 **[291]** An RDT should receive from a remote managing system and process requests to retrieve the service status of the RDT memory device (in or out of service).

O5-40 **[292]** Upon request by a remote managing system, an RDT should provide a managing system with the RDT memory device operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

O5-41 **[293]** Upon request by a remote managing system, an RDT should provide a managing system with the last backup time and last backup destination.

O5-42 **[294]** Upon request by a remote managing system, an RDT should provide a managing system with the last restoration source and the last restoration time.

O5-43 **[295]** An RDT should receive from a remote managing system and process requests to backup the RDT memory device.

R5-44 **[296]** An RDT shall receive from a remote managing system and process requests to restore the RDT memory device.

R5-45 **[297]** An RDT shall receive from a remote managing system and process requests to compare content in the RDT working volatile memory with the non-volatile backup memory.

O5-46 **[298]** An RDT should receive from a remote managing system and process requests to audit the RDT memory device.

O5-47 **[299]** An RDT should receive from a remote managing system and process requests to abort an audit of the RDT memory device.

O5-48 **[300]** An RDT should receive from a remote managing system and process requests to schedule for periodic auditing of the RDT memory device.

O5-49 **[301]** An RDT should report to a managing system when a scheduled audit occurs.

R5-50 **[302]** An RDT shall provide for periodic backup of the RDT memory.

O5-51 **[303]** An RDT should receive from a remote managing system and process requests to schedule for periodic backup of the RDT memory.

O5-52 **[304]** An RDT should autonomously report to a managing system when a scheduled backup occurs.

O5-53 **[305]** An RDT should receive from a remote managing system and process request to provision for full or incremental backup of the RDT memory.

O5-54 **[306]** An RDT should receive from a remote managing system and process request to place the scheduler for backup or audit in-service and out-of-service.

O5-55 **[307]** An RDT should receive from a remote managing system and process requests to retrieve the service status of the scheduler for backup or audit (in-service and out-of-service).

O5-56 **[308]** Upon request by a remote managing system, an RDT should provide a managing system with the operational status of the scheduler for backup and audit indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

- Plug-in Slot

R5-57 **[309]** An RDT shall receive from a remote managing system and process requests to retrieve the following information about the slots in the RDT:

… a. The slot type (e.g. bay, shelf, drawer, slot, etc.)

… b. The slot physical location (e.g. COMMON LANGUAGE® Frame Identification Code).

R5-58 **[310]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the plug-in type allowed for a slot, e.g., CLEI™ codes.

- Plug-in Card

R5-59 **[311]** An RDT shall provide automated self-discovery capabilities for all plug-in units installed in the RDT and receive from a remote managing system and process requests to retrieve the following information:

… a. plug-in type, e.g., CLEI codes

… b. the serial number or other code that can be used to identify the place of manufacture and the date of manufacture.

R5-60 **[312]** An RDT shall store all user-settable data associated with a plug-in unit in a manner that will retain the data when the plug-in is removed.

Thus, whenever a plug-in is changed for maintenance or other reasons, the replacement plug-in will be provisioned in the same manner as the original plug-in, without requiring new provisioning transactions.

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CR5-61 **[313]** If a plug-in card in an RDT has associated software, the RDT shall receive from a remote managing system and process assignment of the software version to the card.

CR5-62 **[314]** If a plug-in card in an RDT has associated software, upon request by a remote managing system, the RDT shall provide the managing system with the software version assigned to the card, including software patches.

O5-63 **[315]** An RDT should receive from a remote managing system and process requests to retrieve plug-in information for plug-ins that are physically inserted into any slot even though it may be inserted into an incorrect slot.

CR5-64 **[316]** If a plug-in of an RDT is capable of detecting and reporting an alarm, the RDT shall receive from a remote managing system and process assignment and retrieval of alarm severity code to the plug-in.

The following status and control operations may also be used during service assurance (e.g., placing a troubled plug-in card out-of-service).

R5-65 **[317]** An RDT shall receive from a remote managing system and process requests to place a plug-in card in the RDT out-of service or in-service.

R5-66 **[318]** An RDT shall receive from a remote managing system and process requests to retrieve the service status of the plug-in card in the RDT (in or out of service).

R5-67 **[319]** Upon request by a remote managing system, an RDT shall provide a managing system with the RDT plug-in card operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-68 **[320]** Upon request by a remote managing system, an RDT shall provide a managing system with the set of current problems still outstanding for the plug-in card indicating the probable cause of the problem and the severity of each problem.

R5-69 **[321]** An RDT shall indicate to a managing system whether the plug-in card installed in the RDT is the correct card as the slot is provisioned.

The following represents the requirements for RDT restoration from a remote backup. Local memory backup capability at the RDT satisfies most data restoration needs of an RDT, but not for catastrophic failures of the RDT that include the non-volatile memory; i.e., failures where the RDT has to be totally re-provisioned from a remote backup. These requirements apply to the target operations environment where an EMS manages an RDT

and the LDS manages a small portion of RDT data. In the absence of an EMS, only the last two requirements apply.

R5-70 **[1825]** The backup of RDT memory is an EML function. The backup system will be responsible for:

… 1. generating periodic binary image backups of the RDT memory onto a media that is physically remote from the RDT

… 2. and using this backup to restore the memory after a catastrophic failure.

R5-71 **[1826]** The backup system shall

… 1. maintain a log of provisioning messages since the last backup

… 2. log the provisioning messages it has sent to the RDT

… 3. receive updates made via a craft interface terminal or other managing system via change notification reports (e.g., attribute value change, object creation, object deletion)

… 4. convert these change notifications and store them in the log so that they can be replayed in the event of a failure.

R5-72 **[1827]** The identity of the backup system and the frequency of backup shall be user-settable.

CR5-73 **[1828]** If capable of requesting a restoration, the RDT managedElementR1 managed object will emit a processingErrorAlarm notification with probableCause=corruptData to the EMS to alert it to the need for memory recovery. After receiving this M-EVENT-REPORT, or as a result of manual processes, the backup system/EMS will restore the RDT memory (restore action on the memory managed object) using the binary backup and will replay RDT provisioning messages since the last backup, which are stored in the log. Destructive updates shall not be made that may affect service.

R5-74 **[1829]** Transfer of the binary backup from the backup system/EMS shall be accomplished using either FTAM or ftp, as defined by individual RBOC requirements. FTAM is considered to be the target protocol for this functionality. For FTAM implementations, the minimal set of features and parameters needed are proposed in GR-303-ILR Issue 303-139.

R5-75 **[1830]** The binary backup shall be transported to an RDT using previously defined GR-303-CORE interfaces (i.e. SONET DCC, dedicated or dial-up connection via an LDS line unit), or a high-speed LAN interface. If the

RDT interfaces to a backup system/EMS via a high-speed LAN for restoration of system software, the protocol requirements defined in GR-828-CORE shall apply.

R5-76 **[1831]** After restoration from the backup system/EMS, the RDT's memory managed objects shall emit an M-EVENT-REPORT (problemType=SoftwareProblemType, memoryId=1, alarmSeverity=warning) to its LDSs. Upon receiving this M-EVENT-REPORT, the LDS shall restore the RDT data it manages. Destructive updates shall not be made that may affect service.

R5-77 **[1832]** For lines that it suspects of being in a mismatched state, the RDT shall also send a STATUS message to the LDS using the Call State Mismatch Procedures defined in GR-303-CORE Section 12.5.5. The LDS shall respond to these STATUS messages as provided in requirements.

5.4.2.3 Provisioning the Digital Transmission Facility (DTF)

This subsection provides the requirements for provisioning managed resources associated with the digital transmission facility. This includes the DS1 termination points for the DS1 facility, IGs, EOC, and TMC/CSC. These operations are mostly performed during capacity activation and inventory assignment.

The operations for provisioning the facility DS1 termination points also apply to provisioning extension DS1 lines for customer access. This set of operations will not be repeated in the subsection for provisioning DS1 extensions for customer access. They may also be used during service activation.

- DS1 Termination Point

R5-78 **[322]** An RDT and an IDT shall receive from a remote managing system and process assignment and retrieval of the following information for the purpose of remote provisioning of a DS1 facility line:

… a. The DS1 line code (B8ZS code is required for DS1 line between the IDT and the RDT. ZBS and B8ZS are used for DS1 extensions.)

… b. The associated plug-in card

… c. The physical location (i.e., port) of the circuit

… d. The DS1 timing source (internal, loop, or through).

CR5-79 **[323]** If a T1 line is terminated directly instead of the DS1 line, an RDT and an IDT shall receive from a remote managing system and process

assignment and retrieval of the T1 line build out stage for the purpose of minimizing cross talk in the T1 lines.

R5-80 **[324]** The RDT or the IDT shall receive from a remote managing system and process assignment and retrieval of alarm severity code for the DS1 circuit. If automatic DS1 protection switching is not provided, the default alarm severity code shall be as follows:

… a. AIS, LOS, and LOF are major alarm service affecting

… b. Yellow alarm is minor alarm service affecting.

CR5-81 **[325]** If a DS1 frame format can be selected in an RDT or an IDT, the RDT or the IDT shall receive from a remote managing system and process assignment and retrieval of the DS1 frame format. The following frame formats shall be supported:

… a. Superframe (SF)

… b. Extended Superframe (ESF).

The following status and control operations may be used also during service assurance (e.g., taking a troubled DS1 out of service).

R5-82 **[326]** An RDT shall receive from a remote managing system and process requests to place a DS1 line circuit out-of-service or in-service.

R5-83 **[327]** An RDT shall receive from a remote managing system and process requests to retrieve the service status of the DS1 line circuit in the RDT (in or out of service).

R5-84 **[328]** Upon request by a remote managing system, an RDT shall provide a managing system with the RDT DS1 line circuit operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-85 **[329]** Upon request by a remote managing system, an RDT shall provide a managing system with the set of current problems still outstanding for the DS1 line circuit in the RDT indicating the probable cause of the problem and the severity of each problem.

As part of turn-up procedures a company should require a technician to verify that the DS1 lines are accurately connected. It must be noted that the addition of DS1 lines to a 303 system is not an automatic flow-through service activation procedure but is a network activation procedure that would normally require an engineering work order of some sort, thus an automatic procedure to verify DS1 wiring miss-connections will not provide much added value.

The following requirements specify the procedure a technician shall use to verify that the DS1 lines are accurately connected.

R5-86 **[1833]** A technician shall

… 1. create a DS1 failure toward the RDT (Note: If the IDT supports transmission of AIS for manually disabled (out-of-service) DS1s, the DS1 can be put into a disabled state via an operations message and as a result AIS will be automatically transmitted over the DS1) on the added DS1 line,

… 2. and then examine the alarms at both ends. The RDT and IDT should have the same DS1# in an alarm state. The IDT will be reporting an incoming Yellow Alarm and the RDT will be reporting an incoming DS1 failure (CFA Red Alarm).

R5-87 **[1834]** The manufacturer is required to provide documentation explaining the detailed procedure to perform this test (i.e., how to insert the failure, and how to detect the failures at the IDT and RDT).

- Interface Group

R5-88 **[330]** An RDT and an IDT shall receive from a remote managing system and process requests to assign a DS1 or VT facility to an IG (i.e., IDT).

R5-89 **[331]** An RDT and an IDT shall receive from a remote managing system and process requests to retrieve the number of the DS1 or VT facility assigned to an IG and the actual DS1 or VT facilities assigned to the group.

R5-90 **[332]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the access lines associated with each IDT (i.e., IG).

CR5-91 **[333]** If both TMC and CSC are supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign the signaling method (TMC or CSC) between the RDT and the IDT for each IG.

R5-92 **[334]** An RDT and an IDT shall receive from a remote managing system and process requests to retrieve the signaling method used between the RDT and the IDT for an IG.

- EOC, TMC, CSC

  The EOC, TMC/CSC are required to have protection paths. The requirements for protection are in Section 5.4.3 under service assurance.

R5-93 **[335]** An RDT and an IDT shall receive from a remote managing system and process retrieval of time slots for the active EOC and the active TMC or CSC.

CR5-94 **[336]** If the CSC signaling method is used, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information for the purpose of remotely provisioning the customized or non generic ringing pattern provided to a customer using the CSC channel:

… a. Customized or non generic alerting cadence code

… b. The lead on which ringing source applies (tip or ring, default=ring)

… c. The ringing polarity (superimposed + or superimposed -)

… d. The ringing pattern (combination of ringing lengths and silent intervals).

R5-95 **[337]** For each call processing data link (i.e., each TMC or CSC SAPI, for both the active and standby channels, per IG), an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following layer 3 timers for the purpose of remote provisioning the layer 3 connection:

… a. T303 for provisioning the RDT wait time for reply to a SETUP message

… b. T396 for provisioning the RDT wait time for reply to a SETUP message after T303 expires.

R5-96 **[338]** For each call processing data link service access points (i.e., each TMC or CSC SAPI, for both the active and standby channels, per IG), an IDT shall receive from a remote managing system and process requests to assign and to retrieve the following layer 3 timer for the purpose of remote provisioning the layer 3 connection: T395 (only on the CSC and only if the IDT supports expanded 911 service) for provisioning the IDT wait time for a reply to an INFORMATION message with signal element.

R5-97 **[339]** For each data link service access point (i.e., each SAPI=0 and SAPI=1, for both the active and standby data links, per IG), an RDT and an IDT shall receive from a remote managing system and process assignment and retrieval of the following LAPD parameters for the purpose of remote provisioning the layer 2 connection:

… a. Maximum number of outstanding information frames at layer 2

… b. Maximum number of retransmission for a frame at layer 2 (N200)

… c. Maximum layer 2 wait time for an acknowledgment of a transmitted frame (T200)

… d. Maximum layer 2 idle time before connection verification is necessary (T203).

The following status and control operations may also be used during service assurance (e.g., retrieving alarm or trouble information relating to the EOC).

R5-98 **[340]** Upon request by a remote managing system, an RDT shall provide a managing system with the EOC and the TMC/CSC operational status indicating whether they are fully inoperable and unable to provide service to the user, or they are fully operable and available for use.

R5-99 **[341]** Upon request by a remote managing system, an RDT shall provide a managing system with the set of current problems still outstanding for the EOC and the TMC/CSC indicating the probable cause of the problem and the severity of each problem.

R5-100 **[342]** Upon request by a remote managing system, an RDT shall provide a managing system with the troubled EOC and the TMC/CSC alarm status indicating whether they are under repair, they have one or more critical alarms, one or more major alarms, one or more minor alarms, or one or more alarms are still outstanding for the EOC and TMC/CSC.

5.4.2.4 Provisioning Customer Access Lines

This subsection provides requirements for provisioning the termination points for customer access lines. The RDT may provide analog line access, special services access, DDS line access, ISDN BRI line access, and DS1 extension. Provisioning for DS1 extension uses the same operations as provisioning the DS1 facility lines. They are listed in the previous subsection (Section 5.4.2.3) under Provisioning DTF and are not repeated here.

The operations presented in this subsection are primarily used during capacity activation, service activation, and inventory assignment.

- Analog Line

R5-101 **[343]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the analog line circuit physical location (i.e., port) and the associated plug-in card.

R5-102 **[344]** An RDT shall receive from a remote managing system and process requests to retrieve the generic signal function code of the RDT analog line circuit.

CR5-103 **[345]** If the analog line circuit is provisionable, an RDT shall receive from a remote managing system and process assignment of the generic signal function code of the analog line circuit.

R5-104 **[346]** An IDT shall receive from a remote managing system and process requests to assign the service type of the RDT analog line circuit to the IDT customer directory number.

R5-105 **[347]** An RDT shall receive from a remote managing system and process requests to assign and retrieve a time-slot to an analog line circuit (cross connection) for nailed up circuits.

R5-106 **[348]** An IDT shall receive from a remote managing system and process requests to assign and to retrieve a time-slot used for a nailed-up analog circuit at the RDT (cross connection). The IDT shall remove that time-slot from the pool of time-slots available for dynamic time-slot assignment.

CR5-107 **[349]** If a circuit is associated with a dynamically assignable time slot (including circuits with reserved time slot and locally switched analog services such as POTS, COIN, and non-designed special services), an RDT shall receive from a remote managing system and process requests to assign and to retrieve a call reference value (CRV) to the circuit (line circuit address) for use by the TMC or CSC signaling.

CR5-108 **[350]** If a circuit is associated with a dynamically assignable time slot (including circuits with reserved time slot and locally switched analog services such as POTS, COIN, and non-designed special services), an IDT shall receive from a remote managing system and process requests to assign and to retrieve a Call Reference Value (CRV) to the customer directory number for use by the TMC or CSC signaling.

CR5-109 **[351]** If the circuit is for non-locally switched or non-switched services (design services such as foreign exchange, private line, and PBX off premises), an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information for the purpose of remote provisioning designed special services:

… a. Loaded or non loaded wires (cable)

… b. Hybrid balance setting at the termination point of the wires for balancing cable input impedance in a two wire circuit

… c. Attenuation distortion equalization in both transmit and receive directions for adjustment of cable loss versus frequency loss

… d. Transmission level point in both transmit and receive directions for adjusting power gain or loss in the wire with respect to a reference point

… e. Impedance at both the transmit and receive directions for balancing the impedance of the circuit.

CR5-110 **[352]** If an analog line circuit uses the CSC signaling method and flash service is provided on the circuit, an RDT shall receive from a remote managing system and process operations message that informs the RDT to detect and accept flash service on that analog line circuit.

CR5-111 **[353]** If an analog line circuit uses the CSC signaling method and flash service is provided on the circuit, an RDT shall receive from a remote managing system and process requests to retrieve the assigned flash detection status of the analog line circuit.

CR5-112 **[354]** If a circuit is nailed-up (the time slot semi-permanently assigned), and full-time on-hook transmission capability is provided, an RDT shall receive from a remote managing system and process requests to enable/ disable full-time on-hook transmission capability.

CR5-113 **[355]** If a circuit is nailed-up (the time slot semi-permanently assigned), and full-time on-hook transmission is provided, an RDT shall receive from a remote managing system and process requests to retrieve the assigned on-hook transmission status (i.e., full-time or not).

The following status and control operations may be used during service activation such as placing a pre-provisioned line in service. However, they may also be used during service assurance such as taking a showering analog line out of service and applying sealing current to a special service circuit.

R5-114 **[356]** An RDT shall receive from a remote managing system and process requests to place an analog line circuit in-service or out-of-service.

R5-115 **[357]** An RDT shall receive from an LDS and process requests to place an analog line circuit in-service or out-of-service when the LDS detects a showering line condition from that analog line circuit.

R5-116 **[358]** If the LDS places an analog line circuit in-service or out-of-service, it shall notify a remote managing system that it performed these functions at the RDT.

R5-117 **[359]** An RDT shall receive from a remote managing system or an LDS and process requests to retrieve the service status of the analog line circuit (in-service or out-of-service).

R5-118 **[360]** An RDT shall provide a managing system with the operational status of the analog line circuit indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-119 **[361]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the control status of the analog line circuit indicating whether it is under test.

CR5-120 **[362]** If sealing current can be applied to an analog line, an RDT shall receive from a remote managing system and process request to apply continuous or pulsed sealing current to an analog line circuit.

CR5-121 **[363]** If sealing current can be turned on and off, an RDT shall receive from a remote managing system and process request to turn on or off sealing current applied to an analog line circuit.

- DDS Line

R5-122 **[364]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information for the purpose of remote provisioning the DDS line circuit:

… a. Physical location of the circuit (i.e., port)

… b. Associated plug-in card

… c. Generic signal function code

… d. Usage of all zero code indication (boolean)

… e. DS0A or DS0B format

… f. Data rate.

CR5-123 **[365]** If the DS0B format is used, an RDT shall receive from a remote managing system and process requests to retrieve the data rate in the DDS line.

CR5-124 **[366]** If a second channel is used for protecting a DDS line, an RDT shall receive from a remote managing system and process provisioning (assignment of time-slot) and retrieval of that secondary channel.

CR5-125 **[367]** If a second channel is used for error correction, an RDT shall receive from a remote managing system and process provisioning (assignment of time-slot) and retrieval of that error correction channel.

R5-126 **[368]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve a time slot to the DDS line (cross connection).

R5-127 **[369]** An IDT shall receive from a remote managing system and process requests to assign and to retrieve a time slot used for a DDS line at the RDT (cross connection). The IDT shall remove that time-slot from the pool of time-slots available for dynamic time-slot assignment.

The following status and control operations may be used during service activation such as placing a pre-provisioned DDS line in service. They may also be used during service assurance such as placing the DDS line out-of-service for maintenance or testing.

R5-128 **[370]** An RDT shall receive from a remote managing system and process requests to place a DDS line circuit in-service or out-of-service.

R5-129 **[371]** An RDT shall receive from a remote managing system and process requests to retrieve the service status of the DDS line circuit (in-service or out-of-service).

R5-130 **[372]** Upon request by a remote managing system, an RDT shall provide a managing system with an RDT DDS line circuit operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-131 **[373]** An RDT shall receive from a remote managing system and process application of continuous or pulsed sealing current to a DDS line circuit.

CR5-132 **[374]** If sealing current can be turned on or off, an RDT shall receive from a remote managing system and process requests to turn on or off sealing current applied to a DDS line circuit.

- ISDN BRA Line

  In an IDLC system, an ISDN Basic Rate Access (BRA) line may be provided by either the 3 DS0 or the 4:1 TDM scheme. Provisioning of either scheme is needed over the open interface. For the interim, assignment of the quarter DS0 is by the LDS. This may not be the long-term scenario since provisioning is typically a managing system (e.g., OS) functionality. The advantages and disadvantages of having the LDS take over this provisioning functionality for a long-term scenario is under study.

R5-133 **[375]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the capability supported by an ISDN BRA line; i.e., a D-channel, a D- and a B-channel, or 2B+D-channels.

R5-134 **[376]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the physical location of the ISDN circuit (i.e., port) and the associated plug-in card.

CR5-135 **[377]** If 4:1 TDM is used, an RDT shall receive from a remote managing system and process requests to assign and to retrieve a Call Reference Value (CRV) to the ISDN BRA circuit for use by the TMC or CSC signaling; CRV suffixes are used to distinguish the B1 and B2 channels.

CR5-136 **[378]** If 4:1 TDM is used, an IDT shall receive from a remote managing system and process requests to assign and to retrieve a call reference value (CRV) to the customer directory number(s) for use by the TMC or CSC signaling; the CRV is used to identify the ISDN BRA circuit/line and CRV suffixes are used to distinguish between the B1 and B2 channels.

CR5-137 **[379]** If 4:1 TDM is used, an RDT shall receive from an LDS and process requests to assign and to retrieve a quarter time slot to the D channel of the ISDN line (cross connection).

CR5-138 **[380]** If 3 DS0 is used, an RDT shall receive from a remote managing system and process requests to assign and to retrieve three time slots each to the B1, B2 and D channels of the ISDN line (cross connection).

R5-139 **[381]** An IDT shall receive from a remote managing system and process requests to assign and to retrieve time slot(s) used for an ISDN BRA line at the RDT (cross connection). The IDT shall remove the time-slot(s) from the pool of time-slots available for dynamic time-slot assignment.

The following status and control operations may be used during service activation such as placing a pre-provisioned ISDN line in service. They may also be used during service assurance such as placing out-of-service for testing purposes. The actual tests for ISDN is in Section 5.4.3 under Maintenance.

R5-140 **[382]** An RDT shall receive from a remote managing system or an LDS and process requests to place an ISDN line circuit in-service or out-of-service.

R5-141 **[383]** An RDT shall receive from a remote managing system or an LDS and process requests for the service status of the ISDN line circuit (in-service and out-of-service).

R5-142 **[384]** Upon request by a remote managing system, an RDT shall provide a managing system with the ISDN line circuit operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-143 **[385]** An RDT shall receive from a remote managing system and process requests to apply continuous or pulsed sealing current to an ISDN line circuit. The request shall specify the sealing current envelope (level and duration).

CR5-144 **[386]** If sealing current can be turned on or off, an RDT shall receive from a remote managing system and process requests to turn on or off sealing current applied to an ISDN line circuit.

R5-145 **[387]** Upon request by a remote managing system or an LDS, an RDT shall provide a managing system or the LDS with the ISDN BRA superframe overhead bit states received from the NT1.

R5-146 **[388]** An RDT shall receive from a remote managing system or an LDS and process requests to assign and to retrieve the ISDN BRA superframe overhead bit states for transmission to an NT1.

R5-147 **[389]** An RDT shall autonomously report to a remote managing system whenever a change in the superframe overhead bits in the ISDN DSL occurs.

R5-148 **[390]** An RDT shall autonomously report to an LDS whenever a change in the superframe overhead bits in the ISDN DSL occurs.

R5-149 **[391]** An RDT shall provide a managing system with the indication of the channel(s) under test (e.g., B1, B2, D, or combination).

R5-150 **[392]** An RDT shall receive from a remote managing system and process requests to enable or disable a loopback test on an ISDN line circuit.

R5-151 **[393]** An RDT shall receive from a remote managing system and process requests to retrieve the assigned loopback permission on an ISDN line circuit.

- DS1 Line

  Provisioning operations for DS1 extension are the same as the provisioning operations listed for Provisioning DTF in Section 5.4.2.3. Additional provisioning operations requirements for DS1 extension are those pertaining to the maintenance of the DS1 extension such as setting up for performance monitoring, threshold setting, and

testing. These additional requirements are listed in Section 5.4.3 along with the maintenance operations requirements.

CR5-152 **[394]** If dynamic time-slot assignment is required for a DS1 extension, an RDT shall receive from a remote managing system and process requests to assign and to retrieve a call reference value (CRV) to the DS1 circuit for use by the TMC or CSC signaling.

5.4.2.5 NE Software Control

Software control operations include initialization and reinitialization, updating, querying, backing up, restoring, and auditing of software in the RDT. For an IDLC system, these operations are currently not required over the open interfaces. However, if desired, the following requirements for operations exchange concerning software management serve as interface guidelines.

Software is a general term used in this document to represent an actual electronic information that is to be managed. Examples of software are: an executable program and a database file. Note that the operations in this section are for managing per software/file. This is different from the memory device management in Section 5.4.2.2 where the integrity of the whole memory device is addressed.

CR5-153 **[395]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to retrieve the following information associated with each software:

… a. Type of software (e.g., executable or data)

… b. Location of the software

… c. Size of the software

… d. Creation date of the software

… e. The identity of the creator

… f. Modification date

… g. Identity of the last modifier

… h. Installation date

… i. Vendor name

… j. Version number.

CR5-154 **[396]** If the software is remotely managed, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the threshold (e.g., elapsed time) for triggering automatic software backup.

CR5-155 **[397]** If the software is remotely managed, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the backup destination.

CR5-156 **[398]** If the software is remotely managed, an RDT shall receive from a remote managing system and process requests to retrieve the last backup time and destination.

CR5-157 **[399]** If the software is remotely managed, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the source for automatic software restoration.

CR5-158 **[400]** If the software is remotely managed, an RDT shall receive from a remote managing system and process requests to retrieve the last restore time and source.

The following status and control operations may be used during service activation such as enabling a version of software for use in the RDT. They may also be used during service assurance such as auditing software for verification.

CR5-159 **[401]** If software is remotely managed, an RDT shall receive from a remote managing system and process request to make the software in the RDT unavailable or available for operations.

CR5-160 **[402]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to retrieve the operational availability status of the software in the RDT.

CR5-161 **[403]** If software is remotely managed, upon request by a remote managing system, an RDT shall provide a managing system with the software operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-162 **[404]** If software is remotely managed, upon request by a remote managing system, an RDT shall provide a managing system with the set of current problems still outstanding for the software in the RDT indicating the probable cause of each problem and the severity of each problem.

CR5-163 **[405]** If software is remotely managed, upon request by a remote managing system, an RDT shall provide a managing system with the software procedural status indicating whether the software is initializing, reporting, terminating, not initialized, or initialization required.

CR5-164 **[406]** If software is remotely managed, an RDT shall autonomously notify a managing system of a software processing error indicating the probable cause, the severity, and whether or not it is service-affecting.

CR5-165 **[407]** If software is remotely managed, an RDT shall receive from a remote managing system and process software installation instructions.

CR5-166 **[408]** If software is remotely managed, an RDT shall process remote instructions from a managing system to revert an applied software or set of software to a desired software.

CR5-167 **[409]** If software is remotely managed, an RDT shall process a remote request from a managing system to validate a specific software in the RDT.

CR5-168 **[410]** If software is remotely managed, an RDT shall process a remote request from a managing system to terminate a validation request of a specific software in the RDT.

CR5-169 **[411]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to back up the RDT software.

CR5-170 **[412]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to restore the RDT software.

CR5-171 **[413]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to audit the RDT software.

CR5-172 **[414]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to abort an audit of the RDT software.

CR5-173 **[415]** If software is remotely managed, an RDT shall receive from a remote managing system and process scheduling for periodic auditing of the RDT software.

CR5-174 **[416]** If software is remotely managed, an RDT shall autonomously report to a managing system when a scheduled audit occurs.

CR5-175 **[417]** If software is remotely managed, an RDT shall receive from a remote managing system and process scheduling for periodic backup of the RDT software.

CR5-176 **[418]** If software is remotely managed, an RDT shall autonomously report to a managing system when a scheduled backup occurs.

CR5-177 **[419]** If software is remotely managed, an RDT shall receive from a remote managing system and process provisioning for full or incremental backup of the RDT software.

CR5-178 **[420]** If software is remotely managed, an RDT shall receive from a remote managing system and process request to place the scheduler for backup or audit in-service and out-of-service.

CR5-179 **[421]** If software is remotely managed, an RDT shall receive from a remote managing system and process requests to retrieve the service status of the scheduler for backup or audit (in-service and out-of-service).

CR5-180 **[422]** If software is remotely managed, upon request by a remote managing system, an RDT shall provide a managing system with the operational status of the scheduler for backup and audit indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

5.4.2.6 NE Report Generation and Scheduling

To monitor activities and performance of the RDT and to coordinate control and operations, an RDT collects certain events that occur in the RDT, generates reports, and forwards these reports to the appropriate systems (e.g., a managing system or an LDS that is not the initiator of the event). Reports may be forwarded right after the event occurrence or on a scheduled basis.

This subsection provides guidelines on operations needed over the interfaces to set up report forwarding, logging at the RDT, and scheduling. The settings may be a one-time only operation done during installation. However, if these controlled capabilities are desired over the open interfaces allowing a managing system control of these capabilities beyond installation time, the following requirements serve as guidelines.

- Automatic Reports of Provisioning Events

R5-181 **[423]** An RDT shall generate automatic reports for state, status, and data changes including removal and addition of managed resources in the RDT

and changes in the settings and characteristic information of a managed resource.

- Forwarding Automatic Reports

CR5-182 **[424]** If the message forwarding capability is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the message destinations.

CR5-183 **[425]** If the message forwarding capability is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the forwarding criteria of selected automatic reports.

CR5-184 **[426]** If the message forwarding capability is desired and backup destination is needed when the active destination is unreachable, an RDT shall receive from a remote managing system and process requests to assign and to retrieve backup destinations for forwarding selected automatic reports.

CR5-185 **[427]** If the message forwarding capability is desired and confirmed or unconfirmed mode is selectable, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the permitted mode.

The following status and control operations may also be used during service assurance.

R5-186 **[428]** An RDT shall receive from a remote managing system and process request to place a message forwarding controller in the RDT in-service or out-of-service.

R5-187 **[429]** An RDT shall receive from a remote managing system and process requests to retrieve the service status of the message forwarding controller in the RDT (in-service and out-of-service).

R5-188 **[430]** Upon request by a remote managing system, an RDT shall provide a managing system with a message forwarding controller operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-189 **[431]** If scheduling is available for a message forwarding controller, upon request by a remote managing system, an RDT shall provide a managing system with an availability status indicating whether the message controller is off or on duty.

CR5-190 **[432]** If the message forwarding controller capability is time restricted, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the time period when the message forwarding controller capability is applicable.

R5-191 **[433]** An RDT shall receive from a remote managing system and process selection and retrieval of daily, weekly, or external scheduling for the message forwarding controller.

- Scheduling Automatic Reports

CR5-192 **[434]** If scheduling for periodic automatic reports is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information:

… a. The messages that the schedule applies to

… a. The time period when the schedule is effective (date, hour, minutes, seconds)

… a. The reporting interval (days, hours, minutes, seconds)

… a. The destination of the scheduled messages.

The following status and control operations may also be used during service assurance.

R5-193 **[435]** An RDT shall receive from a remote managing system and process requests to place a scheduler in the RDT in-service or out-of-service.

R5-194 **[436]** An RDT shall receive from a remote managing system and process requests to retrieve the service status of a scheduler in the RDT (in-service and out-of-service).

R5-195 **[437]** Upon request by a remote managing system, an RDT shall provide a managing system with a scheduler operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-196 **[438]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve start time, end time, and the interval of a scheduler.

- Logging Automatic Reports

CR5-197 **[439]** If logging of automatic reports is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information:

… a. The type of messages to be logged

… b. The source of the messages

… c. The criteria for logging the messages

… d. The logging mode (wrap or stop when log is full).

CR5-198 **[440]** If logging of automatic reports is desired, an RDT shall receive from a remote managing system and process requests to log the following events:

… a. Alarm record for logging alarm messages

… b. State change record for logging state change messages

… c. Resource removal record for logging resource removal messages

… d. Resource added record for logging resource added messages

… e. Characteristic information record for logging data change messages

… f. Performance record for logging performance monitoring messages.

CR5-199 **[441]** If logging of automatic reports is desired, an RDT shall receive from a remote managing system and process requests to retrieve information stored in the above records.

CR5-200 **[442]** If logging of automatic reports is desired and the halt log mode is selected, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the log size threshold at which a warning is issued before log reaches maximum capacity.

CR5-201 **[443]** If logging of automatic reports is desired, an RDT shall receive from a remote managing system and process requests to retrieve the time when a message is logged.

CR5-202 **[444]** If logging of automatic reports is desired and logging can be scheduled, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information:

… a. The time period when logging is effective

… b. The logging interval (the hours in a day or the days in a week).

The following status and control operations may also be used during service assurance.

CR5-203 **[445]** If logging is remotely managed, an RDT shall receive from a remote managing system and process requests to place a log controller in the RDT in-service or out-of-service.

CR5-204 **[446]** If logging is remotely managed, an RDT shall receive from a remote managing system and process requests to retrieve the service status of a log controller in the RDT (in-service and out-of-service).

CR5-205 **[447]** If logging is remotely managed, upon request by a remote managing system, an RDT shall provide a managing system with a log controller operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-206 **[448]** If logging is remotely managed, upon request by a remote managing system, an RDT shall provide a managing system with an availability status indicating whether the log controller is off duty or filled.

CR5-207 **[449]** If scheduling is available for a log controller, upon request by a remote managing system, an RDT shall provide a managing system with an availability status indicating whether the log controller is off or on duty.

CR5-208 **[450]** If the log controller capability is time restricted, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the time period when a logging capability is applicable.

CR5-209 **[451]** If logging is remotely managed, an RDT shall receive from a remote managing system and process requests to select and to retrieve the daily, weekly, or external scheduler for the log controller.

5.4.3 Maintenance

Maintenance involves operations functions whose aim is to ensure the performance of the NE in providing uninterrupted quality services. The operations functions include monitoring the NE performance, alarm surveillance, trouble reports, testing for trouble verification and trouble isolation, and repair and service recovery.

For an IDLC system, maintenance functions include collecting performance monitoring data on the DTF and the ISDN access lines, mandatory protection switching for EOC and TMC/CSC, metallic test access for customer access lines, channel unit test, application of sealing current to analog lines, DDS lines, and ISDN lines, loopback and corrupted CRC test for ISDN lines, and alarm and threshold crossing autonomous reports.

This section provides operations interface requirements for IDLC maintenance. These functions are mostly performed during service assurance. However, the provisioning

information such as threshold setting and scheduling which may be performed during capacity activation and service activation are included in this section along with the maintenance features.

This section is divided into two categories: Section 5.4.3.1 presents performance management, which includes alarm surveillance, protection switching, alarm reports, and performance monitoring. Section 5.4.3.2 presents fault management, which includes metallic test access, channel unit test, loopback test, and corrupted CRC test.

5.4.3.1 Performance Management

Performance management provides a set of functions for monitoring the NE, collecting data, evaluating performance, reporting troubles, and correcting NE behavior. The information gathered may be used for planning and analysis or for maintenance dispatch.

The interface requirements in this section are based on Section 4.5 and some generic performance monitoring requirements in GR-820-CORE, Issue 1.

5.4.3.1.1 Performance Monitoring

R5-210 **[452]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve thresholds for those trouble conditions that are not reported on a per occurrence basis.

CR5-211 **[453]** If an RDT is installed in a concentrated configuration, the RDT shall receive from a remote managing system and process requests to assign and to retrieve thresholds of the number of transmission facility failures that would activate a major alarm. The threshold range shall be the range of only one transmission facility available to only one transmission facility failed.

O5-212 **[454]** If an RDT is installed in a concentrated configuration and can terminate more than 128 lines, the RDT should receive from a remote managing system and process requests to assign and to retrieve thresholds of the number of transmission facility failures that would activate a critical alarm. The threshold range shall be the range of only one transmission facility available to only one transmission facility failed.

R5-213 **[455]** An RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the following performance monitoring (PM) threshold values for a DS1 facility (in ESF format) frame path termination for the current 15-minute period and current day period:

… a. ES-P

… b. SES-P

… c. CSS-P

… d. UAS-P.

R5-214 **[456]** An RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the scanning period (i.e., 15 minutes or 1 day) for collecting a type of PM data (e.g., ES, CV, etc.).

CR5-215 **[457]** If scheduling is supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign daily or weekly PM data collection schedules.

R5-216 **[458]** An RDT and an IDT shall receive from a remote managing system and process requests to place the performance monitoring scanner in-service or out-of-service, where scanner is the capability to periodically sample the value of a set of attributes (e.g., performance monitoring).

R5-217 **[459]** An RDT and an IDT shall receive from a remote managing system and process requests to retrieve the service status of the performance monitoring scanner (in-service and out-of-service).

R5-218 **[460]** Upon request by a remote managing system, an RDT and an IDT shall provide the managing system with the operational status of the performance monitoring scanner indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-219 **[461]** If a scanner capability is time restricted, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the time period when a scanner capability is applicable.

R5-220 **[462]** An RDT and an IDT shall receive from a remote managing system and process requests to select and to retrieve daily, weekly, or external scheduling for scanning performance monitoring data.

CR5-221 **[463]** If time synchronization of the scanner is available, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the time for a scanner to begin scanning.

R5-222 **[464]** Upon request by a remote managing system, an RDT and an IDT shall provide the managing system with an indication of whether the

performance monitoring data is suspected of being corrupted. For example, while an RDT or an IDT has a loopback in progress, the performance monitoring shall be flagged as corrupted for all periods in which the loopback is established.

R5-223 **[465]** Upon request by a remote managing system, an RDT and an IDT shall provide the managing system with an indication of the time elapsed for a performance monitoring scanning activity.

R5-224 **[466]** An RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the number of the collection intervals of a PM data to be compressed. Compression means for a specified number of collection intervals, if all-zero data are collected, only one history data and one report need to be recorded and issued by the RDT and IDT.

CR5-225 **[467]** If a filter for history data is available, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the criteria for logging the history of the PM data.

CR5-226 **[468]** If scheduling is available, an RDT and an IDT shall receive from a remote managing system and process requests to select the PM data to be reported.

R5-227 **[469]** An RDT and an IDT shall report to a managing system on threshold crossing of the following DS1 performance monitoring data with non-alarm, no- service-affecting status:

… a. ES-P

… a. SES-P

… a. CSS-P

… a. UAS-P.

R5-228 **[470]** Upon request by a remote managing system, an RDT and an IDT shall provide the ES-L DS1 line performance data for the current day, current 15-minute period, previous day, and previous 15-minute period.

R5-229 **[471]** Upon request by a remote managing system, an RDT and an IDT shall provide DS1 path performance data for the performance parameters identified in Section 4.6.1.

R5-230 **[472]** An RDT shall report to a managing system on threshold crossing of the following ISDN BRI performance monitoring data with hourly and

daily periods for both customer and network sides with non-alarm, no-service-affecting status:

… a. ES

… b. SES.

R5-231 **[473]** Upon request by a remote managing system or an LDS, an RDT shall provide the following ISDN BRI performance data for the current day, current hourly period, previous day, and previous hourly period:

… a. ES

… b. SES

… c. CV (hourly only).

CR5-232 **[474]** If multi-point eoc configurations are supported and 4:1 TDM is used, the RDT shall provide the performance monitoring data as required above for any nodes that terminate the embedded operations channel (eoc).

5.4.3.1.2 Alarm Summary and Surveillance

Alarm severity assignment may be done one time only during installation, and the operations may not need to be exchanged over the open interface. However, if performed, the following information shall be exchanged. In addition, the requirements in Section 5.4.2.6 on autonomous reports also apply to autonomous alarm reports such as to suppress alarms by classification or severity.

The operations requirements in this section are based on Section 4.7 and some generic performance monitoring requirements in TR-NWT-000474, Issue 4.

R5-233 **[475]** An RDT shall receive from a remote managing system and process requests to assign and to retrieve the following alarm severity categories:

… a. Affecting service

… b. Non affecting service

… c. Independent of service.

… In addition, for each of the above alarm severity categories, the following severity code shall be used:

… 1. Critical

… 2. Major

… 3. Minor

… 4. Warning

… 5. Non alarm.

See Section 6 for default alarm classifications.

R5-234 **[476]** An RDT shall provide at least two external alarm ports that permit the unique reporting of environmental conditions at the RDT location (such as open door, presence of water, and high heat).

R5-235 **[477]** An RDT shall receive from a remote managing system and process requests to assign and retrieve the environmental conditions to be monitored and alarmed for those environmental alarm ports.

CR5-236 **[478]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information:

… a. The list of resources with alarms to be included in the summary

… b. The list of selected alarm status to be included in the summary

… c. The list of selected perceived severity of the alarms to be included in the summary

… d. The list of selected probable cause of the alarms to be included in the summary.

CR5-237 **[479]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the probable cause.

CR5-238 **[480]** If logging of alarm reports is desired, an RDT shall receive from a remote managing system and process requests to retrieve the following information from the alarm log:

… a. The probable cause of the alarm

… b. The severity of the alarm.

CR5-239 **[481]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to place the alarm summary in the RDT in-service or out-of-service.

CR5-240 **[482]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to retrieve the service availability status of the alarm summary in the RDT (in or out of service).

CR5-241 **[483]** If an alarm summary of a specific RDT resource(s) is desired, upon request by a remote managing system, an RDT shall provide the managing system with an alarm summary report(s).

CR5-242 **[484]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to schedule alarm summary report(s).

CR5-243 **[485]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to place the scheduler for alarm summary in-service or out-of-service.

CR5-244 **[486]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to retrieve the service status of the scheduler for alarm summary (in-service or out-of-service).

CR5-245 **[487]** If an alarm summary of a specific RDT resource(s) is desired, upon request by a remote managing system, an RDT shall provide the managing system with the operational status of the scheduler for alarm summary indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-246 **[488]** If an alarm summary of a specific RDT resource(s) is desired, an RDT shall receive from a remote managing system and process requests to retrieve an alarm summary from the RDT.

R5-247 **[489]** An RDT and an IDT shall provide autonomous alarm reports to a remote managing system to indicate changes in the health status of its resources (e.g., self-detected hardware or software troubles, threshold crossings, etc.). An RDT and an IDT shall include the following information in its autonomous alarm reports to a remote managing system:

… a. The time the event occurred

… b. The trouble type (e.g., LOS, processor failure, etc.)

… c. The NE where the alarm is reported

… d. The source of the alarm (e.g., plug-in card, any replaceable unit, transport elements--termination points, etc.)

… e. Designation of severity category

… f. Severity code of the trouble.

R5-248 **[490]** An RDT and an IDT shall not provide autonomous alarm reports to a managing system for subsequent detection of the same trouble that has already been reported. If the trouble is cleared, the clearing of the trouble shall be reported to a managing system.

CR5-249 **[491]** If multi-point eoc configurations are supported and 4:1 TDM is used, the RDT shall provide autonomous reports for performance monitoring threshold crossings for any nodes that terminate the embedded operations channel (eoc).

R5-250 **[492]** An IDT shall report to a remote managing system whenever an RDT rejects a dynamic time-slot assignment due to the time-slot being unavailable (e.g., the time-slot is already in use on a provisioned connection).

5.4.3.1.3 Protection Switching

For an IDLC system that supports more than one DS1 across the interface, protection switching for the EOC and the TMC/CSC are mandatory. As specified in previous sections, the initial protection channel for the EOC is channel number 12 of a DS1 not DS1 #1, and channel number 24 on the same DS1 is reserved for TMC/CSC protection. The threshold for automatic protection switching of DS1 facility lines is as specified in Table 4-1, "Default Values for DS1 Alert Declarations," page 4–30. The conditions for EOC and TMC/CSC protection switching are in Section 12.6.3.1. Protection switching for DS1 lines is optional.

- DS1 Lines (facility or extension)

CR5-251 **[493]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the protection scheme. The protection shall be provisioned to revertive protection with a 1:n protection scheme.

CR5-252 **[494]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the standby (protecting) DS1 facility line.

CR5-253 **[495]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the time delay before restoring to the protected DS1 line after a fault cleared for the purpose of remotely provisioning the DS1 protection switching scheme.

CR5-254 **[496]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the BER threshold for triggering automatic protection switching (see Section 4 for BER threshold requirements for triggering automatic protection switching).

CR5-255 **[497]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve protection priority (See Section 12.6.2.3.2 for detail priority settings).

CR5-256 **[498]** If protection switching for a DS1 line is supported, an RDT and an IDT shall provide a managing system with the protection operational status of the DS1 line indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-257 **[499]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to initiate a manual or forced protection switch of a DS1 line. The RDT and IDT shall report if this request failed (due to time-out or preemption) or is successfully completed. A manually initiated switch shall remain in effect until manually removed.

R5-258 **[500]** An RDT and an IDT shall receive from managing systems and process requests to assign and retrieve the capability to inhibit/allow DS1 protection switching.

CR5-259 **[501]** If protection switching for a DS1 line is supported, an RDT and an IDT shall receive from a remote managing system and process requests to initiate a lockout of protection switching to a DS1 line. The RDT and IDT shall report if this request failed or is successfully completed.

CR5-260 **[502]** If protection switching for a DS1 line is supported, an RDT and IDT shall receive from a remote managing system and process requests to release a manual or forced protection switching of a previously switched DS1 line. The RDT and IDT shall report if this request failed or is successfully completed.

CR5-261 **[503]** If protection switching for a DS1 line is supported, an RDT or IDT shall receive from a remote managing system and process requests to release a DS1 from lockout of protection switching.

CR5-262 **[504]** If protection switching for a DS1 line is supported, an RDT and an IDT shall autonomously report to a remote managing system any

protection switching events including occurrence of automatic protection switching, forced or manual switching, and lockout or released from lockout of protection switching. The near-end of the protection switching (e.g., the IDT if it is the end initiating the protection switch) shall provide the autonomous report to the remote managing system.

- EOC, TMC, CSC

R5-263 **[1835]** An RDT and an IDT shall support EOC and TMC/CSC path protection switching on systems supporting more than one DS1.

R5-264 **[505]** An RDT and an IDT shall receive from a remote managing system and process retrieval of time slots for the second EOC (i.e., the initial standby) and the second TMC or CSC.

R5-265 **[506]** An RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the protection scheme for EOC and the TMC/CSC protection. The protection shall be provisioned to non-revertive protection with a one-to-one cold standby protection scheme.

R5-266 **[507]** An RDT and an IDT shall receive from a remote managing system and process requests to assign and to retrieve the DS1 line for the standby EOC and the standby TMC/CSC.

R5-267 **[508]** An RDT and an IDT shall provide a managing system with the protection operational status of the EOC and TMC/CSC indicating whether they are fully inoperable and unable to provide service to the user, or they are fully operable and available for use.

R5-268 **[509]** An RDT and an IDT shall receive from a remote managing system and process requests to initiate a manual or forced protection switch of an EOC or TMC/CSC path to occur. The RDT and IDT shall report if this request failed (e.g., due to time-out) or is successfully completed.

R5-269 **[510]** An RDT shall receive from an IDT and process requests to initiate a protection switch of an EOC or TMC/CSC path to occur. The RDT shall report if this request failed (e.g., due to time-out) or is successfully completed. See Section 12 for additional EOC and TMC/CSC path protection switching requirements.

R5-270 **[511]** An IDT shall receive from an RDT and process requests to initiate a protection switch of an EOC or TMC/CSC path to occur. The IDT shall report if this request failed (e.g., due to time-out) or is successfully

completed. See Section 12 for additional EOC and TMC/CSC path protection switching requirements.

CR5-271 **[512]** An RDT and an IDT shall receive from a remote managing system and process requests to initiate a lockout of protection switching to an EOC or TMC/CSC path. The RDT and IDT shall report if this request failed or is successfully completed.

CR5-272 **[513]** An RDT and an IDT shall receive from a remote managing system and process requests to release an EOC or TMC/CSC from lockout of protection switching.

CR5-273 **[514]** An RDT and an IDT shall autonomously report to a remote managing system any protection switching events including occurrence of automatic protection switching, forced or manual switching, and lockout or released from lockout or protection switching. The near-end of the protection switch (e.g., the IDT if it is the end initiating the protection switch) shall provide the autonomous report.

- Equipment

  Equipment switching to redundant or backup equipment is not required for an IDLC system. However, if the feature is desired (e.g., automatic power switching), the following operations shall be used to control and coordinate equipment protection switching.

CR5-274 **[515]** If protection switching to backup equipment is desired, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following information for the purpose of remote provisioning the protection scheme:

… a. Protection method (cold or hot standby)

… b. Protection type (revertive or non revertive)

… c. Working and standby resources.

CR5-275 **[516]** If protection switching to backup equipment is supported and the protection type is revertive, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the time delay before restoring to the protected equipment after a fault cleared for the purpose of remotely provisioning the equipment protection switching scheme.

CR5-276 **[517]** If protection switching to backup equipment is supported and protection priority assignment is desired, an RDT and an IDT shall receive

from a remote managing system and process requests to assign and to retrieve protection priority.

CR5-277 **[518]** If protection switching to backup equipment is supported, upon request by a remote managing system, an RDT shall provide the managing system with the protection operational status of the equipment indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

CR5-278 **[519]** If protection switching to backup equipment is supported, an RDT shall receive from a remote managing system and process requests to initiate a manual or forced protection switch to backup equipment. The RDT shall report if this request failed (due to time-out or preempted) or is successfully completed.

CR5-279 **[520]** If protection switching to backup equipment is supported, an RDT shall receive from a remote managing system and process requests to initiate a lockout of protection switching to a backup equipment. The RDT shall report if this request failed or is successfully completed.

CR5-280 **[521]** If protection switching to backup equipment is supported, an RDT shall receive from a remote managing system and process requests to release a manual or forced protection switching of a previously switched backup equipment. The RDT shall report if this request failed or is successfully completed.

CR5-281 **[522]** If protection switching to backup equipment is supported, an RDT shall receive from a remote managing system and process requests to release a backup equipment from lockout of protection switching.

CR5-282 **[523]** If protection switching to backup equipment is supported, an RDT shall autonomously report to a remote managing system any protection switching events including occurrence of automatic protection switching, forced or manual switching, and lockout or released from lockout or protection switching.

5.4.3.2 Fault Management

For an IDLC system, fault management includes metallic and digital test access, circuit test, ISDN test, channel unit test, per call test, trouble detection test, and optional diagnostics.

5.4.3.2.1 Trouble Detection Test

All IDLC systems will provide automatic period automatic trouble detection tests on the equipment units. See Section 6 for trouble detection test requirements.

R5-283 **[524]** An RDT and an IDT shall receive from a managing system and process requests to initiate automatic trouble detection tests.

5.4.3.2.2 Diagnostic

O5-284 **[525]** Suppliers may include optional RDT LU diagnostic capabilities in their IDLC systems.

CR5-285 **[526]** If optional diagnostic routines are provided, the IDLC system LU diagnostics shall provide the capability to verify all of the signaling and transmission capabilities of an individual LU.

CR5-286 **[527]** If diagnostic testing is available, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the following diagnostic parameters:

… a. Type of diagnostic to be performed (local or global)

… b. Phases of diagnostic to be performed (phase numbers)

… c. Number of iterations per phase

… d. Resource(s) to be diagnosed

… e. Termination mode (try all phases or terminate upon failure)

… f. Diagnostic report mode (summary or detailed).

CR5-287 **[528]** If diagnostic testing is available, an RDT shall receive from a remote managing system and process requests to invoke diagnostic testing on specified resources. The equipment must be in an out-of-service state before the RDT can honor the diagnostic request.

CR5-288 **[529]** If diagnostic testing is available, an RDT shall receive from a remote managing system and process requests to schedule diagnostic testing to be performed on specific resource(s) on a scheduled basis.

CR5-289 **[530]** If diagnostic testing is available, an RDT shall receive from a remote managing system and process requests to place the scheduler for diagnosis in-service or out-of-service.

CR5-290 **[531]** If diagnostic testing is available, an RDT shall receive from a remote managing system and process requests to retrieve the service status of the scheduler for diagnosis (in-service or out-of-service).

CR5-291 **[532]** If diagnostic testing is available, upon request by a remote managing system, an RDT shall provide the managing system with reports when scheduled diagnostic testing is performed.

CR5-292 **[533]** If diagnostic testing is available, an RDT shall receive from a remote managing system and process requests to abort any outstanding diagnostic testing in the RDT.

5.4.3.2.3 Circuit Testing

Because of the physically distributed nature of IDLC systems, the primary circuit testing objective is the verification and determination of the location of a fault before dispatch of repair technicians. To accomplish this, the customer's circuit via a copper distribution network can be viewed as comprising the following three sections:

a. The distribution section, which encompasses the metallic loop from the RDT to the Network Interface (NI),

b. The channel section extending from the line interface unit at the RDT to the digital line interface circuitry of the IDT

c. The IDT.

Each section of the customer's circuit must be testable.

Although the CPE, as well as the wiring between the point of termination and the CPE, are not part of the LATA network, the telephone companies may provide assistance in identifying certain failures in this equipment. For example, the telephone company may verify the operation of a telephone set keypad in response to a customer trouble report. In addition, the telephone company may want to do on-hook testing or signaling operations involving the CPE.

R5-293 **[534]** The IDLC system shall not interfere with the normal tests done on distribution pairs including tests of signaling functions of customer provided equipment.

R5-294 **[535]** Per-circuit testing is not intended to detect or locate faults affecting a DS1 facility or common equipment. The IDLC system shall suspend automatic and manual circuit level testing while DS1 facility and common equipment faults exist that may affect the outcome of such tests.

For example, circuit tests shall not be run on the channel section extending from the line unit at the RDT to the digital line interface circuitry of the IDT when the only DS1 facility available to reach the RDT for this circuit is out of service.

The telephone company may want to install a maintenance terminating unit at the network interface to provide the capability to determine whether a fault is in the telephone company's or the customer's portion of a circuit.

R5-295 **[536]** The IDLC system shall be transparent to maintenance terminating unit control tones.

Maintenance terminating units for POTS and two-wire Special Service circuits are described in TR-TSY-000324 and MDP 326-515 (also known as PUB 43003).

To individually test each section of the customer's circuit, test capabilities must be provided as follow in the remaining sections.

A. **Per Call Tests**

Many circuit troubles are detected by per-call or automatic routine tests such as power-cross and ring pretrip tests. See Section 6 for per call test requirements.

CR5-296 **[537]** If power-cross test capabilities are provided, an RDT shall receive from a managing system and process requests to initiate an automatic power-cross test.

CR5-297 **[538]** If power-cross test capabilities are provided, an RDT shall receive from a managing system and process requests to inhibit/allow automatic power-cross testing.

CR5-298 **[539]** If ring pretrip test capabilities are provided, an RDT shall receive from a managing system and process requests to initiate an automatic ring pretrip test.

CR5-299 **[540]** If ring pretrip test capabilities are provided, an RDT shall receive from a managing system and process requests to inhibit/allow automatic ring pretrip testing.

CR5-300 **[541]** If power-cross test or ring pretrip test capabilities are provided, an RDT shall provide an autonomous report to a remote managing system when a circuit fails the test and when the circuit is restored back in-service.

B. **Metallic Test Access**

The distribution section of a customer's circuit is tested by making a series of dc and ac voltage, dc resistance, and ac capacitance measurements on the metallic pair extending from the RDT to the customer's equipment for all combinations of tip, ring, and ground.

Some special services may also require that high-frequency tones (e.g., 82 kHz) be applied to the metallic loop. These tests can be made by a test system located at either the RDT site or at a remote location.

Figure 5-1 shows the configuration for a RTU[1] located at the RDT site. The RTU is controlled by a remotely located (most likely in the central office of the IDLC system) TSC. Because no generic interface between a TSC and a RTU has been published, it is assumed a proprietary interface exists between the TSC and the RTU. Therefore, the messages between the TSC and RTU will be transported over a DS0 channel or metallic pair. In the case where an IDLC system DS0 channel is used, access to that channel is through the switching system via a dial-up or dedicated line (nonswitched circuits are discussed in Section 3.5). The data rate is not to exceed 56 kb/s if the TSC interface to the switching system is digital. A similar interface should be provided at the RDT site between the RDT and the RTU.

1. The RTU is the portion of a TSC/RTU that provides the measurement capabilities of the test system. The RTU may be located remotely from the TSC or co-located with the TSC. For more details on an RTU, see Section 6.2.3.

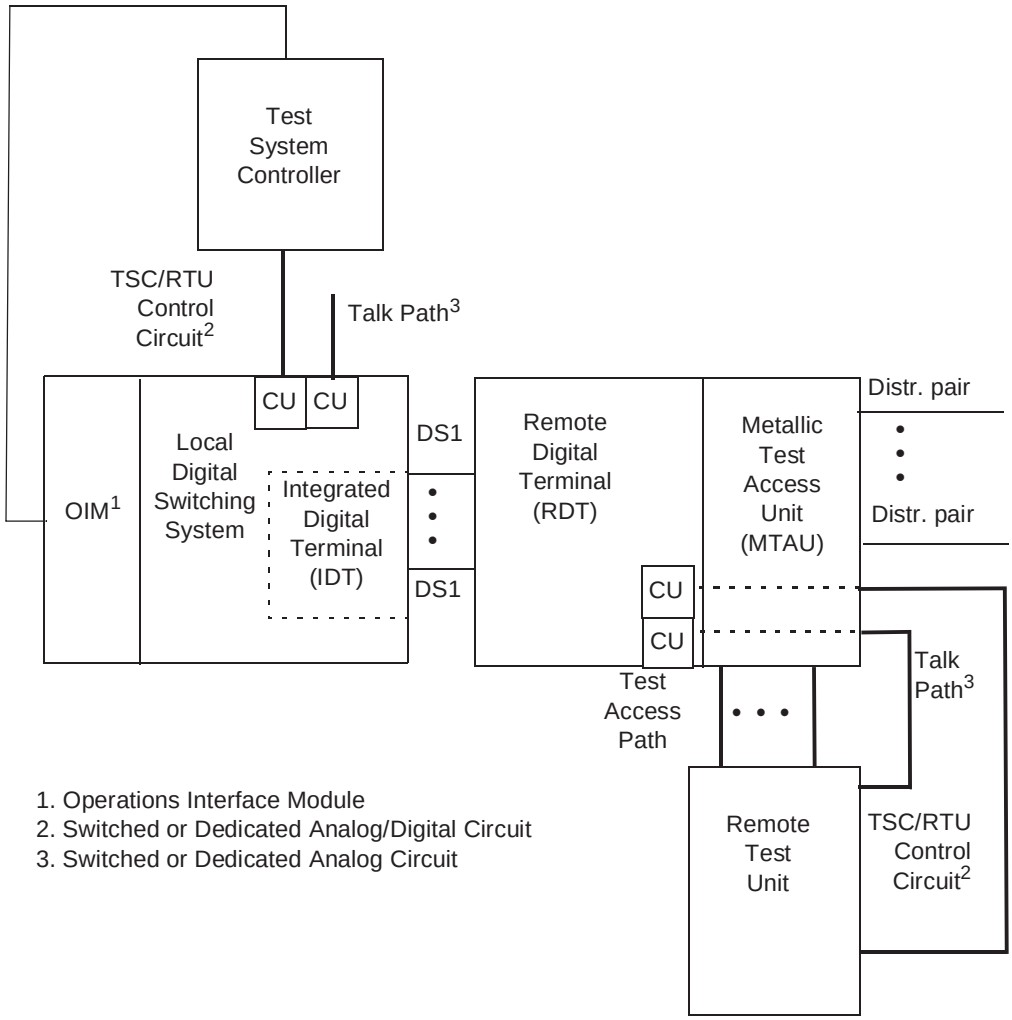


Figure 5-1. Remote Test Unit Co-Located with RDT

The interface between the TSC and the OIM in the LDS is used by the TSC to manage the test access in the RDT.

R5-301 **[542]** An RTU co-located with the RDT will access the distribution section of a circuit through a Metallic Test Access Unit (MTAU). The MTAU shall be an integrated part of the RDT and the MTAU shall meet the requirements of TR-NWT-000818. The built-in metallic test access function shall provide monitoring and full splitting metallic test accesses to individual circuits at the RDT.

A monitor access provides a hitless monitor connection to the circuit under test, i.e., the circuit continuity is maintained. A full splitting access splits the circuit so that tests may be made in either direction or in both directions of transmission.

The following items clarify or limit some of the requirements for MTAUs contained in TR-NWT-000818 as they apply to IDLC systems.

a. TR-NWT-000818 contains a requirement (Table 5-1) recommending the minimum number of test access paths[2] the MTAU should support between the MTAU and the RTU. This table is applicable to special service circuits and recommends a minimum of two test access paths for a MTAU.

R5-302 **[543]** An IDLC system RDT that terminates less than 337 two-wire customer lines shall be equipped with at least one test access path.

O5-303 **[544]** It is an objective that all IDLC systems should have at least two test access paths to lessen the probability a circuit cannot be tested because the test access path is busy or out of service.

For some of the smaller IDLC systems, (e.g., less than 337 two-wire lines), the single test access path option may be chosen to avoid the added expense and complexity of supporting two test access paths.

R5-304 **[545]** An IDLC system RDT that terminates 337 to 950 two-wire customer lines shall be equipped with at least two test access paths.

R5-305 **[546]** An IDLC system RDT that terminates more than 950 two-wire customer lines shall be equipped with at least three test access paths.

b. Multiple test access path considerations

R5-306 **[547]** When multiple test access paths are provided, full access to all circuits terminated on the RDT from any test access path shall be provided. However, full nonblocking access is not required, i.e., the first test access path to be used must be able to access any circuit terminated on the RDT but the second test access path to be used may only be able to access a subset of the remaining circuits independent of which test access path is selected first.

c. Test Access Path Pairs

The facility (F) side of the test access path is toward the RDT. The equipment (E) side of the test access path is toward the customer.

2. The test access path is the metallic leads between the MTAU and the RTU over which tests are performed.

CR5-307 **[548]** Depending on the type of circuits the RDT provides, the following test access pairs shall be provided.

… a. If an RDT provides four-wire circuits, the metallic test access path will only be required to provide four pairs - the equipment and facility "A" and "B" pairs.

… b. If an RDT provides two-wire circuits with signaling (two-wire E&M), the metallic test access path will be required to provide four pairs - the equipment and facility "A" and "B" pairs. The E&M leads shall access the "B" pairs for two-wire E&M circuits.

… c. If an RDT provides four-wire circuits with signaling, the metallic test access path will be required to provide six pairs - the equipment and facility "A," "B," and "C" pairs. The signaling leads shall access the "C" pairs for four-wire circuits with E&M.

… d. For two-wire circuits, the "A" pairs of the metallic test access path will be the only access provided. Two-wire circuits will NOT be required to provide access to the "B" or "C" pairs if they are provided as part of the metallic test access path.

d. Continuity Testing

The TSC/RTU will test the continuity of the test access path before using the test access path for testing.

CR5-308 **[549]** If a full six-pair test access is provided, the RDT shall receive from the TSC/RTU and process requests to test the continuity of the test access path. The integrated MTAU in the RDT will loop the facility A pair to the equipment A pair, the facility B pair to the equipment B pair, and the facility C pair to the equipment C pair upon receipt of the loopback request to allow the TSC/RTU to make the continuity measurements.

CO5-309 **[550]** For RDTs that do not provide a full six-pair interface, the RDT should provide terminations for all six pairs with the unused facility and equipment pairs (B and/or C) shorted together within the RDT or provide the same loopback capabilities as is provided for the used pair(s).

CR5-310 **[551]** For RDTs that do not provide a full six-pair interface and terminations for all six pairs with the unused facility and equipment pairs (B and/or C) shorted together within the RDT or provide the same loopback capabilities as is provided for the used pair(s), the RDT installation documentation shall contain requirements that the unused pairs be shorted at the test access path terminations on the RTU.

e. MTAU Considerations

R5-311 **[552]** The built-in MTAU shall be considered as part of the RDT for memory administration, network monitoring and analysis, and testing operations. The built-in MTAU shall meet the quality and reliability requirements specified for the IDLC system.

R5-312 **[553]** Upon request by a remote managing system, an RDT shall provide the managing system with the RDT test access unit operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-313 **[554]** Upon request by a remote managing system, an RDT shall provide the managing system with the RDT test access unit operating capacity indicating whether it is operating at maximum or minimum capacity or if it has spare capacity to accept more users.

R5-314 **[555]** Upon request by a remote managing system, an RDT shall provide the managing system with the RDT test access unit alarm status.

R5-315 **[556]** Upon request by a remote managing system, an RDT shall provide the managing system with the set of current problems still outstanding in the RDT test access unit indicating the probable cause of the problem and the severity of each problem.

R5-316 **[557]** Upon request by a remote managing system, an RDT shall provide the managing system with an indication of whether it has the capability to terminate and leave a circuit under test.

R5-317 **[558]** An RDT shall receive from a remote managing system and process requests to release all the test access connections and restore the circuits to their normal (non-test) state.

CR5-318 **[559]** If different test configurations are available, an RDT shall receive from a remote managing system and process requests to assign and to retrieve the configuration code. (See TR-NWT-000818 for available codes.)

CR5-319 **[560]** If a test access unit has self diagnostic capability, an RDT shall receive from a remote managing system and process requests for a specific self diagnostic be performed on the test access unit in the RDT.

f. Activity Timer Considerations

R5-320 **[561]** The RDT shall provide a 75-second timer for each test access path on the RDT. Each timer shall be automatically started when test access is

established and stopped when test access is disconnected. Each timer shall have the capability to be reset.

R5-321 **[562]** If a test access has been established on a test access path and the RDT does not receive any command (including one to reset the timer) for this test access path from the test system for a period of 75 seconds, the RDT shall assume the control link has failed, release the test access, and return the test access path to its idle state.

g. Metallic Test Access

For remotely located test systems, the test access to the distribution section is via a metallic test pair between the switching system and the RDT. This test pair may be shared among all co-located RDTs. Appendix A of TR-TSY-000008 is an example of an interface that uses the metallic test pair for testing locally switched circuits. The requirements for non-locally switched and nonswitched circuits have not been specified at this time.

A metallic test pair only provides testing capability for the distribution portion of locally switched circuits; the capability to test toward the line unit of the RDT is not needed for locally switched circuits. The metallic test pair can be used for test access to the distribution portion of non-locally switched and nonswitched circuits. The test pair can also be used to look into the line units of non-locally switched and nonswitched circuits if the RDT provides a look-in look-out capability on the equipment lead of its test access path. However, a test system cannot simultaneously test both the line unit and distribution portion of these circuits using the test pair; the testing must be done sequentially.

A test system co-located with an RDT may give more accurate test results because measurements are not affected by the metallic test pair between the IDT and RDT. Generally the accuracy of test results are more critical for special service circuits than for POTS circuits because of more stringent transmission requirements of special service circuits. Moreover, the increasing use of fiber optic facilities between RDTs and local digital switching systems may make it more difficult for the telephone company to provision a metallic test pair. Thus, use of a metallic test pair is discouraged.

R5-322 **[563]** An RDT shall provide metallic test access to the distribution pairs for locally switched, non-locally switched, and nonswitched circuits including both POTS and Special Service circuits, whether analog or digital.

R5-323 **[564]** An RDT shall receive from a remote managing system and process requests to remove a termination point from service for testing services. The RDT shall continue to allow call processing to take place (e.g.,

dynamic time-slot assignment) for that termination point while it is out-of-service due to testing functions.

R5-324 **[565]** An RDT shall receive from a remote managing system and process requests to assign and to connect a test access path to a specified circuit under test and perform a loop around to the assigned test access path for verifying the integrity of the path.

… a. An idle metallic test access path is assigned to the specified circuit under test. If no idle test access path is available, the RDT shall respond to the remote managing system with an error. If one is available, the RDT shall respond to the remote managing system with the test access path used and the monitor access and split access capabilities of the test access path.

… b. After a test access path is assigned, a loop around is applied to all pairs of the metallic test access path, i.e., the facility "A" pair is connected to the equipment "A" pair to allow the test system to verify the test access path before circuit testing begins.

R5-325 **[566]** An RDT shall receive from a remote managing system and process requests to remove the loop around to the test access path and provide a low-loss, high-impedance monitor connection to the circuit under test. An ac connection between the "A" facility pair of the test access path and the metallic pair terminating on the RDT through an ac impedance greater than 200 kΩ is provided for the monitor state. If a monitor is not provided by the RDT, the RDT will have an open-circuited "connection" to the un-split line termination.

CR5-326 **[567]** If the test access unit has split out only access capability, an RDT shall receive from a remote managing system and process requests to connect a circuit under test in the split out mode. If a monitor connection or a loop around was provided, it shall be removed on all pairs of the test access path and the metallic pair terminating on the RDT shall be connected to the equipment side of the metallic test access path. The split mode consists of opening the path between the line terminating equipment and the metallic pair terminated on the line terminating equipment.

CR5-327 **[568]** If the test access unit does not support simultaneous full splitting connection to a circuit under test, an RDT shall receive from a remote managing system and process requests to change to split in or split out connection mode.

CR5-328 **[569]** If the test access unit does support full split access capability, an RDT shall receive from a remote managing system and process requests to

change to split full connection mode. If a monitor connection or a loop around was connected, it shall be removed from all pairs of the test access path and the line terminating equipment of the RDT shall be connected to the facility side of the metallic test access path. The split mode consists of opening the path between the line terminating equipment and the metallic pair terminated on the line terminating equipment.

R5-329 **[570]** An RDT shall receive from a remote managing system and process requests to restore the circuit under test to its through state and disconnect test access from the circuit. The RDT shall remove the loop around on all pairs of the test access path and disconnect the metallic pair terminating on the RDT from the equipment side of the metallic test path. If the line terminating equipment is connected to the metallic test path, it shall be disconnected from the facility side of the metallic test path. The RDT shall reestablish the path between the line terminating equipment and the metallic pair terminated on the line terminating equipment. It shall also remove any association between the line terminating equipment and the test access path.

CR5-330 **[571]** If an analog line circuit has terminate and leave capability, an RDT shall receive from a remote managing system and process requests to select and to retrieve the terminate and leave configuration.

h. Test Response Circuits

R5-331 **[572]** An RDT shall provide a test response circuit for each metallic test access path provided at the RDT.

R5-332 **[573]** An RDT shall receive from a remote managing system and process requests to place the RDT test response circuit in-service and out-of-service.

R5-333 **[574]** An RDT shall receive from a remote managing system and process requests to retrieve the service status of the RDT test response circuit (in-service or out-of-service).

R5-334 **[575]** An RDT shall provide a remote managing system with an RDT test response circuit operational status indicating whether it is fully inoperable and unable to provide service to the user, or it is fully operable and available for use.

R5-335 **[576]** An RDT shall receive from a remote managing system and process requests to connect a test response circuit to a line termination.

… a. Metallic test access must be established before this request can be honored.

… b. If full splitting test access has been established to the line termination, the RDT shall disconnect the facility pairs of the test access path assigned to the circuit from all external equipment, connect the test response circuit to the line terminating equipment with an absorptive termination across the tip and ring leads of the specified line terminating equipment with a positive tip party identification (PTPG) path-to-ground termination, and present an off-hook condition to the line terminating equipment.

… c. If a split out test access has been established, the RDT shall connect the test response circuit to the line terminating equipment with an absorptive termination across the tip and ring leads of the specified line terminating equipment with a PTPG path-to-ground termination and present an off-hook condition to the line terminating equipment.

R5-336 **[577]** An RDT shall receive from a remote managing system and process requests to disconnect a test response circuit from a line termination. The RDT shall remove the current termination from the specified line terminating equipment, present an on-hook condition to the line terminating equipment, and reestablish the connection between the line terminating equipment and the test access path.

R5-337 **[578]** An RDT shall receive from a remote managing system and process requests for the RDT test response circuit to apply test terminations during line unit testing:

… a. The Absorptive/PTPG termination and the test response circuit shall be connected to the specified line, and the equipment side of the test access path between the metallic test access unit and the remote test unit shall be opened.

… b. If a metallic test access path has not been associated with the specified line, the RDT shall assign an idle metallic test access path to the line and open the assigned test access path. If an idle metallic test access path is not available, the RDT shall reject the request to apply the test termination.

… c. The request shall provide an initial termination, a signal, and a final termination. When the RDT applies the initial termination, the RDT sends a response to the test system indicating the initial termination has been applied. The RDT test response circuit shall

apply the final terminations if and only if, the correct ringing or coin control voltage is applied by the LU.

… For example, if the reflective termination is to be connected to a single party line on the detection of negative ringing on the ring conductor, the RDT will only connect the reflective termination if the test response circuit detects negative ringing on the ring conductor. Any other ringing or coin control voltage detected by the RDT test response circuit is ignored (remains in an on-hook condition).

R5-338 **[579]** An RDT shall receive from a remote managing system and process requests for the RDT test response circuit to remove test terminations. Upon receipt of the request to remove the test termination, the RDT shall remove any termination from the specified line.

CR5-339 **[580]** If test access was established based on the request to apply test termination, the RDT shall restore the circuit and make available the access point upon receipt of the request to remove the test terminations. Otherwise, the RDT shall maintain the test access until it receives other requests to disconnect the test access.

R5-340 **[581]** The RDT test response circuits shall be capable of recognizing negative superimposed ringing applied to the ring conductor.

CR5-341 **[582]** If the RDT can serve multiparty lines, the test response circuits shall also be capable of recognizing negative superimposed ringing applied to the tip conductor, and positive superimposed ringing applied to either the tip or ring conductor.

CR5-342 **[583]** If the RDT can serve coin lines, the test response circuits shall be capable of detecting coin collect and coin refund voltages.

R5-343 **[584]** The test response circuit of the RDT shall place the correct termination across the tip and ring output of the RDT LU for each type of signaling detected.

The test response circuit is used in testing the portion of a line unit used by an individual POTS, multiparty, and coin lines. (The line unit may contain multiple POTS, multiparty, or coin lines.)

C. Digital Test Access

Currently, most locally switched circuits are tested by a test system or by technicians using a local test desk or automated test system that accesses the circuit to be tested over a no-test trunk. The no-test trunk is an analog interface that cannot be used to test the digital channel

unit of a circuit carried by a DLC system without auxiliary equipment that works through the interface described in TR-TSY-000465. The interface described in TR-TSY-000465 is for universal DLC systems, but can be adapted to work with IDLC systems as described in Appendix A of TR-TSY-000008. But in both the universal and integrated DLC systems, the test access and control of the digital channel unit of the circuit is an adaptation of an analog interface. By providing direct digital test access to the digital portion of the circuit to be tested, the use of the no-test trunk and auxiliary equipment can be eliminated for IDLC systems.

R5-344 **[585]** An IDLC system shall provide one of the following:

… a. A built-in (TR-465-specified) channel test capability to test the line units for POTS, multiparty, and coin circuits. This test capability is used in conjunction with no-test trunks as specified in TR-TSY-000465 and TR-TSY-000008, Appendix A. This requirement does not preclude a supplier from offering additional means to initiate these tests (e.g., using software control).

… b. A digital test access to an individual circuit at the IDT with monitoring and full splitting capabilities.

A monitor access provides a hitless monitor connection, i.e., the circuit continuity is maintained to the circuit under test. A full splitting access splits the circuit so that tests may be made in either direction or both directions of transmission.

O5-345 **[586]** It is an objective that the LDS should provide digital test access for non-locally switched and nonswitched circuits.

CR5-346 **[587]** If a digital test access is provided at the LDS for voice grade DS0 or subrate circuits, the digital test access shall be compatible with the DTAU specified in TR-NWT-000818.

CR5-347 **[588]** If a digital test access is provided at the LDS, the test access path between the test system and the DTAU shall be a Type 2 test access link. A Type 2 test access link uses a DS1 to carry the test access paths between the test system and the DTAU. The facility side of the circuit under test shall be toward the RDT and shall be connected to the odd numbered channel of the test access path. The equipment side of the circuit under test shall be away from the RDT and shall be connected to the even numbered channel of the test access path.

When the digital test access is provided in the LDS, the LDS may provide a digital test access for locally switched circuits that is physically separate from the digital test access provided for non-locally/nonswitched circuits. Of course, the LDS may provide the capability for digital test access to all circuits through a single DTAU. The DTAU may be part of the LDS or IDT.

CO5-348 **[589]** If digital test access at the IDT end of the IDLC system is provided by a DTAU external to the LDS or IDT, the stand-alone DTAU should be compatible with the DTAU specified in TR-NWT-000818 and provide access to all circuits carried by the IDLC system.

CR5-349 **[590]** If an IDLC system uses a stand-alone DTAU rather than one built into the LDS or IDT, the following requirements apply:

… a. The DTAU shall operate in the transparent arrangement. The transparent arrangement requirements are given in TR-NWT-000818, Section 3.4.

… b. The supplier shall include two times the one-way DTAU transmission delay in the maximum allowable two-way echo-path-delay discussed in Section 4.4.3, “Delay”. (The maximum one-way transmission delay for a DTAU is 0.7 ms, with an objective of less than 0.5 ms of delay. See TR-NWT-000818, Section 6.5.1.)

… c. The DTAU shall be transparent to DS1 fault locating procedures.

CR5-350 **[591]** If digital test access is included in the RDT, the digital test access shall be compatible with the DTAU specified in TR-NWT-000818.

D. **Line Unit (LU) Test**

The LU test's function is to detect LU failures. The test can include the channel section extending from the LU at the RDT to the digital line interface circuitry of the IDT. Among the methods used to detect failures in the other portions of the channel section are diagnostics of the common equipment in the RDT and IDT, and performance monitoring of the DS1 facility. The method of LU testing will be different for locally switched circuits and non-locally switched/nonswitched circuits, as discussed in the next two sections.

a. Non-locally Switched/Nonswitched Circuits

Non-locally switched/nonswitched circuits that pass through the IDT may be tested by a test system gaining access to the circuit at the IDT or LDS through a DTAU. The same test system or a second test system will gain access to the analog line side of the circuit at the RDT through the built-in MTAU. Each direction of transmission will be tested individually using the test system(s) connected at the IDT/LDS and RDT ends of the IDLC system. The only IDLC system requirements for testing the non-locally switched/nonswitched circuits are the requirements to provide access to the circuit for testing via the MTAU at the RDT and, if provided, the DTAU at the IDT or LDS.

b. Locally Switched Circuits

There are transmission and signaling tests that a test system can perform to check for proper operation of the RDT LUs. The transmission tests are used to check that the

transmission parameters of the RDT LUs are within the proper operating limits. The signaling tests verify that the RDT and the RDT LU can detect and produce the required signaling and supervision signals for single party, multiparty, and coin LUs.

R5-351 **[592]** As part of the MTAU in the RDT, the RDT shall provide the following terminations between the tip and ring leads of the line under test.

… a. Absorptive - a termination with an ac impedance that minimizes the reflection of the incoming ac signal from the IDT

… b. Reflective - a termination with an ac impedance that maximizes the reflection of the incoming ac signal from the IDT. In general, this will be a short circuit (zero ohms).

… c. Absorptive/PTPG - Absorptive termination with a Positive Tip Party Ground

… d. Reflective/NTPG - Reflective termination with a Negative Tip Party Ground

… e. Open

… f. Ring Ground

… g. Negative Tip Ground

… h. Positive Tip Ground.

Positive Tip Party Ground means that the termination in the RDT provides a dc path to ground that will be detected if and only if the RDT LU is providing a positive dc voltage with respect to ground on either the tip or ring conductor. Negative Tip Party Ground means that the termination in the RDT provides a dc path to ground that will be detected if and only if the RDT LU is providing a negative dc voltage with respect to ground on either the tip or ring conductor.

R5-352 **[593]** The above terminations shall be provided for each metallic test access path provided between the RDT and the remote test unit co-located with the RDT.

The following three transmission tests will be made using the above terminations:

1. Echo return loss
2. Two-way channel loss
3. Idle channel noise.

Echo return loss will be determined by transmitting the following test signal to the RDT LU while the line is terminated with the absorptive termination and measuring

the received signal level at the IDT. The test signal is the digitally encoded equivalent of an analog signal meeting the following parameters:

lower frequency	1000 (±100) Hz
upper frequency	2000 (±100) Hz
sweep rate	125 (±25) Hz
amplitude	-3 dBm

A sinusoidal test signal that is swept in frequency is used to minimize interhybrid reflections.

The two-way channel loss will be determined in a similar fashion by making the measurement while the RDT line is terminated with the reflective termination. The received signal is passed through a C-message weighting filter for both the echo return loss and two-way channel loss measurements.

The idle channel noise will be determined by measuring the received signal at the IDT while the idle code is transmitted to the RDT LU and the line is terminated with the reflective termination. The received noise is passed through a C-message weighting filter.

R5-353 **[594]** The IDLC system supplier shall specify the minimum value of the echo return loss in dB, the maximum value of round trip channel loss in dB, and the maximum value of idle channel noise in dB that should be measured to indicate satisfactory performance of the LU.

Signaling tests are required in addition to transmission tests.

R5-354 **[595]** An RDT shall receive from a remote managing system and process requests to connect an analog line circuit to the test response circuit for the purpose of testing a locally-switched channel unit. A successful test access shall precede this request.

R5-355 **[596]** An RDT shall receive from a remote managing system and process requests to disconnect an analog line circuit from the test response circuit after the completion of a channel unit test.

Signaling tests for RDT LUs will be made using the test response circuit and tests to determine the termination applied to the line.

R5-356 **[597]** The RDT LU shall detect the dc portions of the terminations (loop-closure, Automatic Number Identification [ANI], coin relay ground, etc.) and report them to the IDT.

The LU test procedures require the test system to apply the normal ringing code to a given LU based on the line's type, and for multiparty LUs, all ringing codes that the LU is capable of detecting.

The TSC/RTU system will test the transmission and signaling capabilities of the line terminating equipment. The TSC/RTU system must have digital test access to the line terminating equipment through the LDS. When the RDT is using the TMC for signaling and supervision of locally switched circuits, the TSC/RTU can exchange signaling and supervision information with the equipment by inserting and extracting the RBS bits through the digital test access. When the RDT is using CSC, the TSC/RTU system cannot exchange signaling information with the line terminating equipment through the digital test access. The TSC/RTU must request the LDS to use the CSC to exchange specific signaling and supervision information with the RDT. It must also query the LDS for the current supervision state of the circuit under test when this information is needed.

CR5-357 **[598]** If the CSC is used, the IDT shall receive from a remote managing system (e.g., an external test system) and process requests to apply ringing to a LU under test at the RDT. The IDT shall apply the ringing specified in the request using the same method that is used by the IDT during normal call processing.

CR5-358 **[599]** If the CSC is used, the IDT shall receive from a remote managing system and process requests to apply coin control signals to an LU under test in at the RDT. The IDT shall apply the coin control signals specified in the request using the same method that is used by the IDT during normal call processing.

CR5-359 **[600]** If the CSC is used, the IDT shall receive from a remote managing system and process requests to retrieve the current supervision state of a circuit under test.

RDT LUs that terminate coin lines are required to apply different line voltages for coin first and dial tone first coin phones, to read the totalizer, check for local overtime coin deposit, and control coin collection.

When the test system is located externally to the LDS, the test system may choose to insert the appropriate robbed bit signaling codes to control the ringing and coin control functions at the RDT when testing locally switched circuits on an RDT using robbed bit signaling.

R5-360 **[601]** RDT LUs will respond to the terminations applied by the RDT test response circuit with on-hook, off-hook, ring ground, tip ground, coin ground, or a combination of on-hook/off-hook and a ground indication.

R5-361 **[602]** The response of the RDT LU to a stimuli from the LDS or IDT shall be available in the LDS or IDT within 1 second.

The test system or maintenance technician may need to compare the actual remotely settable memory administration data of a LU with their expected values during a testing operation.

R5-362 **[603]** The IDLC system shall provide the capability to read the memory administration data associated with an LU for those items that are remotely settable.

E. **DS1 Testing**

R5-363 **[604]** An RDT and IDT shall receive from a remote managing system and process request to enable or disable a loopback test on a DS1 line circuit.

R5-364 **[605]** An RDT and IDT shall receive from a remote managing system and process requests to retrieve the assigned loopback permission on a DS1 line circuit.

R5-365 **[606]** An RDT and IDT shall receive from a remote managing system and process requests to perform or remove a loopback test on a DS1 line. The request shall specify whether the loopback is near-end or far-end. If the loopback is far-end, the RDT and IDT shall initiate the far-end loopback using the appropriate 16-bit codes sent in the DS1 ESF data link. The 16-bit codes used to control the far-end loopbacks are defined in Section 4. See Section 6 for additional DS1 loopback requirements.

R5-366 **[607]** If the RDT and the IDT have a loopback established on a DS1 facility, the RDT and the IDT shall deny any new loopback requests from a remote managing system.

R5-367 **[608]** An RDT and IDT shall receive from a remote managing system and process requests to terminate a loopback test on a DS1 line.

R5-368 **[609]** Upon request by a remote managing system, an RDT and IDT shall provide the managing system with the loopback test status of a DS1 line indicating whether the loopback test is in progress or idle.

CR5-369 **[610]** If T1-based digital facilities are used, an RDT and IDT shall receive from a remote managing system and process requests to perform Single-Ended Fault Locating (SEFL). See Section 6 for SEFL requirements.

F. ISDN Testing for 4:1 TDM

ISDN testing capabilities require the RDT to mediate from/to the eoc messages (between the NT1 and the RDT) and EOC messages (between the RDT and the OS). The following are requirements for testing functions that are supported by the RDT.

CR5-370 **[611]** If 4:1 TDM is used, an RDT shall receive from a remote managing system and process requests to initiate a loopback test on an ISDN line specifying the channel under test (B1, B2, D, or combination).

CR5-371 **[612]** If multi-point eoc configurations are supported and 4:1 TDM is used, the RDT shall receive from a remote managing system and process requests to initiate a loopback test on an ISDN line specifying the channel under test (B1, B2, D, or combination) on any of the nodes that terminates (or accesses) the embedded operations channel (eoc).

CR5-372 **[613]** If 4:1 TDM is used, an RDT shall receive from a remote managing system and process requests to terminate a loopback test on an ISDN circuit.

CR5-373 **[614]** If multi-point eoc configurations are supported and 4:1 TDM is used, the RDT shall receive from a remote managing system and process requests to terminate a loopback test on an ISDN line specifying the channel under test (B1, B2, D, or combination) on any of the nodes that terminates (or accesses) the embedded operations channel (eoc).

CR5-374 **[615]** If 4:1 TDM is used, an RDT shall receive from a remote managing system and process requests to perform a corrupted CRC test specifying the source of the corrupted CRC (from LT or NT).

CR5-375 **[616]** If multi-point eoc configurations are supported and 4:1 TDM is used, the RDT shall receive from a remote managing system and process requests to perform a corrupted CRC test specifying the source of the corrupted CRC (from LT or NT) on any of the nodes that terminates (or accesses) the embedded operations channel (eoc).

6. IDLC System Capabilities: Requirements and Options

6.1 System Requirements

There is a minimum set of system capabilities that IDLC systems must provide to enable the technicians of a telephone company to maintain systems with timely and economical methods. Other system capabilities are also needed to facilitate automatic service recovery, prevent damage to the equipment, or prevent false billing. These capabilities are discussed below.

6.1.1 Per-Call Tests

Many circuit troubles are detected by the customer, but others may be detected by per-call or automatic routine tests.

R6-1 **[617]** The RDT shall provide tests to detect and verify faults such as low loop resistance or ground conditions, or any other faults within the RDT that could cause false ring-trip or false answer.

R6-2 **[618]** The RDT shall provide tests to verify continuity within the RDT between the distribution pair(s) termination and the DS0 time-slot(s) of the DS1 used to transport the signal to the IDT.

The actual tests needed to satisfy the above requirements depend on the RDT implementation.

Although the following tests detect conditions external to the RDT, the following per-call tests are required to protect the RDT.

6.1.1.1 Power-Cross Test

The power-cross test is not required for all IDLC systems. The intent of the test is to prevent power-crosses from causing catastrophic failures at the RDT, such as causing a fire or having a per circuit trouble propagate to the common equipment of the RDT. Therefore, RDTs whose design, architecture, and/or technology used are such that the RDT will not become a fire hazard and whose common equipment is protected from power-crosses on the distribution cable of a line unit do not need to make per-call power-cross tests.

CR6-3 **[619]** If an undetected power cross may reasonably be expected to cause serious loss of service (e.g., starting a fire or damaging critical common equipment at the RDT), a power-cross test shall be performed by the RDT

to give immediate detection of such crosses. A power-cross test shall be made on both originating and terminating calls.

Because the requirements for the power-cross test depend on a supplier's RDT implementation, the specifics of the test are not specified.

R6-4 **[620]** If a circuit fails the power cross test, the following procedures are applicable:

… a. The circuit shall not be connected to the RDT

… b. The circuit shall automatically be tested with a periodicity of between 1 and 5 minutes

… c. When the circuit passes two consecutive power-cross tests, the line shall be restored to service.

The desire to put a circuit back into service as quickly as possible must be balanced by considerations of processor time, and the need to keep intermittent power-cross conditions from causing a large number of service state changes. The time range in the above retry schedule is to allow flexibility for the RDT to balance these considerations.

6.1.1.2 Ring Pretrip Test

The intent of the ring pretrip test is to prevent a line fault that appears as an off-hook condition to the ring trip detection circuitry from causing a false ring trip or false answer. In some cases, a false ring trip such as this could result in the customer being billed for a call that was not completed to the called party.

The local switching system normally runs a ring pretrip test before applying ringing to a line; but for lines served by an IDLC system, the local switching system cannot perform the ring pretrip test on the line. Therefore, the IDLC system must perform the ring pretrip test when the test is required. A ring pretrip test in not required when the RDT uses the same circuit for off-hook detection and ring trip.[1] For details of this test, see TR-NWT-000506, Section 6.2.4.1.

CR6-5 **[621]** For ground-start lines, and for loop-start lines when the RDT does not use the same circuit for off-hook detection and ring trip or ensure the minimum ring-trip current is always greater than the service request threshold, the RDT shall implement a ring trip test in one of the following ways:

… a. Perform the ring trip test before ringing a line on a terminating call

1. When the RDT uses the same circuit for off-hook detection and ring trip, a fault on the line that would cause ring trip would also result in an off-hook detection. Therefore, the line would be in a permanent signal condition and the switching system should not terminate calls to a line in a permanent signal condition.

… b. Periodically perform the ring pretrip test on all lines.

CR6-6 **[622]** If the RDT performs the ring pretrip test periodically rather than on a per terminating call, the probability of a false ring-trip on a terminating call shall be less than 10^{-5}.

R6-7 **[623]** If a circuit fails the ring pretrip on a terminating call, the circuit shall not be connected to the RDT.

CR6-8 **[624]** For those circuits that have failed a ring pretrip test, the following procedures are applicable:

… a. The circuit shall automatically be tested with a periodicity of between 1 and 5 minutes

… b. When the circuit passes two consecutive ring pretrip tests, the line shall be restored to service.

The desire to put a circuit back into service as quickly as possible must be balanced by considerations of processor time, and the need to keep intermittent ring pretrip conditions from causing a large number of service state changes. The time range in the above retry schedule is to allow flexibility for the RDT to balance these considerations.

The circuit testing requirements to verify the existence of a circuit trouble and to aid in trouble isolation and repair are discussed in Section 5.4.3.2.3, page 5–46.

6.1.2 Memory Backup

CR6-9 **[625]** If the IDT uses volatile store, memory backup of the volatile store shall be provided by the LDS as part of its memory backup requirements.

CR6-10 **[626]** If the RDT uses volatile store, a non-volatile memory backup of the volatile store shall be provided at the RDT per the requirements for memory backup and restoration presented in GR-472-CORE.

The following items clarify or limit some of the requirements for memory backup contained in GR-472-CORE as they apply to IDLC systems.

R6-11 **[627]** Any initialization of the IDLC system volatile memory from the memory backup shall include all changes that have been acknowledged by the RDT in the volatile memory that were initiated by OSs and by technicians. Unacknowledged changes from these sources may be lost.

R6-12 **[628]** The volatile memory of the RDT shall be protected from transient conditions during transitions from commercial ac power operation to

battery backup operation and visa versa. These transitions shall not initiate a restoral of the working memory from the backup memory.

CR6-13 **[629]** If the non-volatile memory backup medium at the RDT relies on the RDT batteries, the batteries shall provide a minimum of 30 days power to the memory backup medium after the loss of ac power at the RDT.

O6-14 **[1794]** It is desirable to remotely manage via a managing system (OS/EM) the backup of software located on the RDT.

The following requirements are applicable if the remote backup feature is provided, per **O6-14**.

R6-15 **[1795]** A remote managing system shall trigger the RDT to initiate the backup of software stored locally. The remote managing system shall inform the RDT of the software to be backed up and the destination to which the software will be backed up.

R6-16 **[1796]** Upon request from a remote managing system to backup software, the RDT shall perform the backup to the specified destination. The destination may be either:

… • the RDT's local memory

… • the remote managing system

… • a remote system.

R6-17 **[1797]** For backups to an RDT's local memory and backups to a remote system, the RDT shall send a positive or negative acknowledgment to the remote managing system indicating the success or failure of the file transfer.

It may also be desirable for an RDT to be programmed to perform software backups according to a specific schedule. This feature will be referred to as the Programmable Software Backup Feature.

O6-18 **[1798]** It is desirable for a RDT to support a Programmable Software Backup feature.

The following requirements apply if the Programmable Software Backup feature is provided, per **O6-18**.

R6-19 **[1799]** The RDT may be programmed to backup the software to either of the following destinations:

… • the RDT's local memory

… • a remote system.

6.1.3 Equipment Maintenance

The IDT and RDT need to be capable of detecting and verifying troubles, initiating service protection procedures, and notifying technicians of troubles through alarms, status indications, and output messages for management of the telecommunications network. The alarms, status indications and output messages identify the location and nature of the trouble, and aid in trouble isolation and repair.

R6-20 **[630]** The IDT shall be maintained as part of the LDS per the requirements of Sections 4.1, "Criteria Common to Switching and Transport Network Elements," and 4.2, "Switching System NE Requirements," in TR-NWT-000474.

The equipment maintenance capabilities required in the RDT are described in the remainder of Section 6.1.3.

6.1.3.1 Self Monitoring

R6-21 **[631]** IDLC equipment shall be self monitoring and capable of detecting equipment hardware or software troubles.

A trouble is a deviation from normal system operations and includes errors and faults. Since corrective maintenance actions cannot start until trouble detection has occurred, it is very important for the IDLC system to detect all actual and suspected hardware or software troubles.

R6-22 **[632]** Maintenance procedures shall be provided for the resolution of the trouble.

The trouble detection functions in the following subsections need to be provided.

6.1.3.1.1 Continuous Automatic Tests

R6-23 **[633]** The IDLC system shall detect troubles such as loss of commercial AC power at the RDT, standby battery voltages that are out of limits, operated fuses, environmental conditions affecting the operation of the IDLC system.

R6-24 **[634]** The detected troubles shall be identified by the unit and by its location within the IDLC system.

6.1.3.1.2 Per-Operation Automatic Trouble Detection Tests

R6-25 **[635]** These per-operation automatic trouble detection tests shall check for database errors, unavailability of system resources, and ineffective call attempts and message transactions.

6.1.3.1.3 Periodic Automatic Trouble Detection Tests

R6-26 **[636]** All IDLC system units shall automatically be tested on a periodic basis except if the unit is in an out-of-service or unavailable state, or if the unit is tested by testing functions of Section 6.1.3.1.1. This testing shall include all standby units of duplicated equipment.

R6-27 **[637]** Non-duplicated units that do not pass all periodic automatic tests shall be put in an out-of-service state if they are providing no service, providing erroneous service, or affecting other equipment.

R6-28 **[638]** A duplicated unit that does not pass all periodic automatic tests shall be put in an out-of-service state and the standby unit shall be placed in service. If the standby unit of a duplicated unit is unavailable, the unit shall follow the above procedures for non-duplicated units.

6.1.3.1.4 Local and Remote Maintenance Center Interfaces Trouble Detection

R6-29 **[639]** Per-operation and per-message transaction tests shall be provided to detect and report troubles in local maintenance interface units or the interface to the remote maintenance center.

O6-30 **[640]** It is an objective that the need for manual trouble detection tests should be minimized.

6.1.3.2 Alarm Classifications

R6-31 **[641]** IDLC systems shall provide alarms that distinguish between service-affecting and non-service-affecting troubles, as well as indicating the severity of the trouble condition (e.g., in terms of approximate number of channels affected).

R6-32 **[642]** For IDLC systems, the following default alarm classifications and designations shall be used unless other classifications are specifically given in other areas of this document:

… a. **Critical alarm** indicates that a severe, service-affecting condition exists and that an *immediate* maintenance response is required. For IDLC systems, a critical alarm shall be generated for equipment failures or fault conditions that cause the equivalent of more than 128 customer lines to be out of service.

… b. **Major alarm** indicates that a service-affecting condition exists and that a *prompt* maintenance response is required. For IDLC systems, a major alarm shall be generated for equipment failures or fault conditions that cause the equivalent of 24 or more customer lines to be out of service.

… c. **Minor alarm** shall be generated to indicate that a nonservice-affecting condition exists or a condition exists affecting service to few customer lines, such as a

… — Failure of duplicated equipment

… — Degraded call capacity

… — Failure of noncall-related equipment such as test equipment

… — Condition exists that is service-affecting for 2 to 23 customer lines.

… For these conditions, a *normal* maintenance response is required.

… d. **Automatic Message** indicates that a condition exists that is service-affecting for a single customer line. A *normal* maintenance response is required. For IDLC systems, an Automatic Message shall be generated for equipment failures or fault conditions detected by a per-call test as described in Section 6.1.1 or by optional internal per-line diagnostics.

When determining the alarm classification to be used in reporting a failure, the classification is determined as if there is the single failure, and the classification should not be based on the cumulative affect of individual failures. For example, 24 single line failures do not result in a major alarm report when the twenty-fourth line fails. Similarly, the failure of the sixth DS1 facility is a major alarm report, despite the fact that the equivalent of more than 128 customers may be out of service. However, a failure of duplicated equipment, that normally causes a switch to backup equipment to protect service and is reported as a minor alarm, takes on the appropriate alarm classification when the switch to the backup equipment cannot be completed. For example, if the DS1 carrying the operations data-link fails and the DS1 or data-link cannot be moved to protection facilities (i.e., the operations data-link is lost), a major alarm is reported by the IDLC system if it terminates up to 128 lines, but a critical alarm is reported if the IDLC system terminates more than 128 lines.

CR6-33 **[643]** An RDT that can be installed in a concentrated configuration shall:

… 1. Activate a major alarm if transmission facility failures reduce its traffic capacity below a threshold selectable by the telephone company.

… 2. Provide a correlation for each system configuration between the traffic capacity as determined according to requirements in Section 8.1.2.2 with a 25% intracall rate and the number of working facilities.

CO6-34 **[644]** An RDT that can be installed in a concentrated configuration and can terminate more than 128 lines should provide a second threshold selectable by the telephone company for which a critical alarm will be activated if transmission facility failures reduce its traffic capacity below this threshold.

R6-35 **[645]** Visual alarm indications shall be provided at the RDT and the detailed RDT alarm information shall be available through the craft interface at the RDT.

R6-36 **[646]** Audible and visual CO alarms shall meet the requirements of TR-NWT-000474, and the detailed IDT alarm information shall be available through the craft interface at the LDS.

R6-37 **[647]** Alarms shall remain active for the duration of the trouble condition.

R6-38 **[648]** The LDS shall provide the capability to set switch distribution points based on alarm information at the IDT. The alarms information to be available at the LDS distribution points shall be user settable through the craft interface of the LDS.

6.1.3.3 Service Recovery

Service recovery capabilities are intended to protect service with minimum impact on service performance by providing features to enable the IDLC system to recover from detected troubles. These troubles may be internal or external to the IDLC system. Service protection capabilities include automatic and manual system hardware resets, switches between active and standby units, software initialization, and software backup from a non-volatile storage device.

R6-39 **[649]** Automatic service recovery strategies shall be provided.

The following subsections identify the recovery functions required.

6.1.3.3.1 Automatic Service Recovery

Automatic service recovery is initiated by the IDLC system upon detection of a trouble when the IDLC system will recover or has a high probability of recovering from the detected trouble.

R6-40 **[650]** Automatic service recovery capabilities shall be provided that include hardware resets, software initialization, and software backup from a non-volatile source.

Some automatic service recovery procedures (e.g., initialization of the data-link between the LDS and RDT) may require an exchange of messages between the LDS and the RDT.

R6-41 **[651]** Units experiencing excessive error rates, units with error rates exceeding a previously established out-of-service limit, or units with service affecting faults shall be automatically placed out-of-service as soon as possible after trouble detection, unless the action is inhibited by a previous manual action or unless the IDLC system operation would be more severely degraded by the removal.

6.1.3.3.2 Manual Service Recovery

R6-42 **[652]** Automatic service recovery capabilities shall be supplemented by manual service recovery capabilities that may be initiated from a local craft interface, or the local or remote maintenance centers.

R6-43 **[653]** Before a manual recovery procedure is actually initiated, a warning shall be issued to the maintenance center or through the craft interface if service will be affected by the action and the action shall only be initiated on verification that the service may be interrupted. Some operations messages allow an action to be “forced” in which case the action is initiated without verification or service affecting notice.

R6-44 **[654]** There shall be no single fault that can totally and simultaneously disable all local and remote maintenance center access to the status of the IDLC system.

R6-45 **[655]** There shall be no single fault that can totally and simultaneously disable all local and remote maintenance center access to the IDLC system maintenance functions.

6.1.3.3.3 Hardware Redundancy

R6-46 **[656]** Hardware redundancy shall be incorporated into the service recovery and protection capabilities so that no single hardware fault can disrupt the operation of the entire IDLC system.

O6-47 **[657]** It is desirable that no single hardware failure affect the service of the equivalent of more than 64 customer lines.

6.1.3.4 Trouble Notification

Trouble notification alerts a technician, either directly or through an OS, to the existence and severity of IDLC system troubles. Trouble indications aid the technician to restore service using spare facilities, to sectionalize the trouble for efficient scheduling and dispatch of repair personnel, and to determine the nature of the trouble and the units likely to be the cause of the trouble.

The following two sections describe required trouble notification functions.

6.1.3.4.1 Alarmed Trouble Notification

R6-48 **[658]** Alarms shall indicate troubles that have an immediate or potential impact on IDLC system operation and performance, and require some action by a technician to restore normal service or prevent degradation of performance.

R6-49 **[659]** Alarm conditions shall be reported by the following methods:

… a. **Local Indications** - appear at the equipment (e.g., an alarm panel and/or Light-Emitting Diodes [LEDs] or Liquid Crystal Displays [LCDs] on plug-ins),

… b. **Central Office Audible/Visual Indications** - indicate critical, major, and minor alarm conditions,

… c. **Centralized Indications** - messages that report alarmed maintenance information to an OS or to a remote centralized maintenance center.

6.1.3.4.2 Non-Alarmed Trouble Notification

R6-50 **[660]** A trouble not requiring immediate technician action shall be reported through an output message and shall not result in an alarm

condition. Non-alarmed trouble notification includes results of semi-automatic trouble detection tests (manually initiated tests).

A more detailed discussion of functional criteria for centralized control, alarm monitoring, and related features in digital transmission systems is given in TR-NWT-000474.

6.1.3.5 Trouble Verification

Trouble verification is the process of confirming the existence of a trouble once a trouble has been detected.

R6-51 **[661]** A trouble shall be verified before automatic service recovery, protection, and trouble notification are initiated.

Trouble verification is needed to verify that the trouble still exists before dispatching a technician and to verify that the trouble has been cleared after a repair has been made.

R6-52 **[662]** The ability to manually verify troubles within the IDLC system shall be provided.

R6-53 **[663]** Periodic automatic trouble verification shall be provided for troubles that may clear with no specific maintenance action being taken.

6.1.3.6 Trouble Isolation

R6-54 **[664]** Trouble isolation shall provide automatic isolation to a minimum number of replaceable elements.

R6-55 **[665]** The replaceable elements shall be reported in the trouble notification message in the order of the most likely element first to the least likely element last.

Trouble isolation occurs after trouble detection, trouble verification, and automatic service recovery and protection procedures have been carried out.

R6-56 **[666]** Trouble isolation shall not affect service.

R6-57 **[667]** To the extent possible, the replacement of any replaceable element shall require a minimum of prerequisite actions, such as removing fuses or other elements.

O6-58 **[668]** It is an objective that the IDT and RDT provide the capability for the replacement of elements without further interruption of service on the IDLC system or related systems.

R6-59 **[669]** Once a trouble has been repaired, the technician shall have the capability to restore the replaced element to service from the Craft Interface Device (CID).

6.1.4 Data-Link (DL) Protection

6.1.4.1 General

Much of the information in this section is repeated from Section 4.10 as an introduction to the Data-Link (DL) protection discussion and as a convenience to the reader.

A DL is a communication path between two or more data termination circuits. Because of the single-ended attributes[2] of the IDLC-system architectures described in this GR, one or more IDT-RDT DLs will be required. These DLs will allow IDLC systems to be compatible with network operational strategies for alarm surveillance, performance monitoring, maintenance (including test access), and memory administration (provisioning). Also realizable via these DLs will be intra-IDLC-system opportunities for concentration mappings, data audits, call processing, and bandwidth management.[3] As described in Section 4.4.1, a 4 kb/s DL may be available in each ESF DS1 between the IDT and RDT. DS0 channels may also be used as DLs. Proprietary systems will need to make implementation decisions such as the following:

a. Number of DLs needed

b. Functionality of DLs

c. What DS1 bandwidth to use for DLs

d. Protocol and language on each DLs.

This section specifies general requirements for DLs and are applicable for any DL implementation.

6.1.4.2 Requirements

As stated in Section 4.10 for IDLC applications, any implementation of data-linking capabilities between the IDT and RDT requires the following:

2. Specifically with respect to operational strategies and call-processing intelligence.

3. ISDN will provide some unique bandwidth-management challenges to IDLC systems, as described in Section 3.6.

a. DL connections shall be within the bandwidth of the interconnecting DS1-rate signal.

b. Sequence control, to maintain the sequential order of messages between the IDT and RDT shall be provided, irrespective of the number of DLs implemented between the IDT and RDT, and the traffic handling strategies.

c. Transmission, format, and operational errors on the DL, shall be detected and recovery strategies from detected transmission, format, and operational errors, shall be implemented.

d. If the DL control circuits cannot recover from the detected errors, a "DL Failure" condition shall be declared and the appropriate application process of the IDLC system shall be notified.

e. In reporting DL failures to OSs, IDLC systems shall report a minor alarm when the system successfully switches to a standby DL. If the system cannot switch to standby, the report shall be a major or critical alarm.[4] A major alarm is reported by those IDLC systems terminating up to 128 lines; a critical alarm is reported by those IDLC systems terminating more than 128 lines.

f. Flow control,[5] of information transfer between the ends of the DL, shall be provided.

In addition to the requirements of Section 4.10, the following requirements need to be satisfied.

R6-60 **[670]** Upon declaration of a "DL Failure," an IDLC system that supports more than one DS1, shall notify the opposite end, and each end shall take steps to effect a coordinated switch-over to a standby DL such that the DL is reestablished within 2 seconds of the declaration.

DL protection may be included as part of facility protection switching described in Section 6.2.1 when facility protection switching is provided.

R6-61 **[671]** IDLC systems with more than one DS1 link shall have a standby DL on a different DS1 than the DS1 containing the primary DL.

A standby DL implies a method for re-establishing DL communications if the primary DL fails.

CR6-62 **[672]** If a DL carries messages that can affect the call control process, no individual service shall be forced into an erroneous on-hook state for more than 100 ms during this switch-over.

4. Although no services may be affected, this is viewed as a major or critical alarm situation because alarms at the RDT are effectively masked and all remote operations are prevented because of the operational isolation of the RDT.

5. Flow control is the means by which the receiving end of the DL controls the rate at which data is transmitted from the source.

R6-63 **[673]** The IDLC system shall continue to monitor the failed DL and the DL shall be declared in-service when it is detected to be without error, for at least 25 seconds.

6.1.5 Single-Ended Fault Locating

6.1.5.1 General

Single-Ended Fault Locating (SEFL) is a procedure for locating faults on a transmission facility, in both the transmit and receive directions, by tests performed at only one end of the transmission facility.

A common facility used in a BCC's loop plant is a T1-type repeatered digital line, which uses metallic cable pairs as a transmission facility. The T1 facility directly accommodates the basic DS1-rate-signal architecture between IDT and RDT.

6.1.5.2 Requirements

Some requirements in this section are written using the notation "IDT (RDT)." These requirements apply to the IDT and to the RDT. The requirements were written in this format to avoid having a second requirement with the same wording, but using the notation in the parentheses instead of the notation immediately preceding the parentheses.

R6-64 **[674]** Far-End Loopback (FELB) capabilities are required for both T1 and DSX-1 based digital facilities at both ends of the transmission facility.

CR6-65 **[675]** If T1-type digital-lines are provided between the IDT and RDT, then the IDLC system shall be able to perform SEFL procedures on those IDT-RDT facilities lines using standard fault-locating methods (see CB-113). This capability shall be provided at both the IDT and the RDT ends of the transmission facility.

CO6-66 **[676]** If only DSX-1 interfaces are provided, then SEFL is optional.

An IDLC system needs to provide the following to achieve single-ended fault locating:

a. Provide digital access to the digital transmission line for generation of fault-locating test signals

b. Provide Voice-Frequency (VF) access to the Fault-Locate (FL) wire for detection of fault-locating responses

c. Provide a capability to effect a far-end loopback of the digital transmission line.

The specific requirements on an IDLC system are:

R6-67 **[677]** The IDT (RDT) shall provide

… a. Test access to the digital line

… b. Test access to the FL wire (an FL wire brings back fault-locating information to test equipment for analysis)

… c. The capability to initiate a FELB, i.e., the received digital line signal at the far end is looped-back to the near end (requirements for the control of the FELB are given in Section 6.1.5.4.)

… d. The capability to recognize the loopback signal within the DS1 and loopback the received DS1 signal in the transmit signal of the same DS1.

CR6-68 **[678]** If the IDT (RDT) has a DS1 facility protection switching capability, the DS1 facility protection switching procedures shall not interfere with the FELB capabilities.

CR6-69 **[679]** If the IDT (RDT) has a DS1 facility protection switching capability, the FELB capabilities shall not interfere with the DS1 facility protection switching procedures.

If the transmission facilities between IDT and RDT are at a higher-than-DS1 rate or preclude bipolar transmission, then fault-locating capabilities will (if needed) be the responsibility of that transmission system. Standard fault-locating techniques use bipolar violations and require facilities capable of transmitting bipolar signals.

6.1.5.3 Remote SEFL

The material that was in this section has been removed from the document. The Remote SEFL capability is no longer required by IDLC systems.

6.1.5.4 DS1 Loopback Control

To be compatible with forward-looking OS-IDLC interfaces as well as a craft interface at a DSX-1, LDS, or RDT, IDLC systems shall support two methods of controlling digital-line loopback activation and deactivation. The first method is via an operations message from an OS or an input through the craft interface. The second method is via 16-bit loopback messages sent over the DS1 ESF data link using the loopback codes defined in Table 4-4.

R6-70 **[680]** The IDT (RDT) shall provide the capability to activate/deactivate a loopback at the IDT (RDT) in response to a loopback or release loopback 16-bit code received in the DS1 ESF data link of the DS1 to be looped-back or the DS1 that is looped-back.

O6-71 **[681]** It is an objective that the IDT (RDT) should be capable of detecting the 16-bit "Network Loopback Activate" and the "Universal Loopback Deactivate" codes using one of the following criteria:

… 1. When the same code is present in two out of three consecutive 16-bit message patterns

… 2. When the same code is present in two consecutive 16-bit message patterns.

The above detection objective is the same as the detection requirement defined in Section 12.6.2 for the 16-bit ESF data link codes used to control DS1 facility protection switching.

R6-72 **[682]** If the IDT has established a loopback on a DS1 facility at the RDT, i.e., the IDT has sent the 16-bit loopback code to the RDT in the DS1 ESF data link of the looped-back DS1, the IDT shall ignore a 16-bit loopback code received in the DS1 ESF data link of the looped-back DS1.

R6-73 **[683]** If the RDT has established a loopback on a DS1 facility at the IDT, i.e., the RDT has sent the 16-bit loopback code to the IDT in the DS1 ESF data link of the looped-back DS1, the RDT shall ignore a 16-bit loopback code received in the DS1 ESF data link of the looped-back DS1.

The above requirements are needed to prevent the sender of the loopback code from establishing a loopback at its end of the DS1 if the far end loops back the DS1 while the loopback code is still being sent, i.e., the sender of the loopback code receives its own loopback code when the far end completes the loopback.

R6-74 **[684]** While the IDT (RDT) has a loopback toward the RDT (IDT), the IDT (RDT) shall monitor the ESF data link of the looped-back DS1 for the 16-bit release loopback code.

Loopback requirements for DS1-Extension Options at the RDT are defined in Section 3.7.4.

6.2 System Options

IDLC systems may provide capabilities that provide economies of operation, enhanced service protection, or features that improve the maintainability of the system. These capabilities are not needed to meet the minimum service and maintenance requirements of

an IDLC system; hence, they are system options. However, when an IDLC system does provide an optional capability, there may be requirements associated with the optional capability. Several optional capabilities and their requirements are discussed in this section.

6.2.1 Facility Protection Switching - Option

6.2.1.1 General

The facility protection switching feature enables traffic on a failed DS1 facility to be moved to one or more alternate DS1 facilities.

The procedures for implementing DS1 facility protection switching across the Generic IDLC Interface are described in Section 12.6.2.

The following subsection provides requirements for IDLC systems with a DS1 facility protection switching capability.

6.2.1.2 Requirements

R6-75 **[685]** IDLC systems shall perform a facility protection switch if and only if that action will restore service.

In addition to continuously monitoring the protection facilities for OOF and LOS, the IDLC system is required to continuously accumulate performance monitoring data on the protection facility. (OOF and LOS are discussed in Sections 4.6.1 and 4.7; performance monitoring parameters are discussed in Section 4.6.1.)

R6-76 **[686]** If a DS1 or DS0 is providing service but does not meet service requirements, protection switching shall only be initiated if the protection DS1 will meet the service requirements of a DS1 in the protection line method.

R6-77 **[687]** During the facility protection switch procedure, the IDLC systems shall maintain all calls that are in the talking state at the initiation of the facility protection switch procedures.

R6-78 **[688]** The RDT shall continue call processing on calls in other states (e.g., ringing, digit collection, etc.).

R6-79 **[689]** The switching system shall determine if call processing on calls in other states (e.g., ringing, digit collection, etc.) is to continue or be dropped, and take the appropriate steps to implement the decision.

CR6-80 **[690]** The time interval that a DS1 facility transmission path may be interrupted because of the DS1 facility protection switch procedures shall be ≤100 ms.

The entire protection switch may take longer than 100 ms, but the transmission path shall not be opened for more than 100 ms.

R6-81 **[691]** The IDLC system shall not apply ringing to any lines that were not in the alerting state at the initiation of the protection switch procedures and continuous ringing shall not be applied to any lines during or after the protection switch procedures.

R6-82 **[692]** The IDLC system shall not produce loud audible signals on any line during the protection switch procedures.

As specified in Section 4.7, the IDLC system sends a major alarm message indicating a red alarm condition and begins Carrier Group Alarm (CGA) processing within 2.5 (±0.5) seconds of initial detection of a OOF or LOS.

R6-83 **[693]** The initiation of a protection switch shall occur at a time after initial detection of OOF or LOS sufficient to allow the IDLC system to meet the 2.5 (±0.5) seconds time constraints for CGA processing if the facilities to complete the protection switch are not available or the IDLC fails to complete the protection switch.

R6-84 **[694]** Intermittent OOF and LOS failures shall be time-integrated so that the integrator decays at a slope of 1/16 of the rise slope.

R6-85 **[695]** Protection switching for an OOF condition shall be delayed at least 200 ms from the initial detection of the OOF condition.

The delay will allow time for the IDLC system to reframe when higher rate (>DS1) digital transmission facilities are used and a protection switch of the higher rate facilities has occurred.

R6-86 **[696]** In addition to initiating a protection line switch on OOF and LOS conditions, the IDLC system shall be capable of initiating a protection line switch based on the DS1 performance threshold and timing criteria in Section 4.6.2.

O6-87 **[697]** The RDT and IDT should examine the DS1 states at its end to determine if a facility automatic protection switch needs to be initiated when an Alarm Indicator Signal (AIS) is detected on a protected DS1.

An AIS can be received when a higher-rate multiplex system is used to transport the DS1s between the RDT and the CO. The protection DS1 may extend from the RDT to the IDT or

from the RDT to the multiplex terminal. In the latter case, a protection switch will not result in a good DS1 signal at the RDT when the fault causing the AIS is between the IDT and the multiplex terminal since the AIS will follow the DS1 signal to the protection DS1. The DS1 signal will be removed from the protection DS1 and the protection DS1 will clear allowing a protection switch to occur. If the DS1 with AIS is put on the protection DS1 again, this sequence of events will repeat until the AIS clears or a DS1 with a higher priority is switched to the protection DS1.

CR6-88 **[698]** If the IDT or RDT switches a DS1 to the protection DS1 on receipt of an AIS, the IDT or RDT shall not initiate a second switch to the protection DS1 if the AIS followed the DS1 to the protection DS1.

R6-89 **[699]** If a DS1 facility goes to a Carrier Group Alarm (CGA) during a protection switch, or the facilities to complete the protection switch are not available, or the IDLC system fails to complete the protection switch, the CGA requirements of Section 4.7 shall be met.

R6-90 **[700]** The IDLC system shall automatically switch back from the protection line when the system determines that such a switch back will support service.

The criteria needed to determine when an automatic switch back from the protection line is initiated depends on the original failure detected.

R6-91 **[701]** The following automatic switch back criteria shall apply for the given detected failure:

… a. **OOF or LOS Condition** - a minimum of 15 (±5) seconds of continuous in-frame operation (see Section 4.7).

… b. **Performance Monitoring** - the failed DS1 has operated at a performance level that exceeds 50% of the protection switch threshold for the restoral times (threshold level dependent) specified in Section 4.6.2. Also, the failed DS1 has experienced at least 10 consecutive seconds containing no Severely Errored Seconds (SESs) (see Section 4.7).

The intent of the above minimum times before declaring a failed facility to be back in service and automatically switching service off the protection facilities is to minimize the effects of intermittent conditions on the facility.

R6-92 **[702]** The IDLC system shall provide a 1 x N protection scheme, i.e., the one protection line can replace any one of N DS1 transmission facilities. The IDLC system shall be capable of providing protection line switching for $1 \leq N \leq 28$.

The maximum value of N was chosen to limit the total number of DS1s of an IDLC system to 28 to promote consistency with higher-rate facilities having DS3 modularity.

6.2.2 Concentration - Option

6.2.2.1 General

An IDLC system has a concentration feature when customer line terminating equipment outnumber DTF time slots. Concentration may provide first cost savings by reducing the number of DTFs and DTF Interfaces required. This may, however, be offset by the added call processing costs, depending on system design and system fill. A concentrated system can provide service approximately equivalent to that of a nonconcentrated system, depending on offered traffic load and system design parameters. The following subsection provides system requirements for concentrated IDLC systems.

6.2.2.2 Requirements

These requirements are specifically for RDTs that do not meet the criteria of "separate entity," as defined in TR-TSY-000511 and GR-512-CORE. That is, the RDT does not home directly on an access tandem with a final group for intraLATA traffic, does not provide dial tone and translations locally, and cannot complete intra-RDT calls when isolated.

O6-93 **[703]** Concentrated IDLC systems should be able to operate in a nonconcentrated mode.

R6-94 **[704]** Concentrated IDLC systems shall be full access at both the IDT and RDT, i.e., no blockage until all available time slots of the entire system are utilized.

R6-95 **[705]** The concentrated IDLC system shall be able to provide a semi-permanent assignment of a time slot to a channel.

R6-96 **[706]** Concentrated IDLC systems shall be able to alter the concentration ratio by adding or removing facilities and associated DTF Interface equipment.

R6-97 **[707]** The adding or removing of interconnecting facilities shall be non-service affecting to the remainder of the system.

O6-98 **[708]** Concentrated IDLC systems should assign time slots to channels in a way that distributes traffic load among interconnecting facilities/DTF interface.

O6-99 **[709]** Concentrated IDLC systems should be able to transfer stable calls from a failing (i.e., LOS/OOF, but not yet a CFA) facility to available time slots on other facilities.

This may be accomplished by using available time slots located among the remaining DTFs.

R6-100 **[710]** Concentrated IDLC systems shall satisfy pertinent traffic requirements, as described in Section 8.1.

6.2.3 Remote Test Unit

The Issue 1 material that was in this section has been removed from the document.

6.2.4 Automatic Line Insulation Tests (ALITs)

There are no automatic routine circuit tests, such as ALITs, for IDLC systems included in GR-303-CORE.

6.2.5 Software Downloading - Option

GR-303-CORE RDTs will likely contain software. A supplier can choose to have this software reside in a non-volatile memory such as a Read-Only Memory (ROM) or choose to have this software reside in a user alterable memory such as Random-Access Memory (RAM) or Electrically Erasable Programmable Read-Only Memory (EEPROMs). RDTs will probably make use of both technologies. The software storage method selected by the supplier governs the options open for software upgrades. When ROM technology is used, site visits to the RDT will be required to install new software generics, whereas a user-writable technology provides the capability to install new software generics from a remote location.

Some software downloading requirements have been added to this section. Additional requirements are currently under study.

R6-101 **[711]** The RDT shall provide the capability to manage its software through the craft interface at the RDT.

Software management includes, but is not limited to, providing capabilities to run diagnostics on the software, to download new software from non-volatile memory at the RDT, to reinitialize the software, to activate/deactivate service applications, and to download new software generics.

R6-102 **[1800]** A remote managing system (OS/EM) shall be capable of triggering the RDT to initiate a software download[6]. The remote managing system shall inform the RDT of the software to be downloaded and the file store where it is located.

R6-103 **[1801]** Upon request by the remote managing system to perform a software download, the RDT shall be capable of initiating the transfer of the software either from the remote file store to its local memory or from its local memory to the working memory, depending on where the software to be downloaded is located.

Note that the download of software from the RDT's local memory to its working memory shall also be capable of being triggered by a remote managing system, per **R6-102**.

Some specific requirements related to the software downloading aspect of software management follow.

R6-104 **[712]** The RDT shall provide the capability to download software to the RDT without service interruption.

R6-105 **[713]** The RDT shall provide the capability for the user or remote managing system to verify the software download before the software is activated in the RDT.

… Verification includes the capability for the user or remote managing system to determine if errors were detected in transferring the software, initiating test or diagnostic procedures on the downloaded software, and may include the capability to run the software on the RDT backup hardware.

O6-106 **[714]** The software generic activation should be non-service affecting.

R6-107 **[715]** If the software generic activation causes service interruption, the activation should take no longer than 5 minutes with an objective that it take less than 1 minute.

6. The software may be downloaded from a remote location to the RDT's local memory or from the RDT's local memory to its working memory.

… Service interruptions during a generic update are included when calculating an RDT's downtime to determine if the downtime reliability objectives are met.

When the line cards used in the RDT contain software that can be downloaded by the user, the following requirements apply:

CR6-108 **[716]** If the line card will be put into an OOS condition while new software is being downloaded to the line card, the line card software shall not be loaded automatically when a new generic is downloaded to the RDT.

R6-109 **[717]** The RDT shall provide the capability to download the software for a given line card type for all line cards of this type present in the RDT with a single operations message.

R6-110 **[718]** The RDT shall provide the capability to download the software for a given line card type on a per line card basis.

CR6-111 **[719]** If the software download to a line card causes the line card to temporarily go OOS, the RDT shall provide the capability to schedule when a line card type will have its software updated (for all line cards of a given type and for an individual line card).

CR6-112 **[720]** If the software download to a line card causes the line card to temporarily go OOS, the software download should be completed within 1 minute if the download is for an individual line card and within 3 minutes if the download is for all line cards at the same time.

… Service interruptions during a generic update of a line card are included when calculating circuit downtime to determine if the downtime reliability objectives are met.

In addition to the above requirements, it is desirable that the RDT support the following capabilities for RDTs that offer the corresponding capability:

O6-113 **[721]** The RDT should provide the capability to manage the loading of new software generics without downloading to the line cards when the software for the line card has not changed (the two software generics are exactly the same).

O6-114 **[722]** The RDT should provide the capability to download software for a given line card type without requiring a complete RDT software download.

7. Requirements Supporting Craftsperson Interfacing to IDLC Systems

7.1 Craft Interface

R7-1 **[723]** A craft interface to the RDT shall be provided at the RDT.

R7-2 **[724]** A craft interface to the IDT shall be provided in the CO.

This section discusses the features of the craft interface.

The Craft Interface Device (CID) is a portable terminal connected to the equipment of intelligent network elements that is used to perform operations activities. For IDLC systems, such a device would be used at the RDT or DSX for maintenance, testing, memory administration, and provisioning activities. Requirements for CIDs and their uses are contained in the following Bellcore documents:

- TA-TSY-000228
- TR-TSY-000824
- TR-TSY-000825
- GR-826-CORE.

The following are general requirements for the provision of CIDs for IDLC systems.

R7-3 **[725]** Local access to the IDLC system for maintenance, testing, and memory administration by technicians in the CO shall be provided through the LDS maintenance console in the CO.

R7-4 **[726]** The IDLC system maintenance, testing, and memory administration functions available at the LDS maintenance console shall also be physically accessible at the DSX. It is assumed that the latter will be a remote access to a standard I/O port of the LDS.

R7-5 **[727]** Local access to the IDLC system for maintenance, testing, and memory administration shall be provided at the RDT. The RDT shall be capable of supporting CIDs with the following characteristics:

… a. RS-232C interface

… b. Data transmission rates of 300 or 1200 baud

… c. Full alphanumeric capability

… d. ASCII compatibility

… e. 80-character line width

… f. Odd parity check.

O7-6 **[728]** It is an objective that the local terminal access device of an RDT should also be usable as the local terminal access device for other network element types.

O7-7 **[729]** It is an objective that the IDLC system be capable of supporting Visual Display Terminals (VDTs).

O7-8 **[730]** IDLC systems supporting VDTs should provide data transmission rates greater than 1200 baud.

O7-9 **[731]** It is an objective that a technician not be required to identify the type of terminal being used.

R7-10 **[732]** All provisioning, maintenance, testing, and memory administration operations supported by an IDLC system through its OS interfaces shall also be supported through the craft interfaces of the IDLC system. These operations are discussed throughout this document.

R7-11 **[733]** The IDLC system shall support the menu mode of operation through the CID interface.

O7-12 **[734]** It is an objective that the IDLC system should support the dialogue (i.e., IDLC system prompts user for required information) mode of operation through the CID interface.

R7-13 **[735]** The IDLC system shall support a command mode of operation through a CID.

R7-14 **[736]** The technicians shall have the capability of entering any craft interface command supported by the IDLC system while in the command mode.

R7-15 **[737]** The input commands used at the RDT craft interface for the command mode shall conform to the commands defined in the following documents:

… • GR-199-CORE

… • GR-833-CORE

… • GR-834-CORE

… • TR-NWT-000835.

… An RDT is not required to support all commands in these documents.

R7-16 **[738]** The input command response message for commands originating from the CID shall conform to the response defined for the command. OSs use the correlation tag, CTAG, parameter in a command to correlate command responses to the command causing the response, i.e., the command response contains the CTAG value of the command causing the response. The correlation of the command and its response for interactions through the CID differ as follows.

… a. The IDLC system shall output a copy of the command preceding all responses to the command.

… b. The technician may use a null value for the CTAG parameter when entering commands through the CID.

Outputting the command and its response together allows the technician to see the command that caused the response. This is very useful when a VDT is used, several commands are input before responses are output, or the response to a command follows the input of the command by several minutes.

O7-17 **[739]** It is desirable that the CID conform to the requirements for monitors, printers, and keyboards given in Appendix D of TA-TSY-000228. However, these requirements do not preclude the use of handheld CIDs at the RDT.

There are no requirements for a technician at the RDT to be able to access an OS through the craft interface of the IDLC system. This does not preclude the use of a dial-up or private line access to an OS from an RDT location.

Section 8.4 discusses security requirements for IDLC systems, including the CID interface.

The supplier of RDT equipment may choose to provide a supervisory system as described in SR-NWT-002166. The supervisory system can be used as a form of remoted CID.

O7-18 **[740]** It is desirable that the supervisory system terminal have identical screens, menus, and dialogue as the local CID.

7.2 Maintenance Access

7.2.1 General

The following requirements are based on OSs and methods affecting DLC systems. Ordinarily, the dividing line for technician/work center responsibility is the MDF. For IDLC, this dividing line is typically placed at the CO DSX-1 bay for T-carrier based systems.

Maintenance, as used here, includes only automatic alarm reporting and technician initiated actions like status report and DTF reconfiguration. Section 5 covers testing.

7.2.2 Requirements

R7-19 **[741]** IDLC shall provide maintenance access both locally and remotely. “Locally” is used in the sense of at or near either the RDT or the IDT. “Remotely” refers to a remote maintenance center.

R7-20 **[742]** Remote maintenance access shall be provided to a location concerned with switch maintenance, and also to a location concerned with loop maintenance. For the purpose of this document these will be referred to as the Switch Maintenance Center (SMC) and the Loop Maintenance Center (LMC). For some applications, these may be the same.

R7-21 **[743]** The SMC shall have full access to all IDLC maintenance capabilities.

R7-22 **[744]** The LMC shall have access only to those IDLC maintenance capabilities associated with the portion of the IDLC system from the DSX-1 bay to the RDT.

R7-23 **[745]** Maintenance access shall be provided locally at the RDT and the DSX-1 bay in the CO.

R7-24 **[746]** Full SMC access shall be provided locally at the maintenance position(s) of the LDS consistent with the requirements of an LDS.

R7-25 **[747]** All locations with full SMC access shall be capable of inhibiting the automatic reporting of alarms associated with the loop portion of the system.

7.3 ISDN Maintenance Transparency

This section discusses specific requirements needed to achieve ISDN maintenance transparency. ISDN maintenance transparency is the ability of craftspeople to perform maintenance activities on an ISDN Basic Rate Access (BRA) line in a manner independent of whether the line terminates directly on the switch or remotely on an IDLC RDT. The requirements cover digital testing, Performance Monitoring (PM) data retrieval, and alarm and PM threshold crossing alert reporting capabilities.

CR7-26 **[748]** If an LDS provides ISDN BRA maintenance capabilities through a craft interface for ISDN BRA lines terminating on the LDS, it shall satisfy the requirements in Sections 7.3.1, 7.3.2, and 7.3.3.

7.3.1 BRA ISDN Digital Testing Transparency

R7-27 **[749]** Craftspeople shall be able to perform BRA ISDN digital testing from a user interface to the LDS for all BRA ISDN lines that terminate on the LDS or terminate on any RDT supported by the LDS.

R7-28 **[750]** The test procedure and format of messages exchanged between the craftsperson and the LDS shall be independent of the location of the BRA ISDN line termination.

R7-29 **[751]** The craftsperson shall have to enter only the directory number or the office equipment number to select an ISDN BRA line to test. Selection by directory number and selection by office equipment number shall both be supported.

R7-30 **[752]** Craftspeople shall be able to access the user interface from a workstation associated with the LDS.

R7-31 **[753]** BRA ISDN digital testing shall consist of the following tests, as described in TR-NWT-000823, OTGR Section 6.4: *Network Maintenance: Access and Testing - Integrated Services Digital Network*:

… • Test loopback of the B1, B2, or 2B+D channels at a Line Termination (LT), or Line Unit/Line Termination (LULT), NT1, or a “Test NT1”

… • Verify the ability of an LT or LULT to detect and count Block Errors (BEs), Errored Seconds (ESs), and Severely Errored Seconds (SESs)

… • Verify the ability of an LT or LULT to generate threshold-crossing alerts for ESs and SESs

… • Verify the ability of an LT or LULT to recognize the power status of an NT1

… • Verify the ability of the LDS to generate an alarm based on detection of Loss Of Signal (LOS) or Loss Of Synchronization Word (LOSW) without an NT1 dying gasp.

R7-32 **[754]** No additional craftsperson database activities beyond those necessary to activate service in the switch shall be needed to support digital testing from the switch.

7.3.2 BRA ISDN Performance Monitoring (PM) Data Retrieval Transparency

R7-33 **[755]** Craftspeople shall be able to perform BRA ISDN PM data retrieval from a user interface to the LDS for all BRA ISDN lines that terminate on the LDS or terminate on any RDT supported by the LDS.

R7-34 **[756]** The PM data-retrieval procedure and format of messages exchanged between the craftsperson and the LDS shall be independent of the location of the BRA ISDN line termination.

R7-35 **[757]** The craftsperson shall have to enter only the directory number or the office equipment number to select an ISDN BRA line for PM data retrieval. Selection by directory number and selection by office equipment number shall both be supported.

R7-36 **[758]** Craftspeople shall be able to access the user interface from a workstation associated with the LDS.

R7-37 **[759]** BRA ISDN PM shall consist of the monitoring of BEs, ESs, and SESs as described in TR-NWT-000823.

R7-38 **[760]** No additional craftsperson database activities beyond those necessary to activate service in the switch shall be needed to support PM data retrieval from the switch.

7.3.3 BRA ISDN Alarm and PM Threshold Crossing Alert Reporting Transparency

R7-39 **[761]** All BRA ISDN alarms and PM threshold crossing alert reports shall be sent to the LDS surveillance OS.

R7-40 **[762]** The alarm/alert report content and format shall be independent of the location of the BRA ISDN line termination, except for the termination location indicator.

R7-41 **[763]** Functionality shall exist by which a craftsperson accessing the LDS surveillance OS can retrieve alert threshold data and current alarm/alert status for all ISDN BRA lines that terminate on the LDS or terminate on any RDT supported by the LDS.

R7-42 **[764]** No additional craftsperson database activities beyond those necessary to activate service in the switch shall be needed to support alarm/alert reporting.

Note that RDT-supported BRA ISDN alarm/alert reports may also be sent to OSs other than the LDS surveillance OS, e.g., a transport surveillance OS.

8. Requirements Supporting IDLC Administration

8.1 Traffic Management

The following criteria apply to all IDLC systems whose performance, due to any aspect of the IDLC system design, is sensitive to the traffic load presented to it. Examples of traffic-sensitive IDLC designs are: (1) An IDLC system with concentration in the RDT such that fewer channels between the RDT and the IDT are provided than the number of customer lines the RDT can serve; (2) an IDLC system that cannot simultaneously provide service to as many lines as it has channels between the IDT and RDT due to power supply limitations; and (3) an IDLC system terminating in an IDT that has fewer time slots accessing the switch than channels between RDT and IDT.

In this section, “traffic registers” refer to any device or method that can record, store, and display or report the traffic data. It is not necessarily a mechanical device.

8.1.1 Background

Switching systems are engineered to provide a specified grade of service to terminated customer lines. Some elements involved in establishing grade of service criteria include blocked calls and ineffective call attempts. The first step in a plan designed to meet customer grade of service objectives is to balance the offered load of customer access lines that interface with the LDS through a line concentrator. Another element is to ensure that concentrations are low enough to handle offered load within service objectives.

An IDT is the physical resource of an LDS that is allocated to a single RDT. An IDT may be a single stage concentrator, or it may be part of an aggregate of IDTs that form a concentrated entity at the IDT interface to the LDS. In addition, an IDT may be a first stage concentrator that feeds into a larger aggregation of IDTs that is also concentrated at the interface to the switch fabric. Principles of traffic management described in this section apply both to single IDTs or to an aggregation of IDTs, should they be concentrated.

LDS architectures that feature a single or multiple stage full access digital concentrator can provide various ratios of concentration for IDLC systems currently available. Typical ratios range from 1.5:1 to 9:1. Thus, an IDT (or the aggregated IDTs) can block calls if the peak offered load from the terminated IDLC systems exceeds the design limit.

Two issues arise from this architecture. First, the IDT becomes a traffic entity that requires individual load monitoring and management. Second, to the extent that the offered load to all IDTs is not uniform, the traffic load must be balanced among IDTs. The penalty caused by load imbalance can take several forms:

a. The assignment OS may have to resort to a restricted assignment algorithm earlier than would otherwise be needed. [1]

b. RDT utilization may have to be decreased (off-loaded).

c. Transfers may be required to improve the balance, making capacity available where needed, but incurring operations expense.

d. Switch capacity may need to be increased by adding an IDT.

Historically in the analog environment, if significant differences in traffic loads existed between load groups, it was necessary to make line equipment transfers. These rearrangements consist of moving individual circuits from Originating Equipment (OE) terminations on heavily loaded load groups to OEs on lightly loaded load groups. This is facilitated by the access to derived pairs and other analog circuits individually terminated on line interfaces via jumpers on a Main Distribution Frame (MDF), and are therefore independently changeable.

Because there is no physical access in the CO to the DS0 signal within the DS1 bitstream of IDLC systems, it becomes more difficult to manage the IDT's traffic. It is not feasible to perform detailed traffic engineering on small customer groups that might be terminated on IDLC RDTs. As a result, gross traffic estimates are made and LDS components are designed accordingly. The concern arises, however, because actual offered load, though likely close to the estimate in the aggregate, could vary widely around that estimate for smaller sub-groups.

The difficulty in managing traffic for IDLC systems versus UDLC systems is caused by the elimination of the DS0 interface and access point at the MDF that is present for analog lines or UDLC systems. Their absence in IDLC removes a flexibility point for traffic management. To alleviate the problem, three conditions are placed on the combination of the LDS and IDLC system:

a. The IDLC interface should restore the needed functions of the MDF, while maintaining the economy of direct digital interface.

b. Service to customers served by traffic sensitive IDLC systems should not be noticeably different than to customers served by dedicated physical pairs from the CO. The lost MDF functionality must be simulated within the IDLC system or LDS and not foster "work around" strategies that promote administrative complexity.

c. IDT utilization should not be reduced versus utilization on other LDS interfaces because the IDLC system provides inadequate controls to manage the IDT's traffic and is inflexible for spreading of offered load among IDTs.

Appendix A provides traffic management alternative proposals for IDLC. These proposals define new features in hardware and switch processor tasks associated with an IDLC interface. Such new features will be a necessary part of an IDLC interface, although they

1. It is expected that these restrictions would be required when the IDT load reaches 85 to 90% of its capacity.

may pose requirements for the LDS independent of the RDT. The proposals are presented only for purposes of discussion. They could be implemented separately or together. Alternately, other approaches could be taken to address this issue.

8.1.2 Requirements

R8-1 **[765]** An IDLC system shall be implemented in such a way that customer line equipment transfers are not necessary to keep the offered load of customer access lines at the LDS in balance.

R8-2 **[766]** Traffic performance at the LDS shall be the same for all calls arriving at the IDT from the RDT and for all calls arriving at the IDT from other sources.

For concentrated RDTs, variation in traffic performance as a result of RDT concentration may vary among RDTs.

8.1.2.1 Traffic Measurements

R8-3 **[767]** All traffic monitoring capabilities for individual lines served by the LDS shall be available for all lines served by IDLC systems.

IDLC system administrators must be able to determine the source of all imbalances in offered loads across IDTs.

O8-4 **[768]** The traffic on individual circuits should be made available (this information is useful in identifying high traffic derived pairs for grooming off IDLC).

R8-5 **[769]** It shall be possible to build load groups by RDT, IDT, or any other loading division required to efficiently monitor and administer system traffic.

R8-6 **[770]** The LDS shall be capable of performing traffic measurements on the smallest rearrangement entity level if non-concentrated, and on a per IDT basis in all cases.

R8-7 **[771]** The following Usage Counts (UCs) and Peg Counts (PCs) are required. TR-TSY-000541, Sections 8.2.2 and TR-TSY-000511, LSSGR Section 11, Table 11-A, provide measurement requirements and busy hour criteria, respectively; Section 7.2 of TR-NWT-000057 contains other DLC monitoring criteria.

… a. Blocked Originating Calls - at the IDT

… b. Blocked Terminating Calls - at the IDT

… c. Intra-IDT calls (if needed).

R8-8 **[772]** The above counts shall be available on a 30-minute schedule.

R8-9 **[773]** The LDS shall provide the capability to send IDLC traffic measurements to the OS supporting other traffic measurements for the LDS on demand from the OS, i.e., the OS will poll the LDS for the traffic data. The LDS shall provide the capability to report the IDLC traffic measurements as a predefined, packaged set of data and the capability to report individual measurements on demand from the OS. The IDLC traffic measurements shall be reported over the same link established to report other LDS traffic measurements to the OS.

Descriptions of the registers used for recording blocked originating calls at the IDT and the blocked terminating calls at the IDT are contained in Section 12.5.5.

8.1.2.2 Traffic Engineering Data

R8-10 **[774]** A uniform grade of service shall be provided to all customers in any class of service. This requires that a concentrated RDT shall have no more than four 1-hour occurrences in a 12-month period when the probability that a call will not be immediately served due to a lack of facilities exceeds 0.5% {P(B)=0.005}.

R8-11 **[775]** The suppliers of RDTs shall provide engineering capacity tables (or formulas) for concentrated RDTs indicating the total traffic capacity limit to meet the above requirement, as a function of the number of RDT-IDT channels. The limits in total capacity must also be quantified by intra-calling rates of lines on the same RDT, from 0% to 100%, in increments of 5%.

R8-12 **[776]** The suppliers of RDTs shall provide engineering capacity tables (or formulas) for concentrated RDTs indicating the call rate capacity in calls/hour for the conditions of 100% originating calls; 100% terminating calls; and 50% originating and 50% terminating calls.

R8-13 **[777]** If the physical design of the RDT permits installation of partial system configurations, the system traffic and call rate capacity information shall be provided for each system configuration.

R8-14 **[778]** The suppliers of RDTs that may be used in a concentrated configuration shall provide the details of the traffic model used to calculate the traffic capacity and call rate capacity of the RDT, including the resulting load versus service relations.

8.2 Facility Rearrangements

There is a requirement for a circuit bridging capability associated with changing terminations on the same LDS, where all or a portion of the circuits being rearranged have no physical access at an SMDF. These resource provisioning operations (not offered services) are typically needed to: (1) rebalance the offered load, (2) support outside plant rearrangements (for growth and maintenance reasons), and (3) maximize party line fill.

In IDLC systems now deployed, the only means available for transferring circuits on IDLC systems is to physically move groups of digital lines at the DSX. In this case, customer lines must be transferred in bulk. Even though the interval required for this manual transfer is of short duration, service is still interrupted. It may be feasible to physically bridge at the Feeder Distribution Interface (FDI) when the “to” and “from” systems appear in the same FDI. But service will still be disrupted because a successful transfer would require that the LDS provide a Telephone Number (TN) at different locations at the same time.

8.2.1 Requirements

The following are high-level functional requirements. These functions do not describe the design or internal operation. How these functions are provided is a design matter and not the subject of this section. Section 3.7.1 covers similar functions for service related requirements.

Circuit Transfers:

R8-15 **[779]** The LDS shall be capable of making one TN appearance at two or more locations on the LDS simultaneously, i.e., on the same IDT, between IDTs, and between IDTs and line interface units. (This capability is done within the switching system.)

R8-16 **[780]** The LDS shall provide the capability to establish and remove the multiple TN appearances through a remote memory administration access.

R8-17 **[781]** All ringing and signaling requirements (Section 3.2.2) shall be satisfied, and all billing collection data requirements for terminating and originating calls will continue while circuits are bridged.

R8-18 **[782]** The addition or removal of any customer access lines shall be completed without loss of service or of customer changeable translations.

R8-19 **[783]** The LDS shall provide the capability to provide or deny terminating and originating call access and toll access to any line sharing a TN through a remote memory administration access.

8.3 Line Unit Slot Independence

R8-20 **[784]** The RDT shall provide the capability to locate the line unit for a service in any of the plug-in slots designated for line units. No services shall be segregated to a specific line unit plug-in slot or group of line unit plug-in slots.

8.4 Security

R8-21 **[785]** An RDT shall provide security capabilities to aid in the physical protection of the RDT as well as the protection of its databases.

The term databases includes any remotely settable or alterable parameter in an IDLC system. These two aspects of IDLC security will be discussed in the following subsections.

8.4.1 Physical Security

Physical security requirements are needed to protect the IDLC system from unauthorized access and when that fails, to detect the unauthorized access to allow the BCCs to take appropriate action. The IDT is located in the CO and will have the same physical security as the LDS. IDLC system RDTs will be remotely located from the CO in controlled environment vaults, huts, and stand-alone cabinets.

R8-22 **[786]** RDTs in stand-alone cabinets shall be provided with a locking mechanism.

Environmental alarming capabilities are discussed in Section 5.

8.4.2 Database Security

Processor-controlled IDLC systems require security capabilities that are not required of systems that are controlled only by maintenance panels and switch setting options. The goal of database security is to prevent the reading, modification, and destruction of database items by unauthorized persons or by inadvertent technician activity. Although this goal is

highly desirable, compromises must be made between an acceptable level of security and the costs involved in providing the security.

This area is currently under study. The requirements given below may change and new requirements may be needed for the management of database security.

8.4.2.1 General Requirements

The database of an IDLC system can be accessed from OSs, and from local or remote craft interfaces (Section 7.1), and each type of interface has somewhat different security requirements.

R8-23 **[787]** The IDLC system shall have the capability to distinguish between operations interfaces associated with an OSs and those associated with a craft interface.

For operations interfaces on the embedded data link(s) to the RDT, the interfaces will be identified as an operations interface or a craft interface as part of the RDT provisioning process.

R8-24 **[788]** The IDLC system shall provide the capability for user login identification and a user password associated with the login for users of the craft interface and OSs that access the IDLC system.

R8-25 **[789]** The IDLC system shall provide the capacity for at least six user logins and their associated passwords for use by OSs.

R8-26 **[790]** The RDT shall provide the capacity for at least six user logins and their associated passwords for use at the craft interface.

O8-27 **[791]** It is an objective that the RDT should provide the capacity for a larger set of logins and their associated passwords.

8.4.2.2 Craft Interface Security

User login/password combinations are needed for the craft interface. The OSs that interface the IDLC system will provide a level of security for the IDLC system. The OSs are required to validate the login and password of the person using the OS and prevent the sending of messages to the IDLC system by unauthorized users.

8.4.2.3 Craft Interface Security for IDT

When the craft interface to the switching system is used to access the IDT, the security requirements of the switching system are applicable to the IDT.

CR8-28 **[792]** If the IDT has a craft interface that is separate from the craft interface of the switching system, the craft interface used to access the IDT shall meet all the security requirements for the RDT craft interface given in Section 8.4.2.4.

8.4.2.4 Craft Interface Security for RDT

This section contains the security requirements for the craft interface at the RDT.

R8-29 **[793]** The RDT shall provide the following capabilities and procedures for the user login process:

… 1. The IDLC system shall provide a user-settable number of tries a user will be given to enter a correct login identification/password combination.

… 2. If a user fails to enter a correct combination within the allotted number of tries, the interface shall be shut down and no new attempts shall be allowed for a preset time interval.

… 3. The number of tries a user will be given to enter a correct login identification/password combination shall be user settable within the range of 3 to 6 attempts.

… 4. The default on these values shall be five attempts.

… 5. The time interval the craft interface shall be shut down following the user failure to enter a correct login/password combination within the allocated number of attempts shall be user settable within the range of 3 to 15 minutes.

… 6. The default on these values shall be 5 minutes.

… 7. The RDT shall have the capability to detect multiple interface shut downs for failed login attempts and alert the maintenance center at the third shut down when the third shut down occurs within 1 hour of the first shut down.

R8-30 **[794]** The RDT craft interface shall have a user-settable timer that will automatically turn off the input portion of the interface if the timer expires, i.e., there has been no input activity for the timed interval.

R8-31 **[795]** The craft interface shall remain open for the RDT to use for output messages.

R8-32 **[796]** The user inactivity timer shall be set as part of the installation provisioning process and shall be provided with a 10-minute default value.

CR8-33 **[797]** RDTs that provide a dial-up line for a remote operations interface shall provide the capability for a dial/dial-back security implementation.

In a dial/dial-back arrangement, the user or OS dials the IDLC system and identifies the calling party. If the calling party is known to the IDLC system and a pre-assigned number has been assigned to the calling party, the IDLC system will use the pre-assigned number to call back the calling party and will drop the original call. The dial/dial-back equipment can be provided through a stand-alone unit or shared among several IDLC systems.

The above security measures are useful in preventing unauthorized access to an IDLC system, but offer no protection against database corruption from inadvertent or intentional actions by authorized users. A security method that will provide greater protection of the database from corruption by inadvertent or intentional actions by an authorized user is given in TR-NWT-000815. Briefly the security method in TR-NWT-000815 uses the following six categories of operations functions in defining user access rights:

a. **Provisioning (Also Referred to as Memory Administration)** - The addition, modification, and deletion of database items in response to service and work orders. Also included is the verification and querying of database items.

b. **System Maintenance** - The maintenance of the normal operations of the network element and terminating facilities. The maintenance functions include diagnostic tests, alarm surveillance, performance monitoring, and corrective action and repair.

c. **Service Testing** - The functions needed to verify, sectionalize, isolate, and verify repair operations for reported or detected circuit troubles.

d. **Network Administration** - The collection and analysis of traffic and equipment utilization data used by network administration for dynamic control of the network as well as for evaluating and planning on a long-term basis.

e. **Billing (Automatic Message Accounting)** - The collection of information needed to properly bill a customer and the control of the collection equipment.

f. **System Administration** - The administration of site-dependent data, the generation of reports, and database security.

The management of a network element falls into one or more of the above categories and the management is controlled through actions requested by an OS or through the craft interface of the network element. In addition to the above six categories of operations functions, the security method defines the following four categories of access rights:

a. **Read Only** - User is only allowed to retrieve and display database items.

b. **Execute -** User is allowed to execute diagnostic and auditing routines.

c. **Write -** User is allowed to add, modify, and delete database items except for the login/password file.

d. **Full -** User is allowed access to the entire database including the login/password file.

The above access rights are given in hierarchal order where an access right includes all rights that occur earlier in the list. The operational function of the user's operations center and the access category needed by the user determine the user's authorization.

The actions to be accomplished in a network element are assigned an authorization code that reflects the work center that needs to request the action and the skill level needed by the user invoking the action. Before an action is executed in the network element, the user's authorization code is compared with the authorization code of the action.

CR8-34 **[798]** For RDTs that provide features that allow access to the RDT data by a telephone company's customers, the RDT shall provide security capabilities such that an action directed to the RDT by a user is only allowed to occur when the user is from an authorized operations center and the user's access code is equal to or greater than that required to invoke the given action. The term user includes both a human user and an OS.

The above security method adds to the cost of an IDLC system and uses additional processor time for authorization code checking before an action takes place in the network element.

CR8-35 **[799]** For RDTs that provide authorization code checking, the RDT shall provide the capability to set three authorization codes per action to allow an action to be used by different operations centers.

CR8-36 **[800]** For RDTs that provide authorization code checking, the RDT shall provide a manual inhibit of authorization code checking.

CO8-37 **[801]** For RDTs that provide authorization code checking, it is an objective that the RDT provide a feature that automatically inhibits authorization code checking when the only active interfaces are with OSs and that automatically enables authorization code checking when a human interface is activated.

Table 8-1 contains a list of security administration messages for IDLC systems. These messages are defined using the Transaction Language 1 (TL1) messages syntax described in TR-NWT-000831. These messages are for use at the craft interface of the RDT and, if the IDT has a craft interface separate from the switching system craft interface, the messages are also used at this interface. The list of messages is not exhaustive, but represents a minimal set of required security administration messages. An RDT shall implement all the commands identified as required (R). A detailed description of the messages listed in Table

8-1 and their responses are given in TR-NWT-000831. If a different language is chosen for this interface, the functional equivalent of Table 8-1 is required.

Table 8-1. Security Messages for Craft Interface Devices

ACT-USER	Message for logging on RDT
CANC-USER	Message for logging off RDT
DEL-SECU-CMD	Delete security parameters associated with an action
DEL-SECU-User	Delete security parameters associated with an user
ED-SECU-CMD	Edit security parameters associated with an action
ED-SECU-PID	Allows users to edit their passwords
ED-SECU-User	Edit security parameters associated with an user
ENT-SECU-CMD	Enter security parameters associated with an action
ENT-SECU-User	Enter security parameters associated with an user
RTRV-SECU-CMD	Retrieve security parameters associated with an action
RTRV-SECU-User	Retrieve security parameters associated with an user

8.5 Equipment Identification Retrieval

Equipment identification retrieval requirements are discussed in Section 5.

9. Requirements Supporting System Turn-Up

9.1 System Turn-Up

9.1.1 General

R9-1 **[802]** When the power is applied to an IDLC system, the system shall go to a known stable state.

R9-2 **[803]** In the time it takes the system to reach the stable state, the system shall not interfere with the operation of other systems that it may be a part of or to which it is connected. For example, the IDT is part of the local switching system.

Another aspect of system turn-up is the data that the telephone company technicians must enter to configure the system for their particular application. Among the items included in the data are logins, passwords, user-selectable options, performance monitoring parameters, and service parameters. User-settable data are discussed in Section 9.1.3. This section represents a distillation of the user-settable data defined throughout this GR. The data presented is not intended to be an exhaustive list of all user-settable data, as IDLC systems from different suppliers may offer options beyond those discussed in this GR, or more parameters may be made user settable than have been required by this document.

9.1.2 System Turn-Up Requirements

The following requirements should be met by IDLC system when the system is powered-on.

R9-3 **[804]** The IDLC system shall not apply ringing or spurious signals to any customer line.

R9-4 **[805]** The IDLC system shall not send spurious signals or supervision data to the switching system.

R9-5 **[806]** The IDLC system shall execute the minimum number of internal diagnostics needed to verify the operation of the major system components. This minimum set of diagnostics shall execute in less than 5 minutes.

O9-6 **[807]** It is desirable that the diagnostics be executed in less than 2 minutes.

R9-7 **[808]** The IDLC system alarms shall reflect the true state of the system after the internal diagnostics have been executed.

R9-8 **[809]** The IDLC system status indicators shall be in a known state and properly indicate the system's status.

R9-9 **[810]** The IDLC craft interface shall be ready to be activated. The IDLC system craft interface shall be activated when a technician enters the "break key" through the CID.

R9-10 **[811]** The IDT shall go to a stable state without an active RDT terminating its DS1s. Similarly, the RDT shall go to a stable state without an active IDT terminating its DS1s.

R9-11 **[812]** The IDT shall continuously monitor the operations data link for activity by the RDT. Similarly, the RDT shall continuously monitor the operations data link for activity by the IDT.

R9-12 **[813]** All DS1 performance monitoring counters shall be set to zero on power-up in both the IDT and RDT; Section 4.6.1 identifies the required counters.

CR9-13 **[814]** If the IDT/RDT is interpreting and storing far-end DS1 performance data based on PRM information, then all associated counters shall be set to zero on power-up; Section 4.9.4 identifies the required counters.

R9-14 **[815]** The following traffic monitoring counters, if required, shall be set to zero on power-up in the IDT:

… 1. Originating calls

… 2. Terminating calls

… 3. Intra-RDT calls. (Intra-RDT calling capability is not supported across the Generic IDLC Interface described in Section 12.)

R9-15 **[816]** The blocked terminating call counter in the IDT shall be set to zero on power-up.

R9-16 **[817]** The blocked originating call counter in the IDT shall be set to zero on power-up.

R9-17 **[818]** At system turn-up, the RDT shall not do an automatic copy of backup memory to working memory.

9.1.3 Memory Administration Data Initialization Requirements

This section contains a list of data that must be initialized by a telephone company when an IDLC system is installed. A given IDLC system installation may have more or fewer items to be initialized, depending on the options included as part of the system. Some of the user-settable data to be initialized affects IDT, RDT, or IDT and RDT related functions. Although suppliers of IDLC systems are free to organize their IDLC system's database to fit their architecture, the data items are identified with the system component in which the affected data will reside for systems meeting the Generic IDLC Interface described in Section 12. The list also includes the section numbers of this GR where the data items are discussed in more detail.

The following data items shall be initialized when an IDLC system is installed:

R9-18 **[819]** The logins and the password associated with each login for all personnel that are to be given access to the system. (RDT, see Section 8.4.2)

R9-19 **[820]** The number of attempts to login to the system that are allowed before the interface is shut down for a specified period of time. The default values shall be 5 attempts and 5 minutes, respectively. (RDT, see Section 8.4.2)

R9-20 **[821]** The length of time a CID is allowed to remain inactive (i.e., nothing input to the system through the interface) before the interface is shut down for input. The default value shall be 10 minutes. (RDT, see Section 8.4.2)

R9-21 **[822]** The command execution authorization code class and level values. (RDT, see Section 8.4.2)

R9-22 **[823]** Manual inhibit of authorization code checking for command execution option. The default value shall be authorization code checking enabled. (RDT, see Section 8.4.2)

R9-23 **[824]** The dial-back telephone numbers when an optional capability to establish an interface to the system through a dial-in port is provided. The default values are empty or null strings for each number provided. (IDT, see Section 8.4.2)

R9-24 **[825]** The alarm classification (i.e., critical, major, or minor) for external conditions alarmed through the IDLC system such as open door, high heat, and presence of water. The default value shall be minor (RDT, see Section 6.1.3.2).

R9-25 **[826]** If alarm/control data are sent/received through an optional E-Telemetry interface, the association between the alarm/control data and the scan/control points shall be specified (LDS, see Section 5.2.2).

The items in the above list need to be initialized when a system is installed because they affect the IDLC system performance or pertain to system requirements.

The memory administration items presented in the following list may be initialized at installation time, at least for some circuits, or they may be initialized when a circuit is put into service as part of the provisioning process.

Other initialization requirements are included in Section 5.

9.1.4 Installation Process Requirements

R9-26 **[827]** Non-locally switched and nonswitched circuits shall be established as required. Default for a circuit is switched (IDT and RDT, see Section 3.5).

R9-27 **[828]** Non-locally switched and nonswitched circuits requiring clear channel capability shall be identified if the robbed-bit signaling option is used. The default is “56 kb/s” (IDT and RDT, see Section 4.4.7).

R9-28 **[829]** Circuits that require bridging capability for services such as off-premises extensions, secretarial lines, and party lines shall have the bridging capability assigned. Default is no bridging capability for a given circuit (IDT, See Section 3.7.1).

R9-29 **[830]** If DS1 extensions are provided at the RDT, the signaling format and zero byte processing shall be specified. Default is the extended superframe format and “bipolar with eight zero substitution,” B8ZS (RDT, see Section 3.7.4).

9.2 Power-On Plug-In Replacement

It is desirable for an IDLC system to provide the capability to replace plug-ins without powering down the system.

When a line unit or redundant common equipment plug-in unit is replaced while the IDLC system is powered:

R9-30 **[831]** The IDLC system shall not apply ringing or spurious signals to any customer line.

R9-31 **[832]** The IDLC system shall not send spurious signals or supervision data to the switching system.

R9-32 **[833]** The IDLC shall execute the minimum number of internal diagnostics needed to verify the operation of the new plug-ins. This minimum set of diagnostics, shall execute in less than 5 minutes.

O9-33 **[834]** It is desirable that the diagnostics be executed in less than 2 minutes.

R9-34 **[835]** The IDLC system alarms shall reflect the true state of the system after the internal diagnostics have been executed.

R9-35 **[836]** The IDLC system status indicators shall be in a known state and properly indicate the system's status.

The following objectives are desirable when a non-redundant common equipment plug-in unit is replaced while the IDLC system is powered:

O9-36 **[837]** The IDLC system should not apply ringing or spurious signals to any customer line.

O9-37 **[838]** The IDLC system should not send spurious signals or supervision data to the switching system.

O9-38 **[839]** The IDLC system should execute the minimum number of internal diagnostics needed to verify the operation of the new plug-in.

O9-39 **[840]** The IDLC system alarms should reflect the true state of the system after the internal diagnostics have been executed.

O9-40 **[841]** The IDLC system status indicators should be in a known state and properly indicate the system's status.

9.3 Automatic Board-to-Board Testing

9.3.1 General

A board-to-board test feature to support the transfer of DLC systems from one or more switches (that may be analog or digital) to an LDS as defined in Section 4.2 of TR-NWT-000504 and in TR-NWT-001465 is a desired capability.

Board-to-board testing is typically performed before the transfer of a number of customer lines from one switching office (offices) to another. The test is done to ensure that the

connection of lines to the new office is correct with respect to the existing connections in the older office. The one-to-one correspondence of lines connected to both switches is verified before the actual transfer, so that cutover can be made without risking loss of subscriber service due to misconnected lines. The test compares subscribers' original Directory Numbers (DN) with the physical locations of corresponding line equipment assigned to the same subscribers in the new switch. There are two distinct applications for this feature. The first application is office cutovers where one office, that is either pre-cut or functioning, is replacing another office (or offices). The need for board-to-board testing arises when UDLC systems are converted to IDLC systems. This often occurs coincident with the cutover of the LDS. For the second application, lines are removed from a working office to a pre-cut or functioning switch on an area transfer basis. Again, the area being transferred may contain UDLC systems, destined for conversion to IDLC systems. For either application, the involved switches may be co-located or remote from each other.

There could be many customer access lines involved in either application; this provides the motivation to verify the ability of the recipient LDS to provide continuing service. The recipient LDS may be a new or existing switch. Avoiding service disruptions is a major goal of this feature.

The following board-to-board testing features apply to those applications where the recipient LDS is co-located or in close proximity to the entity currently serving the DLC system(s) to be transferred, and all or some portion of the existing DTF will be retained in the IDLC system.

Specific requirements for board-to-board testing are not identified at this time because the procedures and needed equipment may be complex and integrally related to LDS design. For example, a significant complexity occurs when the pre-cutover UDLC system (that will be transferred to the LDS and converted to an IDLC system) and the post-cutover IDLC system must operate with different line and signaling formats.

9.3.2 Features

a. Automatic board-to-board testing may use the program capabilities of the LDS to perform board-to-board testing in an automatic manner on the large number of inter-office connections that exist just before an office cut or an area transfer.

b. Board-to-board testing should be accomplished with minimal disturbance to the customer lines in either the idle or busy state.

c. It should be possible to call for this test on a single line, a range of lines, or all the lines on a given RDT.

d. All ringing and signaling requirements (Section 3.2.2) should be tested.

e. All billing collection data requirements for terminating and originating calls should continue while circuits are bridged to both old and new entities.

f. Automatic board-to-board testing should be accomplished without intermediate steps, if possible. For example, transferring UDLC systems in the old switch to temporary UDLC systems on the recipient LDS should be avoided.

The following are high-level functions for board-to-board testing. These functions do not describe the design or internal operation of this capability. How these functions are provided is an LDS design matter and not presented here.

9.3.2.1 Facility Verification

a. Automatic board-to-board testing should verify the ability of the recipient LDS to continue providing service to the customer access lines served by the IDLC system being transferred to the LDS. This verification should be able to be performed in advance of the actual office transfer or cutover while the customer access lines to be transferred continue to be served by the old entity.

b. Board-to-board testing should verify that the connections of transferred customer access lines to the recipient LDS are correct with respect to the existing connections of these customer access lines to the old office (offices). In particular, DN assignments and new office data relations should be verified.

c. The wiring of the Digital Transmission Facility (DTF) path should be checked for continuity through a path that includes the old and new entities and a common point that may be in the DTF, for example, at a bridging repeater in the ORB.

d. The test should be capable of determining and reporting if the test path has been successfully established. During the existence of this test path, office battery from the recipient LDS should not inhibit in any way the signaling and transmission characteristics of any customer access line active in the DLC system of the old office.

In each of the above cases, access to the circuits being transferred is needed in the CO to verify DN translations and OE appearances to minimize loss of service at the actual time of transfer.

The test should have the following testing or verification capabilities:

a. Perform a busy line test to determine if a line is busy or idle in the old office by looking for the presence of battery and ground through the old office and a busy or idle flag in the new office connections to the line.

b. Identify affiliations on 2-party lines and tip or ring affiliations on 4-party lines and hunting conditions on multi-line hunt groups and series completion lines.

c. Test translation between entities for all services that are provisionable by the IDLC system as well as any subscriber settable and changeable translations.

Because the wiring at the RDT does not change during the conversion of a UDLC system to an integrated arrangement, the test does not require the capability of detecting reversed tip/ring connections and the presence of battery or ground in the correct polarity.

9.3.2.2 Testing Procedure

a. It should be possible for the test to generate signals that will be transmitted through the closed path established above and sensed back at the originating entity.

b. After the test path has been successfully established and verified, the test should be capable of receiving and interpreting the specific indicators for each type of entity that indicates a failed test.

c. Under switch processor control it should be possible to call for status by IDLC system or by single access line.

d. It should be possible to establish a priority within the switch processor for completion of the board-to-board testing versus completion of other switch processes.

e. At the actual time of the office cutover or area transfer, there should be at the common point of connection an instantaneous removal of service in the old entity and establishment of uninterrupted service to the IDLC system cut over to the recipient LDS.

f. If a condition occurs during the test so a circuit cannot be successfully tested, or any circuit that remained constantly busy, the test system should be capable of recording each case and provide records of these incidents on request in addition to the results for every circuit tested.

9.3.2.3 Non-Switched and Non-Locally Switched Circuits

Non-switched and non-locally switched circuits are excluded from board-to-board testing support at this time.

10. Miscellaneous

10.1 Physical and Environmental Requirements - General

R10-1 **[842]** The IDT and all other associated IDLC equipment located in telephone COs shall meet the requirements of TR-NWT-000063.

Associated CO equipment includes cable distribution systems, distributing/interconnecting frames, power equipment, Operations Support Systems (OSSs), and cable entrance facilities. TR-NWT-000063 provides the spatial and environmental requirements, including testing methods that apply to CO equipment.

In addition to meeting these overall NEBS requirements for CO equipment, other specific IDLC system physical and environmental requirements are provided in this section.

10.1.1 Physical Requirements

R10-2 **[843]** The RDT shall meet all the RDT physical requirements contained in Section 10 of TR-NWT-000057.

10.1.2 Environmental Requirements

R10-3 **[844]** The RDT shall meet all the RDT environmental requirements contained in Section 10 of TR-NWT-000057.

10.2 Powering and Electrical Safety

R10-4 **[845]** The RDT shall meet all the RDT powering, electrical safety, and electromagnetic compatibility requirements contained in Section 11 of TR-NWT-000057.

10.3 Quality and Reliability

O10-5 **[846]** The individual line downtime caused by the RDT should not exceed 10 minutes per year, based on an assumed Mean-Time-To-Repair (MTTR) of 4 hours.

The individual line downtime for an IDLC system is the expected long-term average time OOS for a customer line (i.e., the customer line is unable to originate or to receive calls), due to all causes within the IDLC system. It is expressed in minutes per year.

The “QUALITY AND RELIABILITY” section of TR-NWT-000057 provides an overview of proposed quality and reliability requirements and objectives for UDLC systems. The RDT and general requirements in this section of TR-NWT-000057 are applicable to IDLC RDTs.

R10-6 **[847]** The RDT shall meet all the general and RDT specific requirements contained in TR-NWT-000057.

R10-7 **[848]** In addition to the requirements of TR-NWT-000057, the IDT of IDLC systems shall meet the reliability requirements contained in GR-512-CORE. This section provides reliability objectives for local switching systems as they apply to (1) cutoff calls, (2) ineffective machine attempts, and (3) downtime.

10.4 System Administration

10.4.1 Documentation

R10-8 **[849]** A supplier shall provide documentation that will permit the telephone companies to readily plan, order, engineer, install, and maintain the system. These documents shall cover the areas specified in TR-NWT-000057 and TR-TSY-000519.

R10-9 **[850]** Documentation shall cover each sub-system element and all of its interfaces as discussed in TR-TSY-000454. The documentation for engineering, ordering, installation, and maintenance of the switching system and the remote DLC must be given for each end-to-end system feature - whether two different manufacturers equipment meet at the interface or not.

The supplier is urged to consult the above mentioned documentation guides and also each region directly to ensure that product information fits each telephone company's specifications.

10.4.2 Personnel Training

R10-10 **[851]** The supplier shall provide training courses or assistance in developing training courses for the telephone company personnel responsible for operating the IDLC system to meet the requirements of TR-NWT-000057.

10.4.3 Equipment Coding

R10-11 **[852]** The IDLC system shall meet the equipment coding requirements of GR-485-CORE. These requirements include the provision of CLEI codes for IDLC system equipment. CLEI code criteria are contained in GR-485-CORE.

10.4.4 Transmission Performance Information

R10-12 **[853]** The supplier shall provide the transmission performance information detailed in PUB 52003. This information is needed to be compatible with mechanized circuit design systems used by some telephone companies.

10.4.5 Electrostatic Discharge

R10-13 **[854]** The supplier shall provide procedures necessary to prevent electrostatic discharge damage to the IDLC plug-in units.

10.4.6 Priority Lines

R10-14 **[855]** A DLC system shall provide the capability to ensure that service can be provided to lines that are providing essential services (fire, police, etc.) under any system condition short of total system failure.

10.4.7 Supplier Support

The IDLC system supplier shall meet the supplier support requirements contained in TR-NWT-000057.

10.5 IDLC Requirements For Remote Switch Units

GR-303-CORE provides requirements for DLC RDTs that terminate on the IDT located in the LDS. These requirements address the situation where all the switch functions are located in the local CO. However, with today's distributed switching system architecture, it is now possible to de-centralize many switching and call processing operations. This is typically accomplished by combining or sharing discrete network elements that can be deployed in locations that may be some distance from the host entity. In some switch architectures, this distance may be over 150 miles.

These network elements, known as RSUs, are generally configured in two distinct applications:

a. Replacement for small Community Dial Offices (CDOs)

b. Extensions of the host office.

This section is concerned with those additional IDLC system and generic IDLC interface requirements needed to allow for the termination of IDLC system RDTs on IDTs in RSUs. The RSU is considered to be an extension of the host switch into a geographically distinct serving area.

Based on that description, the RSU is assumed to provide all the functions that have been allocated as LDS functions, or to allow access to them in addition to providing the IDT functions. The link between the RSU and host switch is assumed to be proprietary, because the host switch and RSU are expected to be manufactured by the same company. Therefore, that link is not the subject of these requirements. However, the additional length introduced by this host to RSU link will increase echo path delay. Echo path delay constraints are discussed later in this section.

10.5.1 Requirements and Options for Customer Services when Using an RSU

There are no new requirements associated with Section 3 applicable to the IDLC/RSU configuration; some additional clarifications are provided:

a. The Zero Transmission Level Point (0TLP) remains defined as the center of the switch, where the switch is now the RSU.

b. The digital link between the host and RSU is assumed to be lossless. Therefore, all loss measurements defined in GR-303-CORE remain unchanged.

c. There are no changes in return-loss and hybrid-balance requirements for RDT channel units due to the presence of an RSU between the RDT and the host LDS. However, the echo path delay requirements of GR-303-CORE should be satisfied. This will limit the distance of RDTs from the host if echo impairments are not otherwise controlled.

10.5.2 Echo Path Delay Requirements for Proprietary Systems That Use an RSU

Grade-Of-Service (GOS) performance is a function of both echo path loss and the round trip echo delay (See Section 7.7.9 of TR-NWT-000507). A design tradeoff between echo path loss, facility propagation delay, equipment performance, and carrier type may be used to achieve both acceptable GOS and reasonable distance limitations.

From a transmission point of view, the basic RSU is considered to be an extension of the host switch. Section 4.4.3 of GR-303-CORE requires that the round trip echo path delay from RDT-to-RDT (where the connection path is in the LDS) be ≤6.5 ms for 99% of such connections, per Table 7.7-10 of TR-NWT-000507. When an RDT of an IDLC system terminates on an RSU, the delay introduced by the RSU reduces the maximum distance the RDT can be located from the RSU's host as compared to an IDLC system's RDT terminated directly on the host.

While not a severe limitation for most RSU/RDT applications, this reduction in maximum allowable facility length, due to the additional RSU delay, may affect some switch and facility planning choices.

The total facility length includes the facility length from the host to RSU plus the facility length from the RSU to the RDT. In the case of proprietary systems where the LDS, RSU, IDT, and RDT are built by a single supplier, a collective delay of these parts must be determined. Section 4.4.3 of GR-303-CORE contains requirements for an IDLC system supplier to provide tables/graphs that indicate the maximum achievable facility length versus quantities of delay being contributed by equipment other than the host, RSU, and RDT (e.g., facility multiplexes and equipment with DCS-type capabilities).

CR10-15 **[856]** If an LDS provides an RSU capability, the supplier shall provide facility length tables/graphs per Section 4.4.3 of GR-303-CORE for an RDT terminated on an IDT in a RSU.

10.5.3 Echo Path Delay for Generic Systems Using an RSU

Grade-Of-Service (GOS) performance is a function of both echo path loss and the round trip echo delay, as described in the section above and in Section 4.4.3. A design tradeoff between echo path loss, facility propagation delay, equipment performance, and carrier type may be used to achieve both acceptable grade-of-service and reasonable distance limitations. From a transmission point of view, the RSU is considered to be an extension of the host network. Section 12.6.1.1 requires that the round trip echo path delay from 2-wire interface to 2-wire interface (RDT-to-RDT), be ≤ 6.5 ms for 99% of such connections, and further distributes this limit between LDS, RDTs, and connecting facilities. When an RDT of an IDLC system terminates on an RSU, the maximum delay introduced by the RSU shall be ≤1.4 ms per Table 7.7-10 of TR-NWT-000507.

To meet the overall 6.5-ms echo path delay requirement, an RDT terminated on an RSU is limited to 40 miles or less from the host LDS, using the maximum RSU delay of 1.4 ms.

This situation occurs when both originating and terminating connections are in RDTs that connect to the local switch through RSUs; this case will represent only a small percentage of RSU/RDT connections. The mileage limit for this case is arrived at by subtracting the allocated delays of the host, RSUs, and RDTs from the 6.5-ms requirement, which leaves 1.3 ms for all other facility-related delays.

Assuming only facility propagation delays (i.e., no facility-multiplexes or equipment with DCS-type capabilities) and assuming 19, 22, 24, or 26 gauge standard capacitance (83 nF/mile) cable, a 2-way facility propagation delay of 16 µs per mile produces a total available facility length of 81 miles. If both RDTs are equidistant from the host, this would limit each host-to-RDT distance to approximately 40 miles.

This constant does not include multiplexes or DCSs that may be included in the digital facilities, but this constant does include the regenerators on metallic facilities.

The delay constant for copper cable can be conservatively applied to fiber cables also. For fiber facilities between the RSU and the RDT, additional multiplexing delay may be introduced that would further reduce the host to RDT mileage limit. Assuming a delay of 125 µs per multiplexing operation, the 1.3 ms allocation for all other facility-related delays is reduced to 0.8 ms. This reduces the maximum host to RDT distance discussed above to approximately 25 miles. For fiber facilities between the host and RSU, a direct fiber interface between host and RSU internal busses is assumed. For this configuration, no additional multiplexing delays are introduced.

In the case where just one side of the connection is an RDT terminated in an RSU, the 6.5-ms echo-path-delay requirement allows the RDT to be deployed up to 200 miles from the host LDS.

As Section 10.5.2 discusses, this reduction in maximum allowable facility length, due to the additional RSU delay, will affect some telephone company plans, but it will not be a severe limitation for most RSU/RDT applications. The total facility length includes the facility length from the host to RSU plus the facility length from the RSU to the RDT. Section 10.5.2 contains requirements for an IDLC system supplier to provide tables/graphs that indicate the maximum achievable total facility length for the IDLC system, both with and without an RSU.

R10-16 **[857]** For suppliers of only part of an IDLC system meeting the generic IDLC interface requirements, the following type tables/graphs shall be provided:

… a. For suppliers of an RSU meeting the Generic IDLC Interface, a comparison of host-to-RSU mileage versus RSU-to-RDT mileage as a function of the echo-path-delay of the RDT and any facility-related equipment (e.g., facility-multiplexes and equipment with DCS-type capabilities) shall be provided.

… b. For suppliers of an RDT meeting the generic IDLC interface, a comparison of host-to-RSU mileage versus RSU-to-RDT mileage as a function of the echo-path-delay of the host, RSU, and any facility-related equipment (e.g., facility-multiplexes and equipment with DCS-type capabilities) shall be provided.

… c. The supplier should provide information on any aspect of the product that would add round trip delay. An example is buffers used in CCC encoding and decoding.

10.5.4 Order Wire Support For RSU Applications

Section 4.5 states that an order wire will be provided between RDT and CO.

R10-17 **[858]** An order wire capability shall be provided between the RDT and RSU; the order wire terminates at the RSU, because the RSU is the work site for maintaining both the IDLC system and the RSU.

10.5.5 Operations System (OS) Interfaces for RSU Applications

R10-18 **[859]** The OS interface for an IDLC system whose RDT terminates on a RSU shall be through the RSU's host switch. The interface between the Operations Interface Module (OIM) in the host switch and the IDLC system's IDT and RDT is an internal switching system interface, and therefore, the details of its implementation is left to the switching system supplier. The RSU shall transparently pass operations messages from the host OIM to subtending RDTs of the RSU. However, the termination of an IDLC system on a RSU shall not add more than 3 seconds delay to the exchange of messages between OSs and the IDLC system.

10.5.6 Data-Link Protection for RSU Applications

One or more data links between a host switch and an RSU terminated on the host are needed to carry IDLC system operations messages between the host and RSU for those RSUs that terminate an IDLC system's RDT.

For RSUs that provide an IDT, the following requirements apply for any implementation of data-linking capabilities between the host and the RSU that carries operations messages for the IDT or RDT:

R10-19 **[860]** Section 6.1.4.2 contains the requirements for data-linking capabilities between the IDT and RDT. The host-to-RSU data-linking capabilities shall not interfere with these requirements.

R10-20 **[861]** Transmission, format, and operational errors on the host-to-RSU data-link(s), shall be detected.

R10-21 **[862]** The host-to-RSU data link shall be duplicated.

The requirements that follow relate to products that meet the generic IDLC interface of Section 12.

R10-22 **[863]** The facility protection switching feature discussed in Section 12.6.2 applies to the facilities between the RSU and the IDLC system's RDT.

R10-23 **[864]** The RSU, in conjunction with its host, shall provide all capabilities allocated to the local switching system in Section 12.6.2.

If facility protection switching is provided for the facilities between the LDS and any one of its RSUs, the protection method and its procedures are assumed to be supplier specific. Thus, this GR does not contain requirements for facility protection switching for these facilities. However, the requirements for data-link protection across the facilities between the LDS and the RSU terminating an IDLC system's RDT contained in this section do apply to products providing the Generic IDLC Interface of Section 12.

10.5.7 Maintenance Access Requirements for RSU Applications

R10-24 **[865]** For IDLC systems whose RDT terminates on an RSU, the maintenance access requirements specified in Section 7.2.2 for the switch maintenance center and the loop maintenance center shall be met.

R10-25 **[866]** If an RSU has a craft interface for RSU operations, this craft interface shall provide operations access for any IDT terminated on the RSU.

R10-26 **[867]** Maintenance access to the DS1 facilities between the IDT and RDT shall be provided at the DSX-1 bay located in the building housing the RSU.

10.5.8 Other Requirements for RSU Applications

No changes in the requirements specified in the following sections of GR-303-CORE have been identified for RSU applications.

a. Section 8: Requirements Supporting IDLC Administration

b. Section 9: Requirements Supporting System Turn-up

c. Section 11: IDLC System Transition Considerations.

11. IDLC System Transition Considerations

11.1 Operations Support-The Current Picture

The Operations Systems (OSs) being developed to support the generic OS-NE interfaces are not likely to be universally deployed throughout the Bellcore Client Companies (BCCs). Even within the same BCC, the various (memory administration, integrated testing, and network monitoring and analysis) OSs supporting the generic OS-NE interfaces will be installed over a period of time. A fallout of this delay is the reluctance of some switch suppliers to supply an Operations Interface Module (OIM) for OS interfaces until OS functionality and open interfaces are available. Alternative OS-NE data connections such as through SONET Data Communications Channel (DCC) are acceptable.

The suppliers of IDLC systems should be constantly alert to the current condition of operations support products, operations support features of those products, the interface requirements from their system to these products, and the programs to deploy various OS products by telephone companies. This GR has earlier described a vision of automated OS support with full features on open interfaces. Suppliers should be alert to see that they have implemented interim plans to maximize their product's value during the transition.

Among the choices that are available to operationally enhance the IDLC products are the following. One or more of them will be needed in the transition period to ensure value to telephone companies. Some of the following operations support capabilities are described in greater detail in the next section.

- Interface existing OSs.

  This includes existing LDS operations interfaces for provisioning, alarm reporting, circuit testing, and alarm reporting. Since these interfaces are frequently proprietary, switch suppliers who are supporting the generic interface of Section 12 are encouraged to advise RDT suppliers of what capabilities they will support over these interfaces.

- Interface through LDS scan and control points.

  Though this interface is relatively primitive, it can be made to provide significant support. The E-telemetry interface is frequently used. Many OSs are application programmable to enhance information provided from a simple contact closure.

- Supervisory Systems.

  An RDT supplier can have control of the operations features and other enhancements for the RDT through a supervisory system. The supervisory system could be a stand-alone product in a maintenance center, but it could be enhanced to have direct interfaces with OS for greater functionality. The supervisory system is discussed in greater detail later in this section and in SR-NWT-002166.

- Local craft interface.

  The local craft interface as described in Section 7 provides a major capability to provision, monitor, and maintain RDTs in the absence of the other operations support products listed above.

11.2 Operations Interface Transition Requirements-Option

Two of the strategies for IDLC suppliers as discussed above that can be used during this transition period are described in the remainder of this section. The first strategy makes use of existing OSs for circuit testing, and surveillance and control functions. The second strategy is the use of a supplier's own supervisory system for memory administration, and surveillance and control functions. These are strategies to be used in the interval between when an IDLC system meeting the requirements of this GR is installed and the installation of OSs meeting the generic OS-NE interfaces and providing needed functionality. These are transitional features and they are not expected to become a permanent part of the operations network.

11.3 Interfacing Existing Operations Systems-Option

Three interfaces that can be used to interface IDLC systems with existing OSs are discussed in the following subsections.

11.3.1 LDS Operations Interface

LDSs provide an interface from the switching system's maintenance console in the CO office to the OS used to maintain the switching system.

CR11-1 **[868]** The LDS should be capable of using the switching system's maintenance console interface to send alarm and status information received from the RDT to the switching system maintenance center, and to receive limited control signals from the center, such as a remote Alarm Cut Off (ACO) command. The alarm and status information sent through the maintenance console interface to the switching system maintenance center should include alarms and status information for the IDT, RDT, and digital facilities alarms detected by the IDLC system.

Section 5.2.2 gives the IDLC system requirements for access to the switching system maintenance console interface.

Traffic operations support is through a proprietary interface to the EADAS OS, or through Bellcore’s traffic management system, DCOS-2000.

11.3.2 E-Telemetry Interface-Option

An E-telemetry interface allows a telephone company to interface both the LDS and its connected RDTs with existing maintenance OSs for surveillance and control. Telephone companies that use an E-telemetry system to interface an existing maintenance OS may want to discontinue using the E-telemetry system for an IDLC system once a maintenance OS becomes available that supports the generic OS-NE interface or once their current OS is upgraded to support the generic OS-NE interface (unless a backup is desired).

There are several limitations to operating with only an E-telemetry system interface that must be considered:

a. It is impractical to collect DS1 performance monitoring data using the E-telemetry interface because of the large amount of data that must be transmitted through the interface.

b. The E-telemetry interface is restricted to reporting of alarms and status, and to limited control activity that is of a binary nature, i.e., activate or deactivate a device. In general, the status to be reported is of a binary nature - the device whose status is being reported is either in state one, scan point activated, or the device is in state two, scan point deactivated. If the status of a device can take on more than two states, it will take multiple scan points to report the status of the device. Thus, from a practical point of view, the status information that can be reported using E-telemetry systems is limited.

c. Maintenance activities are limited because of the small amount of data that can be transmitted using E-telemetry systems.

d. Remote memory administration (provisioning) and testing activities cannot be done using an E-telemetry system.

When only E-telemetry interfaces are available, the following requirements apply:

CR11-2 **[869]** The same alarm and status information that is sent through the switching system maintenance console shall be available at the switching system's distribution points for access by an E-telemetry system.

CR11-3 **[870]** The switching system's control points shall provide limited control of IDLC systems from a remote maintenance center.

This interface is shown in Figure 11-1. Although the data to be sent and received through the switching system maintenance console and E-telemetry interfaces are essentially the same for both interfaces, most telephone companies want the flexibility to be able to send the data to multiple maintenance centers. This allows the telephone company to get the data to those that need the data, and yet be free to organize their maintenance centers in a way fitting their specific corporate needs. Section 5.2.2 gives the IDLC system requirements for an E-telemetry interface. It also describes SAC, APR, and MDP-326-600 (PUB 49001), shown in Figure 11-1.

11.3.3 Circuit Testing Interface-Option

A telephone company may want to use a metallic test pair between the CO and the RDT for circuit testing because the RDT is located near a CO in an area where metallic pairs are available. The unavailability of a test system supporting the testing requirements specified in Section 5.3 is another reason a telephone company may use a metallic test pair for circuit testing.

CR11-4 **[871]** An IDLC system shall provide the capability to do circuit testing of locally switched circuits using a metallic test pair.

O11-5 **[872]** The IDLC system should provide the capability to do circuit testing of non-locally/nonswitched circuits using a metallic test pair.

For locally switched circuits, the requirements for testing with a metallic test pair are specified in Appendix A of TR-TSY-000008. Requirements for adapting the metallic test pair testing capabilities specified in TR-TSY-000008 to non-locally/nonswitched circuits are not specified.

11.4 Supervisory Systems

A supplier of an IDLC system may offer a Supervisory System (SS) to provide remote and local memory administration and/or maintenance capabilities for their IDLC system for those installations in which the OSs supporting the generic OS-NE interface are not available. Generally, the supervisory system will only support the supplier's own IDLC systems, but a single supervisory system may support several installations of the supplier's IDLC systems.

Requirements for features and characteristics of supervisory systems are contained in SR-NWT-002166.

Recommended, conditionally recommended, and objective capabilities are defined in the SR, along with justifications as needed.

The SR addresses the following major topics:

a. Relationship to Sub-Network Control Functions.

b. Architecture Variations for SSs.

   This includes interfacing to RDTs with or without an LDS OIM. The switch management system's role of providing a mediation function for CMISE messages to and from the RDT that are destined for switching OSs is described, and is applicable to the discussion on interfacing with existing OSs in this section.

c. Operations Support Capabilities.

Memory administration, surveillance, and test access are the operations support categories that SSs are expected to support.

d. User System Interface.

   Local access, remote access and multiple access are discussed.

e. Security

   Information on user interface security, SS to RDT interface security, and SS database security is provided.

f. Generic Interface to OSs.

   The interfaces, protocols, and connecting networks are discussed. TL-1 to CMIS translation requirements are identified.

g. Generic Interface to Test Systems.

h. Other Interfaces to OSs.

   Methods for E2A telemetry and SSs together to enhance operations is described.

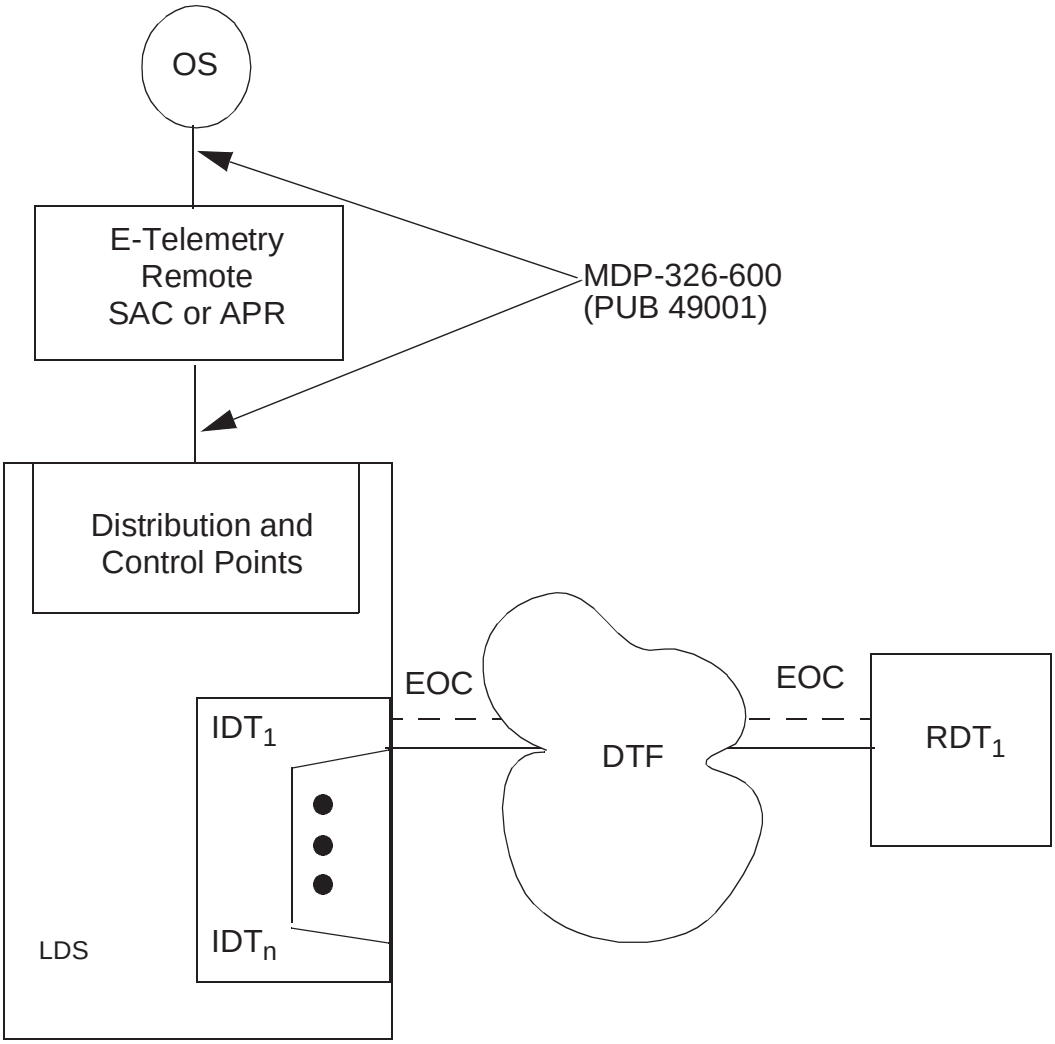
i. Software Downloading

   Benefits of SS support of RDT software downloading is described.

j. General Recommendations

   Managing multiple RDTs by a SS and selecting a SS operating system are discussed.

The use of a supervisory system is not considered to be a permanent part of the operations network.



APR - Alarm Processing Remote
SAC - Status and Command

Figure 11-1. E-Telemetry Interface

12. LDS-RDT Generic Interface - Requirements and Options

12.1 Introduction

The Generic IDLC Interface between an LDS and an RDT is intended to allow interconnection of LDSs and RDTs from different suppliers. The Generic IDLC Interface is one particular implementation of the requirements described in previous sections of this GR. While by no means the only possible implementation of these features, it is Bellcore's view that the interface described herein offers the necessary functionality for likely IDLC applications while taking good advantage of modern, available technologies.

The availability of LDSs and RDTs meeting the Generic IDLC Interface will increase a BCC's options in selecting equipment that best matches its local needs, while employing integrated digital transmission and switching systems. The Generic IDLC Interface, however, should be the interface of choice when a *multiple supplier* IDLC arrangement is desired. The Generic IDLC Interface also reduces the administrative burden of keeping track of many proprietary interfaces.

The Generic IDLC Interface is structured along the lines of the Open Systems Interconnection (OSI) model's layers. The transmission interface is described as a Layer 1, or physical layer, while call processing and operations interfaces between RDT and LDS are described in multiple layers. For these data-oriented interfaces, layer 1 corresponds to the physical characteristics of the data links, layer 2 refers to the data-link control or protocols specified, and application layer refers to the specific message sets used on the data links as illustrated in Figure 12-1. Procedures refer to the assembly and sequencing of call processing or operations messages to accomplish specific LDS - RDT functions, such as call setup or facility protection switching.

The Generic IDLC Interface accommodates a wide variety of IDLC system options. In general, RDTs may choose those options that best meet the applications the RDT is designed for. On the other hand, the LDS is required to accommodate most Generic IDLC Interface variations to be able to connect multivendor RDTs to a single switch.

Most Generic IDLC Interface requirements presented in this GR are organized in categories similar to the end-to-end system requirements. For example, Generic IDLC Interface requirements associated with interfacing to the digital network are grouped together, as a parallel to those system requirements in Section 4. Also, *allocation* of the transmission and signaling requirements presented in Section 3 (Requirements and Options for Customer Services) are grouped together in the Generic IDLC Interface. Where possible, requirements are specified as applying to either the LDS or RDT.

For FITL systems (see TA-NWT-000909), the Generic IDLC Interface is used as an open interface between an HDT (Host Digital Terminal) and an LDS.

Section 12.3 discusses applications of the Generic IDLC Interface options. Section 12.2 presents a brief executive summary of the key features of the generic interface.

12.2 Generic IDLC Interface Requirements - Executive Summary

The physical layer of the Generic IDLC Interface is based on DS1 rate modularity. Across the Generic IDLC Interface, an IDLC system may range in size from 1 to 28 DS1s. The lower limit, one DS1, allows IDLC systems to meet the needs of small line size applications that do not require the ability to back-up critical operations data links. Support of 2 DS1s allows IDLC systems to meet the needs of small line size applications, while also providing the ability to back-up critical operations data links, but it does not include the protection DS1 when the optional automatic facility protection switching is offered. The maximum limit, 28 DS1s, allows IDLC systems to meet the needs of large line size applications. When the optional automatic facility protection switching is offered, the protection DS1 is included within the 28 DS1 maximum limit. The maximum size is limited to 28 DS1s to promote consistency with higher-rate facilities with DS3 modularity.

The DS1 line format is based on the Extended Super Frame (ESF) format (see GR-499-CORE). This frame format uses the channel derived from the 193rd bit of a DS1 Frame for several functions, including synchronization, error detection, and for a derived 4 kb/s operations channel. Performance monitoring of each DS1 facility will be accomplished using the CRC-6 code. The 4 kb/s derived channel can be alternately used to transmit facility operations and far-end performance messages between the RDT and the LDS or can be preempted as a bit oriented channel to transmit alarm codes and protection line switch commands.

The Generic IDLC Interface will support two different call processing techniques. The first is called *hybrid signaling*. In hybrid signaling, ABCD codes are used for call supervision (e.g., on-/off-hook detection) while a time slot is assigned to a line unit. Per-call time-slot assignment is accomplished over a 64 kb/s Time-slot Management Channel (TMC) that carries messages between the LDS and the RDT. These messages are used to make and break time-slot assignments between line units and DS0s on a per-call basis.

The second call processing technique is *out of band signaling* and consists solely of a 64 kb/s channel, the Common Signaling Channel (CSC). The CSC carries messages for making time-slot assignments and for call supervision.

Both the TMC and CSC are based on the LAPD protocol that is used on ISDN D channels. The TMC and CSC messages are based on the Q.931 standard and are largely consistent with the ISDN call control requirements in TR-TSY-000268.

To enable connection with different RDTs serving a wide range of applications, the LDS must accommodate both call processing techniques, but not simultaneously for any one RDT.

A separate DS0 data link, called the Embedded Operations Channel (EOC), is used to transmit operations messages between RDT and LDS, and between RDT and OSs. The operations data link is based on the LAPD protocol. The ESF data-link (4 kb/s) is used to transmit DS1 protection switching and loopback messages.

For ISDN Basic Access capability, requirements are described that specify the mapping of B and D channels onto DS1 facilities at the RDT. This ensures that the LDS can find and properly process all B and D channels. Two methods are described for transporting D channels, one simpler (3DS0) but bandwidth inefficient, the other more efficient (4:1 TDM) but relying on the presence in the RDT of several other feature and interface options.

12.3 Applications of the Generic IDLC Interface

The Generic IDLC Interface requirements include two important choices for RDTs: (1) the number of DS1 interfaces ($1 \leq DS1 \leq 28$), and (2) the selection of a call processing technique (hybrid [TMC] or CSC signaling). Depending on the choices selected, additional options present themselves.

12.3.1 Selecting the Number of DS1s

The lower range of DS1s applies to small RDTs, or RDTs using large concentration ratios. In the first case, a small RDT could accommodate either simple POTS-like services, non-switched special services, or both. In the latter case, the expected application would be heavily residential, implying a POTS-like domination of the service mix. This is because a concentrated system would be required to dedicate time slots to non-switched services, thus rapidly reducing the percentage of channels available for switched services to share. Too many channels dedicated to non-switched services can rapidly reduce the traffic capacity of an IDLC system for the remaining switched traffic.

The upper range of DS1s applies to large RDTs aimed mainly for a large residential, or a commercial area. Such systems will be able to support a broad mix of services - POTS and specials - and subtending applications such as DS1 extensions, etc. It can also support connecting a FITL system to an LDS. If many DS1s are deployed, the transport medium between RDT and LDS is likely to be optical, operating at multiples of DS3 rate (28 DS1s).

12.3.2 Selecting the Call Processing Signaling Method

The RDT may use either hybrid signaling (TMC) or CSC signaling to accomplish call processing functions across the Generic IDLC Interface. CSC signaling uses data-link protocols and messages developed for ISDN to perform call processing functions.

The prime factor in selecting the call processing technique may be the capability deployed in the RDT. Hybrid signaling has an inherent limitation in the number of ABCD patterns that can be sent across the Generic IDLC Interface. For the ABCD method described in this GR, 16 (2^4) signaling states are available in each direction of transmission. Sixteen signaling states may be a limiting factor as new services and associated signaling requirements are identified. Thus, RDTs oriented toward the more sophisticated service

requirements of commercial applications would favor the CSC method to ensure flexibility to handle future services. If the RDT assigned time slots on a per call basis, either the TMC or CSC method could be used. However, the CSC method might be the more cost effective signaling method, even without time-slot assignment, because it represents a fixed system cost, not a per-line cost.

12.4 Interface Functionality

12.4.1 General

This section provides a functional description of a generic interface that will satisfy the IDLC system requirements/features of Sections 3 through 11. This Generic IDLC Interface is defined as being between an LDS and an RDT, as illustrated in Figure 12-2, and will allow multi-supplier configurations of LDSs and RDTs.

Generalized categories of functions that need to be provided across this interface are

- **DS1 Facility Operations** - DS1 facility alarms, loopbacks, and protection switching. The Generic IDLC Interface calls for the use of the ESF (see GR-499-CORE) data link (bit-oriented mode) on each DS1 to provide these functions. The ESF (message-oriented mode) on each DS1 provides far-end performance reporting capabilities on each DS1.
- **IDLC System/Terminal Operations** - IDLC system/terminal alarms, performance monitoring, provisioning, etc. The Generic IDLC Interface calls for the use of a dedicated DS0, to provide these functions.
- **Call Processing** - time-slot assignment, call establishment, call clearing, etc. The Generic IDLC Interface calls for either hybrid signaling (i.e., ABCD robbed-bit-signaling and uses the TMC for time-slot assignments) or out-of-band signaling (i.e., the CSC is used for all signaling and time-slot assignments).
- **Information Transport** - IDLC transport of voice, customer data, etc. The Generic IDLC Interface calls for the use of DS0 channels to provide this function.
- **Loop Testing** - Because loop testing functions are controlled over proprietary data lines between a TSC in the CO or in a remote maintenance center and an RTU at the RDT location, a separate DS0 channel is called for to provide this function.

The above categories can accommodate any of the IDLC system requirements and features described in Sections 1 through 11. The remainder of this section will describe an implementation of a Generic IDLC Interface based on Figure 12-2, to accommodate each of the general categories of functions listed above.

12.4.2 Generic Implementation of Interface Functions

12.4.2.1 DS1 Facility Operations

As Section 12.6.1 specifies, the ESF (see GR-499-CORE) DS1 format shall be used across the Generic IDLC Interface. The capability to provide per-DS1 alarms (AIS and Yellow) and per-DS1 performance monitoring (far end performance reports) is within the definition of the ESF DS1 format.

12.4.2.2 IDLC System/Terminal Operations

As Section 12.6.1 specifies, the Generic IDLC Interface shall support all IDLC system/ terminal operations via a DS0 data link (DS0 number 12 of the primary DS1) dedicated to operations. Details on the physical, protocol, language, and message interface requirements are provided throughout the remainder of Section 12.

An OS will interface an IDLC system through the LDS. In this GR, the LDS feature to provide this communications path is called the “Gateway Feature” of the Operations Interface Module (OIM). It is described in Section 12.7.

12.4.2.3 Call Processing

Call processing is accommodated by either hybrid or out-of-band signaling.

R12-1 **[873]** The LDS shall support hybrid signaling; i.e., ABCD robbed-bit-signaling on a per-channel basis with the TMC being used for all dynamic time-slot management needs.

CR12-2 **[874]** In some BCC access architectures, the LDS will be required to support out-of-band signaling using the CSC; i.e., the CSC is used for all signaling and dynamic time-slot management needs.

The use of the CSC across the Generic IDLC Interface allows all DS0s to be transported as clear-channel DS0s (i.e., DS0s without ABCD robbed-bit-signaling) between the RDT and the LDS. The transport of DS0s as clear channels allows for more flexibility, and simplifies operations and administration, in the digital transmission facility between the RDT and the LDS. SONET-based RDTs satisfying the requirements of Section 13 of this GR transport ABCD codes not in-slot using robbed-bit-signaling, but out-of-band using bits in the SONET VT overhead, thus allowing DS0s to be transported as clear channels.

R12-3 **[875]** The RDT shall either support hybrid signaling, or out-of-band signaling using a CSC.

Sections 12.5.1 through 12.5.5 provide requirements for implementing the Time-slot Management Channel (TMC) and CSC. The ABCD codes, as defined in Section 12.5.2.1, used in the hybrid signaling technique, shall be implemented as described in Section 12.6.1.3.1.

Section 12.5.9 specifies allocation to the RDT of certain maximum signaling timing limits. RDTs designed to just meet the signaling requirements in this GR may result in Universal DLC systems that exceed the overall UDLC requirements. However, an RDT that meets these requirements with sufficient margin may allow a UDLC configuration to meet overall requirements as well, with the same RDT.

12.4.2.4 Information Transport

R12-4 **[876]** The method of transporting customer information across the Generic IDLC Interface shall be via DS0 time slots of the ESF (see GR-499-CORE) DS1 format.

A 64 kb/s CCC is achievable with out-of-slot signaling (i.e., the CSC). Details on time-slot locations are in Section 12.6.1.2, and specifics on the division of IDLC transmission requirements between the LDS and the RDT, are in Section 12.5.8.

RDTs designed to just meet the transmission requirements in this GR may result in Universal DLC systems that exceed the overall UDLC requirements. However, an RDT that meets these requirements with sufficient margin may allow a UDLC configuration to meet overall requirements as well, with the same RDT.

12.4.2.5 Loop Testing

To support proprietary testing protocols between a TSC and its remote measuring unit, one or more DS0 channels may be needed between the RDT and LDS. Because the channel requirements are the same as those for customer information transport, no further requirements are included in the Generic IDLC Interface.

12.4.2.6 Summary

This section identifies the functionality across the Generic IDLC Interface that will satisfy the IDLC system requirements/features of Sections 3 through 11. The following subsections of Section 12 describe the requirements at both the LDS and RDT to meet this interface.

In the remainder of Section 12, the DS0 operations data link is referred to as the EOC (Embedded Operations Channel).

12.4.3 LAPD Protocol

Link Access Procedure on the D Channel for ISDN (LAPD) is the basis for the call processing and operations data-link layer protocol of the Generic IDLC Interface. LAPD is specified in ITU-T Recommendations Q.920 and Q.921 as well as TR-TSY-000793.

Some of the features and capabilities of the LAPD protocol are not needed for the Generic IDLC Interface. Those features and capabilities specified as a necessary subset of LAPD in the following subsections shall be provided by both the RDT and LDS. Where features and capabilities are specified without special exclusions, standard LAPD procedures/ recommendations shall be followed.

12.4.3.1 General LAPD Information

The information originally provided in this section was primarily tutorial in nature. Because of the increased industry familiarity with the protocol, the information has been removed. TR-TSY-000793 contains specific details of the LAPD protocol.

12.4.3.2 LAPD Functions

The information originally provided in this section was primarily tutorial in nature. Because of the increased industry familiarity with the protocol, the information has been removed. TR-TSY-000793 contains specific details of the LAPD protocol.

12.4.3.3 Overview of Frame Structure and Format

The information originally provided in this section was primarily tutorial in nature. Because of the increased industry familiarity with the protocol, the information has been removed. TR-TSY-000793 contains specific details of the LAPD protocol.

R12-5 **[877]** For calculating the 16-bit Frame Check Sequence (FCS) of an LAPD frame, both the RDT and IDT shall preset the initial contents of the register of the device computing the remainder of the division to all ones.

12.4.3.4 Commands/Responses for Data-Link Operation

The method of information transfer chosen for IDLC systems is the multiple-frame-extended mode of operation; as specified in Section 12.4.3.5.1. In this mode, sequentially numbered information frames are exchanged and acknowledged between the IDT and RDT.

R12-6 **[878]** Of the commands/responses identified in Recommendation Q.921, the following constitute the "GR-303 supported" subset needed to achieve the IDLC functionality specified in this document.

… a. Information (I) command - used to transport sequentially numbered frames containing information for application processes across the data link. This information (e.g., Q.931 messages) is carried in the information fields of these frames.

… b. Set Asynchronous Balanced Mode Extended (SABME) command - used to initialize (or re-initialize) the data-link into the modulo-128 multiple-frame-acknowledged mode of operation.

… c. Receive Ready (RR) command/response - used to indicate readiness to receive an I frame, to acknowledge receipt of previous I frames, to clear a previously indicated busy condition, and to determine the status of the data-link layer on the other side of the interface (the poll bit must be set to **1** in this case).

… d. Reject (REJ) command/response - used to request retransmission of I frames. This command/response may also be used to indicate the clearance of a busy condition that was previously reported via a RNR frame.

… e. Receive Not Ready (RNR) command/response - used to indicate a temporary inability to receive additional I frames. Sending this frame with its poll bit set to **1** may be used to determine the status of the data-link layer on the other side of the interface.

… f. Unnumbered Acknowledgment (UA) response - used to acknowledge receipt and acceptance of the mode-setting command SABME. This response also indicates the clearance of any busy condition that was previously reported via a RNR frame.

… g. Disconnected Mode (DM) response - used to report that the data-link layer is in a state such that multiple-frame operation cannot be performed.

For IDLC applications, the following commands/responses of Recommendation Q.921 are not required and are not supported across the Generic IDLC Interface:

- Frame Reject (FRMR) response
- Unnumbered Information (UI) command
- Disconnect (DISC) command
- Exchange Identification (XID) command/response.

There is some concern about interoperability between LAPD implementations specifically implemented to GR-303-CORE requirements and other LAPD implementations that have implemented more than required by GR-303-CORE, maybe even modified off-the-shelf LAPD solutions that support all of the LAPD protocol features. Some vendors are planning to go beyond the subset of LAPD required by GR-303-CORE to offer special features in their products. In that such innovations may prove beneficial to the BCCs, the following criteria on unsupported commands/messages are proposed to allow this to occur while preserving IDT-RDT interoperability between LAPD processors.

CR12-7 **[879]** If an IDT or RDT sends a "GR-303 unsupported" command/message, the sending IDT or RDT shall be capable of autonomous recovery if no response is received.

CO12-8 **[880]** If an IDT or RDT sends a "GR-303 unsupported" command/message, it is desirable that the sending IDT or RDT be capable of autonomously provisioning itself not to continue to generate the "GR-303 unsupported" command/message, if no response is received.

R12-9 **[881]** If an unsupported (includes unrecognized) command/message is received by any LAPD implementation (the GR-303-CORE subset, an extended subset, or full LAPD), it shall be ignored.

R12-10 **[882]** The RDT shall send commands with the C/R bit set to 0, and responses with the C/R bit set to 1.

R12-11 **[883]** The IDT shall do the opposite of the RDT; i.e., commands are sent with C/R set to 1, and responses are sent with C/R set to 0.

Although the FRMR response and the DISC command are not currently "GR-303 supported," they are under study and may become requirements for the Generic IDLC Interface at a future date.

- The FRMR response is used to report an error condition not recoverable by retransmission of the identical frame. Support of FRMR may be used to improve LAPD performance under specific LAPD error/failure conditions.
- The DISC command is used to terminate the multiple frame operation. Support of DISC allows for a controlled termination of multiple frame operation and may help during trouble isolation of LAPD problems.

12.4.3.5 LAPD Requirements for IDLC Systems

The LAPD requirements of ITU-T Recommendation Q.921 described in this section apply to both the RDT and LDS.

The LAPD protocol has certain parameters associated with each Service Access Point (SAP) that must be established at system turn-up for proper operation. In this section, LAPD parameter values are defined for two classifications of IDLC SAPs: the TMC/CSC SAP and the EOC SAP. Where the requirements differ between SAPs, such differences are pointed out; otherwise, the LAPD requirements defined below apply to both the TMC/CSC and EOC SAPs.

12.4.3.5.1 Mode of Operation

Although not truly a parameter of LAPD, the mode of operation for the IDLC system data link must be selected. The mode of operation determines the method(s) of information transfer available to the data-link layer.

R12-12 **[884]** The multiple-frame-extended mode of operation shall be used.

In the multiple-frame mode of operation, a transmitter may send several information frames without waiting for an individual acknowledgment of each frame before transmitting the next frame. A receiver may acknowledge several frames simultaneously, and this acknowledgment may be carried within information frames of its own that it has to transmit. The extended mode is based on modulo 128 operation.

TR-TSY-000793 discusses six states in which a LAPD link controller can be.

R12-13 **[885]** For IDLC applications, only four states are needed and shall be supported: TEI Assigned, Awaiting Multiple Frame Operation, Multiple Frame Operation, and Timer Recovery.

The other two states (TEI Unassigned and Awaiting Release) are not supported for IDLC applications using the Generic IDLC Interface.

12.4.3.5.2 Maximum Number of Outstanding I Frames (k)

R12-14 **[886]** The maximum number of outstanding unacknowledged information frames, **k**, shall be user selectable within the range of 1 to 7, inclusive, with a step size of 1 and a default value of 7.

12.4.3.5.3 Maximum Number of Retransmissions (N200)

R12-15 **[887]** The maximum number of retransmission of a frame allowed, N200, shall be user selectable within the range of 1 to 10, inclusive, with a step size of 1 and a default value of 3.

12.4.3.5.4 Maximum Number of Octets In An I-Frame Information Field (N201)

R12-16 **[888]** For SAPI=1 of the EOC and TMC/CSC, the maximum number of octets in the information field of an I frame, N201, shall be 256. (This SAP is used for operations messages.)

R12-17 **[889]** For SAPI=0 of the TMC/CSC, the maximum number of octets in the information field of an I frame, N201, shall be 32. (This SAP is used for call processing messages.)

12.4.3.5.5 Maximum Number of TEI Assignment Requests (N202)

The maximum number of TEI assignment requests, N202, is a LAPD parameter that is not specified for IDLC systems. TEIs are assigned as specified in Section 12.4.3.5.11.

12.4.3.5.6 Timer T200

Timer T200 specifies the waiting period for receipt of an acknowledgment of a transmitted frame. A study of LAPD suggests that T200 should be at least as great as the time required to transmit three information frames. (See IEEE Publication CH2175-8/85/0000-0121.) Therefore, to protect against timeouts in an error-free condition, the default value of T200 for each SAP is sufficient to allow for the transmission of at least three frames. [1]

R12-18 **[890]** For all SAPs, the value of T200 shall be user selectable within the range of 100 ms to 350 ms, inclusive, the step size shall be 50 ms, and the default value of T200 shall be 150 ms.

12.4.3.5.7 Timer T201

Timer T201 maintains the maximum time between retransmissions of TEI-identity check messages, and is not specified for IDLC systems.

12.4.3.5.8 Timer T202

Timer T202 maintains the minimum time between transmissions of TEI-identity request messages, and is not specified for IDLC systems.

1. In fact, the T200 values specified herein are somewhat greater than the theoretical minimums to make the interface more practical; e.g., less complex and more tolerant of increases in facility delay (which can occur due to signal re-routes during a failure).

12.4.3.5.9 Timer T203

Timer T203 is used to time periods of inactivity on a data link. When T203 expires, a supervisory frame with the poll bit set to **1** is sent to determine if the other side of the interface is capable of sending and receiving frames. The use of T203 is discussed in greater detail in Section 12.6.3.3.

R12-19 **[891]** For all SAPS, the value of T203 shall be user selectable within the range of 10 to 300 seconds, inclusive, the step size shall be 10 seconds, and the default value shall be 30 seconds.

12.4.3.5.10 Idle Code

R12-20 **[892]** During idle conditions (i.e., when no LAPD frames are available for transmission), the LAPD control circuitry shall transmit idle code across the interface. The idle code for the all SAPs shall be contiguous LAPD framing flags.

12.4.3.5.11 SAPI/TEI Addressing Conventions

This section provides the requirements for supporting the Service Access Point Identifier (SAPI) and Terminal Endpoint Identifier (TEI) in the address field of the LAPD frame. SAPI/TEI addressing conventions are defined in Table 12-1 for the EOC and in Table 12-2 for the TMC/CSC.

The number of SAPI/TEIs requiring support by IDLC systems is limited to those indicated in Tables 12-1 and 12-2. These data links are sufficient to support all identified IDLC call processing and operational needs.

R12-21 **[893]** Both the IDT and RDT shall support all SAPI/TEI combinations identified in Tables 12-1 and 12-2. By support it is meant that the LAPD-processor layer will properly respond to incoming frames and higher-layer requests associated with any of these SAPI/TEI combinations.

Proper responses include denials of requests. For example, if the RDT sends a SABME for a SAPI/TEI combination in Table 12-1 for which the IDT is unable to enter the multiple-frame-established state, the proper response for the IDT is a DM response with the F bit set to the same binary value as the P bit in the received SABME command.

R12-22 **[894]** All SAPI/TEIs shall be put into the TEI assigned state at IDT/RDT initialization.

R12-23 **[895]** The IDT or RDT shall establish multiple frame operation on both TMC/CSC paths for the TMC/CSC logical data-link connection SAPI=1, TEI=0 when the IDT or RDT is initialized, re-initialized, or the TMC/CSC path is put into the in-service state.

R12-24 **[896]** The IDT or RDT shall establish multiple frame operation for the TMC/CSC logical data-link connections SAPI=0, TEI=0 when there is information to be sent using this data-link connection.

O12-25 **[897]** The IDT or RDT should establish multiple frame operation on both TMC/CSC paths for the TMC/CSC logical data-link connection SAPI=0, TEI=0 when the IDT or RDT is initialized, re-initialized, or the TMC/CSC path is put into the in-service state.

R12-26 **[898]** The IDT or RDT shall establish multiple frame operation on both EOC paths for the EOC logical data-link connection SAPI=1, TEI=0 when the IDT or RDT is initialized, re-initialized, or the EOC path is put into the in-service state.

R12-27 **[899]** The IDT or RDT shall establish multiple frame operation for each of the other EOC logical data-link connections defined in Table 12-1 when there is information to be sent using that particular data-link connection.

O12-28 **[900]** The IDT or RDT should establish multiple frame operation on both EOC paths for the EOC logical data-link connection SAPI=1, TEI=4 when the IDT or RDT is initialized, re-initialized, or the EOC path is put into the in-service state.

O12-29 **[901]** The IDT should establish multiple frame operation on both EOC paths for all EOC logical data-link connections in Table 12-1 that have been provisioned for use by the OIM in the LDS when the IDT is initialized, re-initialized, or the EOC path is put into the in-service state.

R12-30 **[902]** If the IDT (RDT) fails to establish multiple frame operation on any logical data link on the active or standby EOC or TMC/CSC paths, the IDT (RDT) shall report the failure to an OS and establish a schedule to periodically retry to establish multiple frame operation on the failed logical data-link.

O12-31 **[903]** The schedule for retrying to establish multiple frame operation should meet the following objectives:

… a. The first retry should occur within 1 minute of the failure

… b. The second retry should occur within 3 minutes of the failure

… c. Subsequent retries should occur no more than 5 minutes apart

… d. The retries continue until the operation is successful, i.e., multiple frame operation is established.

R12-32 **[904]** Failures to establish multiple frame operation shall not be reported to an OS during the retry schedule, but if multiple frame operation is established during the retry schedule, the event shall be reported to an OS.

R12-33 **[905]** The following SAPI/TEI combinations shall always have the fixed assignments indicated in Tables 12-1 and 12-2:

… a. SAPI=1 and TEI=0 of the EOC shall be used for EOC path switching operations (see Section 12.6.3).

… b. SAPI=1 and TEI=4 of the EOC shall be used for operations interactions between the IDT and RDT.

… c. SAPI=0 and TEI=0 of the TMC/CSC shall be used as the call processing data link.

… d. SAPI=1 and TEI=0 of the TMC/CSC shall be used for TMC/CSC path switching operations (see Section 12.6.3).

… e. SAPI=1 and TEI=1 of the EOC shall be used for a provisioning/ memory administration OS to communicate with the RDT when an OIM with gateway function is provided (see Section 12.7.1).

… f. SAPI=1 and TEI=2 of the EOC shall be used for a maintenance/ surveillance OS to communicate with the RDT when an OIM with gateway function is provided (see Section 12.7.1).

… g. SAPI=1 and TEI=3 of the EOC shall be used for a testing OS to communicate with the RDT when an OIM with gateway function is provided (see Section 12.7.1).

… h. SAPI=1 and TEI=5 of the EOC shall be used for a TSC to communicate with the RDT when an OIM with gateway function is provided (see Section 12.7.1).

CR12-34 **[906]** For all other SAPI/TEI combinations of the EOC, the assignments of Table 12-1 shall be used as specified in Section 12.7.1.

As discussed earlier in this section, there is some concern about interoperability between LAPD implementations specifically implemented to GR-303-CORE requirements and other LAPD implementations that have implemented more than required by GR-303-CORE, maybe even modified off-the-shelf LAPD solutions that support all of the LAPD protocol features. To preserve interoperability, the following criteria on unsupported SAPI/ TEIs are proposed.

CR12-35 **[907]** If LAPD implementations send frames using "GR-303 unsupported" SAPI/TEIs, the sending end shall be capable of autonomous recovery if no response is received.

O12-36 **[908]** If LAPD implementations send frames using "GR-303 unsupported" SAPI/TEIs, it is an objective that the sending end be capable of autonomously provisioning itself not to continue to generate frames using the "GR-303 unsupported" SAPI/TEIs, if no response is received.

R12-37 **[909]** If a frame with an unsupported (includes unrecognized) SAPI/TEI is received by any LAPD implementation (the GR-303-CORE subset, an extended subset, or full LAPD), it shall be ignored.

12.4.3.5.12 Unrecoverable Data-Link Errors

R12-38 **[910]** If the LAPD parameters of Section 12.4.3.5 are exceeded, and/or timers expire, the defined procedures in Q.921 shall be followed.

R12-39 **[911]** For those errors/failures that cannot be resolved at the data-link layer, the IDLC management entity shall be notified; refer to Section 12.4.3.6.

12.4.3.6 Management Entity Requirements

The IDLC data-link management entity is an application process in both the IDT and RDT that handles IDLC system errors/failures that cannot be handled by routine protocol procedures.

R12-40 **[912]** Notification by the data-link layer that an error/failure has occurred that cannot be resolved by the data-link layer shall cause local diagnostics and corrective action to be initiated.

R12-41 **[913]** When local corrective action cannot clear the error/failure, the IDLC data-link management entity shall determine if an automatic data-link path protection switching, as discussed in Section 12.6.3, shall be initiated.

R12-42 **[914]** If the error/failure cannot be cleared by the local actions of the preceding two requirements, a major or critical alarm shall be sent to the maintenance OS. A major alarm is reported by those IDLC systems terminating up to 128 lines; a critical alarm is reported by those IDLC systems terminating more than 128 lines.

NOTE — The requirements for the standby (protection) TMC/CSC and EOC are now in Sections 12.6.1.3.2 and 12.6.1.3.3, respectively.

12.5 Requirements and Options Supporting Customer Services

12.5.1 Call Processing Techniques

12.5.1.1 Hybrid Signaling

This section was originally entitled “Robbed-Bit Signaling,” and the information it contained has been moved to Section 12.5.2.1.

R12-43 **[915]** The LDS and RDT must be capable of call processing with non-dynamic time-slot assignments, to accommodate high-traffic-load services.

The ABCD codes used in hybrid signaling systems are described in Section 12.5.2.1. The TMC messages are based on TR-TSY-000268 and ITU-T Recommendation Q.931, and are described in Section 12.5.2.2.

12.5.1.2 Out-of-Band Signaling

R12-44 **[916]** The LDS and RDT must be capable of call processing with non-dynamic time-slot assignments, to accommodate high-traffic-load services.

The CSC messages are based on TR-TSY-000268 and ITU-T Recommendation Q.931, and are described in Section 12.5.2.2.

12.5.2 Call Processing Messages

In this section, call processing messages are defined for IDLC systems. The ABCD codes needed for hybrid signaling are described in Section 12.5.2.1. The TMC and CSC messages are described in Section 12.5.2.2.

12.5.2.1 ABCD Codes

Part of describing the Generic IDLC Interface is defining the set of ABCD codes to be used across the interface for hybrid signaling. In selecting the codes, the approach taken was to establish unique relationships between ABCD codes and line signaling states for the various line terminating equipment. TR-TSY-000174 provides ABCD codes that are derived directly from the channel unit AB codes specified in MDP-326-140 (formerly PUB 43801). These codes form the foundation [2]of the ABCD codes defined for the Generic IDLC Interface. Codes for services not addressed in TR-TSY-000174 and MDP-326-140 (formerly PUB 43801) (e.g., coin and multi-party) were added to these.

A, B, C, and D are bits robbed from each time slot of frames 6, 12, 18, and 24, respectively, of the DS1 ESF format (see Section 12.6.1.3.1 for details). These bits are synchronized with the ESF format and provide the capability of defining 16 unique ABCD codes in each direction.

The ABCD codes used across the Generic IDLC Interface are defined in Tables 12-3 through Table 12-6. The ABCD codes are shown as they appear on the digital line and imply specific encoding/decoding requirements for the LDS/IDT, RDT, or other terminating circuit. Undefined codes should only exist during the transition from one signaling state to another, and the duration of these transitions should not exceed 3 ms, the ESF format refresh rate.

R12-45 **[917]** The IDT and RDT shall ignore received ABCD codes not defined in Tables 12-3 through 12-6.

R12-46 **[918]** If undefined codes are continuously (i.e., for at least 3 seconds) received, “DS0 AIS” detection timing and responses shall apply.

O12-47 **[919]** To minimize dial pulse distortion, it is desirable that the IDT and RDT detect a loop closure/loop open transition when either the A or C bit changes from a **1** to a **0** and a loop open/loop closure transition when either the A or C bit changes from a **0** to a **1**. This reduces the refresh time for dial pulse decoding from 3 ms to 1.5 ms.

R12-48 **[920]** When an IDT or RDT receives the “DS0 AIS” (new terminology for UNICODE) pattern, it shall react as described in Section 4.4.9.

R12-49 **[921]** When an IDT or RDT receives the “DS0 Yellow” pattern, it shall react as described in Section 4.9.1.

2. Specifically needed for code compatibility with selected non-locally switched services (e.g., Foreign Exchange Lines/Trunks).

These acronyms are used in the following discussions of ABCD codes to accomplish specific service capabilities.

Acronym	Meaning
LC	Loop Closure
LO	Loop Open
LCF	Loop Current Feed
RLCF	Reverse Loop Current Feed
LCFO	Loop Current Feed Open
DNE	Digital Network Element

12.5.2.1.1 Loop Start - ABCD Codes Received by the RDT

R12-50 **[922]** When the RDT receives the "-R ringing" pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-51 **[923]** The RDT shall be capable of reversing the battery when it receives the "RLCF" pattern, and it shall apply reverse loop current feed to the line as described in TR-NWT-000057. For loop-start circuits, reverse loop current feed is a toll diversion signal or line side answer supervision.

R12-52 **[924]** The RDT must recognize the "RLCF" pattern whether or not it has a toll diversion capability.

CR12-53 **[925]** When the RDT receives the "RLCF" pattern, if it is not capable of reversing the battery, it shall apply loop current feed to the line as described in TR-NWT-000057.

R12-54 **[926]** When the RDT receives the "LCF" pattern, it shall apply loop current feed to the line as described in TR-NWT-000057.

R12-55 **[927]** When the RDT receives the "LCFO" pattern, it shall apply loop current feed open (i.e., interrupt loop current) to the line as described in TR-NWT-000057.

12.5.2.1.2 Loop Start - ABCD Codes Sent to the IDT

R12-56 **[928]** When the RDT detects loop open as described in TR-NWT-000057, it shall transmit the "LO" pattern.

R12-57 **[929]** When the RDT detects loop closure as described in TR-NWT-000057, it shall transmit the “LC” pattern.

12.5.2.1.3 Ground Start - ABCD Codes Received by the RDT

R12-58 **[930]** When the RDT receives the “-R ringing” pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-59 **[931]** The RDT shall be capable of reversing the battery when it receives the “RLCF” pattern, and it shall apply reverse loop current feed to the line as described in TR-NWT-000057. Reverse loop current feed is a toll diversion signal or line side answer supervision.

CR12-60 **[932]** When the RDT receives the “RLCF” pattern, if it is not capable of reversing the battery, it shall apply loop current feed to the line as described in TR-NWT-000057.

R12-61 **[933]** Although the ability to generate toll diversion signals is optional, the RDT must recognize the “RLCF” pattern whether or not it has a toll diversion capability.

R12-62 **[934]** When the RDT receives the “LCF” pattern, it shall apply loop current feed (with tip conductor grounded) to the line as described in TR-NWT-000057.

R12-63 **[935]** When the RDT receives the “LCFO” pattern, it shall apply loop current feed open (i.e., interrupt loop current with tip conductor open) to the line as described in TR-NWT-000057. Loop current feed open is the idle condition for ground start circuits.

12.5.2.1.4 Ground Start - ABCD Codes Sent to the IDT

R12-64 **[936]** When the RDT detects ring ground as described in TR-NWT-000057, it shall transmit the “Ring Ground” pattern.

R12-65 **[937]** When the RDT is applying loop current feed to the line, if it detects loop open as described in TR-NWT-000057, it shall transmit the “LO” pattern. Loop open is the idle condition for ground-start circuits.

R12-66 **[938]** When the RDT is applying loop current feed to the line, if it detects loop closure as described in TR-NWT-000057, it shall transmit the “LC” pattern.

12.5.2.1.5 Loop Reverse Battery - ABCD Codes Received by the RDT

R12-67 **[939]** When the RDT receives the “LO” pattern, it shall apply loop open to the line as described in TR-NWT-000057.

R12-68 **[940]** When the RDT receives the “LC” pattern, it shall apply loop closure to the line as described in TR-NWT-000057.

12.5.2.1.6 Loop Reverse Battery - ABCD Codes Sent to the IDT

R12-69 **[941]** When the RDT detects reverse loop current feed as described in TR-NWT-000057, it shall transmit the “RLCF” pattern. Reverse loop current feed corresponds to detecting a voltage tip negative with respect to ring.

R12-70 **[942]** When the RDT detects loop current feed as described in TR-NWT-000057, it shall transmit the “LCF” pattern. Loop current feed corresponds to detecting a voltage ring negative with respect to tip.

12.5.2.1.7 Coin Option - ABCD Codes Received by the RDT

R12-71 **[943]** When the RDT receives the “-R ringing” pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-72 **[944]** When the RDT receives the “RLCF” pattern, it shall apply positive loop supervision voltage to the line as described in TR-NWT-000057.

R12-73 **[945]** When the RDT receives the “LCF” pattern, it shall apply negative loop supervision voltage to the line as described in TR-NWT-000057.

R12-74 **[946]** When the RDT receives the “Positive Coin Check” pattern, it shall apply positive coin check voltage to the line as described in TR-NWT-000057.

R12-75 **[947]** When the RDT receives the “Negative Coin Check” pattern, it shall apply negative coin check voltage to the line as described in TR-NWT-000057.

R12-76 **[948]** When the RDT receives the “Positive Coin Control” pattern, it shall apply positive coin control voltage to the line as described in TR-NWT-000057.

R12-77 **[949]** When the RDT receives the "Negative Coin Control" pattern, it shall apply negative coin control voltage to the line as described in TR-NWT-000057.

R12-78 **[950]** When the RDT receives the "LCFO" pattern, it shall apply the condition described in TR-NWT-000057.

12.5.2.1.8 Coin Option - ABCD Codes Sent to the IDT

R12-79 **[951]** When the RDT detects loop open as described in TR-NWT-000057, it shall transmit the "LO" pattern.

R12-80 **[952]** When the RDT detects coin circuit ground as described in the ring-ground and tip-ground detection sections of TR-NWT-000057, it shall transmit the "Coin Ground" pattern.

R12-81 **[953]** When the RDT detects loop closure as described in TR-NWT-000057, it shall transmit the "LC" pattern.

12.5.2.1.9 Multi-Party Option - ABCD Codes Received by the RDT

R12-82 **[954]** When the RDT receives the "-R ringing" pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-83 **[955]** When the RDT receives the "LCF" pattern, it shall apply loop current feed to the line as described in TR-NWT-000057.

R12-84 **[956]** When the RDT receives the "+R ringing" pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-85 **[957]** When the RDT receives the "Tip Party Test" pattern, it shall apply the condition described in Section 6.2.4.3 of GR-506-CORE.

R12-86 **[958]** When the RDT receives the "+T ringing" pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-87 **[959]** When the RDT receives the "-T ringing" pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

R12-88 **[960]** When the RDT receives the "LCFO" pattern, it shall apply loop current feed open to the line as described in TR-NWT-000057.

12.5.2.1.10 Multi-Party Option - ABCD Codes Sent to the IDT

R12-89 **[961]** When the RDT detects loop open as described in TR-NWT-000057, it shall transmit the “LO” pattern.

R12-90 **[962]** When the RDT detects tip party ground as described in TR-NWT-000057, it shall transmit the “Tip Party Ground” pattern.

R12-91 **[963]** When the RDT detects loop closure as described in TR-NWT-000057, it shall transmit the “LC” pattern.

12.5.2.1.11 FXS (Loop Start) Option - ABCD Codes Received by the RDT

R12-92 **[964]** When the RDT receives the “-R ringing” pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

CR12-93 **[965]** When the RDT receives the “RLCF” pattern, if it is not capable of reversing the battery, it shall apply loop current feed to the line as described in TR-NWT-000057.

CR12-94 **[966]** If the RDT is capable of reversing the battery, it shall apply reverse loop current feed to the line. Reverse loop current feed is a toll diversion signal or line side answer supervision.

R12-95 **[967]** The RDT must recognize the “RLCF” pattern whether or not it has a toll diversion, or line side answer supervision, capability.

R12-96 **[968]** When the RDT receives the “LCF” pattern, it shall apply loop current feed to the line as described in TR-NWT-000057.

R12-97 **[969]** When the RDT receives the “LCFO” pattern, it shall apply loop current feed open to the line as described in TR-NWT-000057.

12.5.2.1.12 FXS (Loop Start) Option - ABCD Codes Sent to the DNE

R12-98 **[970]** When the RDT detects loop open as described in TR-NWT-000057, it shall transmit the “LO” pattern.

R12-99 **[971]** When the RDT detects loop closure as described in TR-NWT-000057, it shall transmit the “LC” pattern.

12.5.2.1.13 FXS (Ground Start) Option - ABCD Codes Received by the RDT

R12-100 **[972]** When the RDT receives the "-R ringing" pattern, it shall apply an alerting signal to the line as described in TR-NWT-000057.

CR12-101 **[973]** When the RDT receives the "RLCF" pattern, if it is not capable of reversing the battery, it shall apply loop current feed to the line as described in TR-NWT-000057.

CR12-102 **[974]** If the RDT is capable of reversing the battery, it shall apply reverse loop current feed to the line as described in TR-NWT-000057. Reverse loop current feed is a toll diversion signal or line side answer supervision.

R12-103 **[975]** The RDT must recognize the "RLCF" pattern whether or not it has a toll diversion, or line side answer supervision, capability.

R12-104 **[976]** When the RDT receives the "LCF" pattern, it shall apply loop current feed to the line as described in TR-NWT-000057.

R12-105 **[977]** When the RDT receives the "LCFO" pattern, it shall apply loop current feed open to the line as described in TR-NWT-000057.

12.5.2.1.14 FXS (Ground Start) Option - ABCD Codes Sent to the DNE

R12-106 **[978]** When the RDT detects ring ground as described in TR-NWT-000057, it shall transmit the "Ring Ground" pattern.

R12-107 **[979]** When the RDT detects loop open as described in TR-NWT-000057, it shall transmit the "LO" pattern.

R12-108 **[980]** When the RDT detects loop closure as described in TR-NWT-000057, it shall transmit the "LC" pattern.

12.5.2.1.15 FXO (Loop Start) Option - ABCD Codes Received by the RDT

R12-109 **[981]** When the RDT receives the "LO" pattern, it shall apply loop open to the line as described in TR-NWT-000057.

R12-110 **[982]** When the RDT receives the "LC" pattern, it shall apply loop closure to the line as described in TR-NWT-000057.

12.5.2.1.16 FXO (Loop Start) Option - ABCD Codes Sent to the DNE

R12-111 **[983]** When the RDT detects an alerting signal as described in TR-NWT-000057, it shall transmit the “-R ringing” pattern.

R12-112 **[984]** When the RDT detects loop current feed as described in TR-NWT-000057, it shall transmit the “LCF” pattern.

R12-113 **[985]** When the RDT detects loop current feed open as described in TR-NWT-000057, it shall transmit the “LCFO” pattern.

12.5.2.1.17 FXO (Ground Start) Option - ABCD Codes Received by the RDT

R12-114 **[986]** When the RDT receives the “Ring Ground” pattern, it shall apply ring ground to the line as described in TR-NWT-000057.

R12-115 **[987]** When the RDT receives the “LO” pattern, it shall apply loop open to the line as described in TR-NWT-000057.

R12-116 **[988]** When the RDT receives the “LC” pattern, it shall apply loop closure to the line as described in TR-NWT-000057.

12.5.2.1.18 FXO (Ground Start) Option - ABCD Codes Sent to the DNE

R12-117 **[989]** When the RDT detects an alerting signal as described in TR-NWT-000057, it shall transmit the “-R ringing” pattern.

R12-118 **[990]** When the RDT detects loop current feed as described in TR-NWT-000057, it shall transmit the “LCF” pattern.

R12-119 **[991]** When the RDT detects loop current feed open as described in TR-NWT-000057, it shall transmit the “LCFO” pattern.

12.5.2.2 TMC and CSC Messages

This section describes the TMC and CSC messages that the IDT and RDT use for call processing. These messages are based on ITU-T Recommendation Q.931 and, in most cases, are simply specific codings of standard Q.931 messages. However, because the call processing requirements of IDLC systems differ from those of ISDN access for which the Q.931 message set was developed, some of the messages described in this section are extensions of standard Q.931 messages.

Because their purposes differ, the TMC and CSC have two distinct message sets as shown in the following table. The TMC message set is the minimum subset of the CSC message set necessary to perform the time-slot assignment function, except for CONNECT ACKNOWLEDGE, which applies only to the TMC.

Message Name	TMC	CSC
SETUP	Yes	Yes
SETUP ACKNOWLEDGE	No	Yes
ALERTING	No	Yes
CALL PROCEEDING	No	Yes
NOTIFY	No	Yes
INFORMATION	Yes	Yes
CONNECT	Yes	Yes
CONNECT ACKNOWLEDGE	Yes	No
DISCONNECT	Yes	Yes
RELEASE	Yes	Yes
RELEASE COMPLETE	Yes	Yes
STATUS	Yes	Yes
STATUS ENQUIRY	Yes	Yes

The remainder of this section discusses the format and usage of the TMC/CSC messages. The composition of each message is presented in tabular format in the subsections that follow. Each row shows information about a particular field of the message.

R12-120 **[992]** The fields (i.e., Information Elements[3]) of each message shall be transmitted in the same order (and quantity) as they are presented in the table defining the format of that message; that is, row one is sent first, row two is sent second, etc.

The first column of each table contains the name of the information element that makes the field, and the second column shows the direction of transmission, IDT to RDT only (IDT → RDT), RDT to IDT only (RDT → IDT), or Both, to which the field applies. The inclusion status of the field is given in the third column. An entry of “M” means that the field is mandatory for the given direction(s) of transmission and must always be included while an entry of “C” denotes that inclusion of the field is conditional. For conditional fields, information is provided that explains when the field must be present. The final column gives the length in octets of the field; variable lengths indicate the possibility of duplicated Information Elements in specific scenarios.

3. Information elements are the building blocks of TMC/CSC messages and are described in Section 12.5.2.3.

12.5.2.2.1 SETUP Message

R12-121 [993] The SETUP message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Bearer Capability	Both	M	4 or 5
Channel Identification	IDT → RDT	M	6
Signal	IDT → RDT	C	3 or 6

On the TMC, the IDT and RDT transmit a SETUP message to begin time-slot assignment. The IDT includes the channel identification element to specify the DS0 to use for the call. The RDT omits the channel identification element.

CR12-122 [994] On the TMC, both the IDT and RDT shall omit the signal element.

On the CSC, the IDT and RDT send a SETUP message to begin call establishment. The IDT includes the channel identification element to specify the DS0 to use for the call. The RDT omits the channel identification and signal elements from all SETUP messages.

CR12-123 [995] On the CSC, the IDT shall include the signal element only when it is necessary for the RDT to alert the customer.

CR12-124 [996] On the CSC, for a reverting call on a multi-party circuit, the IDT shall include the signal element (3 octets) twice. The first occurrence shall apply to the call*ing* party, and the second shall apply to the call*ed* party.

12.5.2.2.2 SETUP ACKNOWLEDGE Message

R12-125 [997] The SETUP ACKNOWLEDGE message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Channel Identification	Both	M	6

This message is not used on the TMC.

On the CSC, the IDT uses SETUP ACKNOWLEDGE to tell the RDT which time slot to use for an originating call.

12.5.2.2.3 ALERTING Message

R12-126 **[998]** The ALERTING message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	RDT → IDT	M	1
Call Reference	RDT → IDT	M	3
Message Type	RDT → IDT	M	1
Channel Identification	RDT → IDT	M	6

This message is not used on the TMC.

On the CSC, the RDT sends this message to signal that it has successfully begun alerting the customer on a terminating call. The channel identification element allows the IDT to verify that the RDT has used the proper time slot for the call.

R12-127 **[999]** On the CSC, if the IDT receives an ALERTING message in which the DS0 indicated in the channel identification element does not match that allocated to the call by the IDT, the IDT shall initiate call clearing.

12.5.2.2.4 CALL PROCEEDING Message

R12-128 **[1000]** The CALL PROCEEDING message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	RDT → IDT	M	1
Call Reference	RDT → IDT	M	3
Message Type	RDT → IDT	M	1
Channel Identification	RDT → IDT	M	6

This message is not used on the TMC.

On the CSC, the RDT sends this message after successfully seizing a loop reverse battery circuit. The channel identification element allows the IDT to verify that the RDT has used the proper time slot for the call.

R12-129 **[1001]** On the CSC, if the IDT receives a CALL PROCEEDING message in which the DS0 indicated in the channel identification element does not match that allocated to the call by the IDT, the IDT shall initiate call clearing.

12.5.2.2.5 CONNECT Message

R12-130 **[1002]** The CONNECT message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Channel Identification	Both	C	6

On the TMC, the IDT and RDT use CONNECT messages to signal that they have connected the line unit to the time slot being used for the call.

CR12-131 **[1003]** On the TMC, the IDT shall include the channel identification element to tell the RDT which DS0 to use for an originating call.

CR12-132 **[1004]** On the TMC, the RDT shall include the channel identification element so that the IDT can verify that the RDT has used the correct DS0 for a terminating call.

On the CSC, the CONNECT message is used as follows:

CR12-133 **[1005]** On the CSC, the IDT sends a CONNECT message after determining that the RDT can stop scanning for dial pulses from the customer on an originating call. The IDT shall not include the channel identification element in this CONNECT message.

CR12-134 **[1006]** On the CSC, the RDT sends a CONNECT message after detecting that the customer has answered a terminating call; the RDT shall not include the channel identification element in this case.

CR12-135 [1007] On the CSC, the RDT sends a CONNECT message in response to a SETUP message that contains the "Alerting Off" pattern in the signal information element.[4] The RDT shall include the channel identification element in this instance so that the IDT can verify that the RDT has used the correct DS0 for the call.

On both the TMC and CSC, if the IDT receives a CONNECT message in which the DS0 indicated in the channel identification element does not match that allocated to the call by the IDT, the IDT will initiate call clearing as specified in Section 12.5.5.16.8.

12.5.2.2.6 DISCONNECT Message

R12-136 [1008] The DISCONNECT message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Cause	Both	M	5

On the TMC, the IDT transmits a DISCONNECT message to begin clearing a time-slot assignment.

On the CSC, the IDT transmits a DISCONNECT message when it determines that the call must be cleared. The RDT sends a DISCONNECT message to report detecting that a customer who was participating in an active call has gone on-hook or after T305 has expired.

4. Such a SETUP message is used for ISDN Basic Access call establishment and for call establishment not coincident with a terminating call.

12.5.2.2.7 RELEASE Message

R12-137 [1009] The RELEASE message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Cause	Both	M	5

On the TMC, the IDT sends a RELEASE message after the expiration of timer T305 or timer T308 as described in Section 12.5.5. The RDT sends a RELEASE message in response to a DISCONNECT message and after the expiration of timer T308.

On the CSC, the IDT sends a RELEASE message in response to a DISCONNECT message only when it determines that the call can be cleared. The IDT also sends a RELEASE message while in the Call Initiated state (state 1) if it determines that a customer went back on-hook during an originating call before the IDT sent back a SETUP ACKNOWLEDGE. The RDT sends a RELEASE message in response to a DISCONNECT message or after T308 has expired.

12.5.2.2.8 RELEASE COMPLETE Message

R12-138 [1010] The RELEASE COMPLETE message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Cause	Both	M	5

On the TMC, the IDT and RDT send RELEASE COMPLETE in response to a RELEASE message and on setup rejection. The IDT sends RELEASE COMPLETE after the second expiration of timers T303 and T313. The RDT sends RELEASE COMPLETE in the Call Initiated (1) state if the customer hangs-up. Finally, the IDT and RDT send RELEASE COMPLETE after detecting certain error conditions.

On the CSC, the IDT and RDT send RELEASE COMPLETE in response to a RELEASE message. They also send RELEASE COMPLETE after the second expiration of timer T303

and in response to a SETUP message after detecting certain error conditions during call establishment.

12.5.2.2.9 INFORMATION Message

R12-139 **[1011]** The INFORMATION message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Keypad Facility	Both	C	3 - 9
Switchhook	Both	C	3
Signal	IDT → RDT	C	3

R12-140 **[1012]** On both the TMC and CSC, the RDT uses an INFORMATION message to report that a customer previously in a permanent signal state has returned on-hook. The RDT shall include the switchhook element and shall omit the keypad facility element.

R12-141 **[1013]** On both the TMC and CSC, the IDT uses an INFORMATION message to acknowledge an INFORMATION message that indicates that a customer who was in a permanent signal state has returned on-hook. The IDT shall include the switchhook element and shall omit the keypad facility element.

CR12-142 **[1014]** On the CSC, the IDT uses the INFORMATION message to forward to the RDT digits that must be outpulsed to the customer.

… a. The IDT shall include the keypad facility element and shall omit the switchhook element.

… b. The IDT shall transmit all digits (up to a maximum of seven) to be outpulsed in a single INFORMATION message.

CR12-143 **[1015]** On the CSC, the IDT shall include the signal element and shall omit the keypad facility and switchhook elements in the following instances:

… a. The IDT uses an INFORMATION message when it is necessary for the RDT to reminder ring the customer.

… b. If the IDT supports expanded 911 service, the IDT uses an INFORMATION message when it is necessary for the IDT to signal the customer during an emergency 911 call.

CR12-144 [1016] On the CSC, during call establishment, the RDT uses INFORMATION messages to send to the IDT dial pulse digits received from the customer.

… a. The RDT shall omit the switchhook element and shall include the keypad facility element to convey a digit.

… b. The RDT shall transmit a separate INFORMATION message for each dial pulse digit.

Thus, if the customer dials seven digits, the RDT sends seven INFORMATION messages.

CR12-145 [1017] On the CSC, the RDT shall include the keypad facility element and shall omit the switchhook element in the following instances.

… a. While a call is active, the RDT shall use an INFORMATION message to report detecting a switchhook flash.

… b. If the customer uses dial pulse addressing following a switchhook flash while a call is active, the RDT shall use INFORMATION messages to communicate to the IDT any digits dialed.

CR12-146 [1018] On the CSC, in emergency 911 cases where the IDT has not torn down the call, the RDT uses an INFORMATION message to indicate that a customer who was previously on-hook has returned off-hook. The RDT shall include the switchhook element and shall omit the keypad facility and signal elements.

12.5.2.2.10 NOTIFY Message

R12-147 [1019] The NOTIFY message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Notification Indicator	Both	M	3

This message is not used on the TMC.

On the CSC, the IDT sends a NOTIFY message to the RDT to report that it has received a DISCONNECT message from the RDT and is determining whether to clear the call or keep it up for an Emergency 911 call. As an option, the IDT sends a NOTIFY message on lines not provisioned with flash capabilities during special testing scenarios. A NOTIFY message is sent to enable flash when needed followed by a NOTIFY message to disable flash when not needed anymore.

On the CSC, the RDT uses a NOTIFY message during call establishment to report that it has detected a start dial signal from the customer on a loop reverse battery circuit or that the alerting cadence being applied to a loop/ground start circuit is entering the first long silent interval.[5] The NOTIFY message is also used by both the IDT and RDT to perform certain coin and multi-party functions.

12.5.2.2.11 STATUS ENQUIRY Message

R12-148 [1020] The STATUS ENQUIRY message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	IDT → RDT	M	1
Call Reference	IDT → RDT	M	3
Message Type	IDT → RDT	M	1

On both the TMC and CSC, if the IDT determines that a possible call state mismatch exists, the IDT should send a STATUS ENQUIRY message.

12.5.2.2.12 STATUS Message

R12-149 [1021] The STATUS message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	Both	M	1
Call Reference	Both	M	3
Message Type	Both	M	1
Cause	Both	M	5
Call State	Both	M	3

5. If the customer subscribes to calling number delivery as described in TR-NWT-000031, the IDT needs to know when the first long silent interval occurs so that the LDS can send the calling number to the customer.

On both the TMC and CSC, the IDT uses STATUS messages as part of the error-handling procedures described in Section 12.5.5. The RDT uses STATUS messages to reply to STATUS ENQUIRY messages and as part of the error-handling procedures described in Section 12.5.5.

12.5.2.2.13 CONNECT ACKNOWLEDGE Message

R12-150 **[1022]** The CONNECT ACKNOWLEDGE message shall be formatted as follows:

Information Element	Direction	Inclusion Status	Length (Octets)
Protocol Discriminator	RDT → IDT	M	1
Call Reference	RDT → IDT	M	3
Message Type	RDT → IDT	M	1
Channel Identification	RDT → IDT	M	6

On the TMC, the RDT uses a CONNECT ACKNOWLEDGE message to signal that it has connected the line unit to the time slot being used for the call and is inserting and reacting to ABCD codes.

This message is not used on the CSC.

12.5.2.3 TMC and CSC Information Elements

This section describes the information elements that are the building blocks of TMC and CSC messages. These information elements are based on ITU-T Recommendation Q.931 and, in most cases, are simply specific codings of standard Q.931 information elements. However, because the signaling requirements of IDLC systems differ from those of ISDN access for which Q.931 was developed, some of the information elements described here are extensions of standard Q.931 information elements.

The difference between the usage of the TMC and that of the CSC leads to two distinct sets of information elements as shown in the following table:

Element Name	TMC	CSC
Protocol Discriminator	Yes	Yes
Call Reference	Yes	Yes
Message Type	Yes	Yes
Bearer Capability	Yes	Yes

Element Name	TMC	CSC
Cause	Yes	Yes
Call State	Yes	Yes
Channel Identification	Yes	Yes
Notification Indicator	No	Yes
Keypad Facility	No	Yes
Signal	No	Yes
Switchhook	Yes	Yes

The remainder of this section discusses the format and usage of the information elements used in IDLC call processing messages. As specified in Section 12.5.2.2, when multiple information elements are present in a message, they shall appear in the same order as they are described in this document.

R12-151 **[1023]** The composition of each information element is presented in tabular format in the following subsections, and each row of each table shows the bits in a particular octet of the element. Within each octet, the bits shall be sent in ascending numerical order; i.e., bit 1, bit 2 bit 3, etc. The octets of an information element shall be sent in ascending numerical order.

12.5.2.3.1 Protocol Discriminator

R12-152 **[1024]** The Protocol Discriminator element shall be formatted as follows:

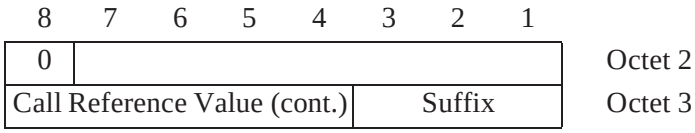
8	7	6	5	4	3	2	1	
0	1	0	0	1	1	1	1	Octet 1

This element is used on both the TMC and CSC reference models to distinguish IDLC call processing messages from standard Q.931 messages. As indicated in the tables of Section 12.5.2.2, the protocol discriminator shall always be the first element included in a TMC or CSC message.

12.5.2.3.2 Call Reference

R12-153 **[1025]** The Call Reference element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	1	0	Octet 1



This element is used on both the TMC and CSC to identify the call (and customer) to which a message applies; as such, this element is useful in dynamically selecting signaling option "16" versus option "T" on per-call DS0 assignments via a TMC (see Sections 12.5.3 and 12.6.1.2). As indicated in the tables of Section 12.5.2.2, the call reference element shall always be the second information element included in a TMC or CSC message.

For IDLC systems, the coding of the call reference element differs from standard Q.931 so that IDLC systems can carry ISDN Basic Access service.

R12-154 **[1026]** The RDT physical line terminations shall be logically or physically numbered sequentially from 1 to the number of lines (maximum=2048) the RDT can provide.

R12-155 **[1027]** The IDT and RDT shall either

… • Use the line termination numbers as the Call Reference Value (CRV) in TMC and CSC messages

… • Support a provisionable association between RDT termination ports (or access circuits derived from various distribution technologies) and CRVs at the RDT (or one of its interface groups; see Section 12.5.10).

A provisioning process (of some degree) is always needed at the LDS to establish in the switch database the desired Telephone Number (TN) to CRV association. If the RDT supports the provisionable association, then a provisioning process is also needed to establish the desired CRV to access circuit association. FITL systems (see TA-NWT-000909) require support of provisionable association between call reference values and access circuit interfaces.

R12-156 **[1028]** Bits 7 through 1 of octet 2 shall be combined with bits 8 through 4 of octet 3 to form a 12-bit call reference value. The call reference value shall identify the specific line termination to which a message pertains. Bit 7 of octet 2 shall be the most significant bit of the call reference value, and bit 4 of octet 3 shall be the least significant bit.

R12-157 **[1029]** Bits 3 through 1 of octet 3 shall comprise the call reference suffix and identify the particular call to which a message refers.[6] The three bits of the call reference suffix shall be encoded as follows:

Coding	Meaning
000	line termination only supports one call at a time
001	call associated with B1-channel of line termination
010	call associated with B2-channel of line termination
011	reserved for future use
↓	↓
111	reserved for future use

R12-158 **[1030]** The call reference suffix shall be included in all messages, including those pertaining to line terminations capable of supporting only one concurrent call.

12.5.2.3.3 Message Type

R12-159 **[1031]** The Message Type element shall be formatted as follows:

6. Note that for the DS1 Extension option (Section 3.7.4), the only required transport capability for locally switched traffic groomed off the DS1 Extension is via a dedicated DS0; therefore, a suffix capable of identifying individual DS0s within a DS1 Extension is not required to satisfy current IDLC requirements.

8	7	6	5	4	3	2	1	
0	Message Type							Octet 1

This element is used on both the TMC and CSC to identify the message being sent. As indicated in the tables of Section 12.5.2.2, the message type shall always be the third information element in a TMC or CSC message and shall be coded as shown in Table 12-7.

12.5.2.3.4 Bearer Capability

R12-160 **[1032]** The Bearer Capability element shall be formatted as follows:

- For normal 64 kbps service;

8	7	6	5	4	3	2	1	
0	0	0	0	0	1	0	0	Octet 1
0	0	0	0	0	0	1	0	Octet 2
1	0	0	0	1	0	0	0	Octet 3
1	0	0	1	0	0	0	0	Octet 4

- For SWF-DS1 service (see Section 12.5.11);

8	7	6	5	4	3	2	1	
0	0	0	0	0	1	0	0	Octet 1
0	0	0	0	0	0	1	1	Octet 2
1	0	0	0	1	0	0	0	Octet 3
1	0	0	1	1	0	0	0	Octet 4
1	Binary Coded Value of (N)							Octet 5

The only values of N that shall be allowed are 2 to 24 (inclusive).

The bearer capability element is used on both the TMC and CSC so that the IDT and RDT can describe the characteristics of the call. Bearer capabilities are service characteristics such as the information transfer rate and whether the call is circuit or packet switched. All calls handled by IDLC systems shall use either of the bearer capability formats depicted above. The bearer capability element is included for compatibility with ITU-T Recommendation Q.931 and positions IDLC systems for future service opportunities.

12.5.2.3.5 Cause

R12-161 **[1033]** The Cause element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	0	0	1	0	0	0	Octet 1
0	0	0	0	0	0	1	1	Octet 2
1	0	0	0	0	0	1	0	Octet 3
1	Cause Value							Octet 4
Diagnostic								Octet 5

The cause element is used on both the TMC and CSC to convey to the recipient the event that led to sending certain messages.

R12-162 **[1034]** The cause value shall indicate an event listed in Table 12-8, and the diagnostic octet shall always be included. As indicated in Table 12-8, the diagnostic octet, for certain cause values, gives the recipient further information about the event.

R12-163 **[1035]** The following list defines the Cause Values that the switch and RDT must support:

16 *Normal Clearing.* The IDT and RDT shall use this cause value to indicate call clearing was initiated after determining that a customer went on-hook.

27 *Destination Out of Service.* The IDT shall use this cause value to indicate that call clearing was initiated because the customer is in a permanent signal state. After receiving a message with this cause value, the RDT shall clear the time slot and continue to monitor the line. The RDT will report the return to on-hook status in an INFORMATION message as described in Section 12.5.5.

30 *Response to STATUS ENQUIRY.* The RDT shall use this cause value in STATUS messages that are sent in response to STATUS ENQUIRY messages.

34 *Channel Unavailable.* The IDT shall use this cause value to reject call establishment when there is no DS0 available to carry a call. The RDT shall use this cause value to reject call establishment when it believes the DS0 specified by the switch is already in use on a provisioned connection or is unavailable (e.g., DS1 carrier failure, out-of-service, not provisioned, unequipped, etc.); the IDT shall report such conditions to the appropriate OS via the requirements of Section 5.

41 *Temporary Failure.* The IDT shall use this cause value if it initiates call clearing after confirming that a call state mismatch exists; call state mismatch procedures are described in Section 12.5.5. The RDT shall use this cause value if it suspects a call mismatch and generates an unsolicited STATUS message; e.g., if the RDT detects an unexpected call origination request as defined in Section 12.5.5.16.10. The IDT and RDT shall use this cause value to indicate call clearing due to some transitory call failure event (e.g., channel ID mismatch, a resource becomes unavailable during a call, blocked calls in the distribution plant, a timer expires, or a processor is reset).

44 *Line Unit Unavailable.* The IDT shall use this cause value to reject call establishment when any circuitry associated with the line termination indicated by the call reference is incapable of providing service. The RDT shall use this cause value to reject call establishment when the line unit indicated by the call reference is incapable of providing service (e.g., it is temporarily unavailable due to testing or maintenance activity, OOS, not provisioned, unequipped, etc.). After receiving a RELEASE COMPLETE message with this cause value, the IDT and RDT shall immediately cease call establishment.

47 *Ring Failure.* The RDT shall use this cause value to reject a call establishment when the line indicated by the call reference fails the ring pretrip test described in Section 6.1.1.

81 *Invalid Call Reference*. The IDT and RDT shall use this cause value to reject a message that contains an erroneous call reference (i.e., one that is not currently in use) as defined in Section 12.5.5.

96 *Mandatory Element Missing*. The IDT and RDT shall use this cause value to reject a message that does not contain all of the necessary information elements.

97 *Message Unimplemented.* The IDT and RDT shall use this cause value to reject an unrecognized message. An unrecognized message is one that they cannot act on according to the procedures of this document.

99 *Information Element Unimplemented.* The IDT and RDT shall use this cause value to indicate that they did not recognize an information element present in a received message. An unrecognized information element is one that they cannot act on according to the procedures of this document.

100 *Invalid Information Element Contents.* The IDT and RDT shall use this cause value to reject a message that contains an incorrectly coded information element. An incorrectly coded information element is one that they recognize but cannot act on according to the procedures of this document.

12.5.2.3.6 Call State

R12-164 **[1036]** The Call State element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	0	1	0	1	0	0	Octet 1
0	0	0	0	0	0	0	1	Octet 2
Call State Value								Octet 3

On both the TMC and CSC, the call state element is used in STATUS messages to report the current state of a call.

R12-165 **[1037]** The call state value shall be the binary representation of one of the call state numbers given in Section 12.5.5.

12.5.2.3.7 Channel Identification

R12-166 **[1038]** The Channel Identification element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	0	1	1	0	0	0	Octet 1
0	0	0	0	0	1	0	0	Octet 2
0	1	1	0	1	0	0	1	Octet 3
1	0	0	DS1 Number					Octet 3a
1	0	0	0	0	0	1	1	Octet 4
1	0	0	DS0 Number					Octet 5

The channel identification element is used on both the TMC and CSC to identify the time slot used for the call; all six octets are always required.

R12-167 **[1039]** The DS1 number shall lie within the range 1 to 28, inclusive, and identifies the DS1 line.

R12-168 **[1040]** The DS0 number shall lie within the range 1 to 24, inclusive, and identifies the specific DS0 within the DS1.

12.5.2.3.8 Notification Indicator

R12-169 **[1041]** The Notification Indicator element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	1	0	0	1	1	1	Octet 1
0	0	0	0	0	0	0	1	Octet 2
1	Notification Description							Octet 3

This information element is not used on the TMC.

The notification indicator element is used on the CSC to extend the capabilities of Q.931 to accommodate coin, multi-party, and custom calling services.

R12-170 **[1042]** The notification description shall be one of those given in Table 12-9.

12.5.2.3.9 Keypad Facility

R12-171 **[1043]** The Keypad Facility element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	1	0	1	1	0	0	Octet 1
Length (octets) of Keypad Information								Octet 2
0	Keypad Information							Octet 3

This element is not used on the TMC.

On the CSC, the keypad facility element is used as specified in Section 12.5.2.2.9. Major uses of the keypad facility element include the following:

- The IDT uses it to forward to the RDT digits that must be outpulsed on loop reverse battery circuits.
- The RDT uses it to report dial pulse digits received from a customer.

- The RDT uses this element to tell the IDT that a customer has “flashed” the switchhook.

R12-172 **[1044]** The IDT and RDT shall encode the keypad information as shown in Table 12-10.

12.5.2.3.10 Signal

R12-173 **[1045]** The Signal element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	1	1	0	1	0	0	Octet 1
0	0	0	0	0	0	0	1	Octet 2
Signal Value								Octet 3

This element is not used on the TMC.

On the CSC, as specified in Section 12.5.2.2.1, the IDT uses the signal element to specify an alerting pattern for the RDT to apply to a loop/ground start circuit.

R12-174 **[1046]** The IDT shall encode the signal value as shown in Table 12-11.

12.5.2.3.11 Switchhook

R12-175 **[1047]** The Switchhook element shall be formatted as follows:

8	7	6	5	4	3	2	1	
0	0	1	1	0	1	1	0	Octet 1
0	0	0	0	0	0	0	1	Octet 2
Switchhook Value								Octet 3

R12-176 **[1048]** The switchhook value shall be 0000 0000 to indicate an on-hook and 0000 0001 to indicate an off-hook.

On both the TMC and CSC, as specified in Section 12.5.2.2.9,

- The RDT uses the switchhook element to report that a customer previously in a permanent signal state has gone on-hook
- The IDT uses the switchhook element to acknowledge that a customer previously in a permanent signal state is on-hook.

On the CSC, as specified in Section 12.5.2.2.9, in emergency 911 cases where the IDT has not torn down the call, the RDT uses the switchhook element to report that a customer who was previously on-hook has returned off-hook.

12.5.3 Time-Slot Management Channel Scenarios

This section was originally entitled, “On-Hook Transmission.” The information it contained has been repackaged to be in this section and in Sections 12.5.4 and 12.5.5.

This section describes the time-slot assignment procedures for hybrid signaling that are used across the Generic IDLC Interface. Once a time slot is assigned to a line unit for a call, supervision is achieved via ABCD codes as described in Section 12.5.2.1. Additional, more detailed, TMC requirements are given in Section 12.5.5.

Message sequence diagrams are used to illustrate the TMC procedures for time-slot assignment. Each diagram has three vertical time lines, one each for the IDT, RDT, and customer. Time starts at the top and proceeds to the bottom of each diagram. Horizontal arrows between the IDT and RDT represent the exchange of TMC messages. Horizontal arrows between the RDT and customer represent changes in the dc state of the loop.

R12-177 **[1049]** The detailed coordination between TMC messages and the beginning/termination of ABCD-coded-signaling insertion/extraction, provided in the following subsections, shall be satisfied on all DS0s utilizing robbed-bit-signaling.

R12-178 **[1050]** For DS0s being assigned via the TMC that do not utilize robbed-bit-signaling, the robbed-bit-signaling function on the assigned DS0 shall be turned off, at both the RDT and IDT, and the DS0 shall provide a 64-kb/s clear-channel-transport capability for the assigned DS0.

… a. For the B channels associated with an ISDN Basic Access circuit, the additional requirements of Section 12.5.4.7 shall be satisfied.

… b. For DDS circuits, the requirements of Section 12.5.4.8 shall be satisfied.

The implication of the above requirement is that a DS0 provisioned for option “16” (see Section 12.6.1.2) must function as if option “T” were selected, when assigned by the TMC to carry an ISDN B-channel.

12.5.3.1 Assignment Initiated by the IDT

TMC signaling for time-slot assignment initiated by the IDT proceeds as shown in Figure 12-3.

R12-179 **[1051]** The IDT shall send a SETUP message that identifies the called line termination and allocates a DS0 to the call. Before sending the SETUP message, the IDT shall begin inserting ABCD coded signaling information into the DS0.

R12-180 **[1052]** Once the RDT determines that it can complete the call and has connected the line unit to the allocated DS0, it shall send a CONNECT message. Before sending the CONNECT message, the RDT shall begin reporting the status of the called line via ABCD coded signaling inserted into the DS0 and shall begin reacting to ABCD coded signaling information received in the DS0.

R12-181 **[1053]** After receiving the CONNECT message, the IDT shall begin reacting to ABCD coded signaling information received in the DS0.

12.5.3.2 Assignment Initiated by the Customer

TMC signaling for time-slot assignment initiated by the customer proceeds as shown in Figure 12-4.

R12-182 **[1054]** When the RDT detects a service request from the customer, it shall send a SETUP message. A service request is a loop closure on loop start circuits and a ring ground on ground start circuits.

R12-183 **[1055]** Once the IDT determines that it can accept the call, it shall send a CONNECT message that tells the RDT which DS0 to use. Before sending the CONNECT message, the IDT shall begin inserting ABCD coded signaling into the DS0.

R12-184 **[1056]** On receipt of the CONNECT message, assuming availability at the RDT of the DS0 channel being assigned, the RDT shall begin reporting the status of the calling line via ABCD coded signaling inserted into the assigned DS0 and shall begin reacting to the received ABCD coded signaling information. After doing so, the RDT shall transmit a CONNECT ACKNOWLEDGE message.

R12-185 **[1057]** On receipt of the CONNECT ACKNOWLEDGE message, the IDT shall begin reacting to the ABCD coded signaling received in the DS0.

12.5.3.3 Clearing

TMC signaling for time-slot clearing proceeds as shown in Figure 12-5.

R12-186 **[1058]** When the IDT determines that the time slot is no longer needed, usually upon receipt of ABCD coded signaling indicating that the customer has gone on-hook, it shall send a DISCONNECT message to the RDT. Before sending the DISCONNECT message, the IDT shall stop reacting to the ABCD coded signaling being received in the DS0.

R12-187 **[1059]** On receipt of the DISCONNECT message, the RDT shall stop reacting to received ABCD coded signaling, disconnect the line unit from the DS0, and send a RELEASE message to the IDT.

R12-188 **[1060]** On receipt of the RELEASE message, the IDT shall disconnect the DS0 and send a RELEASE COMPLETE message to the RDT. The DS0 is now free for other IDLC system traffic.

R12-189 **[1061]** The DISCONNECT message sent by the IDT shall contain one of two cause values, under non-error conditions.

… a. In response to cause value 16, “Normal Clearing,” the RDT follows the procedure described in the above requirements.

… b. In response to cause value 27, “Destination Out of Service,” the RDT shall, in addition to the procedure described in the above requirements, satisfy the criteria in Section 12.5.5.14.2. This permits the IDT to free IDLC system time slots allocated to customers that are being put into a permanent signal state.

12.5.3.4 On-Hook Transmission

The need for an IDLC system to provide an on-hook transmission capability was identified in Section 3.7.3.

R12-190 **[1062]** Hybrid signaling IDLC systems shall support the data transmission requirements described in GR-30-CORE by satisfying the on-hook transmission requirements in TR-NWT-000057 and Section 3.2.1.22 of this document.

Before attempting an on-hook transmission, the IDT needs to ensure that a time slot is assigned.

CR12-191 **[1063]** If the system uses a TMC, the IDT shall allocate a DS0 according to the procedures described in Section 12.5.3.1.

CR12-192 **[1064]** For on-hook transmission not associated with a terminating call, a 2-way transmission path shall be provided within 50 ms of transmitting the CONNECT message toward the LDS.

R12-193 **[1065]** For on-hook transmission associated with a terminating call (e.g., for calling number delivery), the IDT shall coordinate the transmission with the ABCD codes sent to the RDT to ensure that the transmission is not coincident with an ABCD code requiring the application of a power ringing signal.

R12-194 **[1066]** For on-hook transmission not associated with a terminating call, the IDT shall clear the time-slot assignment as described in Section 12.5.3.3 after concluding the transmission.

12.5.4 Common Signaling Channel Scenarios

This section was originally entitled, “Time-slot Assignment.” Most of the information it contained is still found here, but some of it has been moved to Section 12.5.5.

12.5.4.1 General

CSC messages exchanged across the Generic IDLC Interface will cause the IDT and RDT to traverse through a multitude of service-related signaling states during the span of a call.

R12-195 **[1067]** The performance requirements of the IDLC system and the RDT's line-termination circuits necessary to accommodate all service-related signaling states are identified in Sections 12.5.9 and 3.2.2 and shall be satisfied.

The intent of this section is to present CSC scenarios that illustrate the requirements of loop start, ground start, and loop reverse battery circuits. Information is also provided for coin, multi-party, ISDN Basic Access, and DDS circuits.

R12-196 **[1068]** Whenever a transmission path is needed (i.e., the line unit is connected to the DS0), the requirements of Sections 12.5.8 and 3.2.1 shall be satisfied.

Message sequence diagrams are used to illustrate the CSC procedures. Each diagram has three vertical time lines, one each for the IDT, RDT, and customer. Time starts at the top and proceeds to the bottom of each diagram. Horizontal arrows between the IDT and RDT

represent the exchange of call processing information over the CSC. Horizontal arrows between the RDT and customer represent changes in the dc state of the loop. In-band information that the IDT and customer exchange directly is shown using dashed arrows.

12.5.4.2 Loop Start Circuits

12.5.4.2.1 Establishment Initiated by the IDT

See Figure 12-6:

R12-197 **[1069]** The IDT shall send a SETUP message that identifies the called line, allocates a DS0, and tells the RDT what alerting signal to apply to the line.

R12-198 **[1070]** The RDT shall perform the ring pretrip test described in Section 6.1.1.

R12-199 **[1071]** Once the RDT determines that it can complete the call, it shall seize the line by applying, in accord with TR-NWT-000057, the alerting signal specified by the IDT, and it shall send an ALERTING message to inform the IDT that customer alerting has begun.

R12-200 **[1072]** At the beginning of the first silent interval that satisfies the requirements of TR-NWT-000031, the RDT shall send a NOTIFY message.

CR12-201 **[1073]** If the customer subscribes to calling number delivery, the LDS/IDT will forward the calling number to the CPE and the RDT must be supporting the on-hook transmission requirements of Section 12.5.4.9.

R12-202 **[1074]** When the RDT detects loop closure as described in TR-NWT-000057, it shall remove the alerting signal and send a CONNECT message.

12.5.4.2.2 Establishment Initiated by the CPE

See Figure 12-7:

R12-203 **[1075]** When the RDT detects loop closure as defined in TR-NWT-000057 on an idle loop start circuit, it shall send a SETUP message to tell the IDT that a customer is requesting service.

R12-204 **[1076]** Once the IDT determines that it can accept the call, it shall send a SETUP ACKNOWLEDGE message to tell the RDT which DS0 to use.

R12-205 **[1077]** In response to the message, the RDT shall connect the line unit to the allocated DS0 and prepare to receive addressing information from the CPE.

Customers may provide addressing information in two ways, either dial pulses or Dual-Tone Multifrequency (DTMF) signals. If DTMF addressing is used, the tones will pass through the RDT and be interpreted by the LDS.

R12-206 **[1078]** The RDT shall be capable of receiving and interpreting dial pulses from the CPE. The RDT shall forward to the IDT, digit by digit in INFORMATION messages, its interpretation of the dial pulses.

R12-207 **[1079]** When the IDT determines that the address is complete, it shall send a CONNECT message.

O12-208 **[1080]** The LDS may request, via a NOTIFY message, that the RDT apply reverse loop current feed to the line as an indication that the call is a toll call. The RDT should be capable of generating the toll diversion signal.

12.5.4.2.3 Clearing Initiated by the IDT

See Figure 12-8:

R12-209 **[1081]** When the IDT wishes to initiate call clearing, it shall send a DISCONNECT message.

R12-210 **[1082]** In response, the RDT shall apply forward disconnect toward the CPE as specified in Section 6.3.5.2-C of GR-506-CORE.

R12-211 **[1083]** When the RDT detects loop open from the CPE, it shall disconnect the line unit from the DS0 and send a RELEASE message.

R12-212 **[1084]** The IDT shall reply with a RELEASE COMPLETE message after disconnecting the DS0.

R12-213 **[1085]** The DISCONNECT message sent by the IDT shall contain one of two cause values, under non-error conditions.

… a. In response to cause value 16, “Normal Clearing,” the RDT follows the procedure described in the above requirements.

…

b. In response to cause value 27, “Destination Out of Service,” the RDT shall, in addition to the procedure described in the above requirements, satisfy the criteria in Section 12.5.5.14.2. This permits the IDT to free IDLC system time slots allocated to customers that are being put into a permanent signal state.

12.5.4.2.4 Clearing Initiated by the CPE

See Figure 12-9:

R12-214 **[1086]** When the RDT detects loop open from the CPE, it shall send a DISCONNECT message to the IDT.

R12-215 **[1087]** The IDT shall reply with a NOTIFY message and shall stop timer T305 while the LDS determines if the call can be cleared.

R12-216 **[1088]** If the LDS determines that the call can be cleared, the IDT shall disconnect the DS0 allocated to the call and send a RELEASE message.

R12-217 **[1089]** The RDT shall reply with a RELEASE COMPLETE message after disconnecting the line unit from the DS0.

R12-218 **[1090]** The RDT shall be provisionable on a per-circuit basis to support a flash feature. As the default, a flash capability shall be provided on all loop start circuits, and the hit-protection/flash/disconnect timing requirements of Section 6.3.5.2 of GR-506-CORE shall be used by the RDT to interpret a loop open condition as either a switchhook flash or a disconnect signal.

R12-219 **[1091]** The RDT shall be capable of overriding its flash provisioning when it receives a NOTIFY message from the IDT either enabling or disabling a circuit’s flash capabilities. This may occur during special testing scenarios that require flash capabilities. Upon returning to the Null state, the RDT shall return to its original provisioning.

12.5.4.3 Ground Start Circuits

12.5.4.3.1 Establishment Initiated by the IDT

See Figure 12-6:

R12-220 **[1092]** The IDT shall send a SETUP message that identifies the called line, allocates a DS0, and tells the RDT what alerting signal to apply to the line.

R12-221 **[1093]** The RDT shall perform the ring pretrip test described in Section 6.1.1.

R12-222 **[1094]** Once the RDT determines that it can complete the call, it shall seize the line by applying, in accord with TR-NWT-000057, both tip ground and the alerting signal specified by the IDT and shall send an ALERTING message to inform the IDT that customer alerting has begun.

R12-223 **[1095]** At the beginning of the first silent interval that satisfies the requirements of TR-NWT-000031, the RDT shall send a NOTIFY message.

CR12-224 **[1096]** If the customer subscribes to calling number delivery, the LDS/IDT will forward the calling number to the CPE and the RDT must be supporting the on-hook transmission requirements of Section 12.5.4.9.

R12-225 **[1097]** When the RDT detects loop closure as described in TR-NWT-000057, it shall remove the alerting signal and send a CONNECT message.

12.5.4.3.2 Establishment Initiated by the CPE

See Figure 12-7:

R12-226 **[1098]** When the RDT detects a ring ground as defined in TR-NWT-000057 on an idle ground start circuit, it shall send a SETUP message to tell the IDT that a customer is requesting service.

R12-227 **[1099]** Once the IDT determines that it can accept the call, it shall send a SETUP ACKNOWLEDGE message to the RDT that tells the RDT which DS0 to use.

R12-228 **[1100]** In response to the message, the RDT shall apply tip-ring voltage (with the tip conductor grounded), connect the line unit to the allocated DS0, and prepare to receive addressing information from the CPE.

Customers may provide addressing information in two ways, either by dial pulses or by DTMF signals. If DTMF addressing is used, the tones will pass through the RDT and be interpreted by the LDS.

R12-229 **[1101]** The RDT shall be capable of receiving and interpreting dial pulses from the CPE, and shall forward to the IDT, digit by digit in INFORMATION messages, its interpretation of the dial pulses.

R12-230 **[1102]** When the IDT determines that the called address is complete, it shall send a CONNECT message.

12.5.4.3.3 Clearing Initiated by the IDT

See Figure 12-8:

R12-231 **[1103]** When the IDT wishes to initiate call clearing, it shall send a DISCONNECT message to the RDT.

R12-232 **[1104]** In response, the RDT shall apply forward disconnect toward the CPE as specified in Section 6.3.5.2-C of GR-506-CORE.

R12-233 **[1105]** When the RDT detects loop open from the CPE, it shall disconnect the line unit from the DS0 and send a RELEASE message.

R12-234 **[1106]** The IDT shall reply with a RELEASE COMPLETE message after disconnecting the DS0.

R12-235 **[1107]** The DISCONNECT message sent by the IDT shall contain one of two cause values.

… a. In response to cause value 16, “Normal Clearing,” the RDT follows the procedure described in the above requirements.

… b. In response to cause value 27, “Destination Out of Service,” the RDT shall, in addition to the procedure described in the above requirements, continue to monitor the on-/off-hook status of the line and shall send an INFORMATION message to the IDT when the customer returns on-hook. This permits the IDT to free IDLC system time slots allocated to customers that are in a permanent signal state. See Section 12.5.5 for further details.

12.5.4.3.4 Clearing Initiated by the CPE

See Figure 12-9:

R12-236 **[1108]** When the RDT detects loop open from the CPE, it shall send a DISCONNECT message to the IDT.

R12-237 **[1109]** The IDT shall reply with a NOTIFY message and shall stop timer T305 while the LDS determines if the call can be cleared.

R12-238 **[1110]** After the LDS determines that the call can be cleared, the IDT shall disconnect the DS0 allocated to the call and send a RELEASE message.

R12-239 **[1111]** The RDT shall reply with a RELEASE COMPLETE message after disconnecting the line unit from the DS0.

R12-240 **[1112]** The RDT shall be provisionable on a per-circuit basis to support a flash feature. As the default, a flash capability shall be provided on all ground start circuits, and the hit-protection/flash/disconnect timing requirements of Section 6.3.5.2 of GR-506-CORE shall be used by the RDT to interpret a loop open condition as either a switchhook flash or a disconnect signal.

R12-241 **[1113]** The RDT shall be capable of overriding its flash provisioning when it receives a NOTIFY message from the IDT either enabling or disabling a circuit's flash capabilities. This may occur during special testing scenarios that require flash capabilities. Upon returning to the Null state, the RDT shall return to its original provisioning.

12.5.4.4 Loop Reverse Battery Circuits

The T1 standard for loop reverse battery signaling (see ANSI T1.405-1989) describes three pulsing control protocols, wink-start, immediate-dial, and delay-dial, for loop reverse battery circuits, and states that the local exchange carrier selects which of the three protocols is used "... based on network equipment capabilities...."

R12-242 **[1114]** RDTs shall be capable of using the wink-start outpulsing protocol described in T1.405-1989.

CR12-243 **[1115]** RDTs shall, in specific applications, be capable of using the immediate-dial outpulsing protocol described in T1.405-1989.

O12-244 **[1116]** RDTs should be capable of using the delay-dial outpulsing protocol described in T1.405-1989.

R12-245 **[1117]** The RDT shall be provisionable on a per-circuit basis to support one of the three pulsing control protocols: wink-start, immediate-dial, or delay-dial. The default shall be the wink-start outpulsing protocol.

12.5.4.4.1 Establishment

See Figure 12-10:

Call establishment on loop reverse battery circuits is only initiated by the IDT.

R12-246 **[1118]** The IDT shall send a SETUP message that identifies the called line and allocates a DS0.

R12-247 **[1119]** Once the RDT determines that it can complete the call, it shall seize the circuit and respond with a CALL PROCEEDING message.

R12-248 **[1120]** After detecting the start dial signal, the RDT shall transmit a NOTIFY message.

CR12-249 **[1121]** If dial pulse address signaling is being used, the IDT shall send all digits to be outpulsed to the RDT in a single INFORMATION message.

CR12-250 **[1122]** If DTMF or Multifrequency (MF) address signaling is being used, the IDT shall, after receiving the NOTIFY message, send the destination address to the customer.

R12-251 **[1123]** When the RDT detects an off-hook signal from the CPE, it shall send a CONNECT message.

12.5.4.4.2 Clearing Initiated by the IDT

See Figure 12-11:

R12-252 **[1124]** When the IDT wishes to initiate call clearing, it shall send a DISCONNECT message to the RDT.

R12-253 **[1125]** In response, the RDT shall apply forward disconnect toward the CPE as specified in Section 6.3.5.2-C of GR-506-CORE.

R12-254 **[1126]** When the RDT detects an on-hook signal from the CPE, it shall disconnect the line unit from the DS0 and send a RELEASE message.

R12-255 **[1127]** The IDT shall reply with a RELEASE COMPLETE message after disconnecting the DS0.

R12-256 **[1128]** The DISCONNECT message sent by the IDT shall contain one of two cause values.

… a. In response to cause value 16, “Normal Clearing,” the RDT follows the procedure described in the above requirements.

… b. In response to cause value 27, “Destination Out of Service,” the RDT shall, in addition to the procedure described in the above requirements, continue to monitor the on-/off-hook status of the line and shall send an INFORMATION message to the IDT when the customer returns on-hook. This permits the IDT to free IDLC system time slots allocated to customers that are in a permanent signal state. See Section 12.5.5 for further details.

12.5.4.4.3 Clearing Initiated by the CPE

See Figure 12-12:

R12-257 **[1129]** When the RDT detects that the customer is on-hook, it shall send a DISCONNECT message to the IDT.

R12-258 **[1130]** The IDT shall reply with a NOTIFY message and shall stop timer T305 while the LDS determines if the call can be cleared.

R12-259 **[1131]** If the LDS determines that the call can be cleared, the IDT shall disconnect the DS0 allocated to the call and send a RELEASE message.

R12-260 **[1132]** The RDT shall reply with a RELEASE COMPLETE message after disconnecting the line unit from the DS0.

12.5.4.4.4 Clearing Initiated by the CPE during a Basic E-911 Call

See Figure 12-13:

R12-261 **[1133]** When the RDT detects that the customer is on-hook, it shall send a DISCONNECT message to the IDT.

R12-262 **[1134]** The IDT shall reply with a NOTIFY message and shall stop timer T305 while the LDS determines if the call can be cleared.

R12-263 **[1135]** When the RDT detects that the customer has gone back off-hook, it shall send an INFORMATION message to the IDT.

R12-264 **[1136]** When the IDT receives the INFORMATION message, it shall reply with a CONNECT message.

12.5.4.4.5 Clearing Initiated by the CPE During an Expanded E-911 Call - Option

See Figure 12-14:

These requirements in this section hold only for those IDT that support expanded 911 service.

R12-265 **[1137]** When the RDT detects that the customer is on-hook, it shall send a DISCONNECT message to the IDT.

R12-266 **[1138]** The IDT shall reply with a NOTIFY message and shall stop timer T305 while the LDS determines if the call can be cleared.

R12-267 **[1139]** If the LDS determines that the call should not be cleared because it is an emergency 911 call, the IDT can send an INFORMATION message to the RDT to apply ringback to the customer.

R12-268 **[1140]** The RDT shall reply with an ALERTING message to the IDT indicating that the RDT is applying an alerting signal to the line.

R12-269 **[1141]** The IDT shall send an INFORMATION message to the RDT to stop ringback to the customer or to resend ringback to the customer.

R12-270 **[1142]** Upon receipt of the INFORMATION message to stop ringback, the RDT shall acknowledge with an INFORMATION message.

R12-271 **[1143]** When the RDT detects the customer back off-hook, the RDT shall send a CONNECT message to the IDT to re-establish the call.

12.5.4.5 Coin - Option

Dial-tone-first coin service is based on loop-start signaling. Coin-first coin service is based on ground-start signaling. In out-of-band signaling systems, the IDT and RDT exchange NOTIFY messages over the CSC to perform coin specific functions that are not part of normal loop/ground start signaling. See Section 12.5.5 for further details.

12.5.4.6 Multi-Party - Option

Multi-party service is based on loop-start signaling, and this document supports two-party and four-party fully selective service. In out-of-band signaling systems, the IDT and RDT exchange NOTIFY messages over the CSC to perform multi-party specific functions that are not part of normal loop-start signaling. See Section 12.5.5 for further details.

Additionally, special procedures are needed for reverting calls. A reverting call is one in which the call*ing* and call*ed* parties are on the same multi-party circuit.

12.5.4.6.1 Reverting Call Establishment

See Figure 12-15:

R12-272 **[1144]** When the RDT detects loop closure as defined in TR-NWT-000057 on an idle multi-party circuit, it shall send a SETUP message to tell the IDT that a customer is requesting service.

R12-273 **[1145]** Once the IDT determines that it can accept the call, it shall send a SETUP ACKNOWLEDGE message to tell the RDT which DS0 to use.

R12-274 **[1146]** In response to the message, the RDT shall connect the line unit to the allocated DS0 and prepare to receive addressing information from the CPE.

Customers may provide addressing information in two ways, either dial pulses or DTMF signals. If DTMF addressing is used, the tones will pass through the RDT and be interpreted by the IDT.

R12-275 **[1147]** The RDT shall be capable of receiving and interpreting dial pulses from the CPE. The RDT shall forward to the IDT, digit by digit in INFORMATION messages, its interpretation of the dial pulses.

R12-276 **[1148]** When the IDT determines that the address is complete, it shall send a CONNECT message.

R12-277 **[1149]** When the RDT detects loop open from the CPE, it shall send a DISCONNECT message.

R12-278 **[1150]** In response, the IDT shall send a SETUP message since this is a reverting call. The SETUP message shall contain two instances of the signal element. The first instance identifies the call*ing* party, and the second identifies the call*ed* party.

R12-279 **[1151]** The RDT shall apply the alerting signals to the line as described in TR-NWT-000057 and in TR-TSY-000677 (FSD 20-10-0000) and shall send an ALERTING message to inform the IDT that customer alerting has begun.

R12-280 **[1152]** When the RDT detects loop closure as described in TR-NWT-000057, it shall trip ringing and send a CONNECT message.

See FSD 20-10-0000 of the LSSGR for further information on reverting calls.

12.5.4.7 ISDN Basic Access Circuits - Option

12.5.4.7.1 Establishment

See Figure 12-3:

The IDT always begins the TMC/CSC procedures for call establishment on ISDN Basic Access circuits.

R12-281 **[1153]** The IDT shall send a SETUP message to the RDT that identifies the B channel on the line termination and allocates a DS0.

R12-282 **[1154]** Once the RDT determines that it can complete the call and has connected the B channel on the line unit to the proper DS0, it shall send a CONNECT message.

R12-283 **[1155]** As discussed in Section 12.5.3, the ABCD-coded robbed-bit-signaling function shall be turned off on any DS0 being assigned by the TMC to transport a B channel of an ISDN Basic Access circuit and a 64-kb/s clear-channel-transport capability shall be provided for the B channel.

12.5.4.7.2 Clearing

See Figure 12-5:

The IDT begins the TMC/CSC procedures for call clearing on ISDN Basic Access circuits.

R12-284 **[1156]** When the IDT wishes to initiate call clearing, it shall send a DISCONNECT message that identifies the call being cleared from the IDLC system.

R12-285 **[1157]** After the RDT has disconnected the DS0, it shall send a RELEASE message.

R12-286 **[1158]** The IDT shall reply with a RELEASE COMPLETE message after disconnecting the line unit from the DS0.

12.5.4.8 Digital Data System (DDS) Circuits - Option

For the Generic IDLC Interface, the requirements for providing DDS capabilities are as identified in Section 3.4. DDS services are treated as private line circuits across the Generic IDLC Interface and, thus, require no CSC interaction between the IDT and the RDT.

As stated in Section 3.4, the requirements of TA-TSY-000077 and TA-TSY-000083 must be satisfied by IDLC systems that provide DDS services.

R12-287 **[1159]** Because DDS is a private line service, the following requirements shall be met:

… a. A DS0 cross-connect shall be provided in either the LDS or RDT, as described in Section 3.5. If the DS0 cross-connect is provided in the LDS, then a dedicated time slot shall be established for carriage of the DDS channel between the RDT and LDS.

… b. Signaling option “T” shall be selected for all time slots carrying DDS circuits to allow for transparent transport of 64 kb/s between the RDT and LDS.

12.5.4.9 On-Hook Transmission

The need for an IDLC system to provide an on-hook transmission capability was identified in Section 3.7.3.

R12-288 **[1160]** Out-of-band signaling IDLC systems shall support the data transmission requirements described in GR-30-CORE by satisfying the on-hook transmission requirements in TR-NWT-000057 and Section 3.2.1.22 of this document.

The CSC procedures for on-hook transmissions that are not associated with terminating calls are identical to the ISDN Basic Access procedures described in Section 12.5.4.7. For on-hook transmissions that are associated with terminating calls (e.g., for calling number delivery), the RDT must tell the IDT when the alerting cadence enters the first long silent interval as defined in TR-NWT-000031. It does so via a NOTIFY message as discussed in Sections 12.5.4.2 and 12.5.4.3.

12.5.5 Detailed TMC/CSC Procedures

This section was originally entitled, “Call Processing Scenarios.” The information it contained has been moved to Section 12.5.4, and its format has been changed.

This section provides detailed information that describes the operation of the TMC and CSC. The flow diagrams are adapted from the specification and description language diagrams of Recommendation Q.931 and illustrate the criteria using the symbols shown in Figure 12-16. The *Q.931 Control* entity represents that part of the IDT or RDT that is devoted to generating and interpreting TMC or CSC messages, and the flow diagrams depict its operation in detail. The *Call Control* entity represents that part of the IDT or RDT that is responsible for maintaining connections between line units and DS0 time slots. Its operation is described primarily in the text of this section.

A call progresses through different states as various events occur, and this section describes how the IDT and RDT process calls in each state. The following table shows the call states that apply to the TMC and to the CSC.

Number	State Name	TMC	CSC
0	Null	Yes	Yes
1	Call Initiated	Yes	Yes
2	Overlap Sending	No	Yes
6	Call Present	Yes	Yes
7	Call Received	No	Yes
8	Connect Request	Yes	No
9	Call Proceeding	No	Yes
10	Active	Yes	Yes
11	Disconnect Request	No	Yes
12	Disconnect Indication	Yes	Yes
19	Release Request	Yes	Yes
100	Permanent Signal	Yes	Yes

12.5.5.1 Null - 0

12.5.5.1.1 IDT (Null - 0)

R12-289 **[1161]** The leftmost branch of Figure 12-17 applies to both the TMC and the CSC and shows how the switch starts/restarts the TMC/CSC procedures for a terminating call.

… a. The IDT shall provide two registers to record the number of terminating calls that are blocked because a DS0 between the IDT and RDT was not available to assign to the call. One register shall accumulate counts over periods of 30 minutes. The second register, a holding register, shall be provided to retain (for 30 minutes) the count for the previous 30-minute period. These registers, referred to as the IDLC facility blocked terminating call

peg count, are in addition to the blocked call counting registers the LDS provides per the requirements of TR-TSY-000541.

… b. If a DS0 between the IDT and RDT is not available for assignment to the terminating call, the IDT shall increment the IDLC facility blocked terminating call peg count. The LDS shall also provide blocked terminating call treatment for the call as defined in Section 5.2.2 of TR-NWT-000505.

… c. If a DS0 between the IDT and RDT is available for assignment, the IDT shall determine the call reference value to use and transmit a SETUP message. After a sending the SETUP message, the IDT shall start timer T303 and consider the call to be in the Call Present (6) state.

R12-290 **[1162]** The middle branch of Figure 12-17 applies to both the TMC and the CSC and shows how the IDT reacts to a SETUP message that indicates an originating call. The IDT shall inform the LDS that the line termination identified by the call reference value is requesting service and shall consider the call to be in the Call Initiated (1) state. After being notified of the originating call, the IDT shall determine if a DS0 is available for the call.

R12-291 **[1163]** The right branch of Figure 12-17 applies only to the CSC and shows how the IDT sends a reminder ring. The IDT sends an INFORMATION message to the RDT notifying to reminder ring the customer and shall consider the call to be in the Null (0) state.

12.5.5.1.2 RDT (Null - 0)

R12-292 **[1164]** The leftmost branch of Figure 12-18 applies to both the TMC and the CSC and shows how the RDT reacts to a SETUP message that indicates a terminating call. The Q.931 control entity shall inform the call control entity that there is a call destined for the line termination identified by the call reference value. Subsequently, the RDT shall consider the call to be in the Call Present (6) state.

R12-293 **[1165]** The second branch from the left of Figure 12-18 applies to both the TMC and the CSC and shows how the RDT starts the TMC/CSC procedures for an originating call after detecting a seizure signal, or detecting that a line is off-hook upon entering the Null (0) state. The RDT shall stop timer T397 if it is running, determine the call reference value to use, transmit a SETUP message, start timer T303, and consider the call to be in the Call Initiated (1) state.

R12-294 **[1166]** The third branch from the left of Figure 12-18 applies to both the TMC and the CSC and shows how the RDT reacts to an INFORMATION message that acknowledges that a line that had been generating a permanent signal has returned on-hook. The RDT shall stop timer T397 and consider the call to be in the Null (0) state.

R12-295 **[1167]** The fourth branch of Figure 12-18 applies to both the TMC and the CSC and shows how the RDT reacts when T397 expires indicating that the IDT has yet to acknowledge that a line that had been generating a permanent signal has returned on-hook. The RDT shall transmit an INFORMATION message, restart timer T397, and consider the call to be in the Null (0) state.

R12-296 **[1168]** The rightmost branch from the left of Figure 12-18 applies only to the CSC and shows how the RDT reacts to an INFORMATION message that indicates the RDT should reminder ring the customer, and consider the call in the Null (0) state.

12.5.5.2 Call Initiated - 1

12.5.5.2.1 IDT (Call Initiated - 1)

R12-297 **[1169]** The leftmost branch of Figure 12-19 applies only to the TMC and shows how the IDT reacts after successfully connecting the DS0 for an originating call. The IDT shall begin inserting ABCD codes into the DS0, send a CONNECT message, and start timer T313. After sending the message, it shall consider the call to be in the Connect Request (8) state.

R12-298 **[1170]** The second branch from the left of Figure 12-19 applies only to the CSC and shows how the IDT reacts if it can process an originating call. If the necessary IDT resources and a DS0 are available, the IDT shall connect the DS0 and provide dial tone when it is ready to accept addressing information. The IDT shall transmit a SETUP ACKNOWLEDGE message to tell the RDT which time slot has been assigned to the call. After sending the message, it shall consider the call to be in the Overlap Sending (2) state.

R12-299 **[1171]** The third branch from the left of Figure 12-19 applies to both the TMC and CSC and shows how the IDT reacts if it cannot process an originating call.

… a. The IDT shall provide two registers to record the number of originating calls that are blocked because a DS0 between the IDT and RDT was not available to assign to the call, i.e., calls rejected with cause = 34, "Channel Unavailable." One register shall accumulate counts over periods of 30 minutes. The second register, a holding register, shall be provided to retain (for 30 minutes) the count for the previous 30-minute period. These registers, referred to as the IDLC facility blocked originating call peg count, are in addition to the blocked call counting registers the LDS provides per the requirements of Section 8.2 of TR-TSY-000541.

… b. If either the necessary IDT resources or a DS0 between the IDT and RDT is unavailable for an originating call, the IDT shall do one of the following:

… 1. The IDT shall transmit a RELEASE COMPLETE message to inform the RDT that the originating call has been rejected. The cause value shall be 44, "Line Unit Unavailable," if the call was rejected due to the unavailability of IDT resources and 34, "Channel Unavailable," if there was no time slot. After sending the message, the IDT shall release the call reference value and consider the call to be in the Null (0) state. The IDT shall follow the Blocked Originating Call Procedures I defined in Section 12.5.5.19.

… 2. The IDT shall wait for the IDT resources or a DS0 channel to become available. The IDT shall follow the Blocked Originating Call Procedures II defined in Section 12.5.5.20.

Because the procedure for determining call reference values described in this document differs from that of Q.931, the phrase *release the call reference value* has a different meaning. As used here, it means that the IDT may now regard the line termination corresponding to the call reference value to be in its idle (on-hook) state.

R12-300 **[1172]** The fourth branch from the left of Figure 12-19 applies only to the TMC and shows how the IDT reacts to a RELEASE COMPLETE message that signals that the customer has abandoned an originating call. On receipt of the message, the IDT shall release the call reference value and consider the call to be in the Null (0) state.

R12-301 **[1173]** The rightmost branch of Figure 12-19 applies only to the CSC and shows how the IDT reacts to a DISCONNECT message that signals that the customer has abandoned an originating call. On receipt of the message, the IDT shall send a RELEASE message to the RDT and consider the call to be in the Release Request (19) state.

12.5.5.2.2 RDT (Call Initiated - 1)

R12-302 **[1174]** The leftmost branch of Figure 12-20 applies only to the CSC and shows how the RDT reacts when a customer abandons an originating call. If the RDT detects a disconnect signal from the customer, it shall stop timer T303/T396 and transmit a DISCONNECT message with a cause value of 16, “Normal Clearing.” After sending the message, the RDT shall start timer T305 and consider the call to be in the Disconnect Request (11) state.

R12-303 **[1175]** The second from the left branch of Figure 12-20 applies only to the CSC and shows how the RDT reacts to a SETUP ACKNOWLEDGE message that signals that the IDT has accepted an originating call. On receipt of the message, the RDT shall stop timer T303/T396, notify the RDT's *Call Control* entity to connect the line unit to the specified DS0, and consider the call to be in the Overlap Sending (2) state.

R12-304 **[1176]** The third from the left branch of Figure 12-20 applies only to the TMC and shows how the RDT reacts to a CONNECT message that signals that the IDT has accepted an originating call. On receipt of the message, the RDT shall stop timer T303/T396, notify the RDT's *Call Control* entity to connect the line unit to the specified DS0, and consider the call to be in the Active (10) state.

R12-305 **[1177]** The rightmost branch of Figure 12-20 applies to both the TMC and the CSC and shows how the RDT resolves setup glare. On receipt of a SETUP message, the RDT shall stop timer T303/T396, notify the RDT's *Call Control* entity of the terminating call indication, and consider the call in the Call Present (6) state.

R12-306 **[1178]** The leftmost branch of Figure 12-20 (continued) applies only to the TMC and shows how the RDT reacts when a customer abandons an originating call. If the RDT detects a disconnect signal (a continuous loop-open for > 1550 ms) from the customer, it shall stop timer T303/T396 and transmit a RELEASE COMPLETE message with a cause value of 16, “Normal Clearing.” After sending the message, the RDT shall release the call reference and consider the call in the Null (0) state.

O12-307 **[1179]** In the above requirement, a continuous loop-open for >400 ms should be interpreted as a disconnect signal from the customer because flash signals are not expected in the Call Initiated state.

R12-308 **[1180]** The second from the left branch of Figure 12-20 (continued) applies to both the TMC and the CSC and shows how the RDT reacts to a

RELEASE COMPLETE message that signals that the IDT has rejected an originating call. On receipt of the message, the RDT shall stop timer T303/ T396. After releasing the call reference, it shall consider the call to be in the Null (0) state.

R12-309 **[1181]** The third from the left branch of Figure 12-20 (continued) applies to both the TMC and the CSC and shows how the RDT reacts to a T303 timeout that indicates that the IDT has not processed an originating call attempt. On a T303 timeout, the RDT shall retransmit the SETUP message and start timer T396. After doing so, it shall consider the call to be in the Call Initiated (1) state.

R12-310 **[1182]** The rightmost branch of Figure 12-20 (continued) applies to both the TMC and the CSC and shows how the RDT entity reacts to a T396 timeout that indicates that the IDT has not processed an originating call attempt. On a T396 timeout, the RDT shall retransmit the SETUP message and restart timer T396. After doing so, it shall consider the call to be in the Call Initiated (1) state.

12.5.5.3 Overlap Sending - 2

12.5.5.3.1 IDT (Overlap Sending - 2)

This state applies only to the CSC.

R12-311 **[1183]** The left branch of Figure 12-21 shows how the IDT reacts to an INFORMATION message that carries a destination address digit for an originating call. On receipt of the message, the Q.931 control entity shall pass the dialed digit to the call control entity, and the IDT shall consider the call to be in the Overlap Sending (2) state. If it is the first digit, the IDT shall remove dial tone.

R12-312 **[1184]** The central branch of Figure 12-21 shows how the IDT reacts when it has determined that the RDT can stop scanning for dial pulses during the establishment phase of an originating call. The IDT shall transmit a CONNECT message and shall consider the call to be in the Active (10) state.

R12-313 **[1185]** The right branch of Figure 12-21 shows how the IDT reacts to a RELEASE COMPLETE message that signals that the RDT has rejected the time-slot assignment for an originating call because it believed that the

DS0 was already in use. On receipt of the message, the IDT shall release the call reference and consider the call to be in the Null (0) state.

12.5.5.3.2 RDT (Overlap Sending - 2)

This state applies only to the CSC.

R12-314 **[1186]** The left branch of Figure 12-22 shows how the RDT reacts after detecting a dial pulse digit from the customer during the establishment phase of an originating call. The RDT shall transmit an INFORMATION message that carries the dialed digit, and it shall only send a single digit per INFORMATION message. After sending the message, the RDT shall consider the call to be in the Overlap Sending (2) state.

R12-315 **[1187]** The central branch of Figure 12-22 shows how the RDT reacts to a CONNECT message that signals that the IDT has determined that the RDT can stop scanning for dial pulses during the establishment phase of an originating call. On receipt of the message, the RDT shall consider the call to be in the Active (10) state. The RDT shall free the dial pulse detection circuitry if it is a shared resource.

R12-316 **[1188]**

… 1. The right branch of Figure 12-22 shows how the RDT reacts after rejecting the time-slot assignment for an originating call. The RDT shall reject the time-slot assignment if it believes that the DS0 indicated by the IDT is already in use. The RDT shall transmit a RELEASE COMPLETE message with cause value 34, “Channel Unavailable,” and release the call reference value. After sending the message, the RDT shall consider the call to be in the Null (0) state.

… 2. The RDT shall use cause=41 “Temporary Failure” to reject all call setup attempts due to the unavailability of a distribution channel. The LDS shall keep peg counts of call attempt failures due to cause=41, for both originating and terminating calls. To achieve this counting capability at the LDS for originating calls utilizing CSC, the RDT shall be required to generate a SETUP message towards the LDS even when a distribution channel is unavailable. If a distribution channel does not become available upon receipt of the SETUP ACKNOWLEDGE message from the LDS, the RDT shall send a Release Complete to the LDS with cause=41 rather than the Information message.

12.5.5.4 Call Present - 6

12.5.5.4.1 IDT (Call Present - 6)

R12-317 **[1189]** The leftmost branch of Figure 12-23 applies to both the TMC and the CSC and shows how the IDT reacts to a CONNECT message. For the TMC, this CONNECT message is the RDT's normal response to all SETUP messages while, for the CSC, it is the RDT's normal response to SETUP messages that do not contain the signal information element. [7]On receipt of the CONNECT message, the IDT shall stop timer T303 and shall consider the call to be in the Active (10) state.

R12-318 **[1190]** The second from the left branch of Figure 12-23 applies to both the TMC and the CSC and shows how the IDT reacts to a RELEASE COMPLETE message that signals that the RDT has rejected a terminating call. On receipt of the message, the IDT shall stop timer T303 and release the call reference. Afterward, the IDT shall consider the call to be in the Null (0) state.

R12-319 **[1191]** The third from the left branch of Figure 12-23 applies to both the TMC and the CSC and shows how the IDT reacts when T303 times-out before the RDT replies to a SETUP message. If it is the first T303 timeout for the call, the IDT shall retransmit a SETUP message, restart timer T303, and consider the call to be in the Call Present (6) state. If it is not the first T303 timeout, the IDT shall transmit a RELEASE COMPLETE message (cause=41), release the call reference, and consider the call to be in the Null (0) state.

CR12-320 **[1192]** The rightmost branch of Figure 12-23 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts when timer T395 times-out before receiving an ALERTING message from the RDT. The IDT shall retransmit an INFORMATION message with the signal element and consider the call to be in the Call Present (6) state.

CR12-321 **[1193]** The leftmost branch of Figure 12-23 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts to an INFORMATION message that signals that the customer has gone off-hook on a line that was rerung by the operator

7. On the CSC, the IDT sends SETUP messages without the signal element for ISDN Basic Access circuits and for other calls that do not require applying an alerting signal to the line.

before the IDT received an ALERTING message. The IDT sends the off-hook to the LDS and considers the call to be in the Call Present (6) state.

CR12-322 **[1194]** The second from the left branch of Figure 12-23 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts when the switch has processed an off-hook from the customer. The IDT shall send a CONNECT message to the RDT and consider the call to be in the Active (10) state.

CR12-323 **[1195]** The third from the left branch of Figure 12-23 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT signals to the RDT to stop ringing the customer. The IDT shall send an INFORMATION message to the RDT, start timer T395, and consider the call to be in the Call Present (6) state.

R12-324 **[1196]** The fourth from the left branch of Figure 12-23 (continued) applies only to the CSC and shows how the IDT reacts to an ALERTING message that signals that the RDT has successfully connected a loop or ground start line unit to the DS0 and has begun alerting the line. On receipt of the message, the IDT shall stop timer T303 and consider the call to be in the Call Received (7) state.

R12-325 **[1197]** The fifth from the left branch of Figure 12-23 (continued) applies only to the CSC and shows how the IDT reacts to a CALL PROCEEDING message that signals that the RDT has successfully connected the line unit to the DS0 and applied loop closure to seize a loop reverse battery circuit. On receipt of the message, the IDT shall stop timer T303 and consider the call to be in the Call Proceeding (9) state.

R12-326 **[1198]** The rightmost branch of Figure 12-23 (continued) applies to both the TMC and the CSC and shows how the IDT reacts when the LDS signals that it is abandoning a terminating call. The Q.931 control entity shall stop timer T303 and transmit a DISCONNECT message. After doing so, it shall start timer T305 and consider the call to be in the Disconnect Indication (12) state.

12.5.5.4.2 RDT (Call Present - 6)

R12-327 **[1199]** The leftmost branch of Figure 12-24 applies to both the TMC and the CSC and shows how the RDT reacts after successfully connecting the line unit to the DS0 time-slot assigned to a terminating call. The RDT shall transmit a CONNECT message and shall consider the call to be in the Active (10) state.

R12-328 **[1200]** The second from the left branch of Figure 12-24 applies to both the TMC and the CSC and shows how the RDT reacts after rejecting a terminating call. The RDT shall transmit a RELEASE COMPLETE message and release the call reference value. The cause value in the message shall indicate why the RDT rejected the terminating call. After sending the message, the RDT shall consider the call to be in the Null (0) state.

… 1. The RDT shall reject a terminating call

… a. If the RDT line unit is unavailable (see cause=44 in Section 12.5.2.3.5),

… b. If it believes that the DS0 allocated by the IDT is unavailable (see cause=34 in Section 12.5.2.3.5), or

… c. If the line is indicating an on-hook condition, but fails the ring pretrip test described in Section 6.1.1 (cause=47).

… d. The RDT shall use cause=41 “Temporary Failure” to reject all call setup attempts due to the unavailability of a distribution channel. The LDS shall keep peg counts of call attempt failures due to cause value=41, for both originating and terminating calls.

Bellcore Client Companies (BCCs) have identified a need to measure blocking in the distribution network. Bellcore has reissued GR-376-CORE *OTGR Section 15.3: Generic Operations Interfaces Using OSI Tools: Network Data Collection* in 1997 with new managed objects defined for operational measurements (such as distribution blocking) to be collected at an HDT/RDT. These measurements would be collected from the HDT/RDT using a CMISE interface to an EMS/OS.

… 2. The RDT shall not reject (i.e., it shall proceed with information in the received message) a terminating call

… a. On the basis that the DS0 being assigned by the IDT is currently assigned to a non-provisioned (i.e., dynamically assigned time-slot) call, or

… b. If the line unit's secondary-service-state indicates that it is in the test-access state (e.g., the line unit was put into the test-access state by an OS for the purpose of remote testing).

R12-329 **[1201]** The third from the left branch of Figure 12-24 applies only to the CSC and shows how the RDT reacts after successfully connecting a loop or ground start line unit to the DS0 and applying an alerting signal to the line. The RDT shall apply an alerting signal as described in TR-NWT-000057. The RDT shall transmit an ALERTING message and shall consider the call to be in the Call Received (7) state.

CR12-330 **[1202]** The rightmost branch of Figure 12-24 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts to an INFORMATION message that signals to the RDT to either ring the customer again or to stop ringing to the customer. The RDT shall consider the call to be in the Call Present (6) state.

CR12-331 **[1203]** The leftmost branch of Figure 12-24 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts to an off-hook by the customer. The RDT shall send an INFORMATION message to the IDT and shall consider the call to be in the Call Present (6) state.

CR12-332 **[1204]** The second from the left branch of Figure 12-24 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT responds to a CONNECT message indicating that the IDT has reconnected the call. The RDT shall consider the call to be in the Active (10) state.

R12-333 **[1205]** The third from the left branch of Figure 12-24 (continued) applies to both the TMC and the CSC and shows how the RDT responds to a RELEASE COMPLETE indicating that the IDT has timed-out a second time on attempting to establish a setup for a terminating call. On receipt of the RELEASE COMPLETE, the RDT shall release the call reference and consider the call in the Null (0) state.

R12-334 **[1206]** The fourth from the left branch of Figure 12-24 (continued) applies only to the CSC and shows how the RDT reacts after successfully connecting the line unit to the DS0 and applying loop closure to seize a loop reverse battery circuit. The RDT shall apply loop closure as described in TR-NWT-000057 to seize a loop reverse battery circuit and shall transmit a CALL PROCEEDING message. Afterward, it shall consider the call to be in the Call Proceeding (9) state.

R12-335 **[1207]** The right branch of Figure 12-24 (continued) applies to both the TMC and the CSC and shows how the RDT reacts to a DISCONNECT message that signals that the IDT has abandoned a terminating call. On receipt of the DISCONNECT message, the RDT shall begin call clearing and shall consider the call to be in the Disconnect Indication (12) state. The RDT shall remove any alerting signal being applied to the line.

12.5.5.5 Call Received - 7

12.5.5.5.1 IDT (Call Received - 7)

This state applies only to the CSC.

R12-336 **[1208]** The left branch of Figure 12-25 shows how the IDT reacts to a NOTIFY message that signals that the alerting cadence has entered the first long silent interval.[8] On receipt of the message, the IDT shall consider the call to be in the Call Received (7) state. If the customer subscribes to calling number delivery, the LDS shall cause the calling number to be transmitted.

R12-337 **[1209]** The second from the left branch of Figure 12-25 shows how the IDT reacts to a CONNECT message that signals that the customer has answered a terminating call. On receipt of the message, the IDT shall consider the call to be in the Active (10) state.

CR12-338 **[1210]** The third from the left branch of Figure 12-25 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts when the switch has determined to stop ringback to the customer. The IDT shall send an INFORMATION message to the RDT, start timer T395, and consider the call to be in the Call Received (7) state.

CR12-339 **[1211]** The fourth from the left branch of Figure 12-25 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts to an INFORMATION message that acknowledges ringback cancellation. The IDT shall stop timer T395 and consider the call to be in the Call Received (7) state.

CR12-340 **[1212]** The rightmost branch of Figure 12-25 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts to a timer T395 timeout that indicates that the RDT has not responded to the canceling of the ringback. The IDT shall send another INFORMATION message and consider the call to be in the Call Received (7) state.

8. To satisfy the criteria of TR-NWT-000031 for calling number delivery, the IDT must send the data transmission within the first long silent interval of the alerting cadence. Because the RDT controls the alerting cadence in out-of-band signaling systems, the LDS/IDT must wait for the NOTIFY message before beginning the data transmission.

12.5.5.5.2 RDT (Call Received - 7)

This state applies only to the CSC.

R12-341 **[1213]** The left branch of Figure 12-26 shows how the RDT reacts when an alerting cadence has entered the first long silent interval. When the alerting cadence enters the first long silent interval that satisfies the criteria of TR-NWT-000031, the RDT shall transmit a NOTIFY message and consider the call to be in the Call Received (7) state.

R12-342 **[1214]** The second from the left branch of Figure 12-26 shows how the RDT reacts after detecting that the customer has answered a terminating call. While applying an alerting signal to a loop or ground start circuit, if the RDT detects loop closure, it shall trip ringing. The RDT shall then transmit a CONNECT message and consider the call to be in the Active (10) state.

CR12-343 **[1215]** The third from the left branch of Figure 12-26 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts to an INFORMATION message that indicates to stop ringback to the customer. The RDT shall consider the call to be in the Call Received (7) state.

CR12-344 **[1216]** The rightmost branch of Figure 12-26 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts to an INFORMATION message that indicates to stop ringback to the customer. The RDT shall send an INFORMATION message back to the IDT and consider the call to be in the Call Received (7) state.

NOTE — Connect Request - 8 is provided in Section 12.5.5.18.

12.5.5.6 Call Proceeding - 9

12.5.5.6.1 IDT (Call Proceeding - 9)

This state applies only to the CSC.

R12-345 **[1217]** The leftmost branch of Figure 12-28 shows how the IDT reacts to a NOTIFY message that signals that the RDT has detected a start dial signal on a loop reverse battery circuit. On receipt of the message, the IDT shall consider the call to be in the Call Proceeding (9) state.

R12-346 **[1218]** The second branch from the left of Figure 12-28 shows how the IDT reacts when it must forward the destination address to the RDT for outpulsing onto a loop reverse battery circuit. If dial pulse digits will be used to outpulse the destination address, the IDT shall send an INFORMATION message carrying all of the digits to the RDT. If DTMF or MF digits will be used, the IDT shall itself outpulse the number. Afterward, the IDT shall consider the call to be in the Call Proceeding (9) state.

R12-347 **[1219]** The third branch from the left of Figure 12-28 shows how the IDT reacts to a CONNECT message that signals that the customer has answered a terminating call on a loop reverse battery circuit. On receipt of the message, the IDT shall consider the call to be in the Active (10) state.

R12-348 **[1220]** The rightmost branch of Figure 12-28 shows how the IDT abandons a call attempt on a loop reverse battery circuit. The IDT shall transmit a DISCONNECT message and start timer T305. After doing so, it shall consider the call to be in the Disconnect Indication (12) state.

12.5.5.6.2 RDT (Call Proceeding - 9)

This state applies only to the CSC.

R12-349 **[1221]** The left branch of Figure 12-29 shows how the RDT reacts after detecting a start dial signal on a loop reverse battery circuit. The RDT shall transmit a NOTIFY message and shall consider the call to be in the Call Proceeding (9) state.

R12-350 **[1222]** The central branch of Figure 12-29 shows how the RDT reacts to an INFORMATION message that carries the destination number to be outpulsed onto a loop reverse battery circuit. The RDT shall outpulse the destination number as described in Section 5.4.1 of T1.405-1989 and shall consider the call to be in the Call Proceeding (9) state.

R12-351 **[1223]** The right branch of Figure 12-29 shows how the RDT reacts after detecting that the customer has answered a terminating call on a loop reverse battery circuit. The RDT shall transmit a CONNECT message and shall consider the call to be in the Active (10) state.

12.5.5.7 Active - 10

12.5.5.7.1 IDT (Active - 10)

R12-352 **[1224]** The left branch of Figure 12-30 applies only to the CSC and shows how the IDT reacts to an INFORMATION message that signals that the RDT has detected either a switchhook flash or a dial pulse digit from the customer. On receipt of the message, the LDS shall determine whether or not the RDT should connect dial pulse detection circuitry to the line. The IDT shall consider the call to be in the Active (10) state.

R12-353 **[1225]** The right branch of Figure 12-30 applies only to the CSC and shows how the IDT reacts when the LDS determines that the RDT must either attach or remove its dial pulse detection circuitry. The IDT shall transmit a NOTIFY message and consider the call to be in the Active (10) state.

12.5.5.7.2 RDT (Active - 10)

R12-354 **[1226]** The left branch of Figure 12-31 applies only to the CSC and shows how the RDT reacts after detecting either a switchhook flash or a dial pulse digit. The RDT shall transmit an INFORMATION message to tell the IDT of the event detected and shall consider the call to be in the Active (10) state.

R12-355 **[1227]** The second from the left branch of Figure 12-31 applies only to the CSC and shows how the RDT reacts to a NOTIFY message that signals that it must either attach or remove its dial pulse detection circuitry. On receipt of the message, the RDT shall either attach or remove dial pulse detection circuitry as signaled in the message. This branch also shows how the RDT reacts to a NOTIFY message that signals that it must either enable or disable flash for the remainder of the call. On receipt of the message, the RDT shall override its provisioned flash capability and either enable or disable flash as signaled in the message. Afterward, it shall consider the call to be in the Active (10) state.

R12-356 **[1228]**

… 1. The third from the left branch of Figure 12-31 applies only to the TMC and shows how the RDT reacts after rejecting the time-slot assignment for an originating call. The RDT shall reject the time-slot assignment if it believes that the DS0 indicated by the IDT is unavailable (see

cause=34 in Section 12.5.2.3.5). The RDT shall transmit a RELEASE COMPLETE message with cause value 34, "Channel Unavailable," and release the call reference value. After sending the message, the RDT shall consider the call to be in the Null (0) state.

… 2. The RDT shall use cause=41 "Temporary Failure" to reject all call setup attempts due to the unavailability of a distribution channel. The LDS shall keep peg counts of call attempt failures due to cause value=41, for both originating and terminating calls. To achieve this counting capability at the LDS for originating calls utilizing TMC, the RDT shall be required to generate a Setup message toward the LDS even when a distribution channel is unavailable. If a distribution channel does not become available on receipt of the Connect message from the LDS, the RDT shall send Release Complete to the LDS with cause=41 rather than the Connect Acknowledge message. After sending the message, the RDT shall consider the call to be in the Null (0) state.

BCCs have identified a need to measure blocking in the distribution network. Bellcore has reissued GR-376-CORE, *OTGR Section 15.3: Generic Operations Interfaces Using OSI Tools: Network Data Collection* in 1997 with new managed objects defined for operational measurements (such as distribution blocking) to be collected at an HDT/RDT. These measurements would be collected from the HDT/RDT using a CMISE interface to an EMS/OS.

R12-357 **[1229]** The fourth from the left branch of Figure 12-31 applies only to the TMC and shows how the RDT reacts after successfully connecting the line unit to the DS0 indicated by the IDT. After making the connection, the RDT shall begin inserting and reacting to ABCD codes and transmit a CONNECT ACKNOWLEDGE message. Afterward, it shall consider the call to be in the Active (10) state.

R12-358 **[1230]** The right branch of Figure 12-31 applies only to the TMC and shows how the RDT responds to RELEASE COMPLETE messages that indicate that the IDT has timed-out a second time on a call setup attempt. On receipt of a RELEASE COMPLETE message, the RDT shall release the call reference and consider the call in the Null (0) state.

12.5.5.8 Disconnect Request - 11

12.5.5.8.1 IDT (Disconnect Request - 11)

This state applies only to the CSC.

R12-359 **[1231]** The leftmost branch of Figure 12-32 shows how the IDT reacts when the LDS has completed call clearing initiated by the customer. When the IDT has disconnected the DS0 assigned to the call, it shall transmit a RELEASE message and start timer T308. The cause value in the RELEASE message shall match that in the DISCONNECT message. After doing so, it shall consider the call to be in the Release Request (19) state.

R12-360 **[1232]** The second from the left branch of Figure 12-32 applies to reverting multi-party calls.[9] The IDT shall transmit a SETUP message and start timer T303. After doing so, it shall consider the call to be in the Call Present (6) state.

CR12-361 **[1233]** The third from the left branch of Figure 12-32 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT informs the RDT to apply ringback to the customer. The IDT shall send an INFORMATION message, start timer T395, and consider the call to be in the Call Present (6) state.

CR12-362 **[1234]** The fourth from the left branch of Figure 12-32 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts to an INFORMATION message that indicates that the customer has gone off-hook. Upon receipt of the INFORMATION message, the IDT shall consider the call to be in the Disconnect Request (11) state.

CR12-363 **[1235]** The rightmost branch of Figure 12-32 applies only to the CSC and only if the IDT supports expanded 911 service and shows how the IDT reacts when the switch has established that it can re-establish the call. The IDT shall send a CONNECT message and consider the call to be in the Active (10) state.

12.5.5.8.2 RDT (Disconnect Request - 11)

This state applies only to the CSC.

R12-364 **[1236]** The leftmost branch of Figure 12-33 shows how the RDT reacts to a RELEASE message that signals that the IDT has completed call clearing initiated by the customer. On receipt of the message, the RDT shall stop timer T305 and disconnect the line unit from the DS0 assigned to the call. The RDT shall then transmit a RELEASE COMPLETE message, release the call reference, and consider the call to be in the Null (0) state. The cause

9. A *reverting* call is one in which both the calling and called parties share the same multi-party circuit.

value in the RELEASE COMPLETE message shall match that in the RELEASE message.

R12-365 **[1237]** The second branch from the left of Figure 12-33 shows how the RDT reacts to a DISCONNECT message that signals that the IDT has begun call clearing.[10] On receipt of the message, the RDT shall stop timer T305 and transmit a RELEASE message. The cause value shall match that in the DISCONNECT message received from the IDT. After doing so, it shall start timer T308 and consider the call to be in the Release Request (19) state.

R12-366 **[1238]** The third branch from the left of Figure 12-33 shows how the RDT reacts when timer T305 expires because the IDT has failed to reply to a DISCONNECT message. When timer T305 times out, the RDT shall transmit a RELEASE message, start timer T308, and consider the call to be in the Release Request (19) state. The cause value in the RELEASE message shall match that in the DISCONNECT message that initiated call clearing.

R12-367 **[1239]** The rightmost branch of Figure 12-33 shows how the RDT reacts to a SETUP message for a reverting multi-party call. On receipt of the message, the RDT shall stop timer T305 and consider the call to be in the Call Present (6) state.

CR12-368 **[1240]** The leftmost branch of Figure 12-33 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts to a CONNECT message indicating that the call has been re-established. The RDT shall consider the call to be in the Active (10) state.

CR12-369 **[1241]** The second from the left branch of Figure 12-33 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts to an INFORMATION message informing the RDT to apply ringback to the customer. The RDT shall consider the call to be in the Call Present (6) state.

CR12-370 **[1242]** The third from the left branch of Figure 12-33 (continued) applies only to the CSC and only if the IDT supports expanded 911 service and shows how the RDT reacts when it determines that the customer has gone off-hook. The RDT shall send an INFORMATION message and consider the call to be in the Disconnect Request (11) state.

10. This branch addresses the scenario in which the IDT and customer simultaneously initiate call clearing resulting in DISCONNECT messages that “cross” on the CSC.

R12-371 **[1243]** The rightmost branch of Figure 12-33 (continued) applies only to the CSC and shows how the RDT reacts to a NOTIFY message indicating that the IDT has received the DISCONNECT message and is determining whether to tear down the call. The RDT shall stop timer T305 and consider the call to be in the Disconnect Request (11) state.

12.5.5.9 Disconnect Indication - 12

12.5.5.9.1 IDT (Disconnect Indication - 12)

R12-372 **[1244]** The left branch of Figure 12-34 applies to both the TMC and the CSC and shows how the IDT reacts to a RELEASE message that signals that the RDT has completed call clearing. On receipt of the message, the IDT shall stop timer T305 and transmit a RELEASE COMPLETE message. The cause value shall match that in the RELEASE message. If the cause value in the RELEASE message was 27, the IDT shall consider the call to be in the Permanent Signal (100) state. If the cause value was not 27, the IDT shall release the call reference and consider the call to be in the Null (0) state.

R12-373 **[1245]** The central branch of Figure 12-34 applies only to the CSC and shows how the IDT reacts to a DISCONNECT message that signals that the RDT has begun call clearing. On receipt of the message, the IDT shall stop timer T305 and transmit a RELEASE message. The cause value in the RELEASE message shall match that in the DISCONNECT message originally sent by the RDT. After doing so, it shall start timer T308 and consider the call to be in the Release Request (19) state.

R12-374 **[1246]** The right branch of Figure 12-34 applies to both the TMC and the CSC and shows how the IDT reacts when timer T305 expires because the RDT failed to respond to a DISCONNECT message. When timer T305 times-out, the IDT shall transmit a RELEASE message, start timer T308, and consider the call to be in the Release Request (19) state. The cause value in the RELEASE message shall match that in the DISCONNECT message originally sent by the IDT.

12.5.5.9.2 RDT (Disconnect Indication - 12)

R12-375 **[1247]** Figure 12-35 applies to both the TMC and the CSC and shows how the RDT reacts after completing call clearing. After disconnecting the line unit from the DS0 assigned to the call, the RDT shall transmit a RELEASE

message. The cause value in the message shall match that in the DISCONNECT message. After doing so, it shall start timer T308 and consider the call to be in the Release Request (19) state.

12.5.5.10 Release Request - 19

12.5.5.10.1 IDT (Release Request - 19)

R12-376 **[1248]** The left branch of Figure 12-36 applies to both the TMC and the CSC and shows how the IDT reacts to a RELEASE COMPLETE message that signals that the RDT has completed call clearing. On receipt of the message, the IDT shall stop timer T308. If the cause value in the RELEASE COMPLETE message was 27, the IDT shall consider the call to be in the Permanent Signal (100) state. If the cause value was not 27, the IDT shall release the call reference and consider the call to be in the Null (0) state.

R12-377 **[1249]** The right branch of Figure 12-36 applies to both the TMC and the CSC and shows how the IDT reacts when timer T308 expires because the RDT failed to reply to a RELEASE message. The IDT shall determine if it is the first T308 timeout for the call. If it is, the IDT shall transmit a RELEASE message, start timer T308, and consider the call to be in the Release Request (19) state. The cause value in the message shall match that in the preceding RELEASE message. If it is not the first T308 timeout, the IDT shall release the call reference and consider the call to be in the Null (0) state. If the cause value was 27 in the RELEASE message, then the RDT probably never made it to the Permanent Signal (100) state and the switch shall be notified of this.

12.5.5.10.2 RDT (Release Request - 19)

Figure 12-37 applies to both the TMC and the CSC.

R12-378 **[1250]** The left branch shows how the RDT reacts to a RELEASE COMPLETE message that signals that the IDT has completed call clearing. On receipt of the message, the RDT shall stop timer T308. If the cause value in the message was 27, the RDT shall consider the call to be in the Permanent Signal (100) state. If the cause value was not 27, the RDT shall release the call reference and consider the call to be in the Null (0) state.

R12-379 **[1251]** The right branch shows how the RDT reacts when timer T308 expires because the IDT failed to respond to a RELEASE message. The RDT shall determine if it is the first T308 timeout. If it is, the RDT shall transmit a RELEASE message, start timer T308, and consider the call to be in the Release Request (19) state. The cause value in the message shall match that in the preceding RELEASE message. If it is not the first T308 timeout, the RDT shall release the call reference and consider the call to be in the Null (0) state.

12.5.5.11 Call Clearing

12.5.5.11.1 IDT (Call Clearing)

Figure 12-38 illustrates the initial phase of the call clearing procedures used by the IDT.

R12-380 **[1252]** The leftmost branch applies only to the CSC and shows how the IDT reacts to a DISCONNECT message received for a call that is not in state 0, 11, 12, or 100. The DISCONNECT message signals that the RDT has detected that the customer has gone on-hook. On receipt of the message, the IDT shall stop any timer that is running, send a NOTIFY message to the RDT and shall consider the call to be in the Disconnect Request (11) state.

R12-381 **[1253]** The second from the left branch of Figure 12-38 applies only to the CSC and shows how the IDT reacts to a RELEASE message received for a call that is not in state 0, 11, 12, or 100. On receipt of the message, the IDT shall disconnect the DS0 assigned to the call and transmit a RELEASE COMPLETE message. Afterward, it shall release the call reference and consider the call to be in the Null (0) state.

R12-382 **[1254]** The third from the left branch of Figure 12-38 applies to both the TMC and the CSC and shows how the IDT reacts when it determines that a call that is not in state 0, 6, 9, 11, 12, 19, or 100 can be cleared; for TMC this branch only applies in state 1, 8, or 10. The IDT shall stop any timer that is running and transmit a DISCONNECT message. After doing so, it shall start timer T305 and consider the call to be in the Disconnect Indication (12) state.

R12-383 **[1255]** The rightmost branch of Figure 12-38 applies only to the TMC and shows how the IDT reacts when it determines that a call attempt in state 1, 6, or 8 has *experienced a processing error and the call should be released immediately*. The IDT shall stop any timer that is running and transmit a

RELEASE COMPLETE message. After doing so, it shall release the call reference and consider the call in the Null (0) state.

12.5.5.11.2 RDT (Call Clearing)

R12-384 **[1256]** The leftmost branch of Figure 12-39 applies to both the TMC and the CSC and shows how the RDT reacts to a RELEASE message received for a call that is not in state 0, 1, 6, 11, 12, 19, or 100; for TMC this branch only applies in state 10. On receipt of the message, the RDT shall disconnect the RDT line unit from the DS0 assigned to the call. Afterward, it shall transmit a RELEASE COMPLETE message. The cause value shall match that in the RELEASE message. If the cause value in the RELEASE message was 27, the RDT shall consider the call to be in the Permanent Signal (100) state. If the cause value was not 27, the RDT shall release the call reference and consider the call to be in the Null (0) state.

R12-385 **[1257]** The second from the left branch of Figure 12-39 applies to both the TMC and the CSC and shows how the RDT reacts to a DISCONNECT message received for a call that is not in state 0, 1, 6, 11, 12, 19, or 100 that signals that the IDT has determined that the call can be cleared; for TMC this branch only applies in state 10. For the CSC only, on receipt of the message, the RDT shall apply loop current feed open to a loop/ground start circuit and loop open to a loop reverse battery circuit. After doing so, it shall consider the call to be in the Disconnect Indication (12) state.

R12-386 **[1258]** The third from the left branch of Figure 12-39 applies only to the CSC and shows how the RDT reacts when it determines that the customer has gone on-hook. The RDT shall transmit a DISCONNECT message, start timer T305, and consider the call to be in the Disconnect Request (11) state.

R12-387 **[1259]** The rightmost branch of Figure 12-39 applies only to the TMC and shows how the RDT reacts when it determines that a call attempt in state 1 or 6 has experienced a processing error and the call should be released immediately. The RDT shall stop any timer that is running and transmit a RELEASE COMPLETE message. After doing so, it shall release the call reference and consider the call in the Null (0) state.

12.5.5.12 Coin - Option

GR-528-CORE provides detailed criteria for coin service.

12.5.5.12.1 IDT (Coin)

Figure 12-40 applies only to the CSC and shows the additional IDT CSC procedures necessary to support coin service.

R12-388 **[1260]** The left branch shows how the IDT reacts when it needs to perform a coin function. If it is a coin control operation, the IDT shall transmit a NOTIFY message and consider the call to be in the same state. If it is a coin presence test, the IDT shall transmit a NOTIFY message, start timer T399, and consider the call to be in the same state.

R12-389 **[1261]** The central branch shows how the IDT reacts to a NOTIFY message that reports the results of a coin presence test. On receipt of the message, the IDT shall stop timer T399 and process the coin presence test results. It shall consider the call to be in the same state as when it received the NOTIFY message.

R12-390 **[1262]** The right branch shows how the IDT reacts when timer T399 expires before the RDT has reported the results of a coin presence test. If it is the first T399 timeout, the IDT shall retransmit the NOTIFY message, restart T399, and consider the call to be in the same state. If it is not the first T399 timeout, the IDT shall inform the LDS of the error and consider the call to be in the same state as when the timer expired.

12.5.5.12.2 RDT (Coin)

Figure 12-41 applies only to the CSC and shows the additional RDT CSC procedures necessary to support coin service.

R12-391 **[1263]** The left branch shows how the RDT reacts to a NOTIFY message that signals that the IDT needs to perform a coin function. On receipt of the message, the RDT shall initiate the necessary coin operation. After doing so, it shall consider the call to be in the same state as when it received the NOTIFY message.

R12-392 **[1264]** The right branch shows how the RDT reacts after completing a coin presence test. The RDT shall transmit the results in a NOTIFY message and consider the call to be in the same state.

12.5.5.13 Tip Party Test - Option

12.5.5.13.1 IDT (Tip Party Test)

Figure 12-42 applies only to the CSC and shows the additional IDT CSC procedures necessary to support two-party service.

R12-393 **[1265]** The left branch shows how the IDT reacts when it needs to perform a tip party test to determine which party on a two-party line is requesting service. The IDT shall transmit a NOTIFY message, start timer T398, and consider the call to be in the same state.

R12-394 **[1266]** The central branch shows how the IDT reacts to a NOTIFY message that conveys the result of a tip party test. On receipt of the message, the IDT shall stop timer T398 and begin processing the tip party test results. It shall consider the call to be in the same state as when it received the NOTIFY message.

R12-395 **[1267]** The right branch shows how the IDT reacts if timer T398 expires before the RDT has returned the results of a tip party test. If it is the first T398 timeout, the IDT shall retransmit the NOTIFY message, restart T398, and consider the call to be in the same state. If it is not the first T398 timeout, the IDT shall inform the LDS of the error and consider the call to be in the same state as when the timer expired.

12.5.5.13.2 RDT (Tip Party Test)

Figure 12-43 applies only to the CSC and shows the additional RDT CSC procedures necessary to support two-party service.

R12-396 **[1268]** The left branch shows how the RDT reacts to a NOTIFY message that requests it to perform a tip party test on a two-party line. On receipt of the message, the RDT shall initiate a tip party test. It shall consider the call to be in the same state as when it received the NOTIFY message.

R12-397 **[1269]** The right branch shows how the RDT reacts after completing a tip party test. The RDT shall transmit the results in a NOTIFY message and consider the call to be in the same state.

12.5.5.14 Permanent Signal Procedures

These procedures apply to both the TMC and the CSC and have been developed to protect concentrated IDLC systems when many customers generate simultaneous permanent signals.

R12-398 **[1270]** If the IDT wishes to clear a call that is generating a permanent signal, it shall use cause value 27, "Destination Out of Service," in the DISCONNECT message sent to the RDT. The RDT shall not use cause value 27 in a DISCONNECT message.

R12-399 **[1271]** When the RDT receives a DISCONNECT message with cause value 27, it clears the call. However, after completing call clearing, it shall continue to monitor the line for its return to on-hook status.

R12-400 **[1272]** Because cause value 27 is only used to coordinate the clearing of a call from the Active (10) state into the Permanent Signal (100) state, cause value 27 shall only be valid in states 10, 11, 12, and 19; in all other states, a cause value of 27 shall be considered as invalid.

This section describes the procedures followed while the RDT is monitoring the line. If the IDT wishes to query the RDT about the condition of the line, it may send a STATUS ENQUIRY message. If the switch wishes to resend a permanent signal announcement, it may direct the IDT to return the line to the Null (0) state and send a SETUP message to the RDT to initiate (as specified in Section 12.5.5.16.3) a time-slot-assignment for transmission of the permanent signal announcement.

12.5.5.14.1 IDT (Permanent Signal - 100)

Figure 12-44 applies to both the TMC and the CSC.

R12-401 **[1273]** The left branch shows how the IDT reacts to an INFORMATION message that signals that a line that had been generating a permanent signal is on-hook. On receipt of the message, the IDT shall acknowledge that the customer is on-hook by sending an INFORMATION message and shall consider the call to be in the Null (0) state.

R12-402 **[1274]** The right branch shows how the IDT reacts to a SETUP message that signals that a line that had been generating a permanent signal is requesting service.[11] The Q.931 control entity shall inform the call control

11. This branch addresses a possible error scenario in which the IDT fails to receive the INFORMATION message that normally signals that a line that had been generating a permanent signal has gone on-hook.

entity that the line termination identified by the call reference value is requesting service and shall consider the call to be in the Call Initiated (1) state.

12.5.5.14.2 RDT (Permanent Signal - 100)

R12-403 **[1275]** Figure 12-45 applies to both the TMC and the CSC and shows how the RDT reacts after detecting that a line in the Permanent Signal state is generating a valid on-hook, or that a line generating a valid on-hook has just entered the Permanent Signal state. The RDT shall transmit an INFORMATION message, start timer T397, and consider the call to be in the Null (0) state.

O12-404 **[1276]** In the above requirement, a continuous loop open for >400 ms should be interpreted by the RDT as a valid on-hook for lines in the Permanent Signal state because flash signals are not expected in the Permanent Signal (100) state.

12.5.5.15 Call State Mismatch Procedures

A call state mismatch exists when the two ends of an IDLC system, IDT and RDT, perceive the call to be in different call states. These procedures apply to both the TMC and the CSC and have been developed to allow IDLC systems to recover from possible call state mismatches.

12.5.5.15.1 IDT (Call State Mismatch)

Figure 12-46 applies to both the TMC and the CSC and shows the call state mismatch procedures followed by the IDT. The figure appears on two pages.

CR12-405 **[1277]** The left branch of the first page of Figure 12-46 shows how the IDT reacts when it determines that a possible call state mismatch exists. The IDT can, as an option, transmit a STATUS ENQUIRY message and start timer T322. After doing so, it shall consider the call to be in the same state.

NOTE: If the IDT transmits a STATUS ENQUIRY message while in a transitory state (i.e., any state other than 0, 10, or 100), a call state mismatch may result when no “real” mismatch exist.

CR12-406 **[1278]** The right branch of the first page of Figure 12-46 shows how the IDT reacts if the STATUS ENQUIRY option is implemented and timer T322 expires before a STATUS message is received from the RDT. If it is the first T322 timeout, the IDT shall transmit a STATUS ENQUIRY message, restart timer T322, and consider the call to be in the same state as when the timer expired. If it is not the first T322 timeout, the IDT shall immediately release the call by transmitting a RELEASE message with cause value 41, "Temporary Failure." After starting timer T308, it shall consider the call to be in the Release Request (19) state.

R12-407 **[1279]** Figure 12-46 (continued) shows how the IDT reacts to a STATUS message that conveys the state of the call as perceived by the RDT.

… 1. On receipt of the message, the IDT shall stop timer T322 if it is running and determine if a call state mismatch exists. If there is not a mismatch, the IDT shall consider the call to be in the same state.

… 2. If there is a mismatch and cause=30, indicating that the STATUS message is in response to a STATUS ENQUIRY, the IDT shall stop any timers that may be running and transmit a RELEASE COMPLETE message with cause value 41, "Temporary Failure." After doing so, the IDT shall release the call reference and consider the call in the Null (0) state.

… 3. If there is a mismatch and cause is other than 30, indicating that the STATUS message is unsolicited, the IDT shall respond to the STATUS message by either

… a. Stopping any timers that may be running, transmitting a RELEASE COMPLETE message with cause value 41, releasing the call reference, and considering the call in the Null (0) state

… b. Transmitting a STATUS ENQUIRY message, starting timer T322, and considering the call in the same state.

12.5.5.15.2 RDT (Call State Mismatch)

Figure 12-47 applies to both the TMC and the CSC and shows the call state mismatch procedures followed by the RDT.

R12-408 **[1280]** The left branch of Figure 12-47 shows how the RDT responds to the receipt of a STATUS ENQUIRY message. The RDT shall transmit a STATUS message (cause=30) to report its perception of the call state. After doing so, it shall consider the call to be in the same state as when it received the STATUS ENQUIRY message.

R12-409 **[1281]** The right branch of Figure 12-47 shows how the RDT reacts when it determines that a possible call state mismatch exists. The RDT shall transmit a STATUS message and consider the call to be in the same state.

R12-410 **[1282]** An RDT shall use the information contained in a received STATUS message to correct the condition that caused the IDT to send the STATUS message, if possible. The primary intent is that the RDT shall not let itself remain in a sequence that continues to transmit messages that are unacceptable to the IDT without resolving the issue or reporting it to a maintenance center.

12.5.5.16 Error Handling Procedures

This section defines TMC/CSC error conditions and describes the steps that the IDT and/or RDT should take when an error condition is detected.

12.5.5.16.1 Protocol Discriminator Error

This applies to both the TMC and CSC.

R12-411 **[1283]** If the IDT or RDT receives a message in which the protocol discriminator is not coded as described in Section 12.5.2.3, they shall ignore the message. *Ignore* means to act as if the message had never been received.

12.5.5.16.2 Length Error

This applies to both the TMC and CSC.

R12-412 **[1284]** If the IDT or RDT receives a message that is less than five octets long, they shall ignore the message.

12.5.5.16.3 Call Reference Errors

Except as noted, this applies to both the TMC and CSC.

R12-413 **[1285]** If the IDT or RDT receives a message in which the call reference is present but is not coded as described in Section 12.5.2.3 (e.g., greater than 2048 or the range supported by RDT), they shall ignore the message.

R12-414 **[1286]** If the IDT receives any message **except** SETUP, RELEASE COMPLETE, or STATUS in which the call reference value indicates a call that they perceive to be in the Null state, it shall transmit a RELEASE COMPLETE message with cause value 81, “Invalid Call Reference.”

R12-415 **[1287]** If the RDT receives any message **except** SETUP, INFORMATION, RELEASE COMPLETE, STATUS ENQUIRY, or STATUS in which the call reference value indicates a call that they perceive to be in the Null state, it shall transmit a RELEASE COMPLETE message with cause value 81, “Invalid Call Reference.”

R12-416 **[1288]** If the IDT receives a SETUP message in which the call reference indicates a call that it perceives **is not** in the Null state or the Permanent Signal state, it shall ignore the message.

R12-417 **[1289]** If the RDT receives a SETUP message in which the call reference indicates a call that it perceives **is not** in the Null state, it shall proceed as in the rightmost branch of Figure 12-20; except that “Stop T303/T396” shall be interpreted to mean “stop any timer” and “Setup -ind” shall be interpreted to mean “Release -ind” followed by “Setup -ind.”

… For TMC applications, if there is no change in DS0 assignment, the ABCD code being sent to the IDT shall continue to reflect the true status of the line; i.e., the DS0 idle code shall not be sent toward the IDT during the release-setup interval of this error handling procedure because of the possibility of a false ring-trip under specific timing conditions.

R12-418 **[1290]** If the IDT receives a RELEASE COMPLETE message in which the call reference indicates a call that it perceives is in the Null State, it shall ignore the message.

… If the RDT receives a RELEASE COMPLETE message in which the call reference indicates a call that it perceives is in the Null State, it shall satisfy the criteria in R12-425 [1297].

R12-419 **[1291]** On the CSC, if the RDT receives a STATUS message in which the call reference indicates a call that it perceives is in the Null state, it shall ignore the message.

R12-420 **[1292]** On the TMC, if the RDT receives a STATUS message in which the call reference indicates a call that they perceive is in the Null state, they shall ignore the message.

12.5.5.16.4 Message Type Error

Except as noted, this applies to both the TMC and CSC.

R12-421 **[1293]** If the IDT or RDT receives an unrecognized message, they shall ignore the message. An *unrecognized* message is one whose message type is not listed in Table 12-7.

O12-422 **[1294]** On receipt of an unrecognized message, the IDT and RDT should transmit a STATUS message with cause value 97, “Message Type Unimplemented”.

R12-423 **[1295]** If the IDT or RDT receives an unexpected message, other than RELEASE or RELEASE COMPLETE, they shall ignore the message. An *unexpected* message is one not described in Section 12.5.5.

R12-424 **[1296]** If the RDT receives an unexpected RELEASE message in any state other than the Null state, it shall stop any timers that may be running and react as shown in the leftmost branch of Figure 12-39.

R12-425 **[1297]** If the RDT receives an unexpected RELEASE COMPLETE message, it shall react as shown in the leftmost branch of Figure 12-37. “Stop T308” shall be interpreted to mean “stop any timer.”

R12-426 **[1298]** On the TMC, if the IDT receives an unexpected RELEASE or RELEASE COMPLETE message, it shall ignore the message.

R12-427 **[1299]** On the CSC, if the IDT receives an unexpected RELEASE message, it shall react as shown in the leftmost branch of Figure 12-34. “Stop T305” shall be interpreted to mean “stop any timer.”

R12-428 **[1300]** On the CSC, if the IDT receives an unexpected RELEASE COMPLETE message, it shall react as shown in the leftmost branch of Figure 12-36. “Stop T308” shall be interpreted to mean “stop any timer.”

12.5.5.16.5 Mandatory Information Element Missing Error

This applies to both the TMC and CSC.

R12-429 **[1802]** If the IDT or RDT receives a TMC message that is missing the Protocol Discriminator, Message Type, or Call Reference information element, it shall ignore the message. Ignore means to act as if the message had never been received.

R12-430 **[1301]** If the IDT or RDT receives a message other than SETUP, DISCONNECT, RELEASE, or RELEASE COMPLETE that is missing a mandatory information element, they shall ignore the message and transmit a STATUS message with cause value 96, “Mandatory Element Missing.”

R12-431 **[1302]** If the IDT or RDT receives a SETUP message that is missing a mandatory information element, they shall ignore the message and transmit a RELEASE COMPLETE message with cause value 96, “Mandatory Element Missing.”

R12-432 **[1803]** If the IDT or RDT receives a DISCONNECT, RELEASE, or RELEASE COMPLETE message that is missing a mandatory information element besides the cause element, they shall ignore the message and transmit a STATUS message with cause value 96, “Mandatory Element Missing”.

R12-433 **[1303]** If the IDT or RDT receives a DISCONNECT, RELEASE, or RELEASE COMPLETE message that is missing the cause element, they shall react as if the cause element had been included and carried the cause value 16, “Normal Clearing.”

12.5.5.16.6 Information Element Content Error

This applies to both the TMC and CSC.

R12-434 **[1304]** If the IDT or RDT receives a message other than SETUP, DISCONNECT, RELEASE, or RELEASE COMPLETE in which the contents of an information element are invalid, they shall ignore the message and transmit a STATUS message with cause value 100, “Invalid Information Element Contents.” *Invalid* means that the contents are not described in Section 12.5.2.3.

R12-435 **[1305]** If the IDT or RDT receives a SETUP message in which the contents of an information element are invalid, they shall ignore the message and transmit a RELEASE COMPLETE message with cause value 100, “Invalid Information Element Contents.”

R12-436 **[1306]** If the IDT or RDT receives a DISCONNECT, RELEASE, or RELEASE COMPLETE message in which the contents of the cause element are invalid, they shall act as if the cause element had carried cause value 16, “Normal Clearing.”

12.5.5.16.7 Unrecognized Information Element Error

This applies to both the TMC and CSC.

O12-437 **[1307]** If the IDT or RDT receives a message that contains one or more unrecognized information elements, they should accept the message and act on those information elements that they recognize. An *unrecognized* information element is one not listed in Section 12.5.2.2 for the message being received.

CO12-438 **[1308]** If the capability in O12-437 [1307] is supported, then upon receipt of a message with one or more unrecognized information elements, the IDT and RDT should transmit a STATUS message with cause value 99, "Information Element Unimplemented."

An unrecognizable information element can occur anywhere within a message after the Protocol Discriminator, Call Reference, and Message Type. Criteria for determining the length of the information elements, include the following:

- If bit 8 = 1 in the first octet, then it is a single octet element.
- If bit 8 = 0 in the first octet, then it is a variable length element and octet 2 defines the length.
- The maximum TMC message length is 32 octets; from LAPD parameter N201 (maximum number of octets in an I-frame field).

CR12-439 **[1804]** If an IDT or RDT does not support O12-437 [1307], it shall satisfy the requirements in Section 12.5.5.16.5, Mandatory Information Element Missing Error, when unrecognized data is received within a message. Status messages (cause=96) shall only be generated when all mandatory information elements cannot be extracted from the message because of unrecognized data within the message.

12.5.5.16.8 Channel Identification Error

This applies to both the TMC and CSC.

R12-440 **[1309]** If the IDT receives a message in which the DS0 (and DS1) indicated in the channel identification element does not match that assigned to the call, it shall initiate call clearing.

12.5.5.16.9 Cutoff Calls

A cutoff call occurs when an established connection is broken for some reason other than an on-hook by one of the parties. The procedures of Section 12.5.5 of this GR minimize the occurrence of cutoff calls on an IDLC system, but cannot anticipate every possible failure/error scenario.

R12-441 **[1310]** As specified in Section 11.3.3 of TR-TSY-000511 (Section 11 of LSSGR), for all types of failures/errors within a switching system (which includes the IDT), the probability that a stable call is cut off shall not exceed 0.000125. This corresponds to a long-term average cutoff call rate of no more than one cutoff in 8000 calls.

R12-442 **[1311]** For an RDT, the probability that a stable call is cut off shall also not exceed 0.000125.

These requirements are based on call holding times with a mean value and distribution typical of local exchanges.

12.5.5.16.10 Unexpected Call Origination Requests

R12-443 **[1312]** If the RDT detects a call origination request that was preceded by a valid customer disconnect (e.g., a customer off-hook that was preceded by a customer on-hook of greater than 1550 ms) in any state other than the Null or Permanent Signal state, it shall transmit a STATUS message (with cause value of 41) to the IDT.

Upon answering a terminating call, the above criteria will be satisfied and an RDT is allowed, but **not required**, to send a STATUS message.

R12-444 **[1313]** For an RDT in the Permanent Signal state, that detects a call origination request, the RDT shall initiate call establishment via a SETUP message to the IDT, as shown in the second branch from the left of Figure 12-18.

12.5.5.16.11 Call Treatment on RDT Reset

R12-445 **[1314]** An RDT shall generate AIS on all of its outgoing DS1s for at least 3 seconds when the RDT is reset and calls cannot be sustained. The IDT will detect AIS and initiate call clearing in 2.5 ± 0.5 seconds.

12.5.5.17 TMC/CSC Timers

This section describes the timers necessary for the TMC and CSC.

12.5.5.17.1 T303

This timer is used in both the TMC and the CSC. T303 is the length of time that the IDT and RDT will wait for a reply to a SETUP message.

R12-446 **[1315]** At the IDT, the value of T303 is not user settable, its value depends on specific vendor implementations, but shall be within the range of 700 ms to 4 seconds.

R12-447 **[1316]** The above range is not intended to define acceptable response-time performance at the RDT, where the low-load (i.e., no other external stimuli requiring call processing activity) mean response time to a SETUP message shall be no greater than 200 ms.

R12-448 **[1317]** At the RDT, the value of T303 shall be provisionable from 700 ms through 4.7 seconds in steps of 500 ms; the default shall be 700 ms.

R12-449 **[1318]** The above range is not intended to define acceptable response-time performance at the IDT, where the low-load (i.e., no other external stimuli requiring call processing activity) mean response time to a SETUP message shall be no greater than 500 ms.

12.5.5.17.2 T305

This timer specifies the length of time spent waiting for a reply to a DISCONNECT message.

R12-450 **[1319]** For the TMC, only the IDT sends DISCONNECT messages. At the IDT, the value of T305 shall be 4 seconds.

R12-451 **[1320]** For the CSC, both the IDT and RDT send DISCONNECT messages.

… a. At the IDT, the value of T305 shall be 4 seconds.

… b. At the RDT, the value of T305 shall be 13 seconds.

12.5.5.17.3 T308

This timer is used on both the TMC and the CSC. T308 specifies the length of time the IDT and RDT will wait for a reply to a RELEASE message.

R12-452 [1321] At both the IDT and RDT, the value of T308 shall be 4 seconds.

For the TMC, although the RDT normally sends RELEASE messages, the IDT may also send them in certain circumstances. For the CSC, both the IDT and RDT normally send RELEASE messages.

12.5.5.17.4 T322

This timer is used on both the TMC and the CSC. T322 may be used by the IDT when it determines that a possible call state mismatch exists.

CR12-453 [1322] If the IDT implements the optional call state mismatch procedures, the value of T322 shall be 2000 ms.

12.5.5.17.5 T397

This timer is used on both the TMC and the CSC. T397 specifies the length of time the RDT will wait for the IDT to acknowledge an INFORMATION message that indicated that a customer who had been generating a permanent signal has returned on-hook.

R12-454 [1323] The value of T397 shall be 120 seconds.

12.5.5.17.6 T398

This timer is used only on the CSC. T398 specifies the length of time the IDT will wait for a reply to a NOTIFY message requesting a tip party test on a two-party line.

R12-455 [1324] The value of T398 shall be 200 ms.

Section 6.2.4.3 of GR-506-CORE states that the IDT will apply the tip party test condition for at most 200 ms to accommodate lines served by DLC systems.

12.5.5.17.7 T399

This timer is used only on the CSC. T399 specifies the length of time the IDT will wait for the RDT to furnish the results of a coin presence test.

R12-456 **[1325]** The value of T399 shall be 750 ms.

Section 6.2.9.2 of GR-506-CORE states that the IDT should apply the coin presence test condition for at least 300 ms, and Section 6.2.9.6 states that it may take as long as 700 ms after applying the coin presence test voltage before the coin ground is removed.

12.5.5.17.8 T313

This timer is used by the IDT only on the TMC. T313 specifies the length of time the IDT will wait for a reply to a CONNECT message that assigns a DS0 to be used for an originating call.

R12-457 **[1326]** The value of T313 is not user settable, its value depends on specific vendor implementations but shall be within the range of 400 ms to 4 seconds.

R12-458 **[1327]** The above range is not intended to define acceptable response-time performance at the RDT, where the low-load (i.e., no other external stimuli requiring call processing activity) mean response time to a CONNECT message shall be no greater than 200 ms.

12.5.5.17.9 T396

This timer is used in both the TMC and the CSC. T396 is the length of time that the RDT will wait for a reply to a SETUP message following the initial expiration of timer T303.

R12-459 **[1328]** The value of T396 shall be provisionable from 700 ms through 14.7 seconds in steps of 1 second; the default shall be 14.7 seconds.

R12-460 **[1329]** The above range is not intended to define acceptable response-time performance at the IDT, where the low-load (i.e., no other external stimuli requiring call processing activity) mean response time to a SETUP message shall be no greater than 500 ms.

12.5.5.17.10 T395

This timer is used by the IDT only on the CSC and only if the IDT supports expanded 911 service. The ringback timer specifies the length of time the IDT will wait for a reply to an INFORMATION message with a signal element.

CR12-461 **[1330]** The value of the T395 shall be within the range of 1 second to 3 seconds; the default shall be 2 seconds.

12.5.5.18 Connect Request - 8

12.5.5.18.1 IDT (Connect Request - 8)

This state applies only to the TMC.

R12-462 **[1331]** The leftmost branch of Figure 12-27 shows how the IDT reacts to a CONNECT ACKNOWLEDGE message that signals that the RDT has successfully connected the line unit to the DS0 and is now inserting and reacting to ABCD codes. On receipt of the message, the IDT shall stop timer T313 and begin reacting to ABCD codes. Afterward, it shall consider the call to be in the Active (10) state.

R12-463 **[1332]** The central branch of Figure 12-27 shows how the IDT reacts to a RELEASE COMPLETE message that signals that the RDT has rejected the time-slot assignment for an originating call. On receipt of the message, the IDT shall stop timer T313, release the call reference, and consider the call in the Null (0) state.

R12-464 **[1333]** The rightmost branch of Figure 12-27 shows how the IDT reacts when timer T313 times-out before the RDT replies to a CONNECT message. If it is the first T313 timeout, the IDT shall retransmit a CONNECT message, restart T313, and consider the call to be in the Connect Request (8) state. If it is not the first T313 timeout, the IDT shall transmit a RELEASE COMPLETE message, release the call reference and consider the call to be in the Null (0) state.

12.5.5.18.2 RDT (Connect Request - 8)

This state does not apply to the RDT.

12.5.5.19 Blocked Originating Call Procedures I

The requirements in Blocked Originating Call Procedures I are followed by an IDT that immediately rejects an originating call SETUP message from the RDT when the IDT resources or a DS0 channel between the IDT and RDT is not available. These procedures are needed to meet the delayed readiness (delayed dial tone) peg count requirements in

Section 8.2.2.2 of TR-TSY-000541 and the IDLC facility blocked originating call peg counts requirements of GR-303-CORE.

R12-465 **[1334]** The IDT shall follow these procedures during periods from the time the IDT has rejected one or more SETUP messages because the IDT resources or a DS0 between the IDT and RDT were unavailable to the time the rejected call has been either abandoned by the customer or the resources have become available to continue the call processing procedures.

R12-466 **[1335]** The IDT shall treat the call as an abandoned call if the IDT does not receive another SETUP message with the same call reference value within 1 second of transmitting a RELEASE COMPLETE message per the third requirement in Section 12.5.5.2.1 (illustrated in the third branch from the left in Figure 12-19), or if the IDT receives a RELEASE COMPLETE message from the RDT with the same call reference value for the TMC (illustrated in the second branch from the right in Figure 12-19), or if the IDT receives a DISCONNECT message from the RDT with the same call reference value for the CSC.

CR12-467 **[1336]** If a call is abandoned and the SETUP message for this call was rejected with cause 34, the IDT shall increment the IDLC facility blocked call peg count and the LDS shall increment the delayed readiness (delayed dial tone) peg count per the requirements in Section 8.2.2.2 of TR-TSY-000541.

CR12-468 **[1337]** If a call is abandoned and the SETUP message for this call was rejected with cause 44, the LDS shall increment the delayed readiness (delayed dial tone) peg count per the requirements in Section 8.2.2.2 of TR-TSY-000541.

CR12-469 **[1338]** If the IDT receives a SETUP message with a call reference value equal to the call reference value in a SETUP message that had been previously rejected with cause 34 or cause 44, the call has not been abandoned, and the IDT resources or DS0 channel are still not available, the IDT shall reject the SETUP message following the third requirement in Section 12.5.5.2.1 (illustrated in the third branch from the left in Figure 12-19).

CR12-470 **[1339]** If the IDT receives a SETUP message with a call reference value equal to the call reference value in a SETUP message that had been previously rejected with cause 34 or cause 44, the call has not been abandoned, and the IDT resources or DS0 channel are now available, the IDT shall react to the SETUP message following the second requirement

in Section 12.5.5.1.1 (illustrated in the middle branch in Figure 12-17). If the time between the first SETUP message with this call reference value and the transmission of the CONNECT message or the application of dial tone, whichever is later, is greater than 3 seconds, the LDS shall increment the delayed readiness (delayed dial tone) peg count per the requirements in Section 8.2.2.2 of TR-TSY-000541. An RDT's additional contribution to the dial tone delay, as perceived by the customer, is limited to 100 ms per the requirements in Section 12.5.9.1.

12.5.5.20 Blocked Originating Call Procedures II

The requirements in Blocked Originating Call Procedures II are followed by an IDT that does not immediately reject an originating call SETUP message from the RDT when the IDT resources or a DS0 channel between the IDT and RDT is not available, but waits for the IDT resources or a DS0 channel to become available. These procedures are needed to meet the delayed readiness (delayed dial tone) peg count requirements in Section 8.2.2.2 of TR-TSY-000541 and the IDLC facility blocked originating call peg counts requirements of GR-303-CORE.

R12-471 **[1340]** The IDT shall follow these procedures during periods when the IDT has received one or more SETUP messages while waiting for IDT resources or a DS0 between the IDT and RDT to continue the call processing procedures.

R12-472 **[1341]** The IDT shall consider the call to be abandoned if the IDT does not receive another SETUP message with the same call reference value within 20 seconds, or if the IDT receives a RELEASE COMPLETE message from the RDT with the same call reference value for the TMC, or if the IDT receives a DISCONNECT message from the RDT with the same call reference value for the CSC.

CR12-473 **[1342]** If a call is abandoned and the IDT was waiting for a DS0 between the IDT and RDT to become available, the IDT shall increment the IDLC facility blocked call peg count and the LDS shall increment the delayed readiness (delayed dial tone) peg count per the requirements in Section 8.2.2.2 of TR-TSY-000541.

CR12-474 **[1343]** If a call is abandoned and the IDT was waiting for IDT resources to complete the call to become available, the LDS shall increment the delayed readiness (delayed dial tone) peg count per the requirements in Section 8.2.2.2 of TR-TSY-000541.

CR12-475 **[1344]** If a call is abandoned, the IDT shall do one of the following:

… a. If the IDT has received a RELEASE COMPLETE message from the RDT with the same call reference value for the TMC or a DISCONNECT message from the RDT with the same call reference value for the CSC, the IDT shall release the call reference value and consider the call to be in the Null (0) state.

… b. If the IDT has not received a RELEASE COMPLETE message from the RDT with the same call reference value for the TMC or a DISCONNECT message from the RDT with the same call reference value for the CSC, the IDT shall transmit a RELEASE COMPLETE message to inform the RDT that the originating call SETUP message has been rejected. The cause value shall be 44, "Line Unit Unavailable," if the call was waiting for IDT resources to become available and 34, "Channel Unavailable," if the call was waiting for a time slot to become available. After sending the message, the IDT shall release the call reference value and consider the call to be in the Null (0) state.

CR12-476 [1345] If the resources become available to proceed with the call processing procedures, the IDT shall proceed following the first requirement in Section 12.5.5.2.1 (illustrated in the leftmost branch in Figure 12-19). If the time between the receipt of the first SETUP message with this call reference value and the transmission of the CONNECT message or the application of dial tone, whichever is later, is greater than 3 seconds, the LDS shall increment the delayed readiness (delayed dial tone) peg count per the requirements in Section 8.2.2.2 of TR-TSY-000541. An RDT's additional contribution to the dial tone delay, as perceived by the customer, is limited to 100 ms per the requirements in Section 12.5.9.1.

12.5.6 Provisioning Scenarios

The information provided in this section was largely tutorial in nature and has been removed from the GR. The functionality that had been specified in this section is contained in new operations messages written using the ASN.1 syntax. The messages in the ASN.1 syntax are contained in TR-TSY-000303, Supplement 3.

12.5.7 ISDN Basic Access - Option

Overall system requirements for ISDN are provided in Section 3.6. This section describes the implementation of those requirements across the Generic IDLC Interface.

Two methods are provided for accommodating ISDN Basic Access: the 3-DS0 TDM method and the 4:1 TDM method.

R12-477 **[1346]** The IDT shall support the 4:1 TDM method.

R12-478 **[1347]** The RDT shall support the 4:1 TDM method.

R12-479 **[1348]** The RDT shall also support the 3-DS0 TDM method.

Several access configurations/architectures can be used that result in eventual termination of the 3 DS0s in a channel bank that reconstructs the ISDN DSL for direct DSL termination on an ISDN switch.

12.5.7.1 3-DS0 TDM

3-DS0 TDM requires the RDT to dedicate a full DS0 to each B channel, and a full DS0 for the D channel and DSL overhead. The 3-DS0 TDM capability provides for those Basic Access lines that are not terminated at the LDS containing the IDT, i.e., the ISDN DSL is treated as a foreign exchange circuit. RDTs may also employ 3-DS0 TDM for locally terminated Basic Access lines. A detailed description of 3-DS0 TDM is provided in Section 10.2 of TR-NWT-000397.

12.5.7.2 4:1 TDM

In the 4:1 TDM method, B channels may be assigned to DS0 channels between the IDT and RDT on a full-time basis or on demand as needed. This later approach allows the B channels to be concentrated. Up to four 16 kb/s D channels share a single full-time DS0 channel between the IDT and RDT on a TDM basis. The ISDN DSL eoc interfaces a mediation device in the RDT that converts the DSL eoc data into a format understood by OSs and the converted data is transported over the EOC of the IDLC system. Similarly, the mediation device converts messages from OSs into the proper format for the ISDN DSL eoc. Other “indicator bits” in the DSL overhead are processed at the RDT line unit and converted to operations messages on the EOC. A detailed description of 4:1 TDM is provided in Section 10.1 of TR-NWT-000397.

O12-480 **[1349]** D-channel data should not be delayed more than 2 ms relative to its B-channel data, in each direction of transmission; ≤1 ms in LDS and ≤1 ms in RDT.

R12-481 **[1350]** The RDT shall send a Change of Overhead Bit Report to the IDT within 200 ms of the receipt of “valid indication” of an ISDN NT overhead

bit state change. A “valid indication” occurs when a transition is detected for three consecutive superframes.

O12-482 **[1351]** The RDT should suppress the Change of Overhead Bit Report for a particular ISDN DSL during start up and activation of the particular DSL.

12.5.8 Transmission - Voice

12.5.8.1 General

VF transmission requirements for the Generic IDLC Interface are allocated entirely to the RDT.

The VF transmission requirements of Section 3.2.1 are considered met if satisfied in each direction of transmission at the RDT, on an A/D and D/A basis. Compliance with requirements may be determined by using a PCM bank analyzer as shown in Figure 9 of Section E of the Appendix to MDP-326-140 (formerly PUB 43801). In some cases, the requirement specified in this section will differ from the one specified in Section 3.2.1. This is necessary in some cases because the requirements in Section 3.2.1 assume 2-wire analog to 4-wire analog measurements, whereas the measurements in this section are assumed to be 2-wire analog to 4-wire digital.

Alternatively, equivalent compliance may be determined on a A/A basis by looping the DS1 transmit PCM bitstream carrying the transmit DS0 channel of one RDT customer line unit back to the receive bitstream corresponding to another customer line unit where customer line unit performance is required to be equal in the transmit and receive directions. The requirements here may also differ from the requirements in Section 3.2.1 because 2-wire analog to 2-wire analog measurements will be taken. Conventional voice frequency signal source and detection test equipment may be used in these cases.

12.5.8.2 Transmission Level Point

While TLP is technically defined in Section 3.2.1.1 as the “center of the digital switch,” the criteria in this section are considered satisfied for a TLP reference at any convenient measurement access point in the DS1 facility bitstream between the IDT and RDT.

12.5.8.3 Return Loss

R12-483 **[1352]** Either of the following requirements shall be satisfied:

… a. The minimum return loss measured at the 2-wire input to a customer line unit with a reference impedance of 900 Ω in series with 2.16 microfarads shall be as stated in Section 3.2.1.3. This criterion is considered met if the minimum return loss values of Section 3.2.1.3 are exceeded when the DS0 PCM channel corresponding to the customer line unit under test is terminated in a PCM bank analyzer or is looped-back to a 4-wire customer line unit terminated in 600 Ω.

… b. A customer line unit DS0 channel is looped-back to another customer line unit terminated in 900 Ω and satisfies the requirements of TR-NWT-000057.

12.5.8.4 Longitudinal Balance

R12-484 **[1353]** The longitudinal balance requirements of the 2-wire analog port of a customer line unit stated in Section 3.2.1.4 shall be considered met if the performance requirements are exceeded when the corresponding DS0 channel is terminated in a PCM bank analyzer or is looped-back to another DS0 channel with the corresponding line unit terminated in 900 Ω. The metallic voltage is measured at the port under test.

12.5.8.5 Total Loss

For locally switched services on IDLC systems, total loss is separated into two categories: network loss (i.e., the loss needed at the LDS to achieve end-office to end-office objectives), and access loss (i.e., the loss needed in the access network to maintain end-office to CPE objectives).

For non-locally switched and non-switched services, neither the network loss nor the access loss requirements of this section apply. For these special services, service-specific loss/gain requirements are placed on the RDT to achieve the designed transmit and receive Transmission Level Points (TLPs) needed to obtain the required Inserted Connection Loss (ICL) for the specific special-service circuit being provided, as defined in Section 6.2 of TR-NWT-000057.

12.5.8.5.1 Network Loss Plan

The increase in round-trip transmission delay caused by the inherent processing delay of digital network elements (e.g., digital switches, Remote Digital Terminals, and digital facility multiplexers) is a source of echo performance degradation that is manifested as

talker echo (or listener echo for shorter (e.g., intra-switch)). Loss is typically inserted on a connection to control the adverse effect of talker echo.

The network loss plan shall be compatible with the LDS digital-loss implementation requirements of TR-NWT-000507 Section 7.4.1, as follows:

R12-485 **[1354]** For locally switched services, the LDS shall accommodate administrator-selectable assignment of network loss values from 0 dB to 6 dB (in 1-dB steps) on a per-circuit basis in the receive (LDS to RDT) direction of transmission at switch interface points suitable for switched message network connections.

In many networks, loss values are dependent on the type of connection (e.g., intra-office, intra-LATA or inter-LATA) and are usually administered at the point of switching nearest the end-user terminal. Loss values that are not dependent on the type of connection can be inserted at the final digital-to-analog conversion point (e.g., at the RDT).

Digital signal processing (such as the insertion of digital loss), precludes the transmission of unmodified bit streams (i.e., digital bit integrity, across the network). The modification, while not noticeable on voice signals, will degrade digital data and voiceband data signals carried over the PSTN. Consequently, network loss insertion by means other than digital signal processing is desirable.

To maximize the portion of a connection that satisfies the bit integrity criteria, the insertion of loss, where required, should take place as near to the end-user terminals as possible. The goal is to migrate the loss out of the network (toward the end user) and provide digital bit integrity from point of network termination to point of network termination.

O12-486 **[1355]** As an objective, an RDT should be able to be provisioned to insert a fixed loss in the receive (LDS to RDT) direction, for all locally switched services.

12.5.8.5.2 Access Loss Plan

The *access loss plan* shall be implemented for all locally switched circuits such that the "Total Loss" requirements of Section 3.2.1.5 (i.e., maximum of 8 dB between LDS and NI) can be satisfied through the Generic IDLC Interface under any of the following conditions:

a. A 0-dBm, 1004-Hz tone with 600-Ω source impedance is connected at the customer premises end of the highest loss loop/bridged-tap combination for which the IDLC system is specified to be applicable. The attenuated signal is measured via a PCM bank analyzer access to the corresponding DS0 transmit channel in the DS1 facility bitstream.

b. A digital milliwatt signal is applied to the DS0 receive channel and the attenuated signal is measured at the customer premises end of the highest loss/bridged-tap

combination loop for which the IDLC system is specified to be applicable, terminated in 600 Ω.

c. Also, under the assumption that transmit and receive direction channel unit losses are equal, this requirement is also satisfied by connecting the 600-Ω source to a loop as specified above, looping the DS0 channel back to a second customer line unit connected to a second such loop terminated in 600 Ω with the attenuated signal measured across the 600-Ω termination. In this case the total loss shall be less than 16 dB.

Part of the access loss (i.e., “Total Loss” requirement of Section 3.2.1.5) needs to be provided by the IDLC system (IDT and RDT) to satisfy the requirements of Sections 3.2.1.6 through 3.2.1.8.

R12-487 **[1356]** The IDT shall not introduce any IDLC system loss to satisfy the loss requirements of Sections 3.2.1.5 through 3.2.1.8.

R12-488 **[1357]** The RDT shall introduce all of the IDLC system loss needed to satisfy the loss requirements of Sections 3.2.1.5 through 3.2.1.8.

12.5.8.6 IDLC System Loss Tolerance

R12-489 **[1358]** Either of the following requirements shall be satisfied:

… a. The 1004-Hz system loss tolerance of ± 1.0 dB (as specified in Section 3.2.1.6) with respect to the manufacturer's published nominal or average loss is considered satisfied if met in both the transmit and receive directions between the line terminals of an individual line RDT customer line unit and the 0 TLP reference point in the DS1 facility bitstream. The A/D and D/A measurements shall be made using a PCM bank analyzer test set as in Section 12.5.8.5 above.

… b. This requirement is considered satisfied on an A/A basis if the 1004-Hz loss tolerance is ± 1.4 dB between any two customer line unit terminations using a DS1 loopback to accomplish the connection. The analog source impedance and customer line unit termination impedance shall be 900 Ω at 1004 Hz.

O12-490 **[1359]** It is an objective that the above tolerances respectively be

… a. A tolerance of ± 0.5 dB

… b. A tolerance of ± 0.7 dB.

12.5.8.7 Frequency Response

R12-491 **[1360]** Either of the following requirements shall be satisfied:

… a. The requirements of Section 3.2.1.9 are satisfied for both the transmit (A/D) and receive (D/A) directions of transmission from a customer line unit if the 404-Hz and 2804-Hz tolerances (i.e., -0.25 and +0.5 dB) given in Figure B-3 of MDP-326-140 (formerly PUB 43801) are not exceeded as determined using a PCM bank analyzer test set.

… b. A/A measurements may be used to test compliance by looping back the DS1 bitstream from one customer line unit to another. In this case the loss at 404-Hz and 2804-Hz shall be within -0.5 and +l.0 dB of the loss at 1004-Hz with a 900-Ω signal source impedance and customer line unit termination impedance.

12.5.8.8 60-Hz Loss

R12-492 **[1361]** The 60-Hz criteria of 3.2.1.10 is satisfied if a 60-Hz signal applied to the line terminals of an IDLC customer line unit experiences a loss of ≥20 dB more than the 1004 Hz loss; as measured in the A/D direction using a PCM bank analyzer test set to terminate the DS1 facility.

12.5.8.9 Amplitude Tracking

R12-493 **[1362]** Either of the following requirements shall be satisfied:

… 1. The amplitude tracking requirement of Section 3.2.1.11 is satisfied through the Generic IDLC Interface if both of the following conditions are met:

… a. *Transmit-Direction* - With an input 1004-Hz signal from a 900-Ω source connected to the line terminals of a customer line unit and the corresponding DS1 facility terminated in a PCM bank analyzer test set, the loss shall vary less than ± 0.25 dB for input signal levels between -37 and +3 dBm0, shall vary less than ± 0.5 dB for input signal levels from -50 to -37 dBm0, and shall vary less than ± 1.5 dB for input signal levels from -55 to -50 dBm0.

… b. *Receive-Direction* - The same tolerances apply for the receive direction with a digital source signal applied to the DS1 facility via the PCM bank analyzer test set and analog detection across the line terminals of a customer line unit terminated with 900 Ω.

… 2. Assuming symmetric transmit/receive performance, the linearity may be tested on an A/A basis by looping back the DS1 signal to a second channel unit. Under these circumstances, amplitude error shall not exceed twice the maximum deviations stated above for the A/D and D/A test conditions.

12.5.8.10 Idle Channel Noise

R12-494 **[1363]** The idle channel noise criterion of Section 3.2.1.12 shall be satisfied for the Generic IDLC Interface if both the following conditions are met:

… a. With a quiet termination across the line terminals of a customer line unit and the corresponding transmit DS1 signal connected to a PCM bank analyzer test set, the observed noise power at the PCM analyzer shall be less than 18 dBrnC0.

… b. With a 20 dBrnC0 noise source connected to the line terminals of the transmit customer line unit and the transmit DS1 signal looped-back to the receive DS1 of a second customer line unit, the noise measured across a 900-Ω termination of the 2-wire port of the receive customer line unit shall be less than 23 dBrnC0.

12.5.8.11 Signal-to-Distortion Ratio

R12-495 **[1364]** The signal to distortion requirements of Section 3.2.1.13 shall be considered met under either of the following conditions:

… a. Transmit (A/D) and receive (D/A) directions shall each experience S/D ratios greater than or equal to the minimum values specified in the following table using a PCM bank analyzer test set for measurements at the DS1 interface.

Input-Level	Min.-Output-S/D
0 to -30 dBm0	35
-30 to -40 dBm0	29
-40 to -45 dBm0	25

… b. When one customer line unit is looped-back at the DS1 rate to a second customer line unit, using a 1004- to 1020-Hz input signal, the S/D ratios are greater than or equal to the minimum S/D values specified in Section 3.2.1.13.

12.5.8.12 Intermodulation Distortion

R12-496 **[1365]** The criteria of Section 3.2.1.15 shall be considered met at the Generic IDLC Interface when a looped-back connection between any two transmit and receive customer line units at the DS1 interface exhibits values of R2 and R3 greater than 43 and 44 dB, respectively, using the intermodulation test method specified in IEEE 743-1984. Transmit and receive directions of customer line units contribute equally to intermodulation distortion.

12.5.8.13 Single Frequency Distortion

R12-497 **[1366]** The criteria in Section 3.2.1.17 shall be considered met at the Generic IDLC Interface when all of the following conditions are satisfied:

… a. The receive (D/A) direction shall produce less than -28 dBm0 across a 900-Ω termination at any frequency (other than the input frequency) between 0 and 12 kHz when the equivalent of a 0-dBm0 signal at any frequency between 0 and 12 kHz is injected into the receive DS1 bitstream via the equivalent of a codec compliant with TR-NWT-000507.

… b. The receive (D/A) direction shall produce less than -46 dBm0 across a 900-Ω termination at any frequency (other than the input frequency) between 0 and 4.0 kHz when the equivalent of a 0-dBm0 signal at any frequency between 1004 and 1020 Hz is injected into the receive DS1 bitstream.

… c. The transmit (A/D) direction shall produce, at the output of the equivalent of a codec compliant with TR-NWT-000507, less than -28 dBm0 at any frequency (other than the input frequency) between 0 and 12 kHz when a 0 dBm0 signal between 0 and 12 kHz is applied to the customer line unit termination.

… d. The transmit (A/D) direction shall produce less than -46 dBm0 at any frequency (other than the input frequency) between 0 and 4.0 kHz when a 0-dBm0 signal between 1004 and 1020 Hz is applied to the customer line unit termination.

12.5.8.14 Peak-to-Average Ratio

R12-498 **[1367]** The Peak to Average Ratio (P/AR) requirement of Section 3.2.1.19 shall be considered met if the P/AR is >=94 for each of the transmit and receive RDT customer line unit directions when measured and calculated

as specified in MDP-326-140 (formerly PUB 43801) (see also Section C.16 of Appendix).

12.5.8.15 Crosstalk

R12-499 **[1368]** The crosstalk requirement of Section 3.2.1.20 shall be considered met at the Generic IDLC Interface if the equal level crosstalk loss exceeds 65 dB under both of the following conditions:

… a. A disturbing signal at 0 dBm0 at any frequency between 200 Hz and 3.2 kHz across the line terminals of customer line unit “a” produces a signal in the DS1 bitstream in any other DS0 channel “b” < -65 dBm0 as measured with a PCM bank analyzer.

… b. A disturbing signal at 0 dBm0 at any frequency between 200 Hz and 3.2 kHz injected into any DS0 channel “a” using a PCM bank analyzer test set produces a signal of < -65 dBm0 across the line terminals of any other customer line unit “b” terminated in 900 Ω.

12.5.8.16 Hybrid Balance

R12-500 **[1369]** The requirements of Section 3.2.1.23 shall be considered met at the Generic IDLC Interface if the THL limits given are exceeded using a PCM bank analyzer for signal source and detection measurement in the DS1 facility.

12.5.9 Signaling and Supervision

R12-501 **[1370]** For Generic IDLC Interface applications, the requirements of Section 3.2.2 shall be satisfied.

The additional requirements are:

12.5.9.1 Service Related Timing Requirements

R12-502 **[1371]** To allow LDSs to meet the dial tone delay Service Standards in TR-TSY-000511, with respect to the overall dial tone delay that is experienced by the subscriber, RDTs shall satisfy the following:

… a. Origination requests shall be reported to the switching system within 50 ms of their occurrence.

…

b. A 2-way transmission path shall be provided within 50 ms of applying dial tone to the customer (for loop-start circuits), and within 50 ms of applying loop current feed to the customer (for ground-start circuits), except that this dial tone and loop current feed does not need to be provided any quicker than 200 ms following the occurrence of the originating request. Providing a 2-way transmission path within 50 ms of receiving an acknowledgment to an origination request indicating that the switching system has connected to a DS0 time slot and is ready to proceed with the origination request, is an acceptable implementation. The receipt of dial tone from the switching system is an indication that the switching system is ready to accept addressing.

One-way signaling delay limits, RDT-to-IDT and IDT-to-RDT, are defined in Section 3.2.2 and must be satisfied. IDLC delay limits are the same as those specified for UDLC configurations. The elimination of the UDLC COT for IDLC applications allows for relaxed timing requirements on the RDT.

CO12-503 [1372] For any one-way delay requirement identified in Section 3.2.2 that does not specifically allocate the delay, the RDT should be allocated 70% of the available time; any time needed for time-slot management is included in this 70%. The remaining 30% is allocated to the transmission facility and the IDT/LDS.

When an RDT designed to just meet this 70% allocation is used in a UDLC system, the UDLC system may exceed the overall UDLC requirements. However, RDTs that meet these limits with sufficient margin may allow a UDLC configuration to meet overall requirements as well, with the same RDT.

In addition to the one-way delay limits above, specific two-way message-response delay limits are also discussed in Sections 3.2.2 and 12.5.5, and must be satisfied.

CO12-504 [1373] For any two-way message-response delay requirement identified in Sections 3.2.2 or 12.5.5 that does not specifically allocate the delay, the available time for each of these message-response sequences should be allocated 70% to the end of the IDLC system processing the message and generating a response, and 30% to the end of the system that originated the initial message.

A call-processing traffic study (see “A Call-Processing Traffic Study for Integrated Digital Loop Carrier Applications”, IEEE Transactions on Communications, Vol. 36, No. 9, September 1988) has verified that the 64-kb/s TMC/CSC data link layer is sufficiently fast (< 100 ms) to achieve required signaling-response-times for 672 simultaneous calls (the maximum size of a Generic IDLC Interface) under worst-case traffic patterns.

12.5.9.2 60-Hz Induction Immunity

The following criteria helps minimize the probability of an LDS having to take a line out of service as specified in GR-505 Section 3.1.1, “Excessive Origination Protection”, and referenced in Section 3.2.2.1.10, “Showering Lines,” page 3–11, of this document.

R12-505 **[1374]** All filtering necessary to prevent generation of false signaling states due to 60-Hz induction on the RDT's customer lines shall be implemented in the RDT .

12.5.9.3 Non-Locally Switched Services - Option

R12-506 **[1375]** If a non-locally switched or non-switched service requires robbed-bit signaling, the RDT system must support robbed-bit signaling, on that channel, across the Generic IDLC Interface, as specified in Sections 12.5.2.1 and 12.6.1.2. As noted in Tables 12-5 and 12-6, MDP-326-140 (formerly PUB 43801) defines the specific robbed-bit signaling for these services.

12.5.9.4 Intra-RDT Calls

Intra-RDT call-switching capabilities are not supported with the call-processing procedures defined in this GR, across the Generic IDLC Interface.

12.5.10 Multiple Interface Group (Multi-IG) Feature

12.5.10.1 Multi-IG Feature Description

The multi-IG feature is illustrated in Figure 12-48 and discussed below. Several benefits of the multi-IG feature are provided in Section 12.5.10.2. Specific requirements for RDT and IDT are contained in Sections 12.5.10.3 and 12.5.10.4, respectively.

As illustrated in Figure 12-48, the multi-IG feature allows a Call Reference Value (CRV), or line, of any IG to be associated with the Line Circuit Address (LCA) of any Access Circuit (AC). An LCA is the physical location where a customer's distribution pair is terminated; e.g., on shelf-#2, slot-#5, circuit-#2 or on Optical Network Unit (ONU)-#6, slot-#3, circuit-#1. The multi-IG feature allows any access circuit to be assigned to a CRV (or line; if the IG is not GR-303-CORE compatible) on any one of the IGs either during capacity activation or service activation. The actual implementation of the access-circuit association is a supplier's choice; e.g., it can be a memory map of a CRV (or line) to the

LCA of the access circuit, a DS0 crossconnect, or a time slot interchanger. For GR-303-CORE-compatible IGs, an access circuit must be associated with a CRV to gain access to the LDS. The GR-303-CORE interface uses the CRV in its Timeslot Management Channel (TMC) to dynamically assign DS0s to access circuits on a call-by-call basis; i.e., if an access circuit is not assigned a CRV, it will never be assigned a DS0 between the IDT and IG.

The multi-IG feature also allows the DS1, or VT1.5 (if the interface to the RDT is SONET-based), feeder-side interfaces of any IG to be associated with the Line Circuit Address (LCA) of any of the DS1s/VT1.5s available in the Transport Facilities (TFs) between the RDT and IDT. This assignment of DS1s/VT1.5s to IGs usually only occurs during capacity activation.

To support the multi-IG feature in an RDT, an IDT continues to be required to terminate 2 to 28 DS1s/VT1.5s. The logical addresses (i.e., at the IDT and IG) of these DS1s/VT1.5s must be unique and an integer from 1 through 28. They are needed for both operations communications and call-processing functions across the GR-303-CORE Generic IDLC Interface. The IDT also continues to be required to support up to 2048 CRVs. The CRVs identify access circuits and must be uniquely numbered from 1 through M, where M is the maximum number of CRVs to be supported by the GR-303-CORE interface. To communicate with the RDT's IG, the IDT continues to be required to support an Embedded Operations Channel (EOC; SAPI/TEI=1/0 and 1/4 for IDT-IG communications) and TMC, and a backup channel for each. In some IDLC equipment, a Common Signaling Channel (CSC) may be used rather than a TMC.

Figure 12-48 also contains the relative numbering of the IDTs and IGs. The IDTs are numbered uniquely relative to their equipment within the LDS, whereas the IGs are numbered uniquely relative to their RDT. There is no need for an IDT-# and IG-# to be equal for operations communications and call processing across the Generic IDLC Interface. However, for some operations management functions/architectures, the LDS (or RDT) *may* need to know (functionally; e.g., by provisioning, discovery, or other method) the number of the IG (or IDT) it is interfacing with. This concern is currently being reviewed and may result in additional requirements in the future.

To support its multi-IG feature, an RDT is required to support the individual interface requirements of each of its IGs. An RDT must support at least two GR-303-CORE-compatible IGs for the multi-IG feature (but eight [or more] may be needed in some applications), and each of these IGs must support the interface requirements of the IDT discussed above. In addition, the RDT has the flexibility to support IGs other than those that are GR-303-CORE compatible, such as TR-TSY-000008 and direct interfaces to a Digital Channel Bank (DCB) or Digital Crossconnect System (DCS). The maximum number of DS1s/VT1.5s on the feeder-side (i.e., toward the central office) of the RDT is not limited except that each IG supporting GR-303-CORE is limited to a maximum of 28 DS1s/VT1.5s. Additionally, the number of access circuits accommodated by the RDT can exceed 2048 with the constraint that no more than 2048 access circuits can be accommodated by any one GR-303-CORE IG. However, each access circuit must have access to all of the IGs

supported by the RDT. In addition, an access circuit associated with a GR-303-CORE IG must have full access to all the DS0s available to that IG for transport between that IG and its IDT.

Two information models have been published by Bellcore in support of GR-303-CORE products: TR-TSY-000303, Supplement 3, March 1990, Revision 1, August 1992 (hereinafter referred to as CMISE-Supp3) and GR-2833-CORE, Issue 1, February 1994 (hereinafter referred to as CMISE-GR2833). The CMISE-Supp3 model was the first CMISE information model for IDLC systems and is based on 1989 and early 1990 draft standards on Open Systems Interconnection (OSI) system management. It contains many gaps and problems that have since been addressed in the standards. CMISE-GR2833 was published to reflect the current standards and to align the IDLC information model with other technologies such as SONET and Fiber In The Loop (FITL).

An RDT can communicate with Operations Systems (OSs) or a layer of a Telecommunications Management Network (TMN) via one, or a combination, of the following three alternatives: via an Operations Interface Module (OIM) in the LDS by using one of the EOCs (SAPI/TEIs=1/1, 1/2, 1/3, 1/5, etc.) between the IDTs and IGs, via a Gateway in a SONET MUX located in the central office by using the Data Communications Channel (DCC) in the overhead of the SONET transport signal at a SONET-based RDT, or via a line unit in the LDS by using a dedicated or dialed-up DS0 in the IDLC payload (as illustrated in the bottom of Figure 12-48). The most practical communications path is usually dictated by the access architecture implemented by a specific BCC and the specific features of the GR-303-CORE products being deployed; e.g., a DS1-based RDT will likely use a line unit in the LDS as its communications path to the OS if the LDS does not provide an OIM capability. Although several operations paths are available between managers and the RDT, each manager needs to support ONLY one path to the RDT.

12.5.10.2 Multi-IG Benefits

The multi-IG feature provides several benefits for the integrated access architectures made possible with GR-303-CORE products. Some of these benefits are discussed in the subsections that follow.

12.5.10.2.1 Equipment Breakage

Ideally a switching system should allow a DS1 [12]associated with an RDT to terminate anywhere on the switching system with the switching system logically connecting them into a single IDT. This is not always possible because the individual switching system

12. Throughout this section, the terminology DS1 should be interpreted as DS1 or VT1.5 (if the interface is SONET-based). For detailed requirements associated with SONET-based GR-303-CORE products, see Section 13.

equipment units used to terminate the DS1 generally contain the processor(s) to control the DS1 terminations and create the logical IDTs within the equipment unit, and often it is not practical for these processors to communicate among themselves to create logical IDTs from DS1 lines terminated over several equipment units. Thus the DS1s for an individual IDT must, in most cases, all terminate on one switching system equipment unit.

The maximum number of DS1 lines that can terminate on an equipment unit is finite. Also this number may not be a multiple of 28 (maximum number of DS1s between RDT and IDT) and, even if it is a multiple of 28, not all RDTs will have this capacity or need this capacity in a given application. This leads to situations where an RDT is to be installed on an equipment unit that does not have enough remaining DS1 line terminations to accommodate the entire RDT. It may not be desirable to strand this capacity or save it in the hopes that an RDT can be installed to use the remaining DS1 line terminations. Rather it is advantageous to have the capability to use the remaining DS1 terminations on the equipment unit to terminate some of the DS1 lines of the RDT and to terminate the other DS1 lines of the RDT on a different equipment unit. This will reduce or prevent the accumulation of unused equipment due to breakage.

12.5.10.2.2 Growth

With the large line sizes of many GR-303-CORE IDLC systems, the issue of growth of an RDT becomes more critical. In many cases, an RDT that can support 28 DS1s will not use all 28 DS1s at the initial installation. Rather the RDT will be installed with the number of DS1s needed to meet its current demand plus the growth over some number of years. As the actual usage of the RDT approaches the current provisioned capacity, additional capacity will be added to grow the system. This growth generally takes place some years after the initial installation. It may not be economical to reserve the ultimate capacity of the RDT on the individual switching system equipment units for the future growth and therefore, the future growth will need to occur on different switching system equipment units or even different switching systems.

12.5.10.2.3 Service Separation

Some services offered by a telephone company may not be available on all switching systems in a central office. In these situations a multi-IG capability can be used to route the customers to the switching system providing the service requested by a customer.

12.5.10.2.4 Multiple Switching System Central Offices

A central office may contain multiple switching systems. The multi-IG capability will give a telephone company the capability to distribute the lines terminated at the RDT among the

different switching systems in a central office. This can be used to separate customers on an NNX [13]basis for growth or office consolidation.

12.5.10.2.5 Load Balancing

The load on an equipment unit of a switching system that contains the IDT for an RDT may reach its load limit while the RDT has the capacity to provide more service. Without a multi-IG capability, some of the methods that could be used to manage the load on the equipment unit are

- Move some of the load on the equipment unit to another equipment unit
- Move the RDT to another equipment unit
- Cap the growth on the RDT and install a new RDT on another equipment unit.

While the above procedures can still be used when the multi-IG capability is available, the multi-IG feature provides the capability to put the RDT growth on a new equipment unit without changing the existing load.

12.5.10.3 Requirements on an RDT for Multi-IG Feature

R12-507 **[1376]** The RDT shall provide the capability to interface to a minimum of two different GR-303-CORE IDTs (in the same LDS or in different LDSs) and each IG-to-IDT interface shall meet requirements for datalinks (EOC and TMC/CSC) individually.

R12-508 **[1377]** The RDT is limited to a maximum of 28 DS1s per IG [14]and each IG can support up to a maximum of 2048 two-wire terminations toward the customer's premises.

R12-509 **[1378]** Each IDT-IG interface shall be capable of reusing CRV numbers and of being resized, up or down, to support the deployed size of the product.

CR12-510 **[1379]** In some BCC access architectures, an RDT may be required to support more than two GR-303-CORE IGs; eight or more may be needed in some applications.

13. NNX refers to the three digits representing the central office code in a telephone number.

14. All DS1s that are field groomed at the IG and go directly to interoffice facilities are included within the 28 DS1 maximum.

CR12-511 **[1380]** In some BCC access architectures, an RDT may be required to support additional IGs other than GR-303-CORE such as IGs that support the interface requirements in TR-TSY-000008.

CR12-512 **[1381]** In some BCC access architectures, an RDT may be required to support additional IGs other than GR-303-CORE, such as IGs that support the interface requirements in MDP-326-140.

R12-513 **[1382]** An RDT shall support multiple instances of the IDLC Terminal object and each instance shall be uniquely numbered as an integer between 1 and 99.

R12-514 **[1383]** All EOCs shall meet the EOC requirements defined in the other parts of Section 12, including data-link path protection switching, unless otherwise specified.

R12-515 **[1384]** Each IG shall use time-slot 12 of DS1 number 1 (i.e., the logical DS1 number 1 for that IG) for its EOC path and time-slot 12 of another DS1 for its standby EOC path, per current EOC datalink requirements in GR-303-CORE.

R12-516 **[1385]** The RDT shall provide the capability for the user to designate any one of the EOCs for use by OSs to manage the RDT. SAPI/TEI=1/0 and 1/4 of each EOC is reserved for IDT-IG communications while other SAPI/TEIs of each EOC are available for interfacing to an OS (or TMN), when an OIM is implemented by the serving LDS.

O12-517 **[1386]** It is an objective that the RDT should provide the capability for OSs to use any of the EOCs to manage the RDT.

R12-518 **[1387]** The RDT shall provide the capability for the user to designate the destination(s) [i.e., IDT(s) and/or OS(s)] to which an event report will be sent, by event report type.

The RDT may be required to send surveillance event reports over one EOC while sending reports of database changes over a different EOC.

R12-519 **[1388]** The RDT shall provide a TMC/CSC capability for each IG-to-IDT interface when a TMC/CSC is used in the multi-IG environment.

R12-520 **[1389]** All TMCs/CSCs shall meet the TMC/CSC requirements defined in the other parts of Section 12, including data-link path protection switching, unless otherwise specified.

R12-521 **[1390]** Each IG shall use time-slot 24 of DS1 number 1 (i.e., the logical DS1 number 1 for that IG) for its TMC/CSC path and time-slot 24 of another DS1 for its standby TMC/CSC path, per current TMC/CSC datalink requirements in GR-303-CORE.

R12-522 **[1391]** The EOC paths and TMC/CSC paths for a given IDT shall be on the same DS1s.

CR12-523 **[1392]** If the RDT has a DS1 protection switching capability, the RDT shall provide the capability to have a protection switching group for each IDT.

R12-524 **[1393]** All customer line terminations shall be capable of being provisioned to be served by any of the IDTs terminating the RDT.

R12-525 **[1394]** The RDT shall support a provisionable association between any of its access circuits and any CRV (or line; if the IG is not GR-303-CORE) of any IG in the RDT.

Currently, all known GR-303-CORE products plan to use CMISE-Supp3 for all IDT-RDT operations communications, some switching systems are planning to provide some RDT management capabilities using CMISE-Supp3, and RDTs are planning to satisfy the remainder of their management needs from OSs using TL1 messages or from vendor specific Supervisory Systems (SSs)/Element Managers (EMs) using either TL1 or negotiated proprietary (i.e., both RDT supplier and RDT manager agree to support) messages.

CMISE-Supp3 does not support the multi-IG feature in an RDT without some modifications of the current operations interface requirements. Although the following impose some interface restrictions and additional RDT functionality until CMISE-GR2833 is fully implemented, it will allow RDTs with the multi-IG feature to be immediately deployed and manageable.

- Until CMISE-GR2833 is supported, CMISE-Supp3 will continue to be supported on each IDT-IG operations channel; i.e., SAPI/TEI=1/0 and 1/4 of each GR-303-CORE IG's EOC. On these interfaces, the value of the Relative Distinguished Name (RDN) for instances of the Analog Line Termination and ISDN Line Termination object classes can continue to be equal to the value of its Call Reference Value (callRefValue) mandatory attribute per the interoperability agreement discussed at the *GR-303-CORE Generic IDLC Interface Implementation Forum* in Newark, NJ, on November 15 and 16, 1993. An IG will always know to which access circuit a message is directed by the EOC (i.e., SAPI/TEI=1/4) on which the message was received and the value of the callRefValue attribute contained in that message; assumes that a CRV to LCA map exists in the RDT before receipt of the EOC message. For flexible

mapping of CRVs to LCAs of access circuits, an OS (or TMN)-RDT operations channel will need to be used.

- Until CMISE-GR2833 is supported, it is expected that the OS (or TMN)-RDT operations channels will continue to use TL1 or a proprietary language as agreed between an OS (or TMN) and the RDT supplier.

R12-526 **[1395]** Currently, the LDS only uses the value of 1 for the terminalID attribute when generating local names for objects contained in the IDLC Terminal object. An RDT with the multi-IG feature shall be capable of changing (functionally; e.g., actually changing the incoming terminalID attribute value or just interpreting the received value appropriately) the value of the terminalID attribute from 1 to the value of the IG-# associated with the EOC (i.e., SAPI/TEI=1/0 and 1/4) on which the CMISE-Supp3 message from the IDT was received; the IG-# is equal to the terminalID attribute value at the RDT. Also the RDT must change its internal IG-# to 1 for all messages sent to the IDT on the EOC (i.e., SAPI/TEI=1/0 and 1/4).

An individual customer line termination will only be served by one IDT at any given time, but the customer line termination could be moved to another IDT using an operations message from an OS or through the craft interface at the RDT. This reassignment to a different IDT would not be done on a dynamic basis.

12.5.10.3.1 Synchronization In An RDT with Multi-IGs

As specified in Section 4.2, the RDT is a stratum 4 node and receives a reference signal from the IDT that is traceable to a stratum 1 timing source. Even in a multi-IG application, one DS1 must be chosen as the reference signal for the RDT and, therefore, some of the DS1s from multiple IDTs may not always be synchronous with the RDT clock; i.e., the other IDTs may be traceable to a different stratum 1 source than the RDT, or maybe a reference signal fails causing either an IDT or the RDT to be running at less than stratum 1 quality.

R12-527 **[1396]** The RDT shall be capable of reconciling the frequency difference between a DS1 received at any IG and the RDT clock.

Controlled slips via a 125 μsec slip buffer on the receive path is an acceptable implementation. Uncontrolled buffer overwrites/underwrites are not acceptable.

When there is a frequency difference between an IDT clock and the RDT clock, slips will occur at the RDT and the number of slips is a function of the difference in clock frequency between the IDT and RDT. To minimize slips and achieve the service performance objectives, the IDT clocks and the RDT clock may need to be very close in frequency.

Synchronization planning information is provided in TA-NPL-000436 and SR-NWT-002224.

12.5.10.4 Requirements On An IDT for Multi-IG Feature

R12-528 **[1397]** Each IDT-IG interface shall be capable of reusing CRV numbers and of being resized, up or down, to support the deployed size of the product.

12.5.11 NxDS0 Feature - Option

This section provides the criteria needed to support Switched Fractional DS1 (SWF-DS1) service capabilities via GR-303 IDLC systems. Generic requirements for supporting these service capabilities are provided in TR-NWT-001068 and TR-NWT-001203. SWF-DS1 from a non-ISDN interface (per TR-NWT-001068) can be supported today on a GR-303 IDLC system via a POTS line for control and a dedicated DS1 for the NxDS0 data transport between the customer and the LDS. Similarly, SWF-DS1 from an ISDN interface (per TR-1203) can be supported today on a GR-303 IDLC system via a dedicated DS1 (i.e., an ISDN-PRA DS1) for both control and NxDS0 data transport between the customer and the LDS.

Bellcore is defining the generic requirements in this section to provide an NxDS0 capability for GR-303 IDLC systems. To efficiently support SWF-DS1 applications, GR-303 IDLC systems provide the capability to do NxDS0 bandwidth management across the GR-303 interface such that only the requested number (N) of DS0s are provided for data transport between the RDT/HDT and the LDS.

It is not the intention or objective of these generic requirements that a LDS supporting a GR-303 interface be required to support a SWF-DS1 service capability as defined in either TR-NWT-001068 or TR-NWT-001203; this needs to be negotiated between each service provider and their LDS supplier.

The intent of the generic requirements that follow are to provide the GR-303 generic IDLC interface with an NxDS0 capability that is independent of the distribution technology being used between the RDT/HDT and the customer; i.e., the NxDS0 capability needs to be applicable for fiber and coax distribution networks, as well as copper-based DS1 extensions.

R12-529 **[1806]** For an NxDS0 quality transport capability across a GR-303 interface, the following criteria shall be supported:

… 1. The DS0s shall be transported across the GR-303 interface contiguous and within the same DS1/VT1.5.

… 2. Both the RDT/HDT and the IDT shall maintain timeslot sequence integrity between the DS0s of the NxDS0 customer signal and the DS0s used for transport within the IDLC system.

… 3. The NxDS0 switched bundle must be synchronous with the switching/crossconnecting nodes and transport facilities, end-to-end, to ensure a quality delivery of the NxDS0 bundle. Therefore, the customer CPE shall be loop-timed to the RDT/HDT clock, which is traceable to a stratum-1 Primary Reference Source (PRS) under non-failure conditions or traceable to another PRS. If all nodes in the end-to-end connection are traceable to the same PRS, no slips should occur. Even if some nodes are traceable to different stratum-1 PRSs, only one slip (i.e., at the switching/crossconnect nodes where the frequency differences are reconciled) every 72 days would be expected, assuming the worst case frequency difference possible under normal conditions. If a link to a stratum-1 PRS fails anywhere along the NxDS0 end-to-end route, a stratum-3 clock is expected to take control of timing for that segment of the route and the slip rate may increase to one slip every 27 seconds. The above slip rates assume current "controlled slip" techniques for DS1s.

R12-530 **[1807]** For an NxDS0 dynamic bandwidth assignment capability (including the two B-channels on ISDN-BRA circuits) across a GR-303 interface, the following criteria shall be supported for the messages used on the TMC to assign timeslots on a call-by-call basis:

… 1. All NxDS0 bandwidth requests shall be initiated by the IDT; just like all DS0 assignments to ISDN-BRA B-channels are initiated by the IDT. Therefore, for ISDN-PRA interfaces to CPE, the D-channel will need to be nailed-up on a DS0 between the RDT and the D-channel processor in the LDS, just as the D-channel of ISDN-BRA is currently nailed-up on a Quarter-DS0 between the RDT and LDS.

… 2. In the SETUP and CONNECT messages between the IDT and the RDT/HDT, the following Information Elements will need to be enhanced to support the NxDS0 capability, as follows:

… a. Call Reference (for both SETUP and CONNECT) --- Actually it is only the definition of what the Call Reference Value (CRV) represents that needs to be enhanced. The CRV is used to manage access circuits requiring local switching. The access circuit can be a physical termination directly on the RDT or ONU, or a termination derived from a DS1/fiber/coax/radio/etc. distribution system. Therefore, each allowable (as determined by subscription) NxDS0 access circuit needs to have a CRV associated with it but the definition of the Call Reference information element currently

defined in GR-303 does not need to be changed. E.g., if a customer subscribes to have four NxDS0 access circuits associated with a DS1, then four CRVs will need to be provisioned to support that DS1 distribution system; where the value of "N" may be from 1 through 6 on each access circuit, in this example. The suffix to the CRV will always be "000" for NxDS0 access circuits.

… b. Bearer Capability (for SETUP only) --- *Previously* this information element was fixed to indicate 64 kbps of "unrestricted digital information". To support NxDS0 access circuits, the information element was enhanced to be consistent with the requirements of TR-NWT-001203. Specifically,

… — in octet 2, the length of the bearer capability contents changes from 2 octets to 3 octets,

… — in octet 4, a multirate code (11000) is inserted rather than the current code (10000) for 64 kbps, and

… — a fifth octet is added to indicate the binary-coded value of "N".

… c. Channel Identification (for both SETUP and CONNECT) --- Because only contiguous DS0s within the same DS1/VT1.5 will be supported across the GR-303 interface for NxDS0 access circuits, the Channel Identification information element can continue to be used as currently defined in GR-303. The starting DS0 is indicated in the Channel Identification element and the number (N) of contiguous DS0s is indicated in the Bearer Capability element.

… 3. GR-303 ABCD-coded robbed-bit-signaling shall be turned off on all DS0s of the NxDS0 bundle. All DS0s of the NxDS0 bundle shall be transported transparently as an NxDS0 clear channel between the RDT/HDT and IDT.

R12-531 **[1808]** For an NxDS0 operations management capability across a GR-303 interface, the following criteria shall be supported:

… 1. The CMISE/OSI information model defined in GR-2833-CORE shall be used to support NxDS0 access circuits.

… 2. CRVs shall be assignable to NxDS0 access circuits regardless of which distribution technology is deployed.

It should be noted that maintenance and traffic management strategies need to be reviewed to address NxDS0 concerns.

The above are the generic requirements needed to support an NxDS0 capability across the GR-303 interface. The generic requirements provided hereinabove are completely

backwards compatible with existing GR-303 products in that if an RDT *or IDT* does not support the NxDS0 capability, it would simply reject the SETUP request from the IDT *or RDT respectively*, per existing requirements.

12.6 Requirements and Options Supporting Interfacing to the Digital Network

12.6.1 Interface Requirements

The following subsections define the physical and data-link layer requirements that must be satisfied for RDTs and IDTs to communicate via a Generic IDLC Interface. Specific implementations to satisfy DTF requirements in multi-supplier configurations are also provided.

12.6.1.1 Additional DTF-Interface Requirements

DTF requirements in Section 4 were written to ensure DTF/equipment independence and are augmented in this section with the specific implementation selected to achieve the Generic IDLC Interface.

R12-532 **[1398]** In Section 4.1, "Physical Interface," the maximum number of DS1s across the Generic IDLC Interface shall be 28. All DS1s on the network side of the RDT are considered to be included in this maximum of 28.

R12-533 **[1399]** In Section 4.2, "Synchronization," the default reference shall be DS1 number 1.

R12-534 **[1400]** In Section 4.4.1, "DS1 Framing Format," the prescribed use of the ESF data link shall be as defined in Sections 4.8, 4.9, and 12.

R12-535 **[1401]** In Section 4.4.3, "Delay," IDTs shall allow the 1.4-ms requirement of the LDS to be satisfied and shall be considered as part of the 1.4-ms allocation. The round-trip-delay of an LDS, on a connection between two digital interfaces, is required to be ≤ 1.4 ms, for 99% of such connections; per current requirements in TR-NWT-000507.

CR12-536 **[1402]** In Section 4.4.3, "Delay," for IDTs implementing DS0 grooming (i.e., front-end DS0 cross-connect for the purpose of routing non locally switched traffic away from the LDS's switching matrix) or NxDS0 cross-connect capabilities, an additional delay may be needed and, if implemented, shall be ≤ 0.25 ms of additional round-trip-delay in each IDT.

R12-537 **[1403]** In Section 4.4.3, "Delay," the round-trip-delay of an RDT, from an analog access line to the DS1 digital line and back to the analog access line, shall be ≤ 1.0 ms.

CR12-538 **[1404]** In Section 4.4.3, "Delay," for RDTs implementing DS0 grooming (i.e., DS0 cross-connect for the purpose of routing non locally switched traffic away from the LDS) or NxDS0 cross-connect capabilities, an additional delay may be needed and, if implemented, shall be ≤ 0.25 ms of additional round-trip-delay in each RDT.

Given the above delay requirements, a possible configuration could result in 6.5-1.4-2(0.25)-2(1.25)=2.1 ms of round-trip-delay remaining for transmission facility delay, which equates to about 65 miles of range for each RDT (two equi-distant RDTs are assumed; 2.1 ms at 0.016 ms per mile is about 130 miles of total facility length).

As IDLC features are added, the round-trip-delay available for the transmission facility may be reduced and the deployment range of the RDT may become limited. For example, if a stand-alone DTAU is used at the IDT, the two-way transmission delay of the DTAU needs to be considered in determining LDS-RDT deployment lengths.

As required in Section 4.4.3, suppliers shall provide round-trip-delay characteristics, for the LDS and RDT, based on actual round-trip-delay performance.

O12-539 **[1405]** In Section 4.4.3, "Delay," it is desirable that actual round-trip-delays of RDTs and LDS/IDTs be kept to a minimum. The lower the actual round-trip-delay, the more range/flexibility a BCC has in its deployment strategy.

CR12-540 **[1406]** In Section 4.4.7, "Clear Channel Capability," if a DS0 CCC is provided for channels with per-channel signaling needs, the Common Signaling Channel (CSC) shall be used to satisfy those signaling needs across the Generic IDLC Interface.

CR12-541 **[1407]** In Section 4.4.10, "Line-to-Time-Slot Numbering," without DS0 cross-connect capabilities, the maximum number of lines (termination ports) of an RDT shall be 2048.

R12-542 **[1408]** In Section 4.4.11, "Idle Channel Requirements," for DDSs, the specific idle DS0-code-word for that service shall be used (e.g., refer to TA-TSY-000077 for DDS).

R12-543 **[1409]** In Section 4.4.11, "Idle Channel Requirements," for analog services, an idle PCM-code-word shall be used across the Generic IDLC Interface as follows:

…

a. For channels (i.e., time slots) that are assigned to specific line units: If a line unit is in a non-equipped, non-provisioned, or failure state, either a 7F-code (01111111 where "0" is the most significant bit of the PCM-code-word) or a FF-code (11111111) shall be put into the outgoing DS0 with ABCD=0010 (DS0 AIS;

which is the new terminology for UNICODE), where DS0 AIS signaling is applicable. When a failed line unit is in the test state, the outgoing DS0 shall carry the output of the line unit, including the applicable ABCD code that represents the conditions on the drop side of the line unit as seen by the line unit.

… b. For channels that are not assigned to a specific line unit: Either a 7F-code or a FF-code shall be put into the outgoing DS0; no ABCD signaling code is inserted because no service is associated with an unassigned time slot. ABCD codes, extracted from a unassigned DS0, will implicitly appear as “1111” due to this 7F/FF requirement.

If an unprotected DS1 fails, all active calls being carried on the failed DS1 need to be disconnected and all time slots associated with the failed DS1 need to be marked unavailable. Once disconnected, locally switched calls must have access to available DS0s on non-failed DS1s for establishing new calls when needed. The following two requirements clarify the CGA scenario when the Time-slot Management Channel (TMC) is used across the Generic IDLC Interface.

R12-544 **[1410]** In Section 4.7, “Carrier Group Alarm,” at the RDT, on declaration of a DS1 Carrier Failure Alarm (CFA), the following shall occur:

… a. All non locally switched circuits being carried on the failed DS1 shall be treated per current trunk conditioning requirements of this GR; i.e., either perform service-specific conditioning or transmit a DSO AIS code (new terminology for UNICODE) in the downstream direction.

… b. For each affected locally switched call not in the Null (0) state, the RDT shall initiate service-specific conditioning on each line until the call is cleared. The DS1 “Yellow” alarm signal sent to the IDT in response to the locally declared CFA shall cause call clearing (i.e., stop billing and disconnect, with cause equal 16 or 27, each time slot) to be initiated at the IDT.

R12-545 **[1411]** In Section 4.7, “Carrier Group Alarm,” at the IDT, on declaration of a DS1 Carrier Failure Alarm (CFA), the following shall occur:

… a. All non locally switched circuits being carried on the failed DS1 shall be treated per current trunk conditioning requirements of this GR; i.e., either perform service-specific conditioning or transmit a DSO AIS code in the downstream direction.

… b. For each affected locally switched call not in the Null (0) state, the IDT shall initiate call clearing (i.e., stop billing and disconnect, with cause equal 16 or 27, each time slot).

R12-546 **[1412]** In Section 4.10, "Data-Link," for the Generic IDLC Interface, data links shall be provided as defined in Section 12.6.1.2 (Physical Layer Requirements) and Section 12.6.1.3 (Data-Link Layer Requirements).

12.6.1.2 Physical Layer Requirements

R12-547 **[1413]** The architecture of IDLC systems shall be such that all LDS-RDT communications can be accomplished over n DS1-rate interface signals ($2 \leq n \leq 28$),[1] meeting the physical interface requirements of Section 4.1; other facility requirements identified in Section 12.6.1.1 shall also be satisfied.

This does not preclude sharing of common RDT hardware (e.g., power supplies, ringing generators, etc.) over more than 28 DS1 interfaces. This requirement is only intended to limit the need for the LDS to control DS1s as a common system. The value of n is communicated to the LDS processor at system initialization.

The above requirements define the physical interface to the transmission facilities. The following requirements define the standard for formatting the actual DS1-rate signal such that the DS1 signal can be separated back into its constituent channels on the other side of the Generic IDLC Interface. Additional requirements specific to DS1 extensions are defined in Section 3.7.4.

As stated in Section 12.6.1.1, the LDS and RDT uses the ESF format (see TR-NWT-000499) as defined in Sections 4.4.1, 4.4.2, and 4.8, for formatting and interpreting the DS1 signal. The ESF-formatted DS1 signal is a structure built on 24 frames. Each frame consists of 193 bits, as illustrated in Figure 4-1. Once the DS1 signal is frame synchronized, the functionality of each bit of the ESF structure can be uniquely identified. As illustrated in Table 4-2, the constituent parts of ESF formatted DS1 signals are as follows:

a. There is an F-bit appearance once every 193 bits, as illustrated in Table 4-2. For IDLC Generic IDLC Interface applications, these F-bits are used as defined in Section 4.8; see definitions for FPS, CRC, and FDL bits. The FDL-bits are further defined as follows:

   1. As a bit-oriented data link, the FDL bits are used to pass DS1 facility alarm and protection line switching information across the Generic IDLC Interface; requirements of Sections 4.8 and 4.9 apply. Each DS1 path between the IDT and RDT supports this requirement.

1. For the Generic IDLC Interface, at least two DS1s (not counting the protection DS1) are needed to meet back-up requirements for the operations data link; as defined in Section 12.6.1.3.3. For purposes of LDS system administration, n shall be ≤ 28.

2. As a message-oriented data link, the FDL bits are used by the IDT and RDT to accommodate the per-DS1 far-end performance reporting requirements defined in Section 4.9.4.

b. Within each frame there are 24 8-bit time slots, as illustrated in Figure 4-1. As indicated in Table 4-2, these time slots carry 8 bits of traffic data for five out of every six frames. Once every six frames, a per-channel signaling option is available that replaces bit 8 (the least significant bit of the 8-bit time slot) with per-channel signaling information; this is referred to as robbed-bit signaling.

R12-548 **[1414]** For the Generic IDLC Interface, the LDS and RDT shall be capable of assigning either signaling option "T" or "16," of Table 4-2, to any DS0. One of these signaling options shall be assigned to each DS0.

R12-549 **[1415]** Signaling option "T" shall be used when it is desired to continuously transport 8 bits of data on a DS0 transparently (i.e., no robbed-bit signaling) between the LDS and RDT. Option "T" is required for any DS0 providing a 64-kb/s CCC.

… a. When the CSC is used for call processing, option "T" shall be the default selection for all DS0s.

… b. However, DS0s requiring signaling option "16" shall be user selectable on a per-DS0 basis.

R12-550 **[1416]** Signaling option "16" shall be used to accomplish call processing functions when in-slot signaling is required; this is referred to as ABCD robbed-bit signaling.

… a. When hybrid signaling is used for call processing, option "16" shall be the default selection for all DS0s.

… b. However, DS0s requiring option "T" shall be user selectable on a per-DS0 basis.

As described in Section 12.5.3, a DS0 provisioned for option "16" that is assigned to an ISDN B channel shall ignore the option "16" provisioning and function as if option "T" were selected, for the duration of that ISDN B-channel call. Section 12.5.2.3.2 (which specifies the use of the Call Reference suffix to identify ISDN B channels) allows option "T" to be automatically selectable on a per-call basis for ISDN B channels.

12.6.1.3 Data-Link Layer Requirements

To satisfy IDLC-system requirements, for a variety of LDS-RDT multi-supplier combinations, and to make possible the implementation of required IDLC features, four Generic IDLC Interface data links are defined.

a. An in-slot signaling capability, using ABCD robbed-bit signaling, for those IDLC configurations requiring such per-channel signaling capabilities; an RDT design decision. Across the Generic IDLC Interface, time-slot-assignment capabilities and other features requiring out-of-slot signaling cannot be supported with only ABCD robbed-bit signaling.

b. A hybrid signaling capability is also defined for those RDTs that want to offer time-slot-assignment capabilities while retaining their ABCD robbed-bit signaling structure. A TMC is defined to accommodate this need.

c. For RDT designs aimed at providing 64-kb/s CCC on all DS0s, new customer services, and other capabilities associated with CCS, an out-of-slot signaling capability using a CSC is defined.

d. An EOC using a dedicated DS0 is used to establish an operations data link. Use of the LAPD protocol, see Section 12.4.3, allows a single EOC interface to establish virtual interfaces between the following combinations:

    1. The LDS and the RDT.
    2. Some numbers of OSs and the RDT.
    3. Some number of TSCs and the RDT.
    4. Other “user-assignable” destinations and the RDT.

    The EOC data link satisfies operational communications requirements, across the Generic IDLC Interface, with respect to provisioning, maintenance, testing, etc.

R12-551 **[1417]** An LDS shall be capable of satisfying the requirements of all four data links (a through d, above) but will only actually provide those used by a specific RDT.

The following subsections provide requirements needed to define the protocol to be used on each of the four data links defined above.

12.6.1.3.1 ABCD Robbed-Bit Signaling

R12-552 **[1418]** Signaling option “16” of the ESF format identifies four signaling bits (A, B, C, and D) associated with each DS0 channel, and shall be used for transmission of ABCD signaling codes between the IDT and RDT.

These ABCD bits, when used as signaling bits, are the least significant bit of each channel in the 6th, 12th, 18th, and 24th frames of the 24-frame SF. Signaling is accomplished by replacing the bits (located in the positions specified above) of the originally encoded byte with signaling bits. Because this method replaces data bits, it is commonly referred to as “robbed bit” signaling. The replacement bits typically relate to the call state of the subscriber line as, for example, “on-hook” and “off-hook” states.

The ABCD bits allow a maximum of 16 possible states per channel. Functionally, these bits comprise per-channel data-links operating at a rate of 333.3 b/s. Signaling information is refreshed every 3 ms and conveys signaling/supervision information related to the associated service channel.

The use of these data links will depend on the specific line terminating equipment. Alternate means of conveying equivalent information may be available and, thus, this form of signaling will not always be used. For example, to provide 64-kb/s CCC on all DS0s, an out-of-slot signaling method (CSC) is required.

12.6.1.3.2 Call Processing (TMC/CSC) DL Control

One of the ground rules for the Generic IDLC Interface was the adoption of recognized standards. Further, a major goal was to make a choice based on a prospective standard's applicability in other parts of the network. Two standards met these constraints as well as satisfying the functional requirements necessary for an IDLC call-processing DL protocol. These were:

a. The “D-channel” interface (LAPD DL protocol) being proposed for ISDN architectures (see ITU-T Recommendation Q.921) and for the interface between an SPCS and a digital PBX (see TR-TSY-000454).

b. Calcites Signaling System No. 7 (SS7) being proposed for interoffice signaling applications.

R12-553 **[1419]** LAPD has been chosen as the protocol to be used on the DS0 call processing (TMC/CSC) data link and shall be provided.

Specific protocol requirements are defined in the “LAPD Protocol” section. LAPD was chosen for the following reasons:

a. LAPD is becoming the protocol of choice on the line side of the switch; e.g., for both ISDN Basic Rate and Primary Rate Access.

b. SS7 is still considered a protocol optimized for use between the trunk-sides of many switches; e.g., CCIS and inter-networking of ISDN access switches.

A call processing (TMC/CSC) data link will always be required if an RDT Time-Slot-Interchanger (TSI) is used with time slots assigned during call processing (e.g., concentrated RDT) on a per-call basis.

R12-554 **[1420]** The CSC or TMC shall be used to transmit time-slot-assignment and call-processing messages to and from the RDT.

These TMC/CSC messages will include call set up and tear down and for the case of the CSC will allow for a 64-kb/s CCC on all DS0s.

R12-555 **[1421]** Both the RDT and IDT shall provide two TMC/CSC path terminations; one TMC/CSC path termination shall be used for the active TMC/CSC path (protected TMC/CSC path) and the other TMC/CSC path termination shall be used for the standby TMC/CSC path (protecting TMC/CSC path).

R12-556 **[1422]** Time-slot 24 of DS1 number 1 shall be used for one of the TMC/CSC path terminations.

R12-557 **[1423]** Time-slot 24 of DS1 number n shall be used for the second TMC/CSC path termination where n is not DS1 number 1 or, when a protection DS1 is equipped, n is not the protection DS1.

R12-558 **[1424]** The second TMC/CSC path termination shall be on the same DS1 as the second EOC path termination.

R12-559 **[1425]** In the IDT, the DS1 designated to carry the second TMC/CSC path termination shall be user manageable using an operations message.

R12-560 **[1426]** The DS1 designated to carry the second TMC/CSC path termination shall only be changed by an operations action at the IDT and not through an independent action of the IDT.

At the RDT, the DS1 used for the second TMC/CSC path termination may be fixed when the RDT is turned-up, i.e., the second TMC/CSC can only be on a specific DS1, or the RDT may provide the capability to configure which DS1 is to have the second TMC/CSC path termination using an operations message.

CR12-561 **[1427]** If the DS1 designated to carry the second TMC/CSC path termination is user manageable at the RDT, the DS1 shall only be changed by an operations action at the RDT and not through an independent action of the RDT.

R12-562 **[1428]** The redundancy of the TMC/CSC path hardware and software shall allow maintenance operations to be carried out on one of the TMC/CSC paths without affecting the operation of the other TMC/CSC path, i.e., the other TMC/CSC path shall remain in service.

These maintenance operations include the removal of the circuit pack or packs containing the hardware and/or software associated with the two TMC/CSC paths.

R12-563 **[1429]** When the IDT or RDT is initialized or reinitialized, the default is to make the TMC/CSC path on DS1 number 1 active.

R12-564 **[1430]** Time-slot number 24 within the DS1s carrying the two TMC/CSC paths shall not be included in the list of time slots available for call processing.

The requirements for establishing multiple frame operation for the logical data-link connections used on the TMC/CSC paths are specified in Section 12.4.3.5.11.

R12-565 **[1431]** Once multiple frame operations has been established for an TMC/CSC logical data-link connection, the connection shall remain in multiple frame operation except when specific requirements in this document call for multiple frame operation to be released or as the result of the path going to the out-of-service state.

R12-566 **[1432]** The IDT or RDT shall initiate an TMC/CSC path protection switch to DS1 number 1 following the procedures of Section 12.6.3 when the RDT or IDT is initialized or re-initialized. The near end shall follow the procedures in Item 3 of the first requirement in Section 12.6.3.5.5 when the far end is initialized or re-initialized.

A TMC/CSC path protection switch is done as part of the initialization or re-initialization procedures to align the active TMC/CSC paths at each end of the system. If a misalignment existed following an initialization or re-initialization, the misalignment would be detected when the IDT or RDT tried to use the TMC/CSC path that was active at its end. However, a TMC/CSC path protection at that time is more likely to interfere with call processing than a path switch done following an initialization or re-initialization.

12.6.1.3.3 Operations DL Control

There is ongoing work within Bellcore to document generic OS interfaces to network elements. The recommendations contained in TR-TSY-000827 and GR-828-CORE specify the generic protocol and language (except that the ASN.1 syntax is now required to convey operations messages between the RDT and IDT) to be used. It is assumed that all OS-LDS communications will evolve toward these requirements. There are additional functions, however, that need to be defined to extend these requirements to a subtending RDT of an IDLC system. Section 12.7.1 defines the functional capabilities needed in an LDS to provide a “Gateway Function” between an OS and an RDT.

R12-567 **[1433]** LAPD shall be the protocol used for the DS0 operations (EOC) data link.

Specific protocol requirements are defined in the “LAPD Protocol” section. LAPD facilitates the interface to the OS and simplifies the LDS' gateway function, as described in Section 12.7.1.

R12-568 **[1434]** Both the RDT and IDT shall provide two EOC path terminations; one EOC path termination shall be used for the active EOC path (protected EOC path) and the other EOC path termination shall be used for the standby EOC path (protecting EOC path).

R12-569 **[1435]** Time-slot 12 of DS1 number 1 shall be used for one of the EOC path terminations.

R12-570 **[1436]** Time-slot 12 of DS1 number n shall be used for the second EOC path termination where n is not DS1 number 1 or, when a protection DS1 is equipped, n is not the protection DS1.

R12-571 **[1437]** In the IDT, the DS1 designated to carry the second EOC path termination shall be user manageable using an operations message.

R12-572 **[1438]** The DS1 designated to carry the second EOC path termination shall only be changed by an operations action at the IDT and not through an independent action of the IDT.

At the RDT, the DS1 used for the second EOC path termination may be fixed when the RDT is turned-up, i.e., the second EOC can only be on a specific DS1, or the RDT may provide the capability to configure which DS1 is to have the second EOC path termination using an operations message.

CR12-573 **[1439]** If the DS1 designated to carry the second EOC path termination is user manageable at the RDT, the DS1 shall only be changed by an operations action at the RDT and not through an independent action of the RDT.

R12-574 **[1440]** The redundancy of the EOC path hardware and software shall allow maintenance operations to be carried out on one of the EOC paths without affecting the operation of the other EOC path, i.e, the other EOC path shall remain in service.

These maintenance operations include the removal of the circuit pack or packs containing the hardware and/or software associated with the two EOC paths.

R12-575 **[1441]** When the IDT or RDT is initialized or reinitialized, the default is to make the EOC path on DS1 number 1 active.

R12-576 **[1442]** Time-slot number 12 within the DS1s carrying the two EOC paths shall not be included in the list of time slots available for call processing.

The requirements for establishing multiple frame operation for the logical data-link connections used on the EOC paths are specified in Section 12.4.3.5.11.

R12-577 **[1443]** Once multiple frame operations has been established for an EOC logical data-link connection, the connection shall remain in multiple frame operation except when specific requirements in this document call for multiple frame operation to be released or as the result of the path going to the out-of-service state.

R12-578 **[1444]** The IDT or RDT shall initiate an EOC path protection switch following the procedures of Section 12.6.3 when the RDT or IDT is initialized or re-initialized. The near end shall follow the procedures in Item 3 of the first requirement in Section 12.6.3.5.5 when the far end is initialized or re-initialized.

An EOC path protection switch is done as part of the initialization or re-initialization procedures to align the active EOC paths at each end of the system. If a misalignment existed following an initialization or re-initialization, the misalignment would be detected when the IDT or RDT tried to use the EOC path that was active at its end. However, a EOC path protection at that time is more likely to interfere with operations than a path switch done following an initialization or re-initialization.

12.6.1.4 Convergence Function

The convergence function is defined to bridge the LAPD protocol at layer 2 with the application layer. The maximum size of the information field in an LAPD frame is 256 octets for SAPI 1 (SAPI 1 is used on the EOC for all functions and on the TMC/CSC for path protection switching functions as defined in Section 12.4.3.5). There will be Application Protocol Data Units (APDUs), i.e., “messages,” being sent to or sent by the application layer that are longer than 256 octets. These APDUs must be segmented for transmission and reassembled at the far end. These functions are done in the convergence function defined in this section. The convergence function is used for all APDUs sent over the EOC and TMC/CSC using SAPI 1 regardless of the TEI used and the length of the APDU.

12.6.1.4.1 EOC Segmentation/Reassembly Requirements

R12-579 **[1445]** When the number of octets in an APDU is greater than (N201 - 1), the convergence function shall segment the APDU into the minimum number of segments necessary to transmit the APDU. (N201 is the maximum number of octets in the information field of a LAPD information command.)

R12-580 **[1446]** The segments shall be sequenced so that the first segment transmitted contains the first portion of the APDU, the next segment

transmitted contains the next portion of the APDU, and this process continues until the final segment transmitted contains the final portion of the APDU.

R12-581 **[1447]** The convergence function shall be capable of simultaneously segmenting one APDU for each unique SAPI-TEI combination that is in multiple frame established state on the active EOC path, SAPI=1 TEI=0 on the standby EOC path, and SAPI=1 TEI=0 on the active and standby TMC/CSC path.

R12-582 **[1448]** The convergence function shall be capable of simultaneously assembling one APDU for each unique SAPI-TEI combination that is in multiple frame established state on the active EOC path, SAPI=1 TEI=0 on the standby EOC path, and SAPI=1 TEI=0 on the active and standby TMC/CSC path.

For a given SAPI-TEI combination, the convergence function can only segment one APDU and reassemble one APDU at a time, i.e., frames from more than one APDU cannot be interleaved on the same logical channel defined by the SAPI-TEI combination.

The maximum size of an APDU that must be processed by the convergence function is 10K (10240) octets.

R12-583 **[1449]** An RDT or IDT shall have the capability to reassemble APDUs as large as 10240 octets.

An RDT or IDT is not required to provide 10K octets of buffer space for each SAPI-TEI combination contained in Table 12-1; a common buffer area may be shared among the SAPI-TEI combinations.

CR12-584 **[1450]** Any vendor that provides less buffer space than is needed to simultaneously reassemble a 10K octet APDU for every SAPI-TEI combination in Table 12-1 shall include procedures in its buffer management process to prevent the EOC from “locking-up”, i.e., APDUs cannot be reassembled because the convergence function ran out of buffer space.

R12-585 **[1451]** These procedures shall include the capability to temporarily shut down some of the logical channels at the data link layer (cause a receiver-not-ready condition) until buffer space becomes available.

R12-586 **[1452]** The convergence function shall not discard completely assembled APDUs to receive new APDUs.

O12-587 **[1453]** The procedures should not rely on the discarding of partially reassembled APDUs to prevent a "lock-up."

R12-588 **[1454]** The convergence function shall have the capability to temporarily stop the application layer from passing new APDUs to it.

R12-589 **[1455]** The convergence function shall not discard partially segmented or unsegmented APDUs.

The Generic IDLC Interface requires that a second EOC path be provided as a standby protection path. If LAPD protocol errors as defined in Section 12.6.3 are detected on the active EOC path, the operations traffic is automatically switched to the EOC standby path.

O12-590 **[1456]** During an EOC protection path switch the convergence function should cease sending new segments to the LAPD process for all SAPI-TEI combinations except SAPI=1 TEI=0.

The SAPI=1 TEI=0 combination is used for sending the CMIS M-ACTIONs that control the EOC protection path switch and these M-ACTIONs must continue to be sent to complete the EOC protection path switch.

There is a similar protection path for IDLC systems that have a TMC or CSC. For this data link, the convergence function only processes the APDUs to be sent using SAPI=1 TEI=0, i.e., APDUs containing CMIS M-ACTIONs to control the TMC or CSC protection path switching procedures.

R12-591 **[1457]** The convergence function shall continue to process APDUs for SAPI=1 TEI=0 during an TMC or CSC protection path switch.

R12-592 **[1458]** The first octet of the information field of all LAPD information frames sent using SAPI 1 shall be used as a header octet, and the format of the header octet shall be as follows:

bit	8	7	6	5	4	3	2	1
	1	x	x	x	0	0	B	F

… The B (bit 2) and F (bit 1) bits are used for segmenting and reassembly of APDUs sent using SAPI 1.

… The bits in the header octet are used as follows:

… • Bit 2 (B) shall be set to 1 for the first frame containing a portion of an APDU, otherwise bit 2 shall be set to 0.

… • Bit 1 (F) shall be set to 1 for the frame containing a final portion of an APDU, otherwise bit 1 shall be set to 0.

… • If the entire APDU is contained within the frame, both bit 1 and bit 2 shall bet set to 1.

… • A frame that is neither a first nor a last is called a middle frame and bits 1 and 2 shall be set to 0.

… • Bit 3 and bit 4 shall be set to 0.

… Bits 5, 6, and 7 (x) are not used.

… Inside the header octet bit 1 shall be the first bit transmitted.

12.6.1.4.2 Error Handling Within the Convergence Function

As stated above, a second EOC path is provided as a standby protection path. The procedures to switch between the active and standby EOC paths do not guarantee all LAPD frames that are in transit between the IDT and RDT during the EOC path switch will be delivered. This lack of a guarantee that all in transit frames will be delivered impacts the convergence function in the following ways:

- If an entire APDU has been passed from the convergence function to layer 2 (LAPD process), the convergence function responsibilities are complete and no action is needed if an EOC path protection switch occurs.
- If part of an APDU has been passed from the convergence function to layer 2 when an EOC path protection switch occurs, some of the LAPD frames for the APDU may have been lost.

O12-593 **[1459]** Once the EOC path protection switch has been completed, the convergence function should reprocess the entire APDU, i.e., the entire APDU is passed to the LAPD process even though part of the APDU was passed to the LAPD processor before the EOC protection path switch occurred.

There are other error conditions that may be encountered by the convergence function that may or may not be associated with a path protection switch.

R12-594 **[1460]** If the convergence function is reassembling an APDU and it receives an information field of an APDU segment indicating the segment is the first segment of an APDU before it has received an information field of an APDU segment indicating a final segment, the convergence function shall discard the partially reassembled APDU and begin reassembling the new APDU.

R12-595 **[1461]** If the convergence function receives an information field of an APDU segment indicating the segment is the last segment of an APDU

before it has received an information field of an APDU segment indicating a first segment, the convergence function shall discard the segment.

R12-596 **[1462]** If the convergence function receives an information field of an APDU segment indicating the segment is a middle segment of an APDU before it has received an information field of an APDU segment indicating a first segment, the convergence function shall discard the segment.

R12-597 **[1463]** The convergence function shall discard the APDU segment if bits 3 through 8 inclusive do not match the pattern defined above.

Other than the objective to retransmit an APDU during a EOC protection path switch given above, there are no peer-to-peer error recovery requirements in the convergence function. If APDUs are lost or corrupted because the frames were discarded by the convergence function, the loss or corruption of these APDUs or "messages" will be the responsibility of the application processes.

12.6.1.5 Application Layer

The application layers for the EOC and SAPI 1 of the TMC/CSC are described in this section.

The information models for the operations messages carried on these data links are found in Supplement 3 of TR-TSY-000303 and GR-2833-CORE. An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.

R12-598 **[1464]** Operations applications messages shall be written using the Common Management Information Service (CMIS).

R12-599 **[1465]** The services and protocols for CMIS shall conform to ISO/IEC 9595 and ISO/IEC 9596-1, respectively.

R12-600 **[1466]** The Remote Operations Service (ROS) shall be used as the underlying service to CMIS in accordance with the specification in CMIS.

R12-601 **[1467]** The ROS services and protocols specified in ITU-T X.219 and X.229, respectively, shall be supported.

R12-602 **[1468]** The Association Control Service Element (ACSE) shall be supported when a 7-layer OSI protocol stack is implemented for OS to RDT, OS to LDS, or IDT to RDT operations communications.

CR12-603 **[1469]** When the ACSE is supported, the requirements for Interactive Class Applications defined in GR-828-CORE shall apply.

CR12-604 **[1470]** When the ACSE is supported, the Authentication functional unit defined in ISO 8650, Amendment 1, 1990 is a desirable option. Implementation of this objective requires Industry agreement on an authentication method and may be an area for future Bellcore requirements work.

CR12-605 **[1471]** When the ACSE is supported, both the managing and managed systems shall be capable of initiating associations.

Bellcore proposes that application-layer associations for provisioning or testing purposes would be initiated as needed and released when the functions are complete. Application-layer associations for maintenance or surveillance purposes should be initiated and remain up.

R12-606 **[1472]** The ASN.1 type AP-title-form 1 and AE-qualifier-form1 (as defined in ISO/IEC 8650/Technical Corrigendum 1) shall be used for the AE-title.

Proposed default AE-title values for functional OSs are provided in Table 12-12. These default values are based on Directory Name forms in ISO/IEC 9594-7 | ITU-T X.521. These forms are also referenced in the Draft Proposed American National Standard - Directory Service for TMN and SONET.

R12-607 **[1473]** The transfer syntax to be used for the messages shall be the Basic Encoding Rules (BERs) for Abstract Syntax Notation One (ASN.1) defined in ITU-T X.209/ISO 8825.

R12-608 **[1474]** The maximum length of an APDU generated in the application layer shall be 10240 octets. This length includes all header information for the CMIS and ROS protocols, and also includes BER encoding.

12.6.2 DS1 Facility Protection Switch - Option

DS1 facility protection is an option for IDLC systems. The procedures to be followed when facility protection switching is implemented for the Generic IDLC Interface are presented in this section (see Section 6.2.1 for general facility protection switching requirements).

A facility protection switching feature enables traffic on a failed or degraded DS1 facility to be moved to one or more alternate DS1 facilities.

R12-609 **[1475]** When an IDLC system includes the facility protection switching option, a dedicated protection facility with a 1:n arrangement shall be used for the Generic IDLC Interface.

The dedicated protection facility includes the DS1 termination and the ESF framer. An ESF framer is required for the protection DS1 to do performance monitoring of the protection DS1 facility. Performance monitoring of the protection DS1 facility will allow each end of that facility to determine the state of its received signal. (If an IDT or RDT processed the performance monitoring report sent from the other end of the protection DS1 within the ESF data link, the IDT or RDT could also determine the state of its transmitted DS1 signal. However, the processing of the performance monitoring report messages of the ESF is optional for the protection DS1.)

When a TMC or CSC path is provided, the term “primary DS1” refers to the DS1 that carries the active TMC or CSC path. Otherwise the “primary DS1” refers to the DS1 that carries the active EOC path.

The term “protection DS1” refers to a DS1 that does not carry calls under no-fault conditions, i.e., the dedicated protection facility.

R12-610 **[1476]** The default protection DS1 shall be the highest numbered DS1 (≤ 28) the RDT can accommodate.

Thus the protection DS1 for a given IDLC system can always keep the same number and be independent of the actual number of DS1s installed; i.e., growth DS1s will all have lower DS1 numbers than the protection DS1.

O12-611 **[1477]** The RDT should offer the capability for the user to provision which DS1 will serve as the protection DS1.

The term “near end” refers to the end of the DS1 facility, IDT, or RDT, that initiates a DS1 facility protection switch or release while the term “far end” refers to the opposite end of the DS1 facility.

General requirements for the DS1 facility protection switching procedures are given below. Some requirements in this section are written using the notation “IDT (RDT).” These requirements apply to the IDT and the RDT. The requirements were written in this format to avoid having a second requirement with the same wording, but using the notation in the parentheses instead of the notation immediately preceding the parentheses.

R12-612 **[1478]** Calls in the talking state at the start of a facility protection switch shall be maintained in the talking state during a facility protection switch.

R12-613 **[1479]** The IDT shall continue call processing on calls in other states (e.g., ringing, digit collection, etc.) unless directed by the LDS to disconnect the circuit.

R12-614 **[1480]** The RDT shall continue call processing on calls in other states (e.g., ringing, digit collection, etc.) unless directed by the IDT to disconnect the circuit.

R12-615 **[1481]** The time interval that a DS1 facility transmission path may be interrupted shall be ≤ 100 ms.

The entire protection switch may take longer than 100 ms, but the transmission path is not to be interrupted for more than 100 ms, when switching from one transmission path to another transmission path, to minimize call processing errors during the protection switch. (This 100-ms interruption does not include the time a path may be interrupted by a DS1 line failure but only the time a path is interrupted by actions taken during facility protection switching.)

R12-616 **[1482]** The protection DS1 shall always be powered up and carrying a signal.

R12-617 **[1483]** When the protection DS1 is not in use, the traffic signal carried by the protection DS1 shall be a replica of the traffic signal carried by the primary DS1.

R12-618 **[1484]** The DS1 whose traffic carrying signal has been moved to the protection DS1 shall continue to carry a replica of its traffic carrying signal after a successful switch to the protection DS1 has been completed.

R12-619 **[1485]** The IDT and RDT shall provide the capability to initiate both manual and automatic protection switching from its end of the DS1 facility.

R12-620 **[1486]** In response to operations messages received from an OS or as input from a craft interface at the LDS (RDT), the IDT (RDT) shall provide the capability:

… 1. To initiate a switch to the protection facility (Figure 12-54)

… 2. To initiate a release from the protection facility to working facility (Figure 12-56)

… 3. To initiate a forced release from the protection facility to working facility (Figure 12-56)

… 4. To inhibit a switch to the protection facility

… 5. To inhibit a release from the protection facility to the working facility.

The IDT and RDT need state and status information on the DS1 facilities to carry out the facility protection switching procedures.

R12-621 **[1487]** The IDT and RDT shall each keep state and status information for their own DS1 terminations. The IDT and RDT shall provide the capability to retrieve this information from a remote location.

The following information and actions based on the state and status information is needed to implement the facility protection switching feature.

R12-622 **[1488]** The DS1 shall be in the “equipped” state if the DS1 has been equipped, i.e., the physical equipment necessary to put the DS1 in service is present.

R12-623 **[1489]** The DS1 shall be in the “unequipped” state if any of the physical equipment necessary to put the DS1 in service is missing.

R12-624 **[1490]** In response to operations messages received from an OS or as input from a craft interface at the LDS (RDT), the IDT (RDT) shall provide the capability to inhibit a facility protection switch.

R12-625 **[1491]** The default for facility protection switching shall be not inhibited.

R12-626 **[1492]** If the facility protection switching is inhibited, both automatically initiated and manually initiated (by an operations message or input from a craft interface) switching of the DS1 from its working DS1 to the protection DS1 shall be inhibited.

R12-627 **[1493]** If a DS1 is on the protection DS1 when facility protection switching is inhibited, the DS1 shall not be forced off the protection DS1 and all facility protection DS1 release procedures are applicable.

R12-628 **[1494]** In response to operations messages received from an OS or as input from a craft interface at the LDS (RDT), the IDT (RDT) shall provide the capability to inhibit a facility protection switch release.

R12-629 **[1495]** The default value for the facility release shall be not inhibited.

R12-630 **[1496]** If the facility release is inhibited, both automatically initiated and manually initiated (by an operations message or input from a craft interface) releasing of the DS1 from the protection DS1 to its working DS1 shall be inhibited.

Note that for a given DS1, both facility protection switching and release may be inhibited at the same time; this effectively locks a DS1 in its current position.

R12-631 **[1497]** A DS1 shall be in the in-service state when the DS1 is capable of providing its service function.

R12-632 **[1498]** A DS1 shall be in the out-of-service state when the service functions of the DS1 are denied for some cause.

A DS1 may be out of service from a detected failure such as Loss-Of-Signal (LOS), Loss-Of-Frame (LOF), or receipt of 10 consecutive path Severely Errored Seconds (SES-P), or the DS1 may be put in the out-of-service state by an operations message.

R12-633 **[1499]** A DS1 shall not be put in the out-of-service state when its Bit Error Ratio (BER) exceeds the automatic protection switching threshold BER.

The protection DS1 is still available for use when its BER exceeds the automatic protection switching threshold BER.

R12-634 **[1500]** If the protection DS1 is in the out-of-service state, a facility protection switch shall not be allowed.

There are no procedures to force a DS1 onto the protection DS1 when the protection DS1 is in the out-of-service state. If a DS1 is in the out-of-service state and on the protection DS1, the DS1 can be returned to the out of service DS1 if the DS1 is pre-empted by the primary DS1 or a forced release of the protection DS1 is initiated by an OS or through a craft interface. Similarly, a DS1 on the protection DS1 because of degraded performance can be returned to a DS1 whose BER exceeds the automatic protection switching threshold BER value when the DS1 is pre-empted by a DS1 with a hard failure condition or a forced release. The term hard failure is defined as a loss-of-signal condition, out-of-frame condition, a Carrier Failure Alarm (CFA), and, if facility protection switching is provided on receipt of an AIS, AIS on the DS1 to differentiate these failures from an automatic protection switch performance monitoring threshold crossing. A manual protection switch is also treated as a hard failure.

R12-635 **[1501]** A protection DS1 shall be “in use” at the IDT (RDT) if the protection DS1 is carrying a DS1 signal that is the result of an automatically or manually initiated switch of the DS1 signal to the protection DS1 and the IDT (RDT) is taking its received signal from the protection DS1.

R12-636 **[1502]** A protection DS1 shall be “not in use” at the IDT (RDT) if the protection DS1 is carrying a traffic bearing DS1 that is a replica of the primary DS1 signal or a quasi-random signal, and the IDT (IDT) is not taking a received signal from the protection DS1.

R12-637 **[1503]** Both the IDT and RDT shall record the identity, i.e., the DS1 number, of the DS1 whose signal is currently carried on the protection DS1.

R12-638 **[1504]** The IDT (RDT) shall examine the DS1 states at its end to determine if a facility automatic protection switch needs to be initiated when any one of the following conditions occur on a DS1 in the protection group. (This is done even when a retry schedule has been established per the requirements in Section 12.6.2.3 Step 7.):

… 1. A Loss-of-Signal (LOS) condition is detected

… 2. An Out-of-Frame (OOF) condition exists for more than 200 ms

… 3. 10 consecutive path Severely Errored Seconds (SES-P) are detected

… 4. An automatic protection switch performance monitoring threshold crossing is detected

… 5. A DS1 is released from the protection DS1, i.e., the protection DS1 becomes free (see Sections 12.6.2.5 and 12.6.2.6)

… 6. Protection switching for a DS1 is enabled following an inhibit

… 7. The release of the DS1 on the protection DS1 is enabled following an inhibit (pre-emption can now occur)

… 8. The state of the protection DS1 changes from Out-Of-Service (OOS) to In-Service (IS).

CR12-639 **[1505]** If the IDT (RDT) provides DS1 protection switching on receipt of an Alarm Indication Signal (AIS), the IDT (RDT) shall examine the DS1 states at its end to determine if a facility automatic protection switch needs to be initiated when an AIS is received on a DS1 in the protection group.

R12-640 **[1506]** If IDT (RDT) determines there is one or more DS1s waiting to use the protection DS1[2] and the protection DS1 is in service, the IDT (RDT) shall initiate a protection switch following the procedures in Section 12.6.2.3.

The protection DS1 state and status data are used to make this determination as shown in Figure 12-49. The decisions in Figure 12-49 are based on only what is known at the end examining the state and status data. The term “hard failure” in the figure is defined to differentiate these failures from an automatic protection switch performance monitoring threshold crossing. A manual protection switch is also treated as a hard failure when determining if the protection switch will be initiated.

2. A DS1 is “waiting to use the protection DS1” if the DS1 has a fault condition that would cause the DS1 to be switched to the protection DS1. There may be more than one DS1 waiting to use the protection DS1 because the protection DS1 was not available, protection switching was inhibited at the time the protection switch was to be done, the protection switch could not be completed, or there are multiple DS1s that have a fault condition.

R12-641 **[1507]** The IDT (RDT) shall examine the DS1 states at its end to determine if a facility release needs to be initiated when anyone of the following conditions occur:

… 1. The failure of the DS1 on the protection DS1 clears (see Section 6.2.1.2 for criteria)

… 2. The performance level of the DS1 on the protection DS1 becomes better than the performance monitoring level at which a facility protection switch is initiated (see Section 6.2.1.2 for criteria), or

… 3. The release of the DS1 on the protection DS1 is enabled following an inhibit.

R12-642 **[1508]** When a facility release needs to be initiated, as determined in the above requirement, the release shall be delayed 1 second to allow the far end to clear its CFA.

CR12-643 **[1509]** If the IDT (RDT) switches a DS1 to the protection DS1 on receipt of an AIS, the IDT (RDT) shall examine the DS1 states at its end to determine if a facility release needs to be initiated when an AIS received on the DS1 on the protection DS1 clears.

The protection DS1 state and status data are used to make this determination as shown in Figure 12-55.

The 16-bit codewords or messages in the following requirement are defined in Table 4-4 and these messages are used in the DS1 facility protection switching procedures of Section 12.6.2.3 and/or the DS1 facility protection release procedures of Section 12.6.2.5.

R12-644 **[1510]** The following messages that are used in the DS1 facility protection switching procedures and/or DS1 facility protection release procedures shall be transmitted in the ESF data link of the protection DS1 using the ESF 16-bit patterns defined in Table 4-3:

… 1. Idle

… 2. Protection switch line n, where *1<=n<=28*,

… 3. Protection switch acknowledge

… 4. Protection switch complete

… 5. Protection switch release

… 6. Forced protection switch release.

R12-645 **[1511]** The IDT and RDT shall be capable of detecting the 16-bit messages used in the DS1 facility protection switching procedures and/or

DS1 facility protection release procedures using one of the following criteria:

… 1. When the same message is present in two out of three consecutive 16-bit message patterns,[3] or

… 2. When the same message is present in two consecutive 16-bit message patterns.

R12-646 **[1512]** The 16-bit messages used in the DS1 facility protection switching procedures and/or DS1 facility protection release procedures shall be repeated until a response from the opposite end is recognized or a timeout specified in the procedures occurs.

The "protection switch complete" message is continuously transmitted on the protection DS1 while the protection DS1 is being used by a given DS1. This message can be interrupted to transmit the ESF data-link Performance Report Message (PRM) on the protection DS1. (The PRM is discussed in Section 4.9.4.)

R12-647 **[1513]** The IDT (RDT) shall not send ESF data-link PRMs during the DS1 protection switch or release procedures, but the IDT (RDT) shall resume sending the PRMs following the completion of the DS1 protection switch or release procedures.

R12-648 **[1514]** The IDT (RDT) shall not invoke the error recovery procedures of Section 12.6.2.6 on receipt of an ESF data-link PRM.

The facility protection switching messages from the extended superframe data-link should not be queued. If the previous protection switching message has not been processed before a new message is received, the previous message should be discarded and all actions should be based on the current protection switching message.

R12-649 **[1515]** The IDT (RDT) shall be capable of responding to a facility protection switch or release message within 150 ms of detecting the message.

There are error recovery actions included in the facility protection switching procedures. For some of the error recovery actions, a time is given that specifies the time interval one end of the system is to wait for a response from the opposite end of the system before starting error recovery actions. These intervals are the maximum time given the opposite end to respond to a message under abnormal conditions, but they do not change the basic requirement to respond to a protection switch or release message within 150 ms.

3. The detection requirements have been specified to allow for accurate and timely detection of the messages of Table 4-3 that are used in the DS1 facility protection switching procedures in the presence of a 10^{-3} Bit Error Ratio (BER).

An unrecognized code is defined as any 16-bit pattern not defined in Table 4-3.

R12-650 **[1516]** The IDT (RDT) shall declare an unrecognized code has been received when the code pattern received is not recognized for 10 consecutive 16-bit patterns in the ESF data link of the protection DS1.

… All of the 10 consecutive patterns do not need to be the same 16-bit pattern, but only that the patterns are not defined in Table 4-3.

R12-651 **[1517]** The IDT (RDT) shall invoke the error recovery procedures of Section 12.6.2.6 when the receipt of an unrecognized code has been declared.

R12-652 **[1518]** When the protection switch or release procedures require the IDT (RDT) to change the message being sent in the ESF data link, the IDT (RDT) shall not transmit the “idle” message during the transition.

R12-653 **[1519]** If a Carrier Failure Alarm (CFA) is declared during the facility protection switch procedures, a yellow alarm signal shall be transmitted on the failed DS1's ESF data link and trunk conditioning shall begin for the circuits carried on the failed DS1 (see Section 4.7).

… The declaration of the CFA shall not interrupt the facility protection switch procedures.

R12-654 **[1520]** The RDT shall provide the capability for both the IDT and an OS to retrieve the data associated with the facility protection switch using an operations message.

R12-655 **[1521]** The facility protection switch shall include the DS1 framer circuitry.

12.6.2.1 Successful Facility Protection Switch Procedures

The following tasks are performed at the conclusion of all successful automatic and manually initiated facility protection switches and are referred to as the “Successful Facility Protection Switch Procedures” in the facility protection switching procedures.

R12-656 **[1522]** If trunk conditioning (that is normally done when a CFA is declared on the failed DS1 [see Section 4.7]) was started for the circuits carried on the DS1 that was moved to the protection DS1, the trunk conditioning shall be stopped.

The need to perform trunk conditioning for the failed DS1 is eliminated when a successful facility protection switch has been completed because the circuits are in service on the protection DS1. However, the Yellow signal continues to be sent on the failed DS1 even after the switch to protection.

R12-657 **[1523]** The IDT and RDT shall update the state and other data required for facility protection switching that are given above plus any other data the IDT and RDT may keep relative to facility protection switching.

R12-658 **[1524]** The near end shall report the facility protection switch to the maintenance OS and/or other OSs designated by the telephone company using an operations maintenance message. The message shall indicate that the facility protection switch has been completed for a failed facility or in response to a manual request for the protection switch. This message shall be sent over the EOC if the near end is the RDT and internally to the OIM if the near end is the IDT.

CR12-659 **[1525]** If a DS1 on the protection DS1 was pre-empted, the near end shall report the facility protection release of the pre-empted DS1 to the maintenance OS and/or other OSs designated by the telephone company using an operations maintenance message. The message shall indicate that the DS1's use of the protection DS1 has been pre-empted. This message shall be sent over the EOC if the near end is the RDT and internally to the OIM if the near end is the IDT.

R12-660 **[1526]** The IDT and RDT shall terminate any protection switch retry schedule established per the requirements in Section 12.6.2.3, Step 7.

R12-661 **[1527]** If the IDT (RDT) determines a protection switch is required on examining the state of all its DS1s following the completion of the DS1 protection switch, the IDT (RDT) shall send the “protection switch complete” message for at least 0.5 seconds before beginning the DS1 facility protection switch procedures of Section 12.6.2.3.

R12-662 **[1528]** If the IDT (RDT) determines a protection switch is required on examining the state of all its DS1s following the completion of the DS1 protection switch, the IDT (RDT) shall begin the DS1 facility protection switch within 30 seconds of sending the “protection switch complete” message on the protection DS1.

The 0.5 seconds is to allow for the far end to complete its switch of the DS1 to the protection DS1. The 30 seconds can be used to let the system settle down before starting another protection switch.

12.6.2.2 Failed Facility Protection Switch Procedures

The following tasks are performed if an automatic facility protection switch cannot be completed when an attempt is made to move a failed DS1 to the protection DS1 and are referred to as the "Failed Facility Protection Switch Procedures" in the facility protection switching procedures. Among the reasons a facility protection switch may fail to complete are

1. The protection DS1 is unequipped
2. A protection switch is inhibited
3. The protection DS1 is out of service
4. The protection DS1 is in use
5. The far end fails to respond to the facility protection switching messages.

For example, the near end may initiate a facility protection switch but the far end will not honor the switch request because protection switching is inhibited at its end.

If the DS1 facility protection switch procedures cannot be completed, the following procedures apply:

R12-663 **[1529]** The requirements discussed in Sections 4.7 and 4.9 are applicable and shall be met by the IDT and RDT.

R12-664 **[1530]** If the IDT (RDT) declares a CFA on the DS1 carrying the active EOC path and a facility protection switch cannot be completed, the IDT (RDT) shall initiate an EOC path protection switch following the procedures described in Section 12.6.3.

R12-665 **[1531]** If the IDT (RDT) declares a CFA on the DS1 carrying the active TMC/CSC path and a facility protection switch cannot be completed, the IDT (RDT) shall initiate a TMC/CSC path protection switch following the procedures described in Section 12.6.3.

CFA is defined in Section 4.7.

12.6.2.3 Facility Protection Switching Procedures

When either the IDT or RDT detect conditions requiring a facility protection switch, the facility protection switching procedures are as specified in the following three subsections.

12.6.2.3.1 DS1 Number n Is To Be Put On The Protection DS1

The procedures to put DS1 number n on the protection DS1 are discussed in this section and are shown in Figure 12-50. If there is another DS1 using the protection DS1, it may be pre-empted (see Figure 12-49).

R12-666 **[1532]** The following list defines the pre-emption rules that shall be used to determine if the DS1 currently carried on the protection DS1 is to be pre-empted:

… a. The primary DS1[4] with a hard failure shall pre-empt a DS1 with hard failure or a DS1 with an automatic protection switch performance monitoring threshold crossing.

… b. A DS1 with a hard failure shall pre-empt a DS1, including the primary DS1, with an automatic protection switch performance monitoring threshold crossing.

1. Near End Activities:

R12-667 **[1533]** The near end shall transmit a “protection switch line n” message on the protection DS1. (The next step for the near end is 3a, 3b, 3c, 3d, or 3e.)

2. Far End Activities:

R12-668 **[1534]** When the far end detects a “protection switch line n” message on the protection DS1, the far end shall determine if the “protection switch line n” message is to be honored (the protection DS1 state and status data known to the far end is used to make this determination as shown in Figure 12-51) and do one of the following:

… a. The far end shall transmit the “protection switch acknowledge” message toward the near end on the protection DS1 when pre-emption is not needed. (The next step for the far end is 4a or 4d.)

… b. If there is a DS1 on the protection DS1 that is to be pre-empted, the far end shall, immediately switch its receive from the protection DS1 to the DS1 whose signal is currently carried on the protection DS1 and transmit the “protection switch acknowledge” message toward the near end on the protection DS1 when this step is complete. (The next step for the far end is 4a or 4d.)

… c. If there is a DS1 on the protection DS1 that is not to be pre-empted (based on the conditions seen by the far end), the far end shall

4. When a TMC/CSC is provided, the primary DS1 carries the active TMC/CSC path. When a TMC/CSC is not provided, the primary DS1 carries the active EOC. The service state of the active path does not change the definition of the primary DS1.

continue to send the “protection switch complete” message. (The next step for the far end is 4b or 4e.)

… d. If the protection DS1 is not in use, but the far end cannot complete the protection switch of DS1 number n, e.g., protection switching is inhibited at the far end, the far end shall continue to send the “idle” message to the near end. (The next step for the far end is 4c or 4e.)

3. Near End Activities:

R12-669 **[1535]** The near end shall do one of the following based on the response or lack of response from the far end:

… a. If the near end detects a “protection switch acknowledge” message and pre-emption is not needed, the near end shall remove the current DS1 transmit signal from the protection DS1, put the DS1 number n transmit signal on the protection DS1, and transmit the “protection switch acknowledge” message toward the far end on the protection DS1 when this step is complete. (The next step for the near end is 5a or 5b.)

… b. If the near end detects a “protection switch acknowledge” message and there is a DS1 on the protection DS1 that is to be pre-empted, the near end shall immediately switch its receive signal from the protection DS1 to the DS1 whose signal is currently carried on the protection DS1, remove the current DS1 transmit signal from the protection DS1, put the DS1 number n transmit signal on the protection DS1, and transmit the “protection switch acknowledge” message toward the far end on the protection DS1 when this step is complete. (The next step for the near end is 5a or 5b.)

… c. If the near end continues to detect an “idle” message for 3 seconds and there is no DS1 on the protection DS1 that is to be pre-empted, the near end shall remove the “protection switch line n” message and resume transmitting the “idle” message and proceed as specified in step 7.

… The 3-second time interval begins after the near end has transmitted three “protection switch line n” message patterns.

… d. If the near end continues to detect a “protection switch complete” message for 3 seconds and there is a DS1 on the protection DS1 that is to be pre-empted, the near end shall remove the “protection switch line n” message and resume transmitting the “protection switch complete” message and proceed as specified in step 7.

… The 3-second time interval begins after the near end has transmitted three “protection switch line n” message patterns.

… e. If none of the above conditions is met during the 3-second interval following the transmission of three “protection switch line n” message patterns by the near end, the near end shall perform the “Failed Facility Protection Switch Procedures” and proceed as specified in Section 12.6.2.6.

4. Far End Activities:

R12-670 **[1536]** The far end shall do one of the following based on the response or lack of response from the near end:

… a. If the far end detects the “protection switch acknowledge” message on the protection DS1 and the far end is transmitting the “protection switch acknowledge” message, the far end shall remove the current DS1 transmit signal from the protection DS1, put the DS1 number n transmit signal on the protection DS1, switch its receive signal from DS1 number n to the protection DS1, and transmit the “protection switch complete” message toward the near end on the protection DS1 when this step is complete. (The next step for the far end is 6a or 6b.)

… b. If the far end detects the “protection switch complete” message on the protection DS1 and the far end is transmitting the “protection switch complete” message, the far end shall continue to transmit the “protection switch complete” message. (The far end has completed the procedures.)

… c. If the far end detects the “idle” message on the protection DS1 and the far end is transmitting the “idle” message, the far end shall continue to transmit the “idle” message. (The far end has completed the procedures.)

… d. If the conditions of Item a of this requirement are not met during the 3-second interval following the transmission of three “protection switch acknowledge” message patterns by the far end, the far end shall perform the “Failed Facility Protection Switch Procedures” and proceed as specified in Section 12.6.2.6.

… e. If the conditions of Items b and c of this requirement are not met during the 6-second interval following the receipt of three “protection switch line n” message patterns by the far end, the far end shall perform the “Failed Facility Protection Switch Procedures” and proceed as specified in Section 12.6.2.6.

5. Near End Activities:

R12-671 **[1537]** The near end shall do one of the following based on the response or lack of response from the far end:

… a. If the near end detects the “protection switch complete” message on the protection DS1 and the near end is transmitting the “protection switch acknowledgment” message, the near end shall immediately switch its receive signal from DS1 number n to the protection DS1, transmit the “protection switch complete” message toward the far end on the protection DS1, and perform the “Successful Facility Protection Switch Procedures” given above. (The near end has completed the procedures.)

… b. If the near end is transmitting the “protection switch acknowledgment” message and the near end does not receive the “protection switch complete” message within 3 seconds, the near end shall proceed as specified in Section 12.6.2.6.

… The 3-second time interval begins after the near end has transmitted three “protection switch acknowledge” message patterns.

6. Far End Activities:

R12-672 **[1538]** The far end shall do one of the following based on the response or lack of response from the near end:

… a. If the far end detects the “protection switch complete” message on the protection DS1 and the far end is transmitting a “protection switch complete” message, the far end shall perform the “Successful Facility Protection Switch Procedures” given above. (The far end has completed the procedures.)

… b. If the far end does not receive the “protection switch complete” message within 3 seconds, the far end shall proceed as specified in Section 12.6.2.6.

… The 3-second time interval begins after the near end has transmitted three “protection switch complete” message patterns.

7. Near End Activities:

This step applies when a protection switch could not be completed because of conditions at the far end.

R12-673 **[1539]** The near end shall perform the “Failed Facility Protection Switch Procedures.”

R12-674 **[1540]** If the protection line is available for service (IS, not in use, and enabled at the near end) or a pre-emption of the DS1 on the protection DS1 was attempted, but the facility automatic protection switch has been denied by the far end, the near end shall periodically re-initiate the facility automatic protection switching procedures following the schedule given below:

… a. The first retry should occur within 1 minute of the failure

… b. The second retry should occur within 3 minutes of the last retry

… c. The third retry should occur within 5 minutes of the last retry

… d. Subsequent retries should occur no more than 10 minutes apart

… e. The retries continue until either the DS1 clears or a facility protection switch is successful.

… The retry schedule is not used when a manually initiated DS1 facility protection switch fails.

12.6.2.3.2 Multiple DS1 Failures

The procedure for multiple DS1 facility failures are as follows:

If a failure on another DS1 facility is detected while a DS1 facility protection switch is in progress:

R12-675 **[1541]** The facility protection switch in progress shall be completed.

R12-676 **[1542]** The protection DS1 state and status data shall be used to determine if a facility protection switch is to be initiated (see Figure 12-49) when the in-process protection switch is completed.

R12-677 **[1543]** The following list, beginning with the highest priority, provides the priorities that should be used to determine the priority of a DS1 when it becomes necessary to resolve contention for the protection DS1. This list is used to resolve contention when there are multiple DS1 failures at one end of the DS1 facilities, when both the IDT and RDT have initiated DS1 protection switches (this list does not define the pre-emption rules defined in Section 12.6.2.3.1).

… 1. Primary DS1[5] with a hard failure

5. When a TMC/CSC is provided, the primary DS1 carries the active TMC/CSC path. When a TMC/CSC is not provided, the primary DS1 carries the active EOC. The service state of the active path does not change the definition of the primary DS1.

… 2. DS1s with hard failures - the priority of the DS1s in this category is in decreasing order with increasing DS1 number, e.g., DS1 number 3 has a higher priority than DS1 number 4

… 3. Primary DS1 with an automatic protection switch performance monitoring threshold crossing

… 4. DS1s with automatic protection switch performance monitoring threshold crossing - the priority of the DS1s in this category, excluding the primary DS1, is in decreasing order with increasing DS1 number, e.g., DS1 number 3 has a higher priority than DS1 number 4.

No two DS1s have equal priorities.

In the following requirement, the IDT cannot determine why the RDT has initiated a facility protection switch and the RDT cannot determine why the IDT has initiated a facility protection switch. Therefore, each end must treat the switch request as if the far end has detected a hard failure and the priorities for the primary DS1 and DS1s with hard failure given above apply.

R12-678 **[1544]** If the RDT is sending a “protection switch line n” message on the protection DS1 (the RDT has initiated a facility protection switch on DS1 number n) and the IDT is sending a “protection switch line m” message (the IDT has initiated a facility protection switch on DS1 number m) on the protection DS1, the following procedures shall be used to resolve the contention for the use of the protection DS1:

… 1. When the priority of DS1 number m is greater than the priority of DS1 number n or if m equals n -

… a. The RDT shall cease to transmit the “protection switch line n” message and begin to transmit the “protection switch acknowledge” message.

… b. The IDT shall continue to transmit the “protection switch line m” message on the protection DS1.

… The above is depicted in Figure 12-52.

… c. The IDT and RDT shall complete the facility protection switch on the failed facility (DS1 number m) detected by the IDT following the procedures in Section 12.6.2.3.1.

… 2. When the priority of DS1 number n is greater than the priority of DS1 number m -

… a. The RDT shall continue to transmit the “protection switch line n” message on the protection DS1.

… b. The IDT shall cease transmitting the “protection switch line m” message on the protection DS1 and begin to transmit the “protection switch acknowledge” message.

… The above is depicted in Figure 12-53.

… c. The IDT and RDT shall complete the facility protection switch on the failed facility (DS1 number n) detected by the RDT following the procedures in Section 12.6.2.3.1.

12.6.2.3.3 Manual Facility Protection Switching

A manual facility protection switch may be initiated by an operations message received from an OS or from the craft interface at the LDS or RDT.

R12-679 **[1545]** The IDT and RDT shall follow the procedures given in Section 12.6.2.3.1 (see Figure 12-54) for a manually initiated facility protection switch.

R12-680 **[1546]** A manually initiated facility protection switch and a hard failure shall have the same priority in the protection switching procedures.

A manual protection switch can cause a DS1 that is on the protection DS1 for an automatic protection switch performance monitoring threshold crossing to be pre-empted, but a manual switch will not pre-empt a DS1 that is on the protection DS1 for a hard failure. A manual protection switch of the primary DS1 can cause a DS1 that is on the protection DS1 for a hard failure to be pre-empted. A DS1 put on the protection DS1 by a manual facility protection switch will remain on the protection DS1 until released through an operations message or pre-empted by the “primary” DS1.

12.6.2.4 Successful DS1 Facility Protection Release Procedures

The following tasks are performed at the conclusion of all successful automatic and manually initiated facility protection switch recoveries and are referred to as the “Successful DS1 Facility Protection Release Procedures” in the DS1 facility protection release procedures.

R12-681 **[1547]** The IDT (RDT) shall update the state and other data required for facility protection switching that are given in Section 12.6.2 plus any other data the IDT (RDT) may keep relative to facility protection switching.

R12-682 **[1548]** The near end shall report the DS1 facility protection release to the maintenance OS and/or other OSs designated by the telephone company

using an operations maintenance message. The message shall indicate that the DS1 facility protection release has been completed. This report shall be sent over the EOC if the near end is the RDT and internally to the OIM if the near end is the IDT.

R12-683 **[1549]** If the IDT (RDT) determines a protection switch is required on examining the state of all its DS1s following the release of a DS1 from the protection DS1, the IDT (RDT) shall send the "idle" message for at least 0.5 seconds before beginning the DS1 facility protection switch procedures of Section 12.6.2.3.

R12-684 **[1550]** If the IDT (RDT) determines a protection switch is required on examining the state of all its DS1s following the release of a DS1 from the protection DS1, the IDT (RDT) shall begin the DS1 facility protection switch within 30 seconds of sending the "idle" message on the protection DS1.

The 0.5 seconds is to allow for the far end to complete its release of the DS1 from the protection DS1. The 30 seconds can be used to let the system settle down before starting another protection switch.

12.6.2.5 DS1 Facility Protection Release Procedures

The DS1 facility protection release procedures for both automatic and manual releases are given in this section.

The end initiating a facility protection release is referred to as the near end in the release procedures.

R12-685 **[1551]** Once the facility protection DS1 release procedures are started, the release procedures shall be completed except as specified.

R12-686 **[1552]** If the DS1 being removed from the protection DS1 fails during the release procedures, the release procedures shall be completed and the state of all DS1s are examined to determine if that or another DS1 should be put on the protection DS1.

12.6.2.5.1 DS1 Number n on Protection DS1

If the fault on DS1 number n clears, the release procedures are as follows:

In step 2 below, both the IDT and RDT may be receiving the “protection switch release” message because both the IDT and RDT may initiate the release procedures at the same time.

R12-687 **[1553]** If the RDT is transmitting and receiving the “protection switch release” message, the RDT shall stop sending the “protection switch release” message and respond to the message from the IDT as given in step 2 below.

R12-688 **[1554]** If the RDT is transmitting the “forced protection switch release” and receiving the “protection switch release” message, the RDT shall stop sending the “forced protection switch release” message and respond to the message from the IDT as given in step 2 below. The RDT shall treat the release as a forced release because it has a forced release pending.

… The RDT shall report a successful forced release to the originator of the manual forced release request when the release is completed.

1. Near End Activities:

R12-689 **[1555]** The near end shall transmit the “protection switch release” message on the protection DS1. (The next step for the near end is 3a, 3b or 3c.)

2. Far End Activities:

R12-690 **[1556]** When the far end detects the “protection switch release” message on the protection DS1, the far end shall do one of the following:

… a. If the protection release can be completed, the far end shall switch its receive from the protection DS1 to DS1 number n and transmit the “protection switch acknowledge” message toward the near end on the protection DS1. (The next step for the far end is 4a or 4d.)

… b. If the far end cannot complete the facility protection DS1 release, the far end shall transmit the “protection switch line n” message to the near end on the protection DS1. (The “protection switch line n” message is sent when the far end wants to keep DS1 number n on the protection DS1. The far end may have detected a failure on DS1 number n or the release may be inhibited at the far end.) (The next step for the far end is 4b, 4c or 4d.)

3. Near End Activities:

R12-691 **[1557]** The near end shall do one of the following based on the response or lack of response from the far end:

… a. If the near end detects the “protection switch acknowledge” message on the protection DS1, the near end shall switch its receive from the protection DS1 to DS1 number n, remove the DS1 number n transmit signal from the protection DS1, put a replica of the primary DS1 transmit signal or a quasi-random signal on the protection DS1, and transmit the “idle” message toward the far end on the protection DS1. (The next step for the near end is 5a or 5c.)

… b. If the near end detects the “protection switch line n” message on the protection DS1, the near end shall resume transmitting the “protection switch complete” message toward the far end on the protection DS1 (the next step for the near end is 5b or 5c) or the near end shall clear the protection DS1 using the Error Recovery for Facility Protection Switching and Release procedures in Section 12.6.2.6.

… c. If the near end does not receive the “protection switch acknowledge” or the “protection switch line n” message from the far end within 3 seconds of sending the “protection switch release” message, the near end shall report the failure to complete the DS1 facility protection release, transmit the “protection switch complete” message, and periodically retry a DS1 facility protection release following the schedule given below:

… 1. The first retry should occur within 1 minute of the failure

… 2. The second retry should occur within 3 minutes of the last retry

… 3. The third retry should occur within 5 minutes of the last retry

… 4. Subsequent retries should occur no more than 10 minutes apart

… 5. The retries continue until the DS1 facility protection release is successful.

… The retry schedule is not used when a manually initiated DS1 facility protection release fails.

… The time interval begins after the near end has transmitted three “protection switch release” messages. (The next step for the near end is 5b or 5c.)

4. Far End Activities:

R12-692 **[1558]** The far end shall do one of the following based on the response or lack of response from the near end:

… a. If the far end detects the “idle” message on the protection DS1 and the far end is transmitting the “protection switch acknowledge” message, the far end shall remove the DS1 number n transmit signal from the protection DS1, put a replica of the primary DS1 transmit signal or a quasi-random signal on the protection DS1, transmit the “idle” message toward the near end on the protection DS1, and perform the “Successful DS1 Facility Protection Release Procedures” procedures given above. (The far end has completed the procedures.)

… b. If the far end detects the “protection switch complete” message on the protection DS1 and the far end is transmitting the “protection switch line n” message, the far end shall transmit the “protection switch complete” message toward the near end on the protection DS1. (The far end has completed the procedures.)

… c. If the far end detects the “protection switch complete” message on the protection DS1 and the far end is transmitting the “protection switch acknowledge” message, the far end shall switch its receive from DS1 number n to the protection DS1 and resume transmitting the “protection switch complete” message toward the near end on the protection DS1. (The far end has completed the procedures.)

… d. If the conditions in Items a, b, and c of this requirement are not met in the 6- to 30-second period following the transmission of the “protection switch acknowledge” or “protection switch line n” message (see Step 2 above), the far end shall clear the protection DS1 using the Error Recovery for Facility Protection Switching and Release procedures in Section 12.6.2.6.

5. Near End Activities:

R12-693 **[1559]** The near end shall do one of the following based on the response (or lack of response) from the far end:

… a. If the near end detects the “idle” message on the protection DS1 and the near end is transmitting the “idle” message, the near end shall perform the “Successful DS1 Facility Protection Release Procedures” given above. (The near end has completed the procedures.)

… b. If the near end detects the “protection switch complete” message on the protection DS1 and the near end is transmitting the “protection switch complete” message, the near end performs the “Successful DS1 Facility Protection Release Procedures” given above except that a report is not sent to an OS indicating the release was completed.

… c. If the conditions in Items a and b of this requirement are not met in the 6- to 30-second period following the transmission of the "idle" or "protection switch complete" message (see Step 3 above), the near end shall clear the protection DS1 using the Error Recovery for Facility Protection Switching and Release procedures in Section 12.6.2.6. (The near end has completed the procedures.)

12.6.2.5.2 Manual Facility Protection Switching Release

A manual facility protection DS1 release may be initiated by an operations message received from an OS or from the craft interface at the LDS or RDT (see Figure 12-56).

R12-694 **[1560]** If the IDT (RDT) receives an operations message requesting a facility protection DS1 release, the IDT (RDT) shall follow the procedures given in Section 12.6.2.5 to complete the release.

R12-695 **[1561]** The IDT and RDT shall provide the capability to initiate a forced release of the protection DS1.

The operations message will include a parameter that can be used to indicate the release of the protection DS1 is to be forced even if the facilities to complete the release are not available or not in service. A forced release may cause the DS1 whose signal was carried on the protection DS1 to go into an out-of-service state. If facility protection switching is inhibited for the DS1 forced off the protection DS1 or for the protection group and, if the DS1 forced off the protection DS1 goes into an out-of-service state, a CFA will be declared and, if required, trunk conditioning will be performed (see Section 4.7). The appropriate alarm indicator will be activated and a report alarm operations message will be sent to the surveillance OS. These actions will be carried out by the IDT (RDT) if the failure is detected by the IDT (RDT).

If facility protection switching is not inhibited for the DS1 forced off the protection DS1 or for the protection group and, if the DS1 forced off the protection DS1 meets any of the requirements for initiating a DS1 facility switch, a facility protection switch will be initiated following the procedures in Section 12.6.2.3. Thus the same DS1 signal may be returned to the protection DS1 when facility protection switching is enabled. The hierarchical rules of Section 12.6.2.3 are applicable.

The forced release of the protection DS1 follows the procedures of Section 12.6.2.5 with the following exceptions:

R12-696 **[1562]** The "forced protection switch release" message shall be used instead of the "protection switch release" message.

R12-697 **[1563]** In Step 2 of Section 12.6.2.5.1, the far end shall not deny the release of the protection line because the DS1 is out-of-service or the automatic protection switch performance monitoring threshold has been crossed for the DS1.

R12-698 **[1564]** In Step 3 of Section 12.6.2.5.1, the near end shall not periodically try to force a release if the forced release was not acknowledged by the far end.

12.6.2.6 Error Recovery for Facility Protection Switching and Release

An IDT or RDT may find its protection facilities in a state for which a non-intrusive recovery procedure cannot be defined. For example, if the IDT (RDT) goes through a software reinitialization, the IDT (RDT) may not know if the protection DS1 is in use, and if the protection DS1 is in use, the IDT (RDT) may not know which DS1 is on the protection DS1.

R12-699 **[1565]** For those steps in the facility protection switching procedures and the facility protection release procedures in which specific error handling actions are not defined and for those conditions when the IDT (RDT) cannot determine the correct state of the protection DS1, the IDT (RDT) shall carry out the error recovery actions of Section 12.6.2.6.1. This includes receipt of unrecognized codes defined earlier in Section 12.6.2 and receipt of valid codes that should not be received at a particular step of the procedures.

R12-700 **[1566]** If the IDT (RDT) receives an unexpected “idle” message, i.e., the facility protection switching and facility protection release procedures do not explicitly state that an “idle” message is to be received or the “idle” message should not be received in the current state, the end receiving the “idle” message shall carry out the error recovery actions of Section 12.6.2.6.1.

12.6.2.6.1 Error Recovery Actions

R12-701 **[1567]** The IDT (RDT) shall do the following as part of the DS1 facility protection switching and DS1 facility protection release error recovery actions:

… a. Send the “idle” message on the protection DS1

… b. Switch any receive signal from the protection DS1 to its DS1, e.g., if DS1 #n receive is being taken from the protection DS1, the IDT (RDT) will now take DS1 #n receive from DS1 #n,

… c. Put a replica of the primary DS1 traffic signal or a quasi-random signal on the protection DS1 when "idle" is received

… d. Invoke the "Successful DS1 Facility Protection Release Procedures" in Section 12.6.2.4.

12.6.2.7 Failure or Degradation of the Protection DS1

This section contains the procedures to be followed when the protection DS1 fails or degrades. The term "failure" as used in this section is a CFA, an AIS, or YELLOW on the protection DS1. The requirements for declaring a CFA and detecting an AIS or YELLOW are given in Sections 4.7 and 4.9.

R12-702 **[1568]** If the IDT (RDT) detects a failure on the protection DS1, the IDT (RDT) shall do one of the following:

… 1. If the protection DS1 is not in use, the requirements of Sections 4.7 and 4.9 are applicable except for trunk conditioning.

… 2. If the protection DS1 is in use, the requirements of Sections 4.7 and 4.9 are applicable including trunk conditioning and the IDT (RDT) shall free the protection DS1 using the procedures in Section 12.6.2.6.

If the IDT (RDT) detects that BER of the protection DS1 exceeds the protection switching BER threshold while the protection DS1 is in use, no action is required by the IDT (RDT) with respect to the DS1 on the protection DS1.

12.6.3 EOC and TMC/CSC Path Protection Switching

Automatic EOC and TMC/CSC path protection switching is required for those Generic IDLC Interfaces that support more than one DS1, even though facility automatic protection switching discussed in Section 12.6.2 is optional. The EOC and TMC/CSC path protection requirements are to provide data-link layer protection of these paths, which includes the DS0 paths. EOC and TMC/CSC path-protection switching procedures are discussed in this section. Some requirements in this section are written using the notation "IDT (RDT)." These requirements apply to the IDT and the RDT. The requirements were written in this format to avoid having a second requirement with the same wording, but using the notation in the parentheses instead of the notation immediately preceding the parentheses.

Throughout this section the EOC path and TMC/CSC path are discussed as if both always exist, but only the EOC path must exist across the Generic IDLC Interface. The TMC/CSC

path is only required when the IDLC system has a per-call time-slot assignment capability. The per-call time-slot assignment capability can be used in both concentrated and non-concentrated IDLC systems. All references to the TMC/CSC path in this section are applicable only to those IDLC systems that provide a per-call time-slot assignment capability.

R12-703 **[1836]** An RDT (IDT) that supports more than one DS1, shall support the functional requirements in this section that pertain to TMC/CSC Path Protection Switching.

R12-704 **[1569]** The functional requirements in this section shall be implemented using the services and information model defined in GR-2833-CORE.

CR12-705 **[1570]** On an interim basis, the services and information model defined in Supplement 3 of TR-TSY-000303 may be used to support management functions between the IDT and RDT.

An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.

R12-706 **[1571]** Path protection shall protect the EOC path against all single failures other than catastrophic failures.

Catastrophic failures are defined as failures that result in the inability of the IDLC system to process or maintain calls and process operations messages. Examples of catastrophic failures include loss of power or failure of all transmission facilities.

R12-707 **[1572]** A fault on the active EOC path shall not cause a fault on the standby EOC path when the standby path becomes active.

This is intended to prevent oscillation between the active and standby EOC paths.

R12-708 **[1573]** Path protection shall protect the TMC/CSC path against all single failures other than catastrophic failures.

Catastrophic failures are defined above.

R12-709 **[1574]** A fault on the active TMC/CSC path shall not cause a fault on the standby TMC/CSC path when the standby path becomes active.

This is intended to prevent oscillation between the active and standby TMC/CSC paths.

12.6.3.1 General EOC Path and TMC/CSC Path Protection Switch Requirements

The following are general EOC path and TMC/CSC path protection switching requirements.

R12-710 **[1575]** In response to operations messages received from an OS or as input from a craft interface at the LDS or RDT, the IDT and RDT shall provide the capability to initiate a switch from the active EOC path to the standby EOC path.

R12-711 **[1576]** In response to operations messages received from an OS or as input from a craft interface at the LDS or RDT, the IDT and RDT shall provide the capability to initiate a switch from the active TMC/CSC path to the standby TMC/CSC path.

R12-712 **[1577]** In response to operations messages received from an OS or as input from a craft interface at the LDS or RDT, the IDT and RDT shall provide the capability to initiate a forced switch from the active EOC path to the standby EOC path even though the standby EOC path may be in an "out-of-service" state.

R12-713 **[1578]** In response to operations messages received from an OS or as input from a craft interface at the LDS or RDT, the IDT and RDT shall provide the capability to initiate a forced switch from the active TMC/CSC path to the standby TMC/CSC path even though the standby TMC/CSC path may be in an "out-of-service" state.

R12-714 **[1579]** A manual path protection switch using the forced mode of the operations message cannot be used to override an inhibit of the path protection switch; the inhibit must be removed before a path protection switch can be initiated automatically or manually.

The IDT and RDT need state and status information on the EOC and TMC/CSC paths to carry out the path protection switching procedures.

R12-715 **[1580]** The IDT and RDT shall each keep state and status information for their own EOC and TMC/CSC path terminations.

The following information and actions based on the state and status information shall be provided to implement the path protection switching feature:

R12-716 **[1581]** An EOC path shall be in the "active" state when it is used to carry operations messages between the IDT and RDT

R12-717 **[1582]** A TMC/CSC path shall be in the “active” state when it is used to carry call processing messages between the IDT and RDT.

When an EOC path is in the “active” state, LAPD I-Frames may be transmitted and received on any logical channel defined in Table 12-1 that is in multiple frame operation on the EOC path. When an TMC/CSC path is in the “active” state, LAPD I-Frames may be transmitted and received on any logical channel defined in Table 12-2 that is in multiple frame operation on the TMC/CSC path.

R12-718 **[1583]** An EOC path shall be in the “standby” state when it does not carry operations messages on any logical channel except the SAPI=1, TEI=0 logical channel.

… Only the SAPI=1, TEI=0 logical channel shall be used to transmit I-Frames on the standby EOC path and these I-Frames shall only be used to transmit the path protection switch messages (Section 12.6.3.4) when an EOC path switch is to be done.

R12-719 **[1584]** A TMC/CSC path shall be in the “standby” state when it does not carry any call processing messages.

… Only the SAPI=1, TEI=0 logical channel shall be used to transmit I-Frames on the standby TMC/CSC path and these I-Frames shall only be used to transmit the path protection switch messages (Section 12.6.3.4) when an TMC/CSC path switch is to be done.

R12-720 **[1585]** One of the two EOC paths shall be in the “active” state and the other shall be in the “standby” state.

R12-721 **[1586]** One of the two TMC/CSC paths shall be in the “active” state and the other shall be in the “standby” state.

R12-722 **[1587]** In response to operations messages received from an OS or as input from a craft interface at the LDS or RDT, the RDT and IDT shall provide the capability to inhibit an EOC or TMC/CSC path switch.

R12-723 **[1588]** The default value for EOC and TMC/CSC path switching is not inhibited.

R12-724 **[1589]** An EOC or TMC/CSC path is in the “in-service” state when the EOC or TMC/CSC path is capable of providing its service function, i.e., transporting I-Frames between the IDT and RDT.

R12-725 **[1590]** An EOC or TMC/CSC path is in the “out-of-service” state when the EOC or TMC/CSC path is not capable of providing its service function,

i.e., it cannot be used to transport I-Frames between the IDT and RDT, for some cause.

R12-726 **[1591]** A TMC/CSC path shall be in the "out-of-service" state for data link protection switching when multiple frame operation cannot be established for SAPI=1, TEI=0 and SAPI=0, TEI=0 on the TMC/CSC path.

R12-727 **[1592]** At the RDT, an EOC path shall be in the "out-of-service" state for data link protection switching when multiple frame operation cannot be established for SAPI=1, TEI=0 and SAPI=1, TEI=4 on the EOC path.

R12-728 **[1593]** At the IDT, an EOC path shall be in the "out-of-service" state for data link protection switching when multiple frame operation cannot be established on the EOC path for SAPI=1, TEI=0 and SAPI=1, TEI=4 and any other SAPI,TEI combination in Table 12-1 that has been provisioned for use by the gateway function described in Section 12.7.1.

R12-729 **[1594]** If the standby EOC or TMC/CSC IDLC Data Link Termination is in the "out-of-service" state, only a forced path protection switch shall be allowed to the standby path; an automatic or normal path switch to an out of service standby path shall not be allowed.

R12-730 **[1595]** When an EOC (TMC/CSC) path switch is in progress, the IDT and RDT shall not send new information to the LAPD layer for any data-link connections of the EOC (TMC/CSC) path except for the SAPI=1, TEI=0 connection.

A path switch is in progress for the initiator of the switch from the point in time when the need for a path switch is detected until the response to the protection switch message from the opposite end is processed. A path switch is in progress for the recipient of the protection switch message from the point in time when the protection switch message is decoded until the response to the protection switch is sent to the initiator of the switch.

R12-731 **[1596]** EOC and TMC/CSC path protection switching shall be non-revertive, i.e., when the condition that caused the path protection switch clears (see Section 12.6.3.6), the currently active EOC path or active TMC/CSC path shall remain active.

R12-732 **[1597]** Both the IDT and RDT shall have the capability to initiate an EOC or TMC/CSC path protection switch.

The end initiating an EOC or TMC/CSC path protection switch is called the near end and the opposite end is called the far end.

12.6.3.2 Detection of EOC and TMC/CSC Path Faults

The four data-link layer protection switching parameters used to determine when an automatic EOC or TMC/CSC path protection switch was to be initiated that were discussed in previous issues of this document have been reduced to one - failure to establish or re-establish multiple frame operation on specific logical data-link connections. A new requirement has been added (see Section 12.6.3.2.5) to initiate a path switch when the near end detects a condition that indicates the IDT and RDT may have different active EOC or TMC/CSC paths. (A requirement in the facility protection procedures requires an EOC or a TMC/CSC path switch when the DS1 carrying the active EOC or TMC/CSC cannot be switched to the protection DS1.)

R12-733 **[1598]** Once a path protection switch is initiated for the EOC (TMC/CSC) path, a new protection switch for the EOC (TMC/CSC) path shall not be initiated until the path switch has been completed or a failure of the path switch has been declared.

12.6.3.2.1 Received Disconnected Mode Response Frame Counter

The requirement for a Received Disconnected Mode Response Frame Counter contained in Issue 1 of TR-TSY-000303 has been removed from this GR. This does not preclude a supplier from implementing the counter.

12.6.3.2.2 Data Link Reset Counter

The requirement for a Data Link Reset Counter contained in Issue 1 of TR-TSY-000303 has been removed from this GR. This does not preclude a supplier from implementing the counter.

12.6.3.2.3 Failure to Establish Multiple Frame Operation

R12-734 **[1599]** If the IDT (RDT) detects that the logical data link defined by SAPI=0, TEI=0 or the logical data link defined by SAPI=1, TEI=0 goes from the multiple frame established state to any other state on the active TMC/CSC path and the IDT (RDT) fails to re-establish multiple frame operation on this logical data link, the IDT (RDT) shall initiate a data link path switch for the TMC/CSC path following the procedures of Section 12.6.3.5.

R12-735 **[1600]** If the IDT (RDT) detects that the logical data link defined by SAPI=1, TEI=4 or the logical data link defined by SAPI=1, TEI=0 goes

from the multiple frame established state to any other state on the active EOC path and the IDT (RDT) fails to re-establish multiple frame operation on this logical data link, the IDT (RDT) shall initiate a data link path switch for the EOC path following the procedures of Section 12.6.3.5.

R12-736 **[1601]** If the IDT detects that any logical data link defined in Table 12-1 goes from the multiple frame established state to any other state on the active EOC path except if the logical data link has been removed from service and the IDT fails to re-establish multiple frame operation on this path, the IDT shall initiate a data link path switch for the EOC path following the procedures of Section 12.6.3.5.

R12-737 **[1602]** At the IDT, the logical data links in Table 12-1, except the logical data links defined by SAPI=1, TEI=0 and SAPI=1, TEI=4, shall be considered to have been removed from service if they have not been provisioned for use with the OIM of the LDS. (The OIM is defined in Section 12.7.1.)

R12-738 **[1603]** If the IDT (RDT) fails to re-establish multiple frame operation on any logical data link on the active or standby EOC or TMC/CSC paths, the IDT (RDT) shall report the event to an OS and establish a schedule to periodically retry to re-establish multiple frame operation on the failed logical data link.

R12-739 **[1604]** The schedule for retrying to re-establish multiple frame operation shall follow the schedule defined in Section 12.4.3.5.11.

R12-740 **[1605]** Failures to re-establish multiple frame operation during the retry schedule shall not be reported to an OS, but if multiple frame operation is re-established during the retry schedule, the event shall be reported to an OS.

12.6.3.2.4 Received Invalid Frame Counter

The requirement for a Received Invalid Frame Counter contained in Issue 1 of TR-TSY-000303 has been removed from this GR. This does not preclude a supplier from implementing the counter.

12.6.3.2.5 Information Frame Received on Standby Path

R12-741 **[1606]** If a message or part of a message is received on any SAPI, TEI combination on the standby EOC (TMC/CSC) path except SAPI=1, TEI=0

more than 5 seconds after completing a data-link path switch, the receiver of the message or part of a message shall initiate an EOC (TMC/CSC) data-link path protection switch following the procedures of Section 12.6.3.5.

When the near end detects the condition indicating there is a mismatch between the active EOC (TMC/CSC) paths at the two ends, the near end may request the far end to switch to the near end's active path (the realignment takes place at the far end) or the near end may choose to switch to the path that is active at the far end (the realignment takes place at the near end). When the near end chooses to switch to the path that is active at the far end, the near end must still send a path switch request to the far end, and the near end only switches when the far end response indicates the path is already active. (See Section 12.6.3.5.2.)

If a message is received on any SAPI, TEI combination on the standby EOC or TMC/CSC path except SAPI=1, SAPI=0, the message may be sent to the upper layers for processing or the message may be discarded.

O12-742 **[1607]** If a message is received on any SAPI, TEI combination on the standby EOC or TMC/CSC path except SAPI=1, SAPI=0, it is an objective that the messages be sent to the upper layers for processing.

12.6.3.2.6 Removal of Protection Switch Inhibit

R12-743 **[1608]** When the EOC or TMC/CSC path protection switch state goes from inhibited to enabled at the IDT (RDT), the IDT (RDT) shall examine the EOC or TMC/CSC conditions at its end of the path to determine if a data-link path switch needs to be initiated.

12.6.3.3 Forced EOC and TMC/CSC Path Activity

LAPD timer T203 is used to specify the maximum time the EOC path or TMC/CSC path is allowed to remain idle.

R12-744 **[1609]** The “connection verification procedures” of Section 5.10.3 of ITU-T Recommendation Q.921 shall be implemented in both the IDT and RDT for logical data link connections in the multiple frame established state. These procedures shall apply to both the active and standby EOC paths and both the active and standby TMC/CSC paths.

12.6.3.4 EOC and TMC/CSC Path Protection Switch Messages

R12-745 **[1610]** An operations message shall be used to control the EOC path and TMC/CSC path protection switch.

R12-746 **[1611]** A single operations message shall be generated and broadcast on both the active and standby EOC paths using the logical data link defined by SAPI=1, TEI=0 if the EOC path is to be switched.

R12-747 **[1612]** A single operations message reply shall be generated and broadcast on both the active and standby EOC paths using the logical data link defined by SAPI=1, TEI=0 if an EOC path switch was requested.

O12-748 **[1613]** Messages broadcasted on both the active and standby EOC paths should be within 500 ms of each other.

R12-749 **[1614]** A single operations message shall be generated and broadcast on both the active and standby TMC/CSC paths using the logical data link defined by SAPI=1, TEI=0 if the TMC/CSC path is to be switched.

R12-750 **[1615]** A single operations message reply shall be generated and broadcast on both the active and standby TMC/CSC paths using the logical data link defined by SAPI=1, TEI=0 if a TMC/CSC path switch was requested.

O12-751 **[1616]** Messages broadcasted on both the active and standby TMC/CSC paths should be within 500 ms of each other.

R12-752 **[1617]** Under no load conditions, the recipient of the operations message controlling the data-link path switch shall send the reply within 500 ms of receiving the message at the LAPD layer.

O12-753 **[1618]** Under no load conditions, the recipient of the operations message controlling the data-link path switch should send the reply within 200 ms of receiving the message at the LAPD layer.

R12-754 **[1619]** Under overload conditions, the recipient of the operations message controlling the data-link path switch shall send the reply within 5 seconds of receiving the message at the LAPD layer.

R12-755 **[1620]** Under no load conditions, the recipient of the reply to the operations message controlling the data-link path switch shall act on the reply within 500 ms of receiving the message at the LAPD layer.

O12-756 **[1621]** Under no load conditions, the recipient of the reply to the operations message controlling the data-link path switch should act on the reply within 200 ms of receiving the message at the LAPD layer.

R12-757 **[1622]** Under overload conditions, the recipient of the reply to the operations message controlling the data-link path switch shall act on the reply within 5 seconds of receiving the message at the LAPD layer.

CR12-758 **[1623]** If a message is received on both the active and standby EOC paths (SAPI/TEI = 1/0), only one message shall be sent to the application layer.

CR12-759 **[1624]** If a message is received on both the active and standby TMC/CSC paths (SAPI/TEI = 1/0), only one message shall be sent to the application layer.

12.6.3.5 EOC and TMC/CSC Path Protection Switch Procedures

When multiple frame operation cannot be established or reestablished, or messages or parts of messages are received on any SAPI,TEI combination on the standby path except SAPI=1, TEI = 0 as described in Section 12.6.3.2, the procedures of this section are used to control the EOC path or TMC/CSC path protection switch.

A manual data-link protection switch may also be requested by an OS sending an operations message to the IDT or RDT. The recipient (IDT or RDT) of this message will act as the near end when it initiates a protection switch using the procedures in this section. The operations message from the OS is processed by the IDT (RDT) and a new operations message is sent on the EOC or TMC/CSC path by the IDT (RDT).

The term “available” as used in the path protection switch procedures means the path is in service and protection switching has not been inhibited. For a forced path protection switch initiated from an OS or user interface, a path is also “available” when the path is out of service.

The term “normal” switch as used in the path protection switch procedures means the protection switch is allowed to proceed only when the standby data-link path is in service and protection switching is not inhibited.

The term “forced” switch as used in the path protection switch procedures means the protection switch, in response to a manual request, is allowed to proceed when protection switching is not inhibited without regard to the service state of the standby data-link path. That is, the path switch can proceed when the standby data-link path is in either the in-service or the out-of-service state as long as path switching is not inhibited.

12.6.3.5.1 Near End Activities

R12-760 **[1625]** The near end shall determine if the standby path is available and do one of the following:

… 1. If the standby path is available, the near end shall send the appropriate operations message to the far end on both the active and standby EOC paths if the EOC path is to be switched or both the active and standby TMC/CSC paths if the TMC/CSC path is to be switched. The operations message shall identify the EOC or TMC/CSC path that is to be made inactive at the far end.

… 2. If the protection path needed to complete the protection switch is not available, the near end shall attempt to maintain service on the faulty path and report the failed EOC or TMC/CSC path protection switch per the requirements in Section 12.6.3.5.5 below.

12.6.3.5.2 Far End Activities

R12-761 **[1626]** When the far end receives a data-link protection switch operations message, the far end shall do one of the following:

… 1. If the protection switch is a “normal” switch, the standby path protecting the active path identified in the operations message is in service, and protection switching is not inhibited, the far end shall make the standby path active. The far end shall send an indication that the switch was completed to the near end on both the active and standby EOC paths if the EOC path was switched or both the active and standby TMC/CSC paths if the TMC/CSC path was switched.

… 2. If the protection switch is a “forced” switch and path protection switching is not inhibited, the far end shall make the standby path active. The far end shall send an indication that the switch was completed to the near end on both the active and standby EOC paths if the EOC path was switched or both the active and standby TMC/CSC paths if the TMC/CSC path was switched.

… 3. If the standby path protecting the active path identified in the operations message is in service and protection switching is inhibited, the far end shall send an indication that an error occurred to the near end on both the active and standby EOC paths if the EOC path was to be switched or both the active and standby TMC/CSC paths if the TMC/CSC path was to be switched. The error value mapping to this error condition shall indicate that the path switch was denied because protection switching was inhibited.

… 4. If the protection switch is a “normal” switch and the standby path protecting the active path identified in the operations message is out of service, the far end shall send an indication that an error occurred to the near end on both the active and standby EOC paths if the EOC path was to be switched or both the active and standby TMC/CSC paths if the TMC/CSC path was to be switched. The error value mapping to this error condition shall indicate that the path switch was denied because the standby data-link path was out of service.

… 5. If the standby path protecting the active path identified in the operations message is already active, the far end shall send an indication that an error occurred to the near end on both the active and standby EOC paths if the EOC path was to be switched or both the active and standby TMC/CSC paths if the TMC/CSC path was to be switched. The error value mapping to this error condition shall indicate that the data-link path is already active.

… 6. If the standby path protecting the active path identified in the operations message is not the protection path for the active path, the far end shall send an indication that an error occurred to the near end on both the active and standby EOC paths if the EOC path was to be switched or both the active and standby TMC/CSC paths if the TMC/CSC path was to be switched. The error value mapping to this error condition shall indicate that the identification of the standby path in the operations message is not the correct standby path for this EOC or TMC/CSC path. This includes the case where the identified standby path is actually active but the path is not the correct active path for the EOC or TMC/CSC path over which the operations message was received.

12.6.3.5.3 Near End Activities

R12-762 **[1627]** When the near end receives the reply (confirmation) message for the operations message controlling the data-link path switch, the near end shall do one of the following:

… 1. If the reply message for the operations message controlling the data-link path switch indicates that the path protection switch was completed at the far end, the near end shall make the appropriate path active at the near end, and report the EOC or TMC/CSC path protection switch per the requirements in Section 12.6.3.5.5.

… 2. If the reply message for the operations message controlling the data-link path switch indicates that the path protection switch was not completed at the far end and the error condition indicates protection

switching was inhibited, the standby data-link path was out of service, or the operations message contained an invalid identification of the standby data-link path, the near end shall report the failed EOC or TMC/CSC path protection switch per the requirements in Section 12.6.3.5.5.

… 3. If the reply message for the operations message controlling the data-link path switch indicates that the path protection switch was not completed at the far end, and the error condition indicates the standby data-link path is already active, the near end shall make its standby EOC or TSC/CSC path active, report the EOC or TMC/CSC path protection switch per the requirements in Section 12.6.3.5.5 below. (This is a successful data-link protection switch that does not require a retry schedule.)

… 4. If the near end does not receive the reply message in the period between 10 and 30 seconds after sending the operations message controlling the data-link path switch, the near end shall report the failure to complete the path switch per the requirements in Section 12.6.3.5.5.

12.6.3.5.4 Path Switch Initiated at Both IDT and RDT

R12-763 **[1628]** If the IDT receives an operations message requesting an EOC (TMC/CSC) path switch after it has sent an operations message requesting an EOC (TMC/CSC) path switch but before it has received a reply message, the following apply:

… 1. The IDT shall send an indication that an error occurred to the RDT on both the active and standby EOC (TMC/CSC) paths. The error shall indicate that a path protection switch is in-process.

… 2. The IDT shall follow the near end procedures defined in Section 12.6.3.5.3 above for the operations message it sent to the RDT.

R12-764 **[1629]** If the RDT receives an operations message requesting an EOC (TMC/CSC) path switch after it has sent an operations message requesting an EOC (TMC/CSC) path switch but before it has received a reply message, the following apply:

… 1. The RDT shall follow the far end procedures defined in Section 12.6.3.5.2 above for the operations message requesting an EOC (TMC/CSC) path switch it received from the IDT.

… 2. The RDT shall recognize the IDT reply with an error indication of a path switch is in-process as a valid reply message for the operations

message it sent to the IDT requesting an EOC (TMC/CSC) path switch and that no further action is required.

12.6.3.5.5 Completion of Path Protection Switch Procedures

R12-765 **[1630]** The near end shall do one of the following:

… 1. If the EOC or TMC/CSC path switch was initiated by the IDT or RDT for a detected fault (see Section 12.6.3.2) and the path protection switch was completed successfully, the near end shall resume transmitting messages on the active path and report the protection switch to the appropriate OS.

… 2. If the EOC or TMC/CSC path switch was initiated by the IDT or RDT in response to an operations message or input from the user interface and the path protection switch was completed successfully, the near end shall resume transmitting messages on the active path and report the protection switch to the originator of the manual switch request.

… 3. If the EOC or TMC/CSC path switch was initiated by the IDT or RDT for a detected fault or upon initialization/re-initialization (see Section 12.6.3.2) and the path protection switch was not completed successfully, the near end shall do the following:

… a. Report the failed protection switch to the appropriate OS,

… b. Resume transmitting messages on its active EOC path or TMC/CSC path if possible

… c. Establish a schedule to retry the path protection switch using the following schedule:

… i. The first retry should occur within 1 minute of the failure,

… ii. The second retry should occur within 3 minutes of the failure,

… iii. Subsequent retries should occur no more than 5 minutes apart,

… iv. The retries continue until the operation is successful, i.e., a path switch is completed, or the reason for initiating a path protection switch no longer exists.

… 4. If the EOC or TMC/CSC path switch was initiated by the IDT or RDT in response to an operations message or input from the user interface and the path protection switch was not completed successfully, the near end shall resume transmitting messages on the active path if possible, and report the failed protection switch to the originator of the manual switch request.

R12-766 **[1631]** Failures to complete the path protection switch during the retry schedule shall not be reported to an OS but if the path protection switch is completed during the retry schedule, the event shall be reported to an OS.

R12-767 **[1632]** If an EOC or TMC/CSC path goes out of service because the path switch failed to complete successfully, the near end shall report the failure to the appropriate OS.

12.6.3.6 EOC and TMC/CSC Path Recovery

R12-768 **[1633]** Following an EOC path protection switch, the standby EOC path shall be available for path protection switching at the RDT when multiple frame operation has been re-established for the logical data links defined by SAPI=1, TEI=4 and SAPI=1, TEI=0 on the standby EOC path.

R12-769 **[1634]** Following an EOC path protection switch, the standby EOC path shall be available for path protection switching at the IDT when multiple frame operation has been re-established on the standby EOC path for the logical data links defined by SAPI=1, TEI=4, SAPI=1, TEI=0, and all other SAPI,TEI combinations in Table 12-1 that have been provisioned for use by the gateway function described in Section 12.7.1.

R12-770 **[1635]** Following an TMC/CSC path protection switch, the standby TMC/CSC path shall be available for path protection switching at the IDT and RDT when multiple frame operation has been re-established for the logical data links defined by SAPI=0, TEI=0 and SAPI=1, TEI=0 on the standby TMC/CSC path.

12.7 Operations Requirements Across the Generic IDLC Interface

12.7.1 OS/IDLC Communication Conventions

An LDS will have an interface to OSs. The collection of LDS equipment, firmware, and software needed to implement this interface is referred to as the Operations Interface Module (OIM).

R12-771 **[1636]** The IDT shall use the OIM of the local switching system to communicate with OSs. The OIM interface to OSs/EMs is allowed to be separate and different than other LDS interfaces to OSs/EMs. This allows LDS suppliers to accommodate different migration plans on each interface, as needed.

Because the local switching system's OIM stands between an IDLC system's RDT and the OSs, the OIM needs added functionality to implement the RDT to OS (RDT-OS) interface. In this document, the LDS OIM function that provides this communications path is called the “Gateway Function”; the function provides a gateway to the IDLC system's RDT to communicate with OSs.

R12-772 **[1637]** The LDS shall provide a “Gateway Function” in its OIM that provides the capability for the RDT to communicate with OSs using the EOC between the IDT and RDT.

Unless otherwise stated, LDS OIM, OIM, and gateway all refer to the same logical entity in the LDS.

Additional detail requirements for the gateway are currently under study. The services provided by the gateway may include the following:

- **Message Routing** - Provides a function to route messages from an OS to the IDT or RDT, as required, and to route responses to these messages back to the originating OS. Automatic messages (alarms or reports) are also routed by the gateway.
- **Protocol Conversion** - For messages targeted for the RDT, the protocols used for the interface between the OSs and the LDS are converted to the protocols used on the EOC and vice versa. For messages targeted for the IDT, the protocols are converted to the internal protocols of the LDS.
- **Speed Matching** - The gateway must provide a function to match the different data transmission rates of a DS0 (64 kb/s) EOC to the data transmission rate of the OS to LDS interface (1.2 kb/s to 56 kb/s).
- **Buffering** - The gateway must provide a buffering function to accomplish the speed matching function and to smooth out the peaks and valleys in the message traffic. The gateway must provide the capability to buffer messages being sent to an OS from an IDT or RDT until a path to the OS is established.
- **Concentration** - The gateway must do statistical multiplexing of the operations messages from the various OSs, IDTs, and RDTs. This service includes the speed matching and buffering services discussed above.
- **Operations Data-Link Management** - The gateway must manage the communication links between the OSs and the OIM based on the status of the EOCs between the IDT and RDT and vice versa. The gateway needs the capability to turn traffic on and off as well as establish connections on the OSs to OIM links.

Bellcore has published two documents describing Bellcore's view of proposed generic requirements for operations interfaces between telecommunications NEs and OSs. TR-TSY-000827 contains the proposed generic requirements when a non-Open Systems Interconnection (OSI) communications architecture is implemented. TR-TSY-000827 defines an OS-NE interface based on the X.25-related family of protocols at the physical,

data link, and network layers of the interface. In this model the application interfaces directly to the services provided by the network layer. GR-828-CORE contains the proposed generic requirements when the communications architecture is based on the OSI reference model.

The OIM and gateway requirements given in this section are for the non-OSI communications architecture. The OIM and gateway requirements are based on the protocols for layers 1, 2, and 3 and they are independent of the protocols used at the application layer. The OIM and gateway requirements for the OSI communications architecture will be provided at a later date.

12.7.1.1 OS-to-RDT Communications

In the operations environment of a telephone company, there generally will be several different OSs that will need to manage or receive information from an IDLC RDT. The different OSs may be devoted to a given function such as memory administration, maintenance, testing, surveillance, administration, or some combination of the above. In addition to the OSs managing the RDT, there will be TSC/RTU systems that will need to communicate with the RDT to manage test access and other functions during circuit and facility testing or the testing of the RDT components. All of the OSs and TSC/RTU systems that are remotely located from the RDT need to use the EOC between the IDT and RDT to exchange operations messages. The OIM with gateway function in the LDS provides access to the EOC for these systems. The following subsections give the requirements for the gateway function.

12.7.1.1.1 RDT Routing

The EOC supports several logical data-link connections that are identified by a SAPI and the TEI used in the LAPD protocol header (see Section 12.4.3.5.11). These logical data-link connections are used in forwarding OS and TSC/RTU operations messages to the RDT.

The OS-to-OIM interface (see Section 12.7.1.5) is based on the X.25-related family of protocols. These protocols enable simultaneous virtual calls and/or permanent virtual circuits to exist on a single physical medium through the use of logical data-link connections. For a virtual call, or switched virtual circuit as it is also called, the logical data-link connection is assigned during the call setup phase. For Permanent Virtual Circuits (PVCs), the logical data-link connection is assigned at the time of subscription to the service. The messages for a given RDT from a given OS or TSC/RTU system will be sent over a given logical data-link connection. The logical data-link connections are used by the gateway function to determine the RDT to which the messages are to go to in one of the following ways:

- **PVC** - When a PVC is used, it is mapped to one and only one RDT and one and only one OS. The PVC identification can then be used to identify the specific OS that is communicating with a specific RDT.
- **Switched Virtual Circuit (SVC)** - When a SVC is used, the called and calling Address Extension Facilities (AEFs) are used to identify the specific RDT and the specific OS or TSC/RTU system during the call setup phase. Each OS, TSC/RTU system, and RDT will have a unique Network Service Access Point (NSAP) Address for use with the AEF.

TR-TSY-000827 discusses the AEF and NSAP.

The EOC has several logical data-link connections defined in Table 12-1. A given logical data-link connection on the EOC is used to transport the operations messages from a given OS, a given TSC/RTU system, or the IDT between the IDT and RDT. Some OSs have been identified in Table 12-1 by the nominal function they provide. For example, Table 12-1 indicates that messages of the provisioning OS are sent to the RDT on the logical data-link connection identified by SAPI=1, TEI=1, but this does not indicate that all provisioning operations messages are sent to the RDT on the logical data-link connection identified by SAPI=1, TEI=1. For example, if the Maintenance and Surveillance OS needed to send a provisioning operations message to the RDT, the message would be sent using the logical data-link connection identified by SAPI=1, TEI=2 not the logical data-link connection identified by SAPI=1, TEI=1. These requirements on the use of SAPI/TEI addressing for routing purposes are currently under study and may be changed in the future.

R12-773 **[1638]** When a PVC is used by an OS to communicate with an RDT, the LDS shall provide the capability to enter the PVC to RDT and PVC to EOC logical data-link connection mapping for the PVC through the user system interface of the LDS.

O12-774 **[1639]** When a PVC is used by an OS to communicate with an RDT, the LDS should provide the capability to enter the PVC to RDT and PVC to EOC logical data-link connection mapping for the PVC through a remote operations interface to the LDS.

R12-775 **[1640]** When a SVC is used by an OS to communicate with an RDT, the LDS shall provide the capability to enter the RDT Network Service Access Point (NSAP) address to RDT mapping for use with the SVC through the user system interface of the LDS.

O12-776 **[1641]** When a SVC is used by an OS to communicate with an RDT, the LDS should provide the capability to enter the RDT NSAP address to RDT mapping for use with the SVC through a remote operations interface to the LDS.

R12-777 **[1642]** When a SVC is used by an OS to communicate with an RDT, the LDS shall provide the capability to enter the OS or TSC/RTU system NSAP address to EOC logical data-link connection mapping for use with the SVC through the user system interface of the LDS.

O12-778 **[1643]** When a SVC is used by an OS to communicate with an RDT, the LDS should provide the capability to enter the OS or TSC/RTU system NSAP address to EOC logical data-link connection mapping for use with the SVC through a remote operations interface to the LDS.

R12-779 **[1809]** For the X.25/SVCs case, the routing, protocol conversion, and NSAP addressing definitions in the following references shall be supported:

… a. Section 1.3 of TR-TSY-000830, *Operations Technology Generic Requirements (OTGR): Section 11.4 Generic Operations Interface - Operations Interworking*, Issue 1 (Bellcore, June 1990), currently provides the routing and protocol conversion requirements between an X.25/SVC interface to an OS/EM and a GR-303 LAPD interface on the EOC of an RDT.

… b. Section 11.1.5.3.7.F of TR-TSY-000827, *Operations Technology Generic Requirements (OTGR): Section 11.1 Generic Operations Interface - Non-OSI Communications Architecture*, Issue 1 (Bellcore, November 1988), currently requires that both the Called and Calling Address Extension Facilities (AEF) be used and defines the OSI Network Service Access Point (NSAP) address format to be supported.

The RDT will be required to support a full 7-layer OSI protocol stack on interfaces to OSs/EMs supporting the GR-2833 CMISE information model; as proposed in SR-3581, *TR-NWT-000303 Operations Migration Strategy*, Issue 1 (Bellcore, June 1995). At the Network Layer, the RDT will support CLNP over the GR-303 Convergence Function, and LAPD/EOC will continue to be required for interfacing to the OIM.

R12-780 **[1810]** For full 7-layer OSI communications between the RDT and its managing OSs/EMs, the OIM shall support the same criteria as specified above for supporting non-OSI communications. For this architecture, the OIM to OS/EM interface must use X.25/SVCs or X.25/PVCs at the lower layers of the 7-layer OSI protocol stack: this stack is defined in GR-828-CORE *Operations Technology Generic Requirements (OTGR): Section 11.2 Generic Operations Interface - OSI Communications Architecture*, Issue 1, Revision 1 (Bellcore, September 1995). The OIM would simply route the User Data (i.e., the entire CLNP PDU including the PDU Header)

of the X.25 packet of an RDT's EOC. The CLNP PDU is re-assembled at the RDT and passed to the CLNP processor of the RDT's 7-layer stack.

CR12-781 **[1811]** If the OIM to OS/EM interface is not using X.25/SVCs or X.25/PVCs at the lower layers (e.g., a LAN or RFC 1006 over TCP/IP protocol case), the OIM should implement CLNP at the Network Layer to achieve Relay and Routing capabilities and interface via the GR-303 Convergence Function to a SAPI-TEI datalink of an RDT's EOC. An OIM with CLNP implemented at the Network Layer can also support the CLNP over X.25 protocol case on the OIM to OS/EM interface.

R12-782 **[1644]** The RDT shall provide the capability to enter the OS or TSC/RTU system to EOC logical data-link connection mappings for the user-assignable logical data-link connections in Table 12-1 through the user system interface of the RDT.

The PVC and NSAP address mappings are static data in the LDS. The PVC is mapped to both the RDT and the EOC logical data-link connection because the PVC fixes both the RDT and the OS or TSC/RTU system. When SVCs are used, the RDT NSAP Address only maps to a given RDT while the OS NSAP address or TSC/RTU system NSAP address only maps to a given EOC logical data-link connection. However, once a SVC is established, the LDS can generate a dynamic mapping of the SVC to RDT and EOC logical data-link connection.

There will be a PVC to RDT and EOC logical data-link connection mapping for each PVC, a RDT NSAP to RDT mapping for each RDT, and an OS NSAP or TSC/RTU system NSAP to EOC logical data-link connection mapping for each OS and TSC/RTU system. The same OS NSAP and TSC/RTU system NSAP to EOC logical data-link connection mappings are used for all EOCs.

Figure 12-62 contains some examples of communication paths between OSs and RDTs using the gateway function of the OIM. In Figure 12-62, OS_1 has communications paths established with RDT_{35} and RDT_4. The called NSAP address in the message sent by OS_1 to establish SVC_1 is used by the OIM to determine the EOC to be used to reach $RDT_{35.}$ The calling NSAP address in the message sent by OS_1 to establish SVC_1 is used by the OIM to determine the EOC data-link connection, SAPI=1 TEI=1 to be used by the OIM when forwarding messages from OS_1 to RDT_{35}. The called NSAP address in the message sent by OS_1 to establish SVC_2 is used by the OIM to determine the EOC to be used to reach RDT_4. The calling NSAP address in the message sent by OS_1 to establish SVC_2 is used by the OIM to determine the EOC data-link connection, SAPI=1 TEI=1 to be used by the OIM when forwarding messages from OS_1 to RDT_4. In both of these cases, the same calling (OS_1) NSAP address is used and maps to the EOC data-link connection defined by SAPI=1, TEI=1 in the EOCs for RDT_{35} and RDT_4. Each RDT has a unique NSAP address that enables the OIM to determine the EOC to be used based on mappings provisioned in the LDS.

Once SVC_1 has been established, the OIM will forward all messages received from OS_1 on this SVC to RDT_{35} using the EOC logical data-link connection SAPI=1, TEI=1. Also, the OIM will forward all messages received from RDT_{35} on logical data-link connection SAPI=1, TEI=1 to OS1 using SVC_1. Similarly, the OIM will forward all messages received from OS_1 on SVC_2 to RDT_4 using the EOC logical data-link connection SAPI=1, TEI=1 once SVC_2 has been established. Also, the OIM will forward all messages received from RDT_4 on logical data-link connection SAPI=1, TEI=1 to OS_1 using SVC_2.

OS_2 uses PVCs to communicate with the RDTs. The OIM will forward all messages received from OS_2 on PVC_1 to RDT_4 using the EOC logical data-link connection SAPI=1, TEI=2. Also, the OIM will forward all messages from received RDT_4 on logical data link connection SAPI=1, TEI=2 to OS_2 using PVC_1. Similarly, the OIM will forward all messages received from OS_2 on PVC_2 to RDT_{17} using the EOC logical data-link connection SAPI=1, TEI=2 and the OIM will forward all messages received from RDT_{17} on logical data-link connection SAPI=1, TEI=2 to OS_2 using SVC_3.

In the above examples, the LDS has been provisioned with the information to enable it to make the mappings between PVC and OS NSAP address and a unique SAPI, TEI logical data-link connection on the EOCs. The LDS has also been provisioned with the information to enable it to map a PVC and RDT NSAP address and a unique RDT EOC.

R12-783 **[1645]** When the OIM with gateway function receives a message for an RDT, the messages shall be forwarded from the gateway to the RDT over the IDLC system EOC using the appropriate EOC logical data-link connection.

In summary, the logical data-link connection used by the OS to send the command to the OIM is used to select the IDLC EOC and the logical data-link connection within the EOC to be used in forwarding messages from an OS or TMC/RTU system to a particular RDT. However, the use of these logical connections for message routing are currently under study and may be changed in the future.

12.7.1.1.2 IDT Routing

The OIM with gateway function may be used by OSs and TSC/RTU systems for management access of the IDT. The management and implementation of the OIM-to-IDT interface is to be defined by the LDS supplier.

12.7.1.2 RDT-to-OS Communications

The messages used by an OS or TSC/RTU system to manage an RDT are sent in a confirmed mode, i.e., the RDT must respond to the message. The response can be used to return requested data, indicate the action requested in the message was completed, or

indicate an error that prevented the completion of the action requested in the message. Responses are defined as part of the management information model defined in GR-2833-CORE.

12.7.1.2.1 RDT Response Routing

R12-784 **[1646]** The RDT shall send its response to a message on the same logical data-link connection on which it received the message.

For example, if the RDT receives a message over the EOC on the logical data-link connection identified by SAPI=1, TEI=2, the RDT will send its response on the logical data-link connection identified by SAPI=1, TEI=2.

R12-785 **[1647]** When the OIM with gateway function receives a message for an RDT, the OIM gateway function shall use the RDT and EOC logical data-link connection mapping information to route responses from the RDT to the appropriate OS or TSC/RTU system.

12.7.1.2.2 IDT Response Routing

As stated above, the OIM with gateway function may be used by OSs and TSC/RTU systems for management access to the IDT and the interface between the IDT and gateway is an internal LDS interface that is to be defined by the supplier.

12.7.1.3 Automatic Message Routing

Messages are generated automatically by the IDLC system to report alarms and automatic actions such as a protection line switch or a database restoral from a non-volatile database backup. These messages must be routed to the proper OS or TSC/RTU system and, for the RDT, some of the messages are also routed to the IDT. The routing from the RDT to an OS is done using the EOC logical data-link connections defined in Table 12-1. The RDT sends the automatic messages to the IDT over the EOC logical data-link connection per the requirements in this section and the OIM in the LDS uses the logical data-link connection information to route the message to the appropriate OS or TSC/RTU system.

R12-786 **[1648]** The IDT shall use automatic messages to report events in the IDT to the appropriate OS using the reporting mechanism of the LDS.

R12-787 **[1649]** The RDT shall use automatic messages to report events in the RDT to the appropriate OS and/or the IDT using the logical data-link connections defined in Table 12-1.

R12-788 **[1812]** The OIM shall implement procedures, where needed, such that autonomous messages sent from the RDT do not get lost/corrupted even when the link between the OIM to the OS/EM is not immediately available/established. It is a supplier's decision as to how to implement this requirement; e.g., message buffering, datalink flow-control, etc. The implementation, however, shall not impose additional requirements on the RDT or OS/EM.

12.7.1.3.1 Automatic Message Routing Defaults

When the user has not provisioned the automatic message destination for a given message, the requirements in this section provide the default destinations to be used.

R12-789 **[1650]** The RDT shall send all event reports destined for the OS that manages the provisioning or memory administration functions at the RDT to the IDT using the EOC logical data-link connection defined by SAPI=1, TEI=1, unless the RDT has been provisioned to use a different EOC logical data-link connection or path.

R12-790 **[1651]** The RDT shall send all event reports destined for the OS that manages the performance monitoring, surveillance, or maintenance functions at the RDT to the IDT using the EOC logical data-link connection defined by SAPI=1, TEI=2, unless the RDT has been provisioned to use a different EOC logical data-link connection or path.

R12-791 **[1652]** The RDT shall send all event reports destined for the IDT to the IDT using the EOC logical data-link connection defined by SAPI=1, TEI=4, unless the RDT has been provisioned to use a different EOC logical data-link connection.

R12-792 **[1653]** When the RDT has a test access established for a line, the RDT shall send notifications applicable to the line, including a Change of Overhead Bit Reports for a Basic Rate Access ISDN line, to the TSC/RTU system that established the test access using the same EOC logical data-link connection that was used to establish the test access to the line.

CR12-793 **[1654]** If the IDT does not support all logical data-link connections as required in this document, and the RDT cannot establish multiple frame operation on the default logical data-link connections defined by SAPI=1, TEI=1 and SAPI=1, TEI=2 when the RDT has an event report to send on one of these logical data-link connections, the RDT shall do the following for the interim

… a. Send the event report to the IDT on the logical data-link connection defined by SAPI=1, TEI=4.

… b. Continue to use SAPI=1, TEI=4 for these event report types until multiple frame operation is established on the default logical data-link connection.

CR12-794 **[1655]** If the RDT supports scheduled reporting of events, the RDT shall return all scheduled reports on the same logical data-link connection that was used to establish the scheduled report unless another logical data-link connection or path is designated when the schedule is established.

CR12-795 **[1656]** If there is a TAU initialization at the RDT, the RDT shall send a TAU initialization report to all TSC/RTU systems that currently have a test access established at the RDT using the logical data-link connection that was used to establish the test access.

12.7.1.4 Circuit/Equipment Identity

R12-796 **[1657]** The customer line in the RDT shall be numbered consecutively from one to N, where N is the maximum number of lines (i.e., wire pairs; e.g., each two-wire circuit is one line and each four-wire circuit is two lines) that can be terminated on the RDT.

R12-797 **[1658]** There shall be a fixed mapping of the line number to the physical location of the line on the RDT.

See Section 12.5.2.3 Item b for a discussion of mapping of line numbers to the Call Reference Values used by the TSC or CSC for call setup.

R12-798 **[1659]** The line of a four-wire circuit shall be identified by the line identification of the lowest line of the circuit, e.g., if a four-wire circuit terminates on lines 11 and 12, the line equipment in the RDT shall be identified as line 11.

R12-799 **[1660]** The line of a two-wire circuit requiring a bandwidth greater than 64 kb/s, i.e., the circuit requires more than one DS0, across the RDT to IDT interface, shall be identified by the line equipment.

A program circuit and ISDN Basic Rate Access Digital Subscriber Line (DSL) are examples of circuits requiring multiple DS0s across the RDT to IDT interface. The ISDN channel identity requirements for call processing messages are discussed in Section 12.5.1.2. (See Section 3.6 for a discussion of ISDN.)

R12-800 **[1661]** The DS1s on the facility side of the RDT, i.e., the DS1 going to the IDT or CO, shall be numbered from one to M (M ≤ 28) where M is the maximum number of DS1s that can be used by the system for the RDT to IDT interface.

R12-801 **[1662]** The DS1s on the equipment side of the RDT, i.e., the DS1 going to customer premises, shall be numbered for the lowest 2-wire line of the two 2-wire used for the DS1.

The time-slots within a DS1 are numbered 1 to 24 as discussed in Section 4.4.2.

R12-802 **[1663]** The supplier shall provide documentation containing access identification for other equipment and logical entities that must be accessed by an OS or a technician via the craft interface.

… The access identifications may be architecture dependent, but they shall be unique within the supplier's equipment.

For non-concentrated IDLC systems, see Section 4.4.10 for DS1 time-slot to line numbering requirements.

12.7.1.4.1 OS-to-OIM Interface

The LDS may have several interfaces to embedded OSs and to OSs that only manage switching systems. These interfaces terminate on what are called OIMs in this document. The OIM addressed in this section is the OIM with a gateway function that provides the capability for remote OSs and TSC/RTU systems to communicate with the RDT over the EOC between the IDT and RDT. This does not preclude the use of this OIM by OSs or TSC/RTU systems that manage the switching system. The OIM as used here does not necessarily refer to a specific piece of hardware, but it refers to all the hardware, firmware, and software needed to implement the OIM functionality.

R12-803 **[1664]** The LDS shall provide an OIM that meets the requirements of TR-TSY-000827 for Protocol Layers 1, 2, and 3.

R12-804 **[1665]** The LDS shall support both X.25/PVCs and X.25/SVCs.

R12-805 **[1666]** The LDS shall provide an operations interface module (OIM) that meets the requirements of GR-828-CORE.

12.7.2 Operations Messages

The application layer for the operations messages exchanged over the EOC and SAPI 1 of the TMC/CSC are described in Section 12.6.1.5. The information model for the operations messages carried on these data links is found in GR-2833-CORE. On an interim basis, the services and information model defined in Supplement 3 of TR-TSY-000303 may be used to support management functions between the IDT and RDT. An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.

As noted in Section 12.6.1.5, the operations messages are written using CMIS. The services and protocols for CMIS are based on ISO/IEC 9595 and ISO/IEC 9596-1, respectively. Remote Operations Service (ROS) are used as the underlying service to CMIS in accordance with the specification in CMIS. The ROS services and protocols specified in ITU-T X.219 and X.229, respectively, are used to support CMIS.

The transfer syntax to be used for the messages is the Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) defined in ITU-T X.209 and ISO 8825.

The operations (management) functions for an IDLC system are discussed in Section 5.

12.7.2.1 System Administration and Security Messages

System administration and security requirements are discussed in Section 5 and Section 8.4 for IDLC systems.

12.7.2.2 Memory Administration (Provisioning)

Memory administration requirements are discussed in Section 5.

12.7.2.3 System Maintenance Messages

System maintenance requirements are discussed in Section 5.

12.7.2.4 Circuit Testing (System Maintenance) Messages

The requirements for integrating a circuit test system into an IDLC system are not included in this GR. A circuit test system integrated into the RDT of an IDLC system will require new messages to support the integrated circuit test feature.

12.7.2.5 Test Access (System Maintenance) Messages

The RDT is required to provide metallic test access to the metallic cable pairs beyond the RDT. Metallic test access is discussed in Section 5.

The RDT may provide digital test access at the RDT as an option. Digital test access is discussed in Section 5.

12.7.3 Testing

This section describes the IDLC system's role in the testing procedures. The testing will include POTS and special service circuits as well as testing of facilities and common equipment. The testing procedures presented are aimed at verifying, sectionalizing, and identifying the faulty units in response to trouble reports and alarms, and once the trouble is repaired, verifying the repair. Testing procedures will be presented for switched services circuit testing, special service circuit testing, facility testing, and common equipment testing.

12.7.3.1 Switched Services Testing

Switched services testing is discussed in Section 5.

12.7.3.1.1 Metallic Test Access

Metallic test access is discussed in Section 5.

12.7.3.1.2 Line Terminating Equipment Testing

Line terminating equipment testing is discussed in Section 5.

12.7.3.1.3 Line Terminating Equipment Diagnostic - Option

Line terminating equipment diagnostics are discussed in Section 5.

12.7.3.2 Special Service Testing

Special service testing is discussed in Section 5.

12.7.3.3 Facility Testing

Facility testing is discussed in Section 5.

12.7.3.3.1 Far-End Loopback - With Protection Switch Option

Loopback requirements are given in Section 6.1.5.4. Management of loopbacks is discussed in Section 5.

12.7.3.3.2 Far-End Loopback - Without Protection Switch

Far-end loopback management is discussed in Section 5.

12.7.3.4 Common Equipment Testing

Common equipment testing is discussed in Section 5.

12.7.4 Maintenance Scenarios

Maintenance operations are initiated for troubles within the IDLC system or for circuits carried by the IDLC system when a trouble is detected. These troubles may be detected by self-testing features, performance monitoring features, or through customer trouble reports. Maintenance operations are needed to

- Report detected troubles
- Verify a reported trouble
- Initiate service protection procedures
- Sectionalize and locate faults
- Repair the fault
- Verify the repair.

12.7.4.1 Trouble Reporting

The management of trouble reports is discussed in Section 5.

12.7.4.2 Trouble Verification

Trouble verification is discussed in Section 5.

12.7.4.3 Service Protection

Service protection features are intended to protect service with minimum impact on service performance by providing features to enable the IDLC system to recover from detected troubles. Service protection capabilities include automatic and manual actions.

12.7.4.4 Sectionalize and Locate Fault

Sectionalization and fault locating are discussed in Section 5.

12.7.4.5 Verify Repair

Verification of repairs is discussed in Section 5.

12.8 Requirements and Options Supporting System Turn-up

12.8.1 Memory Administration Data Initialization for the Generic IDLC Interface

IDLC system memory administration data initialization requirements are discussed in Section 9.1.3 and Section 5.

12.8.2 System Start

System start addresses the procedures required to bring an IDLC system back into service after it has been powered down. These procedures do not address the procedures for installing and testing the IDT, DS1 facilities, or the RDT.

If the RDT has been powered down by turning off its power switch, the power will be restored by a field technician returning the power switch to the on position. When the RDT is powered on, the requirements of Section 9.1.2 shall be met by the IDLC system. Operations requirements are discussed in Section 5.

12.8.3 Power on Following Commercial AC Power Failure

The RDT is required to have battery backup to provide power during an ac power failure at the RDT (see the "POWERING AND ELECTRICAL SAFETY" section of TR-NWT-000057). The ac power failure may last for a longer time period than provided for by the battery backup at the RDT. If the RDT is automatically powered on following an ac power failure of a longer duration of time than the battery backup protection provided, the requirements of Section 12.8.2 apply with the following exceptions:

R12-806 **[1667]** The RDT shall copy its non-volatile backup memory to its working memory.

R12-807 **[1668]** The RDT shall send an operations automatic message to the network monitoring and analysis system to report the restoral of the commercial ac power.

12.8.4 Power-on Plug-in Replacement

It is desirable for an RDT to provide the capability to replace all plug-ins without powering down the system. Section 9.2 identifies requirements and options to support this need. Operations requirements are discussed in Section 5.

12.9 UDLC To IDLC Transition Considerations

This section discusses ways of minimizing the impact on operations and equipment when a UDLC system is to be integrated into a local switching system.

a. The UDLC system interface between the COT and RDT should meet the Generic IDLC Interface described in Section 12.

b. The operations interface for the UDLC system should be provided by an operations interface module in the UDLC system's COT.

c. As far as possible, a UDLC COT should perform the same functions as are performed by the IDLC IDT and local switching system.

d. The UDLC system should follow the testing procedures described in this GR.

It is apparent from the above list that the impact on operations and equipment when integrating a UDLC system will be minimized when the interface between the COT and RDT of the UDLC system is based on the Generic IDLC Interface discussed in Section 12.

The same considerations apply to a switching system supplier that offers both a UDLC system and an IDLC system where the IDLC system interfaces their switching system through a proprietary IDLC interface. If the supplier wishes to offer the capability of

integrating their UDLC system into their switching system using their proprietary interface, the COT to RDT interface should match their proprietary IDLC interface to minimize operational and equipment impacts when the integration takes place. However, in this scenario, there is only an advantage when the UDLC system and switching system are from the same supplier. There may be significant economic and operational penalties, or integration may not be possible, when the UDLC system and switching system are from different suppliers in this scenario.

12.9.1 Signaling and Transmission Considerations

The overall system signaling and transmission requirements for UDLC and IDLC systems are the same. What is different is how the signaling and transmission impairments are allocated among the system components. For an IDLC system, all the impairments (except delay) are allocated to the RDT, whereas in a UDLC system the impairments must be allocated between the COT and RDT. Thus the signaling and transmission requirements for the UDLC RDT are more stringent than the signaling and transmission requirements for the IDLC RDT.

If a supplier starts by building a UDLC system, the supplier should not have a problem with signaling and transmission impairments when the system is integrated. In fact, the RDT will perform better than required because the impairments allocated to the COT are removed by the integration. However, if a supplier builds an IDLC RDT taking full advantage of the additional signaling and transmission tolerances allowed for an IDLC RDT, that RDT may not be able to be used in a UDLC system by adding a COT - without improving the signaling and transmission performance of that RDT.

As was mentioned above, this GR does not require a supplier of IDLC systems to also market a UDLC system. By the same token, a supplier of UDLC systems is not required to offer an integratable UDLC system.

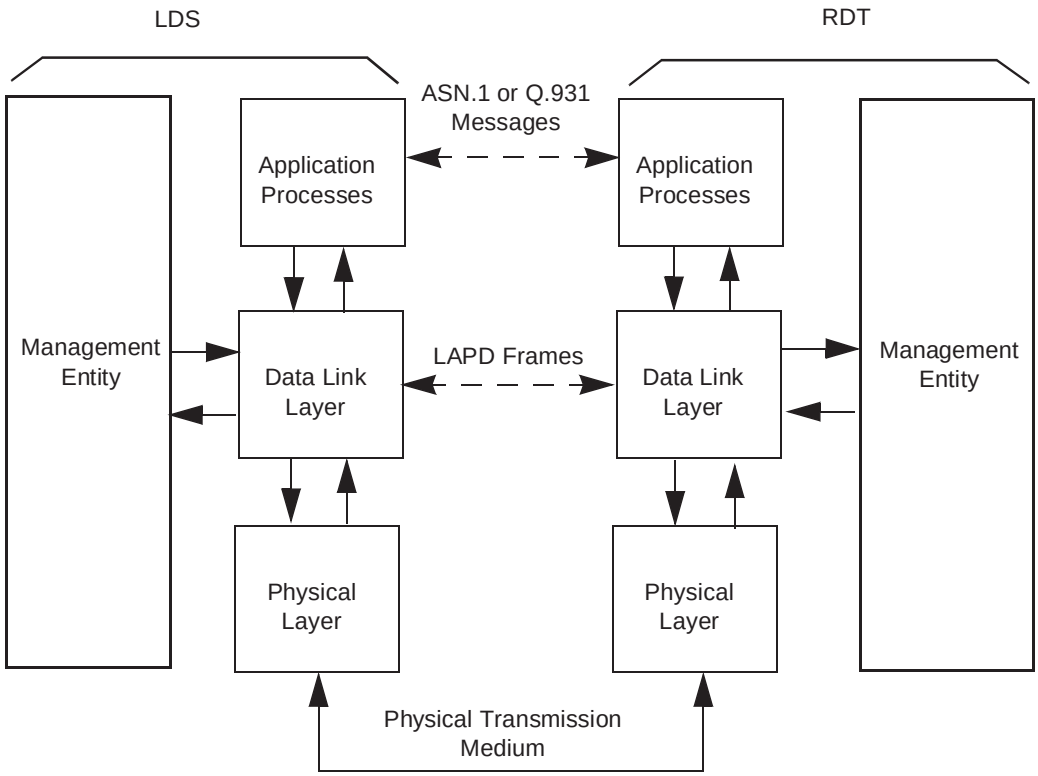


Figure 12-1. Layer Structure of an IDLC System

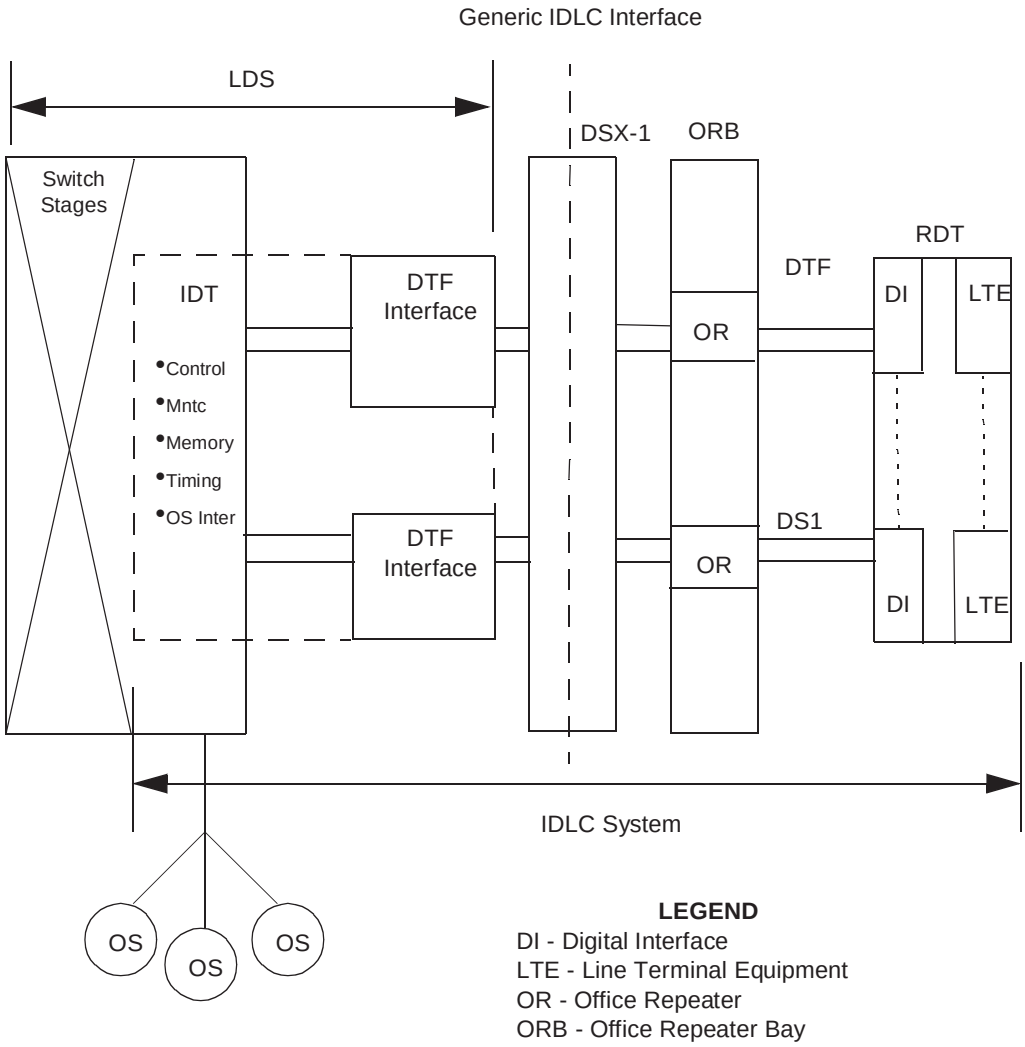


Figure 12-2. Generic IDLC System

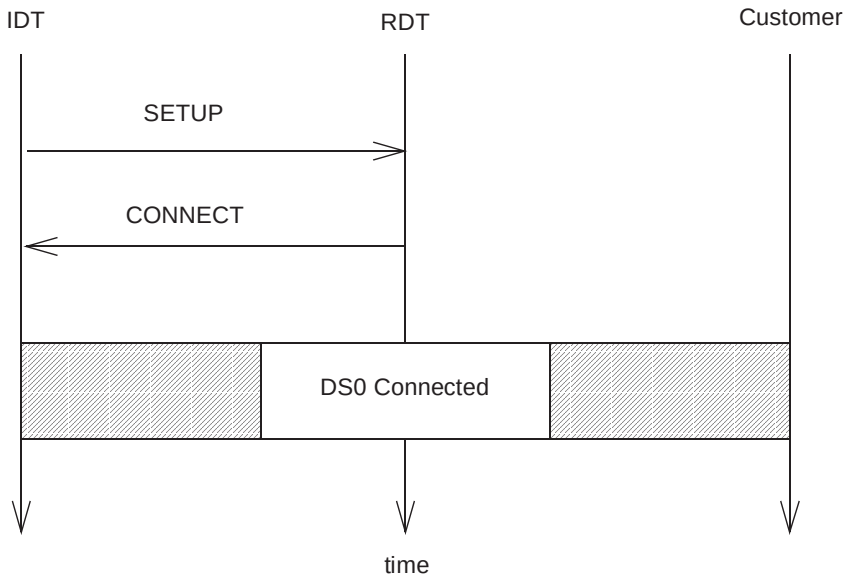
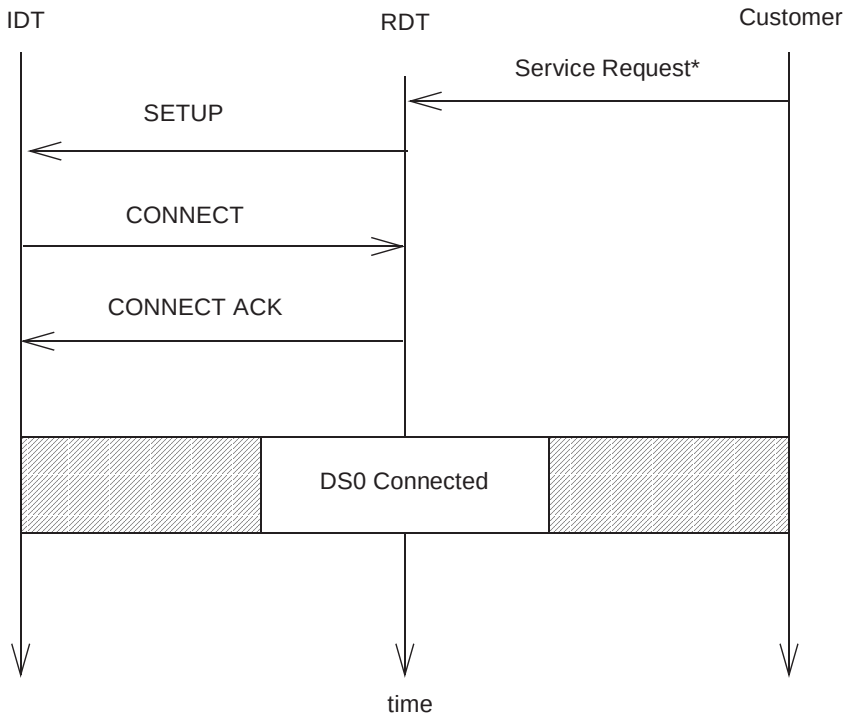


Figure 12-3. TMC/CSC - IDT Initiated Time-Slot Assignment



* A service request corresponds to a loop closure on loop start circuits and to a ring ground on ground start circuits.

Figure 12-4. TMC - Customer Initiated Time-Slot Assignment

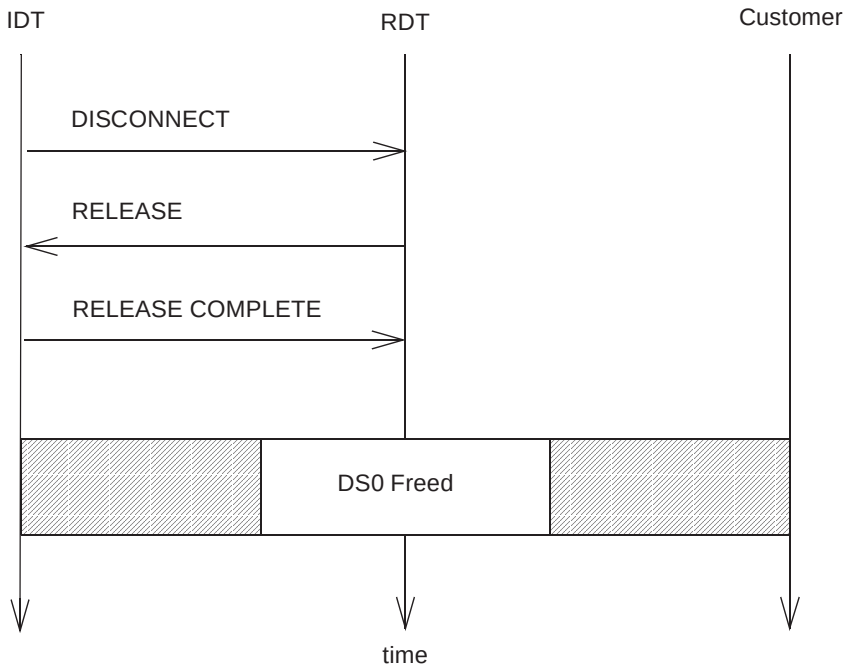
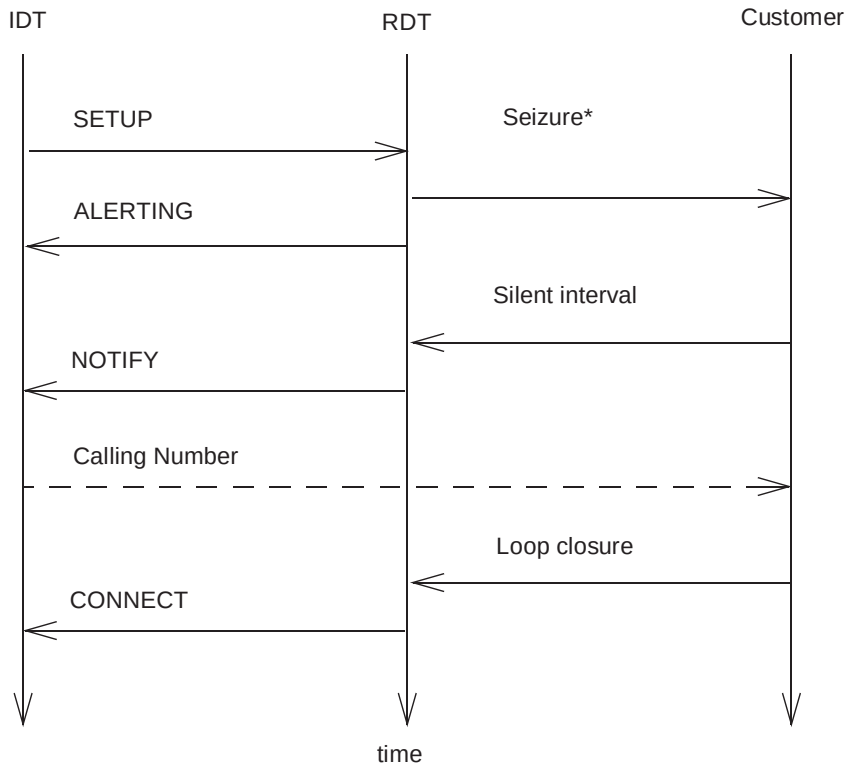
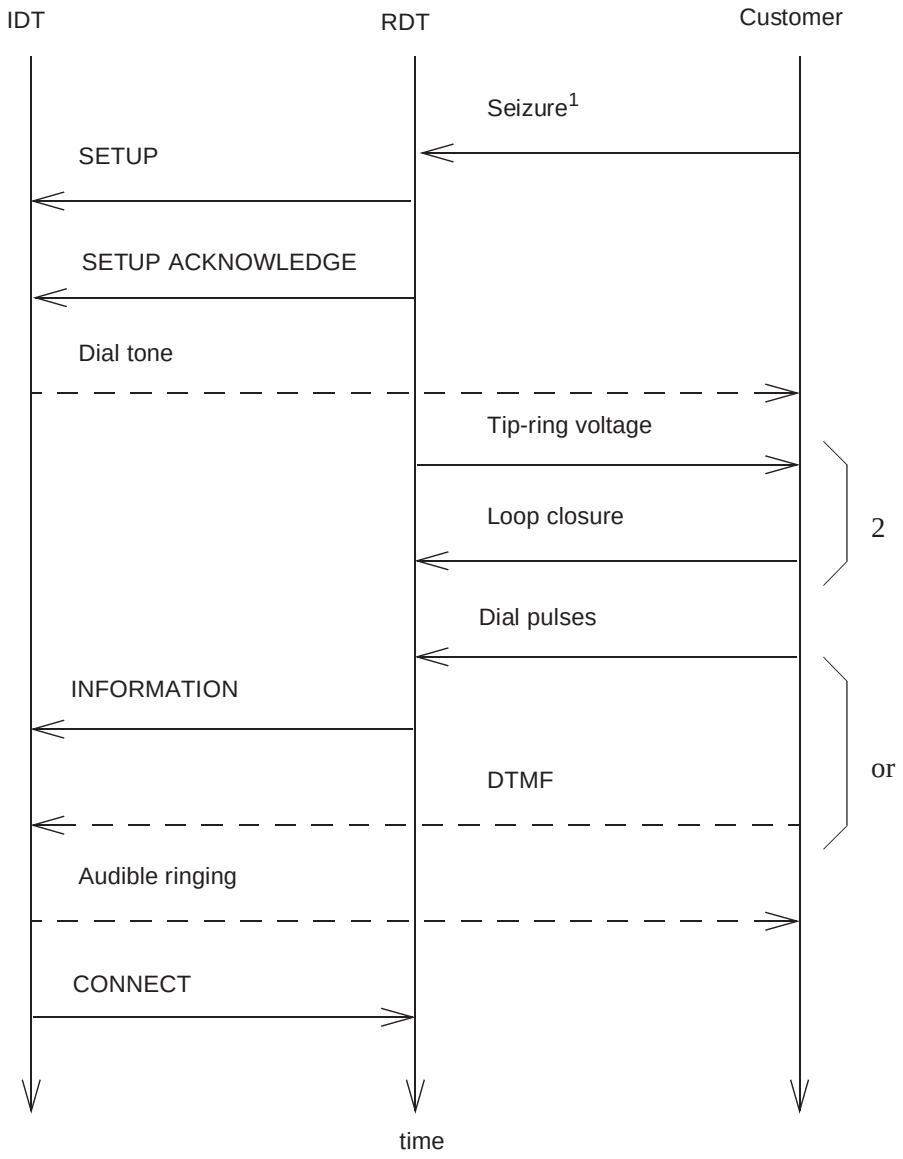


Figure 12-5. TMC - Time-Slot Clearing



* The seizure will be one of the following:
1. On loop start circuits, applying an alerting signal to the line.
2. On ground start circuits, applying tip ground and an alerting signal to the line.

Figure 12-6. CSC - IDT Initiated Call Establishment for Loop/Ground Start Circuits



1. The seizure will be loop closure on loop start circuits and ring ground on ground start circuits.
2. This applies to ground start circuits.

Figure 12-7. CSC - Customer Initiated Call Establishment for Loop/Ground Start Circuits

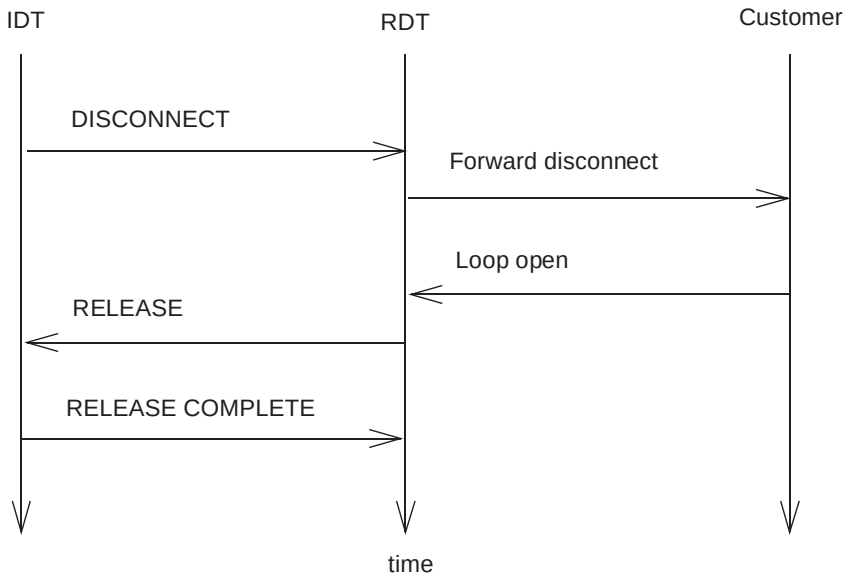


Figure 12-8. CSC - IDT Initiated Call Clearing for Loop/Ground Start Circuits

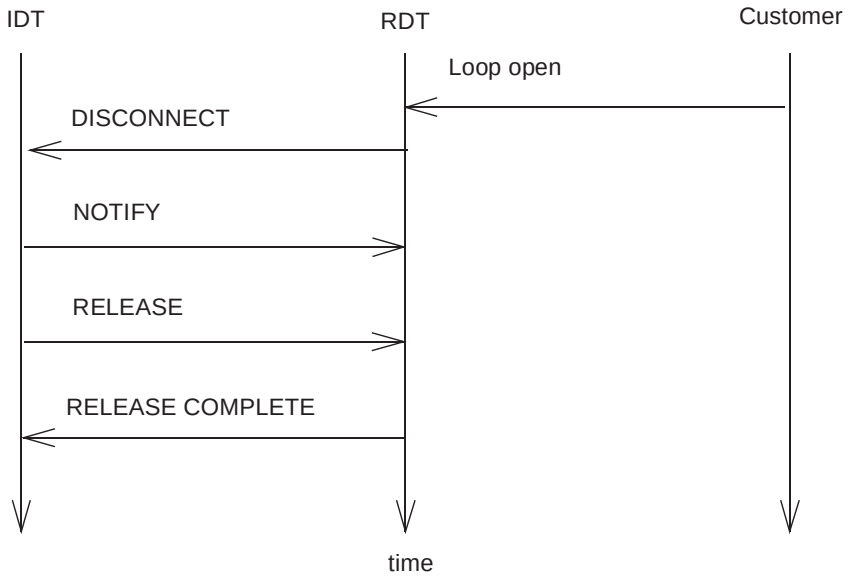
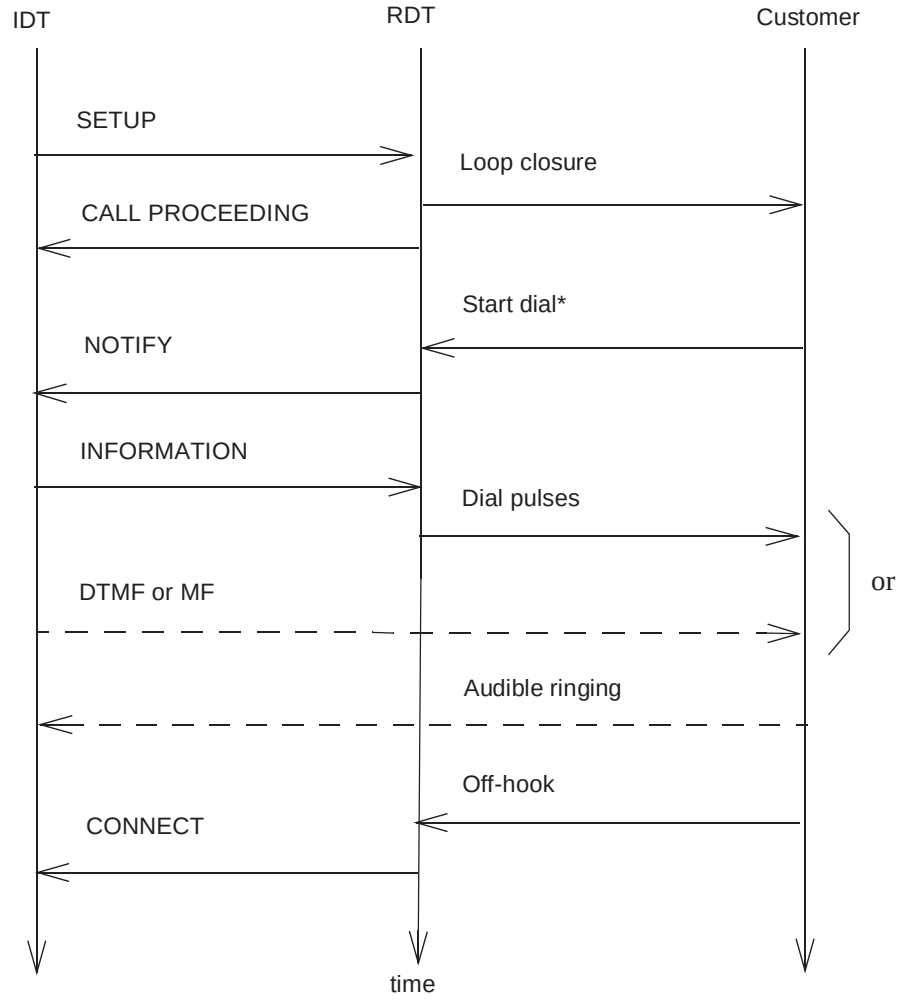


Figure 12-9. CSC - Customer Initiated Call Clearing for Loop/Ground Start Circuits



* The start dial signal will be one of the following:

1. For wink-start operation, a wink signal.
2. For immediate-dial operation, there is no explicit start dial signal from the customer.
3. For delay-dial operation, a transition from reverse to normal battery.

Figure 12-10. CSC - Call Establishment for Loop Reverse Battery Circuits

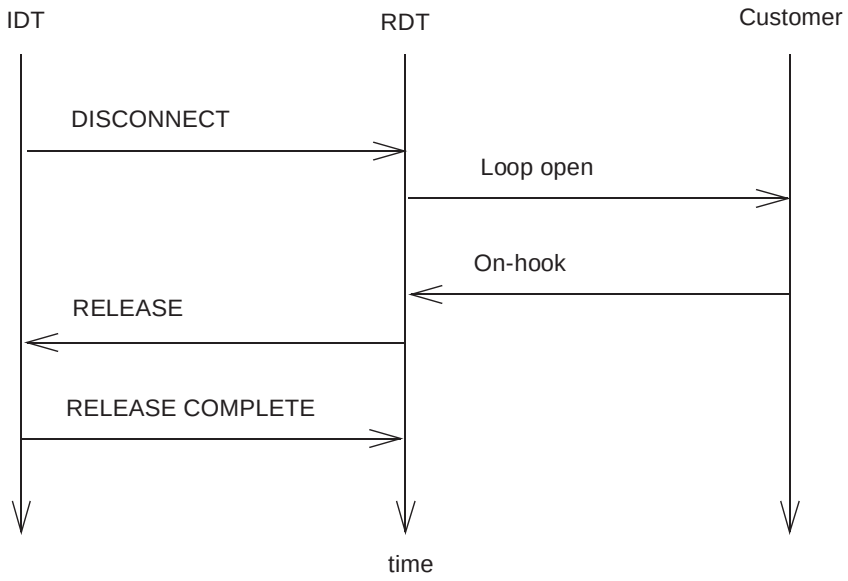


Figure 12-11. CSC - IDT Initiated Call Clearing for Loop Reverse Battery Circuits

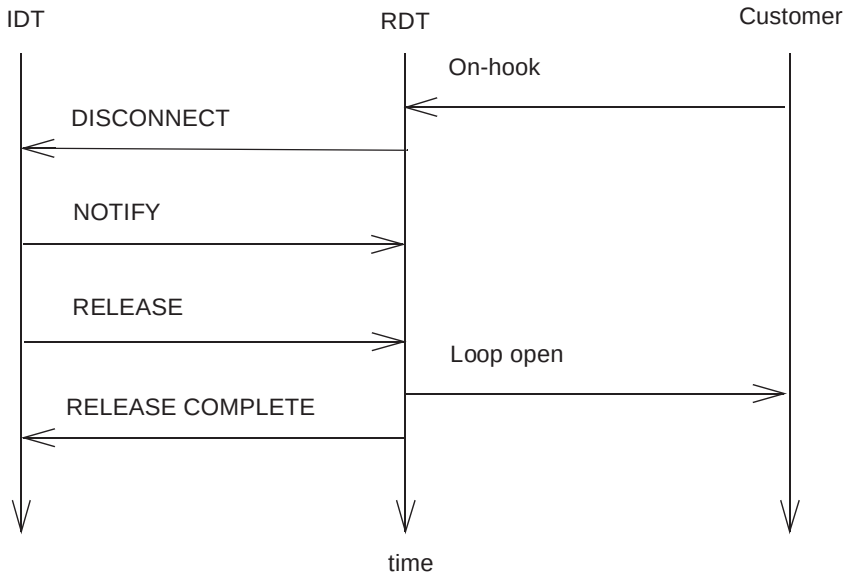


Figure 12-12. CSC - Customer Initiated Call Clearing for Loop Reverse Battery Circuits

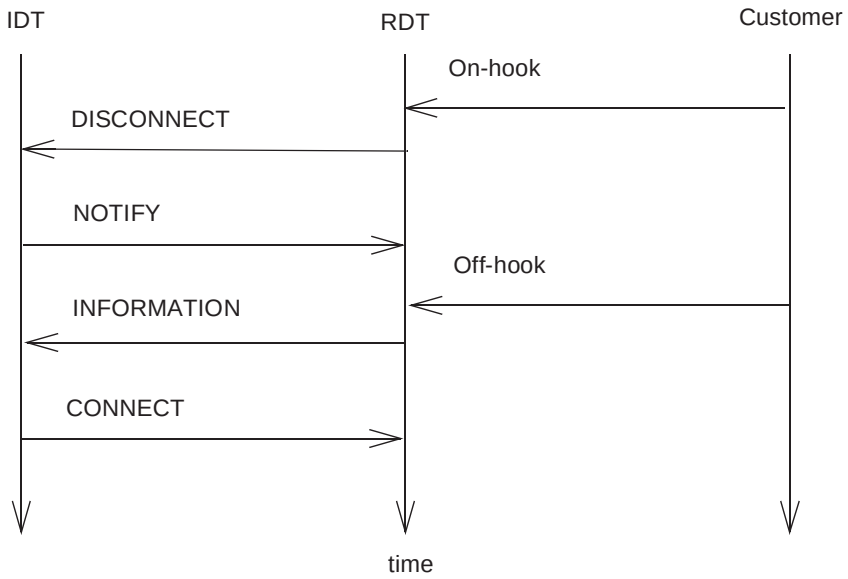


Figure 12-13. CSC - 911 Onhook/Offhook

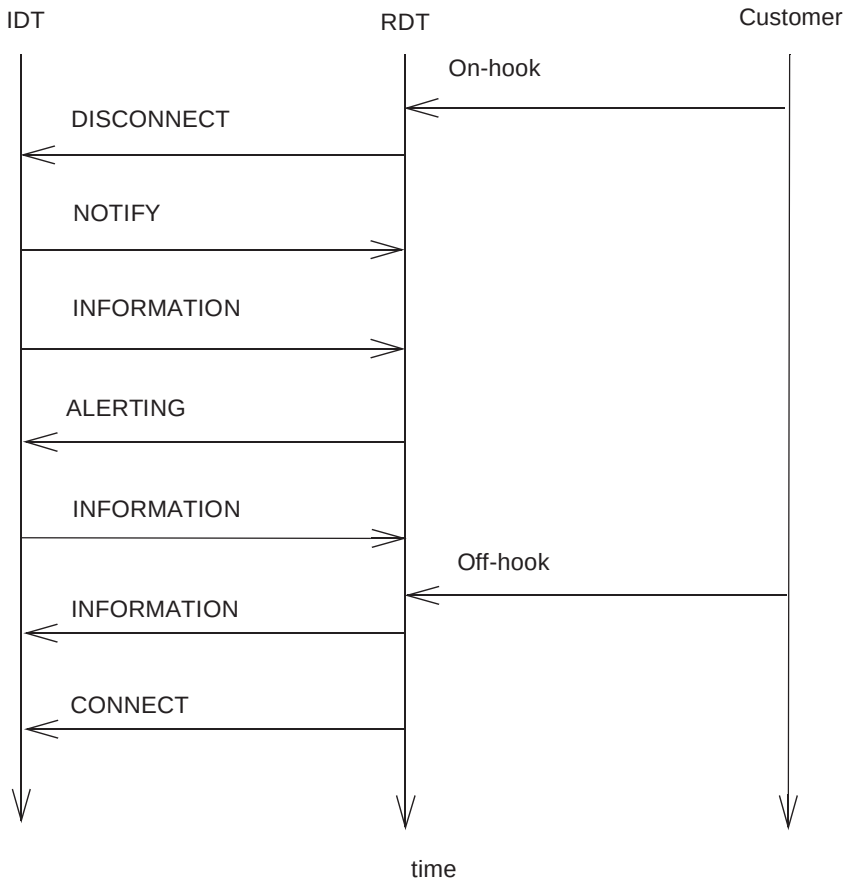


Figure 12-14. CSC - Expanded 911 with Ringback

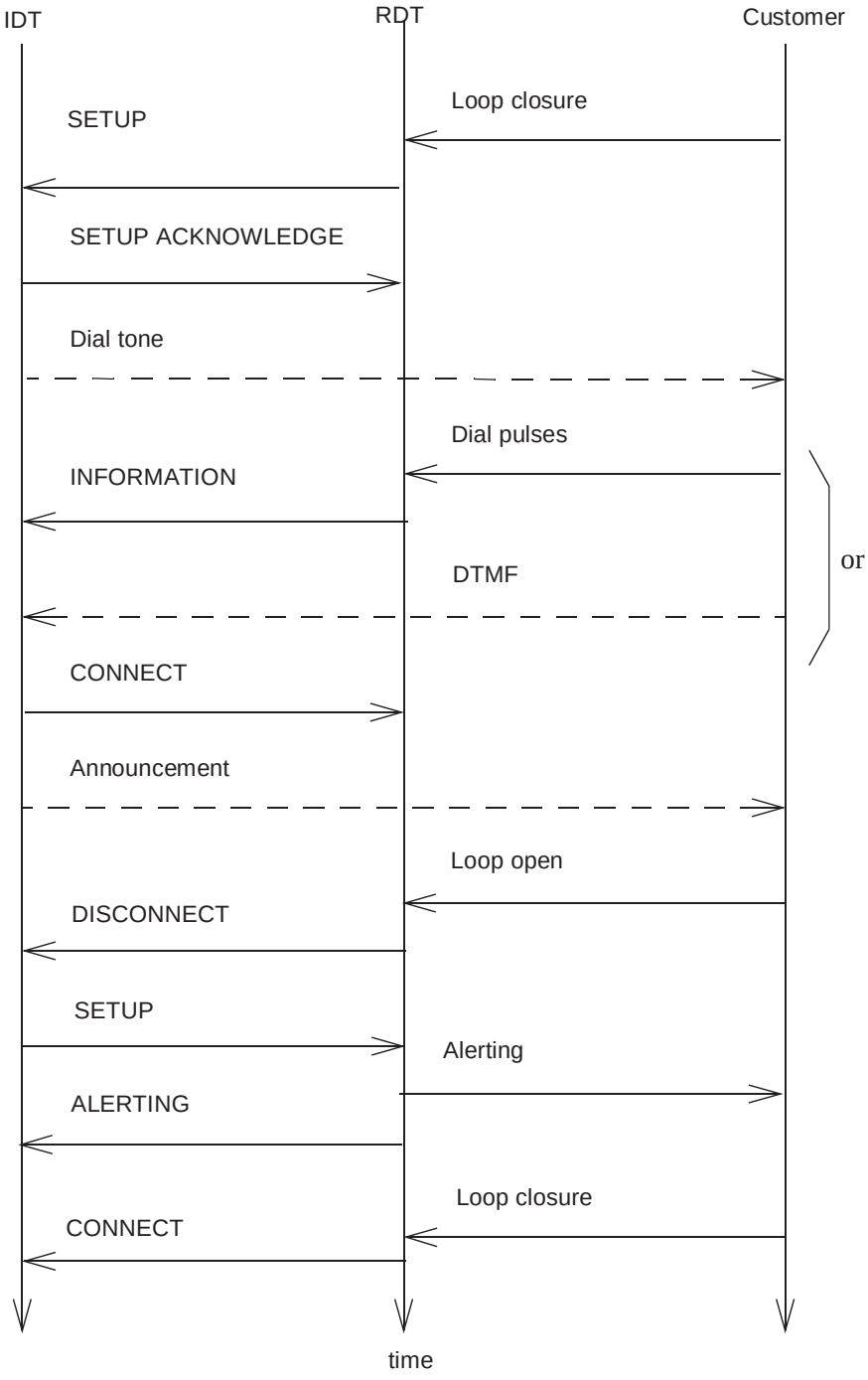


Figure 12-15. CSC - Reverting Calls on Multi-party Circuits

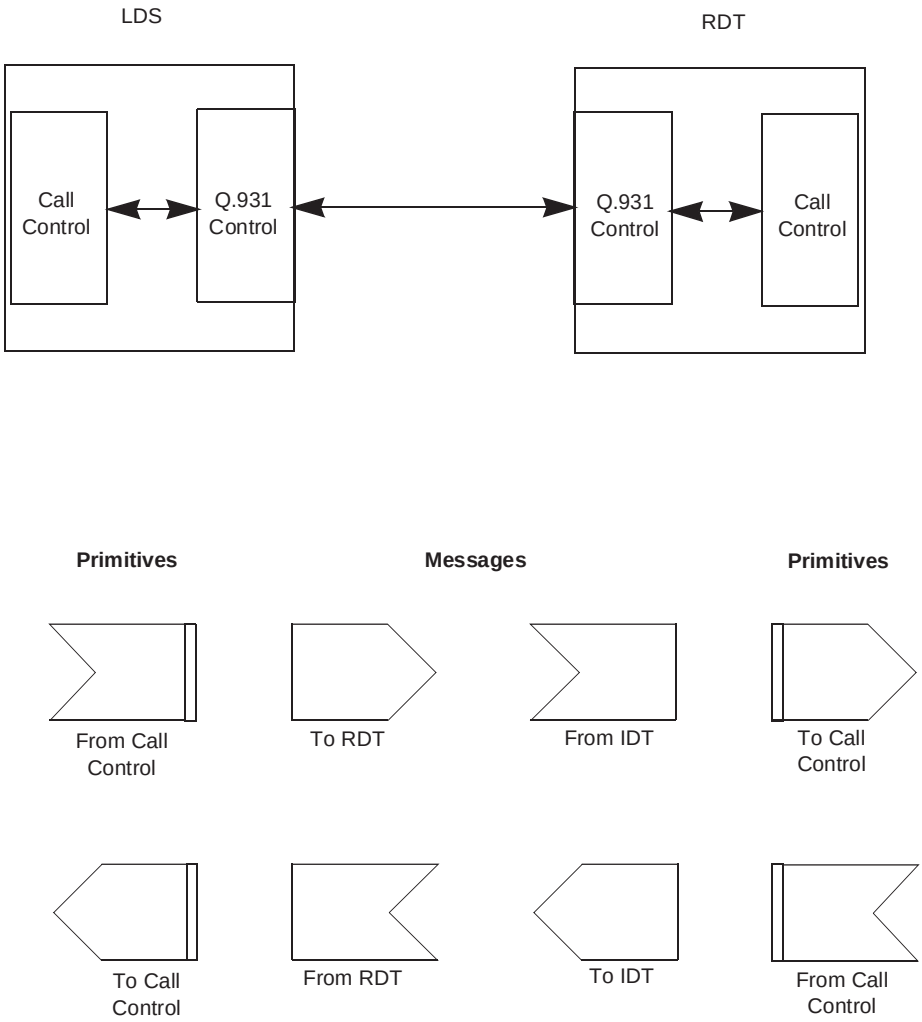


Figure 12-16. Flow Diagram Symbols

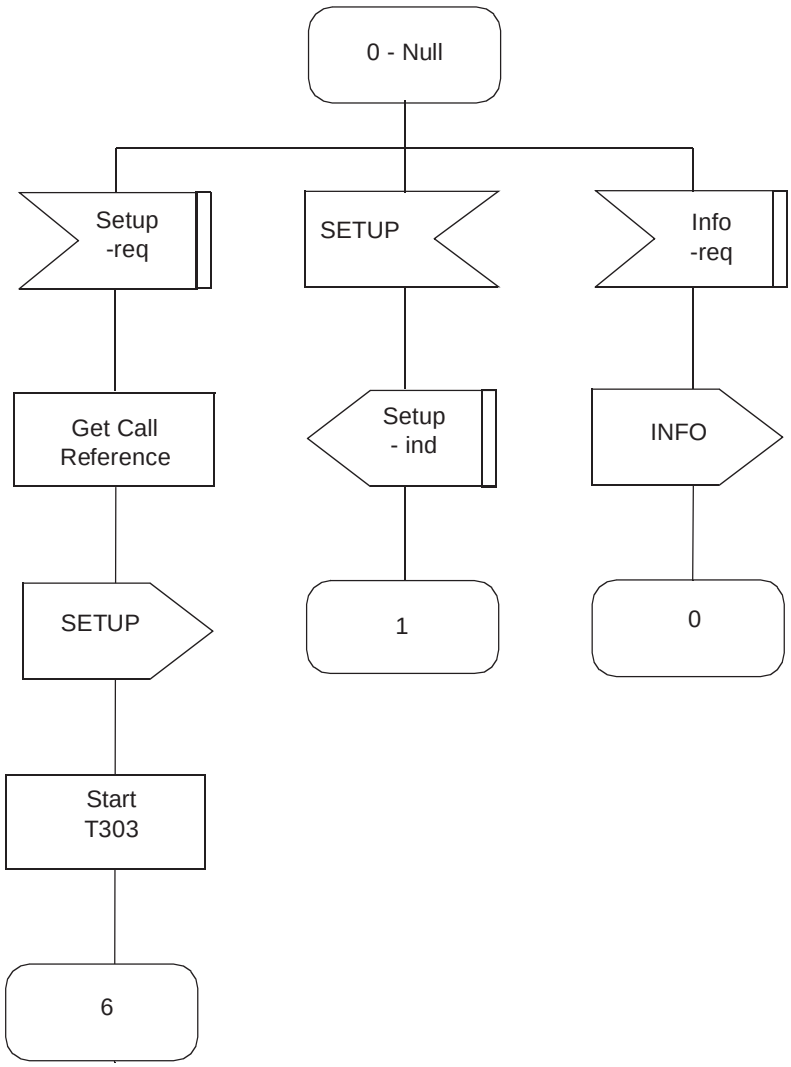


Figure 12-17. Null State - IDT

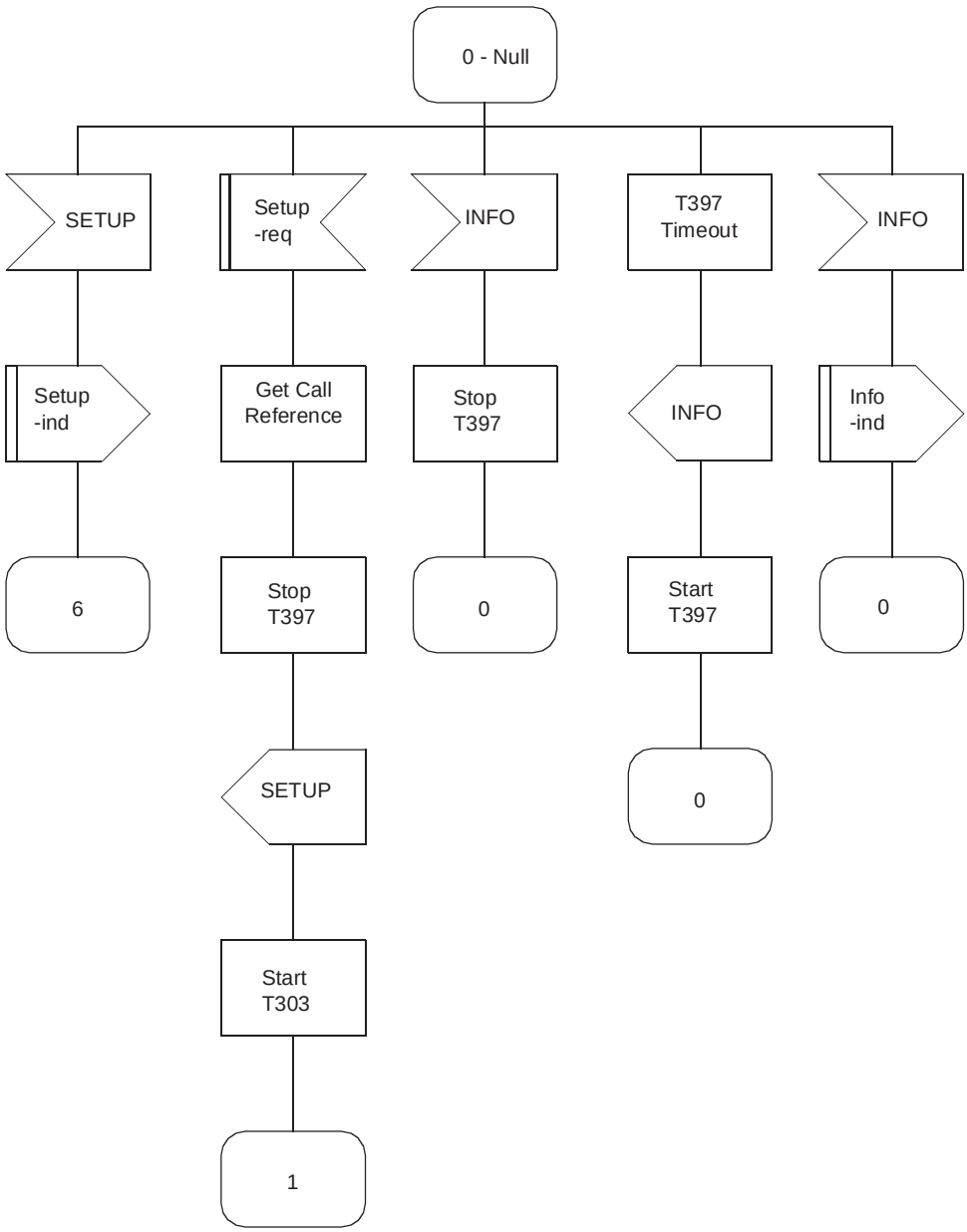


Figure 12-18. Null State - RDT

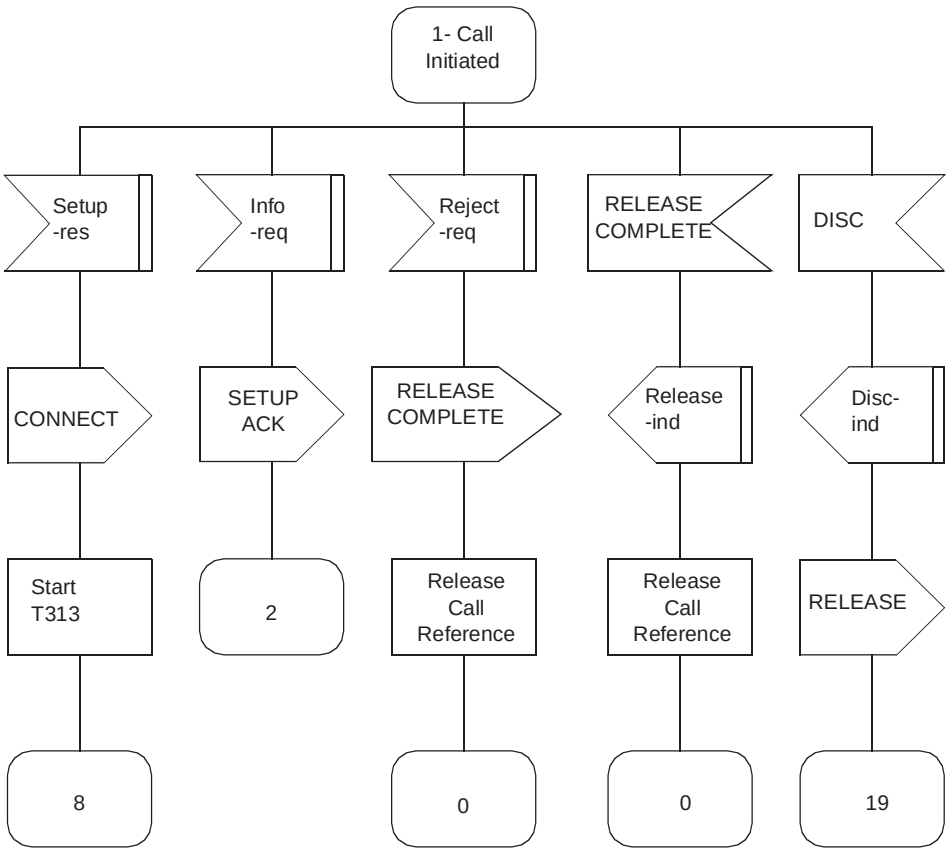


Figure 12-19. Call Initiated State - IDT

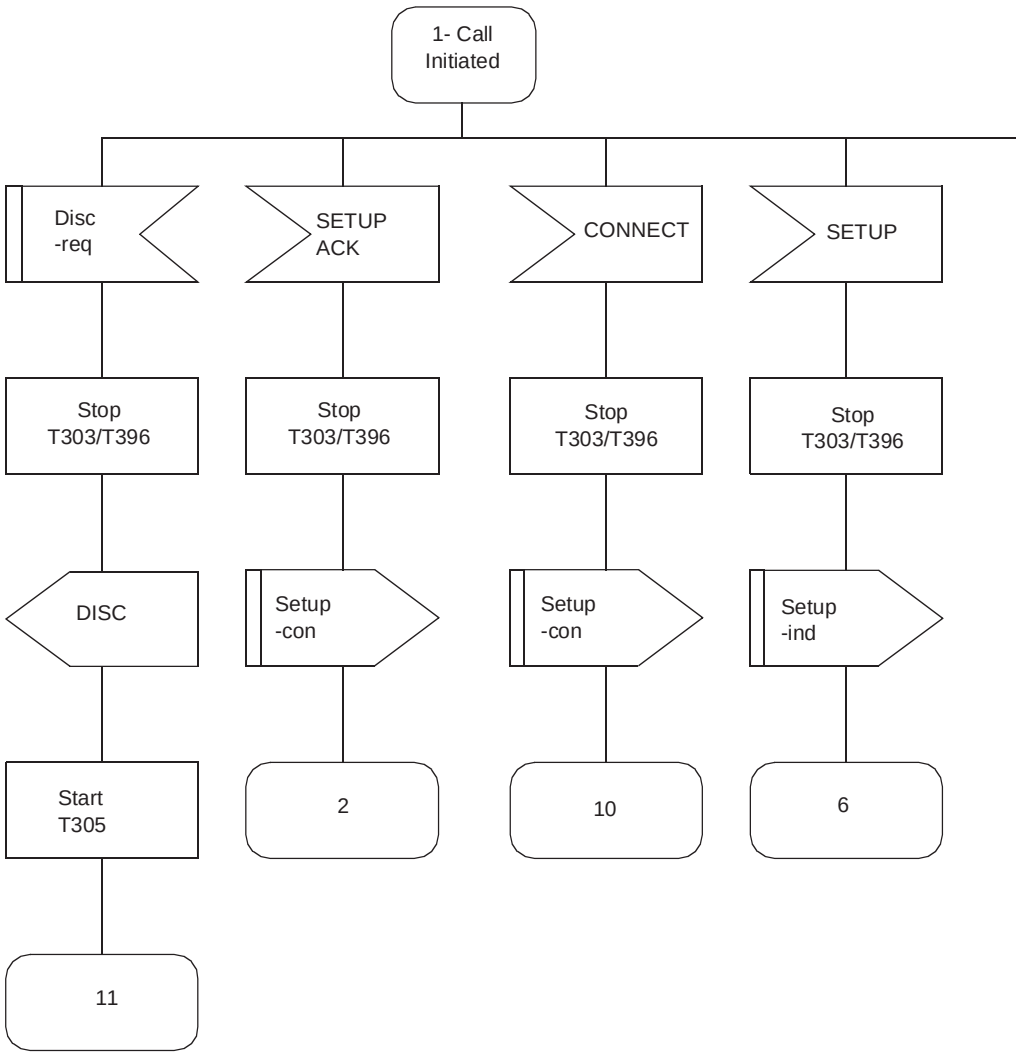


Figure 12-20. Call Initiated State - RDT

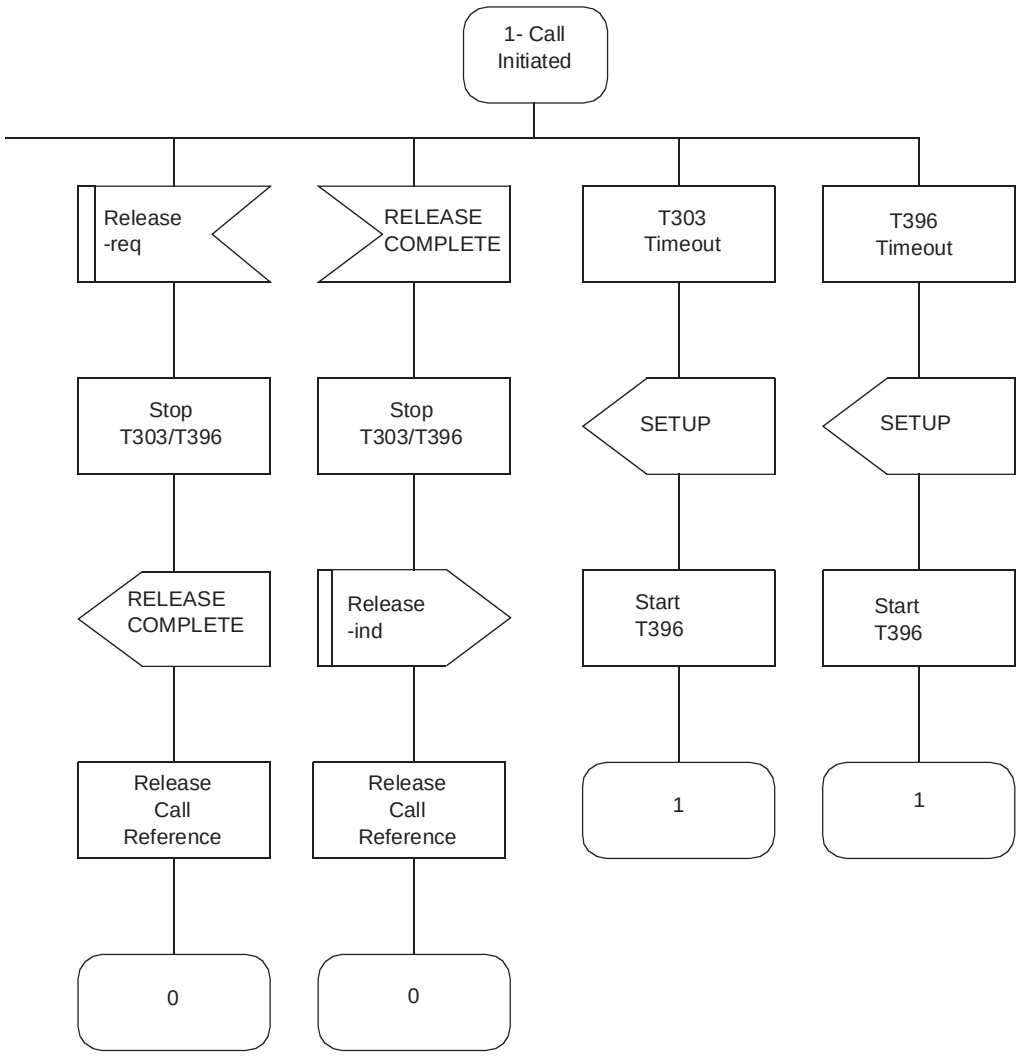


Figure 12-20. Call Initiated State - RDT (Continued)

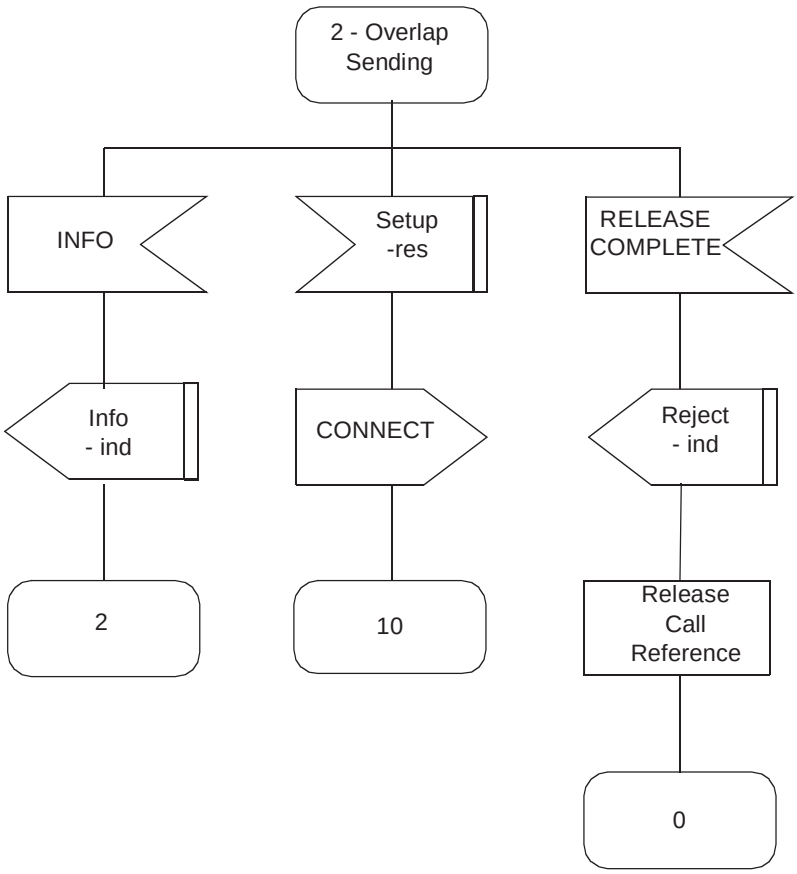


Figure 12-21. Overlap Sending State - IDT

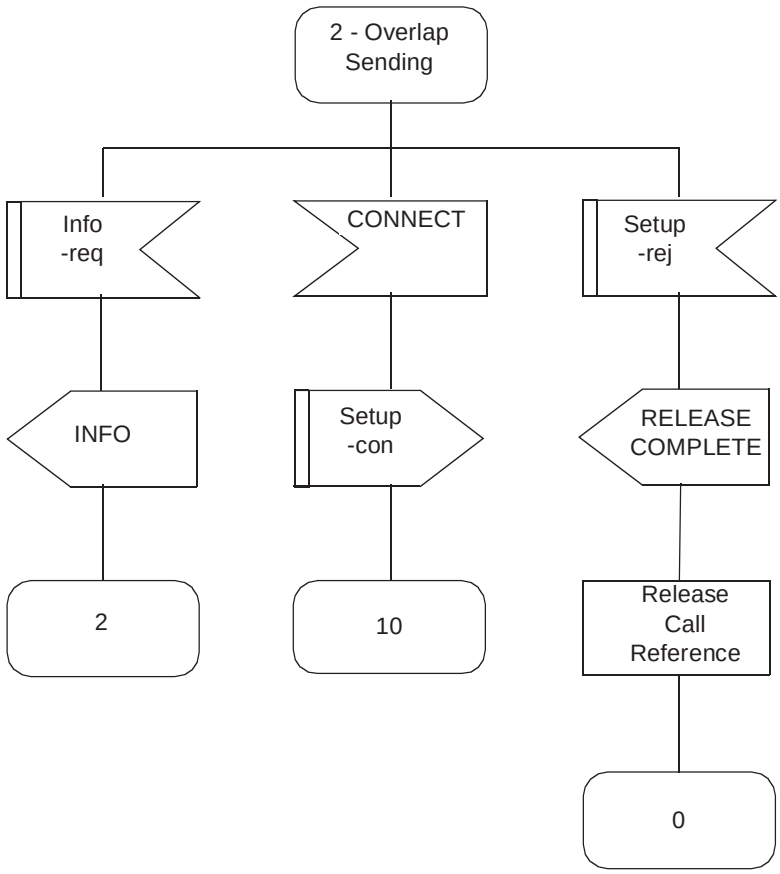


Figure 12-22. Overlap Sending State - RDT

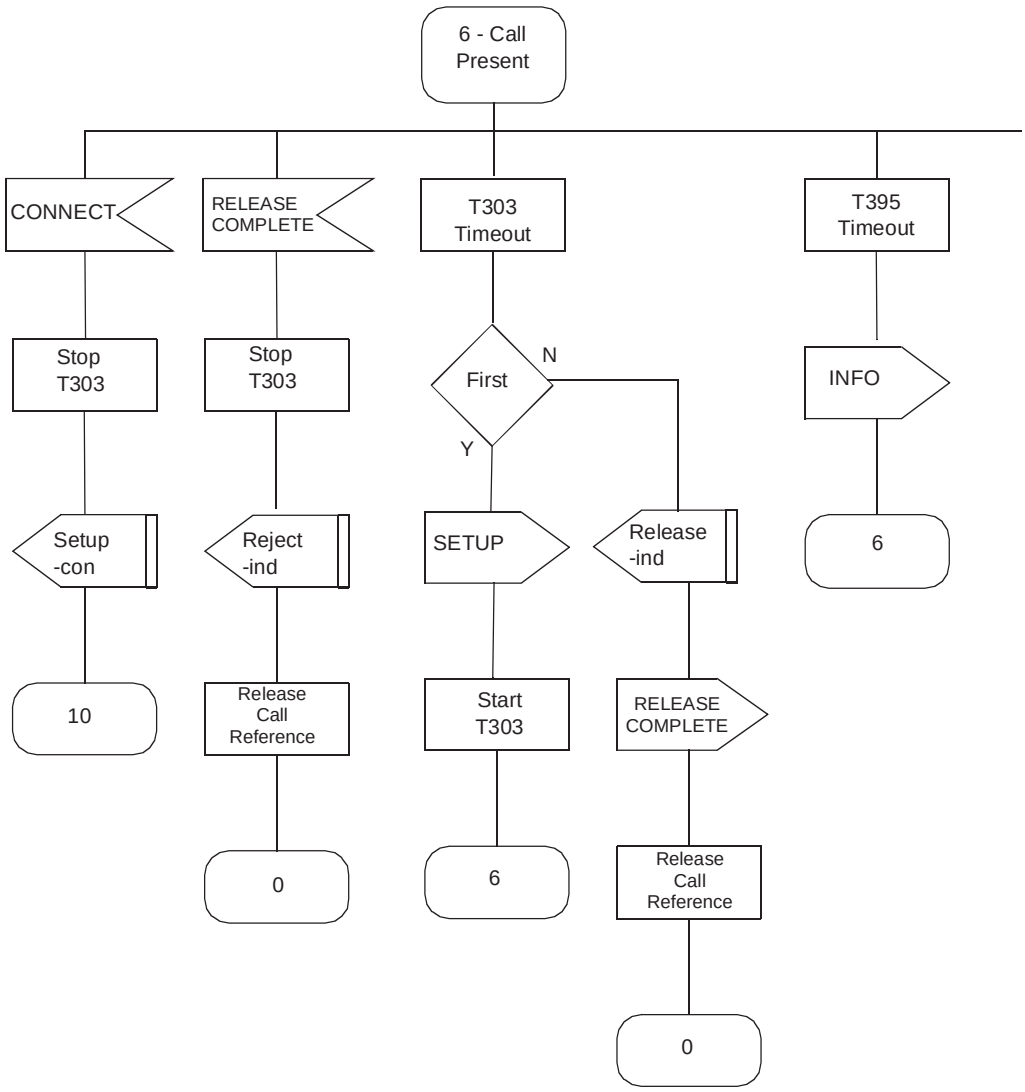


Figure 12-23. Call Present State - IDT

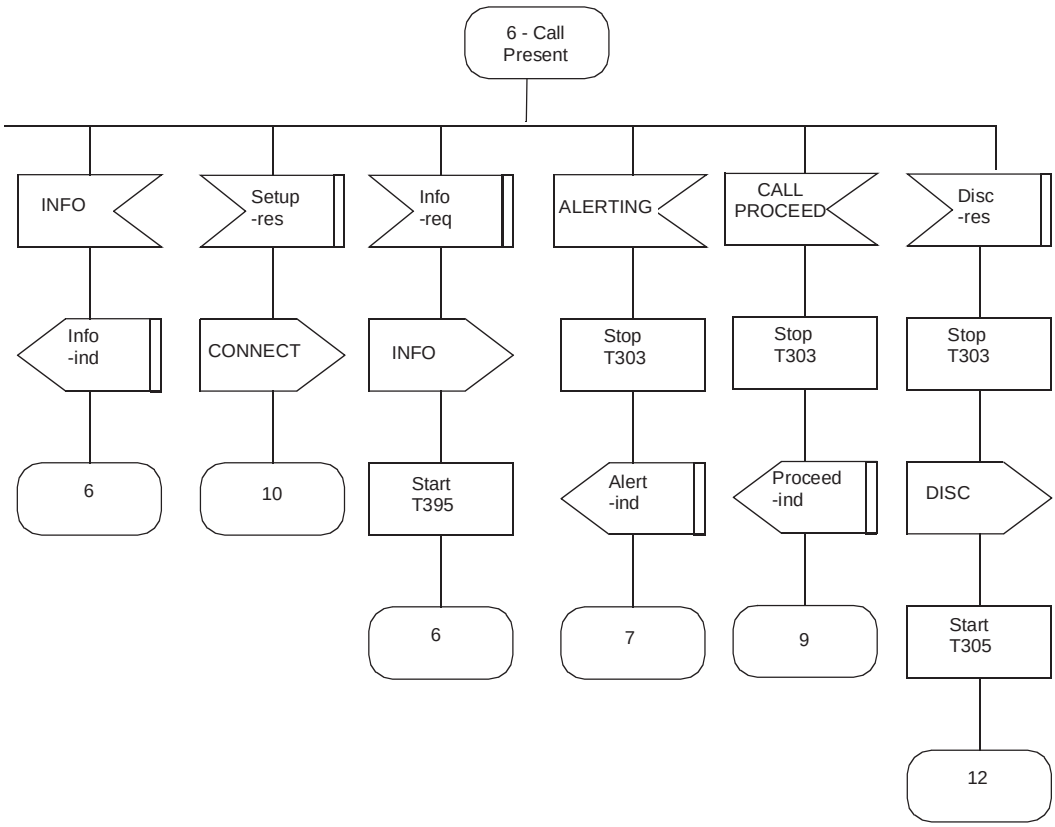


Figure 12-23. Call Present - IDT (Continued)

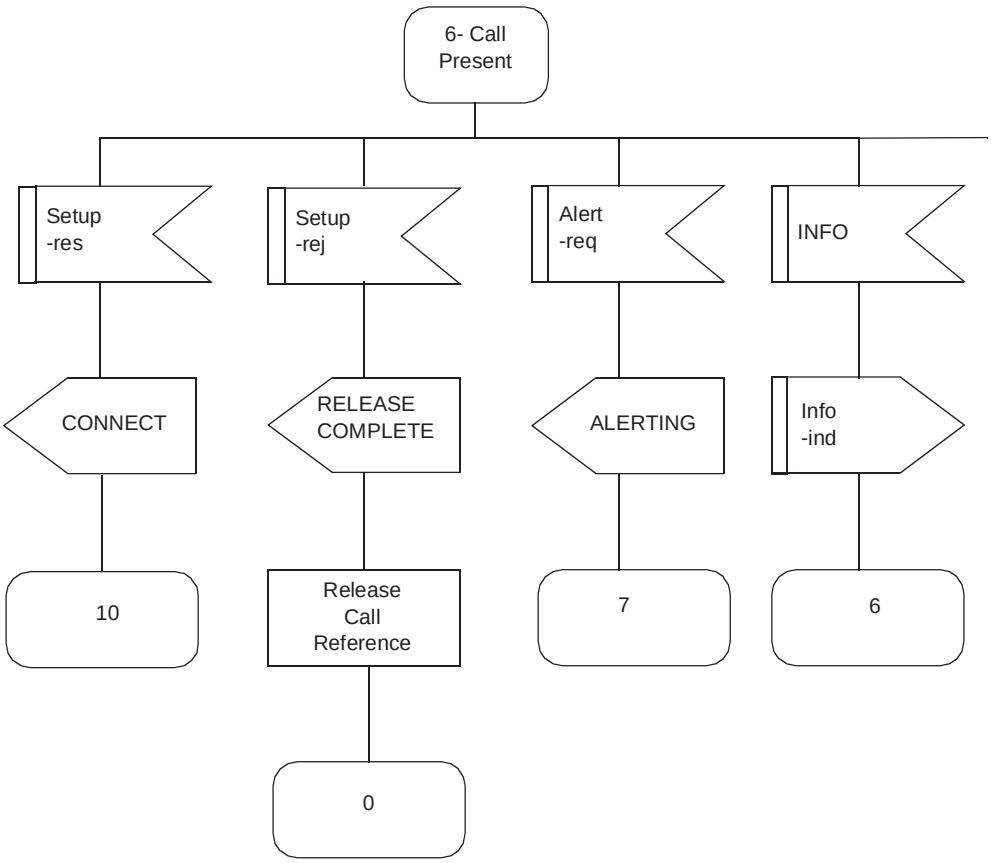


Figure 12-24. Call Present State - RDT

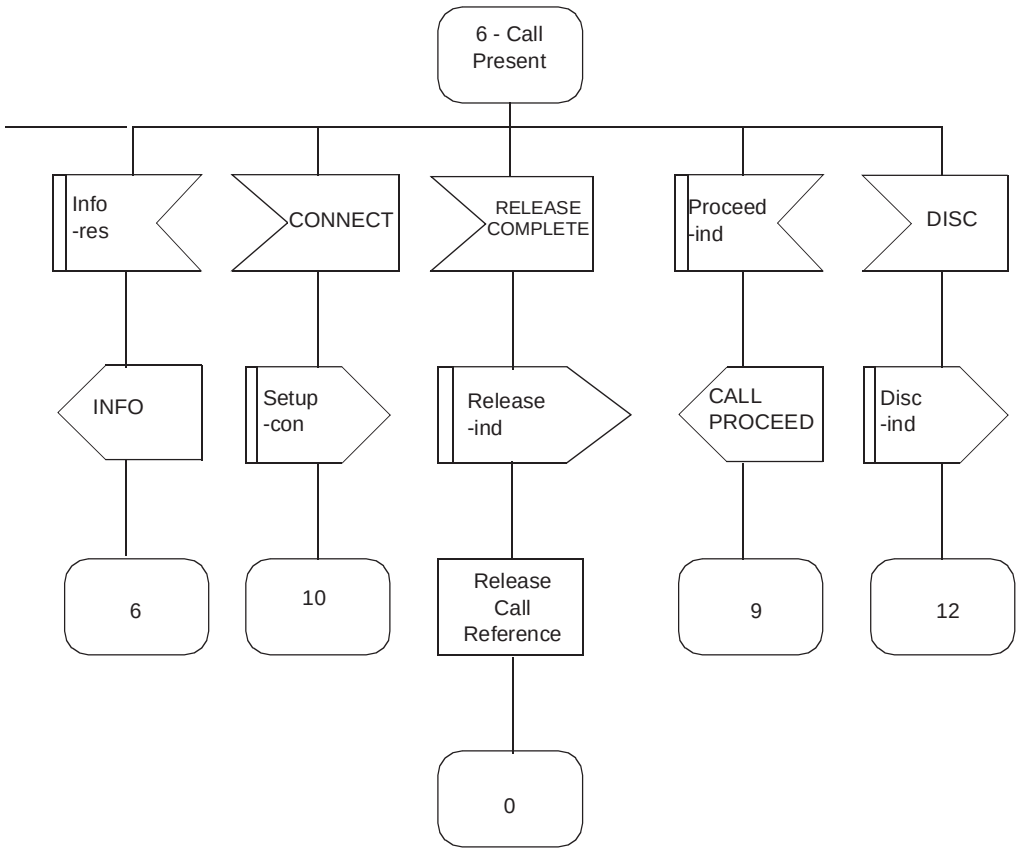


Figure 12-24. Call Present State - RDT (Continued)

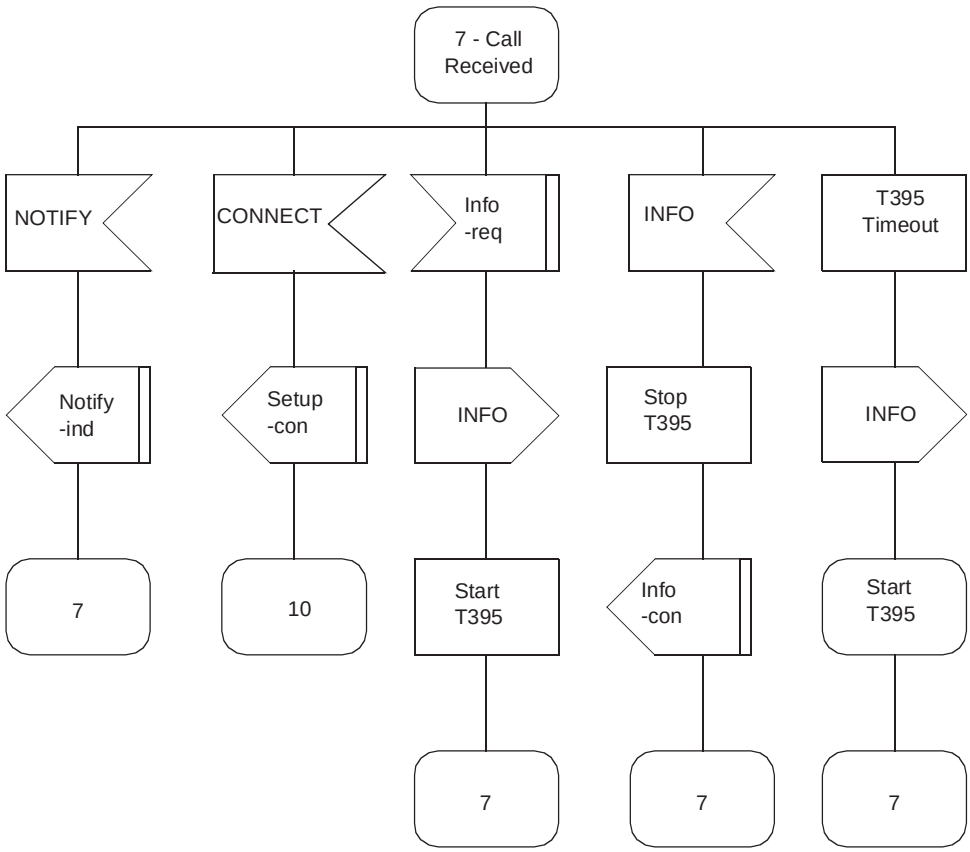


Figure 12-25. Call Received State - IDT

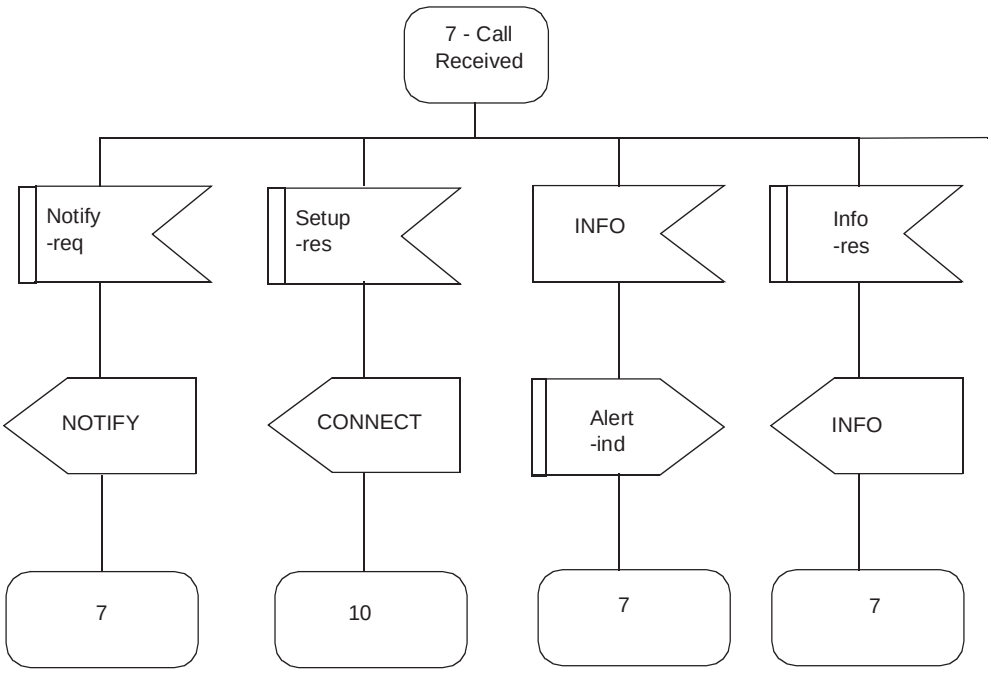


Figure 12-26. Call Received State - RDT

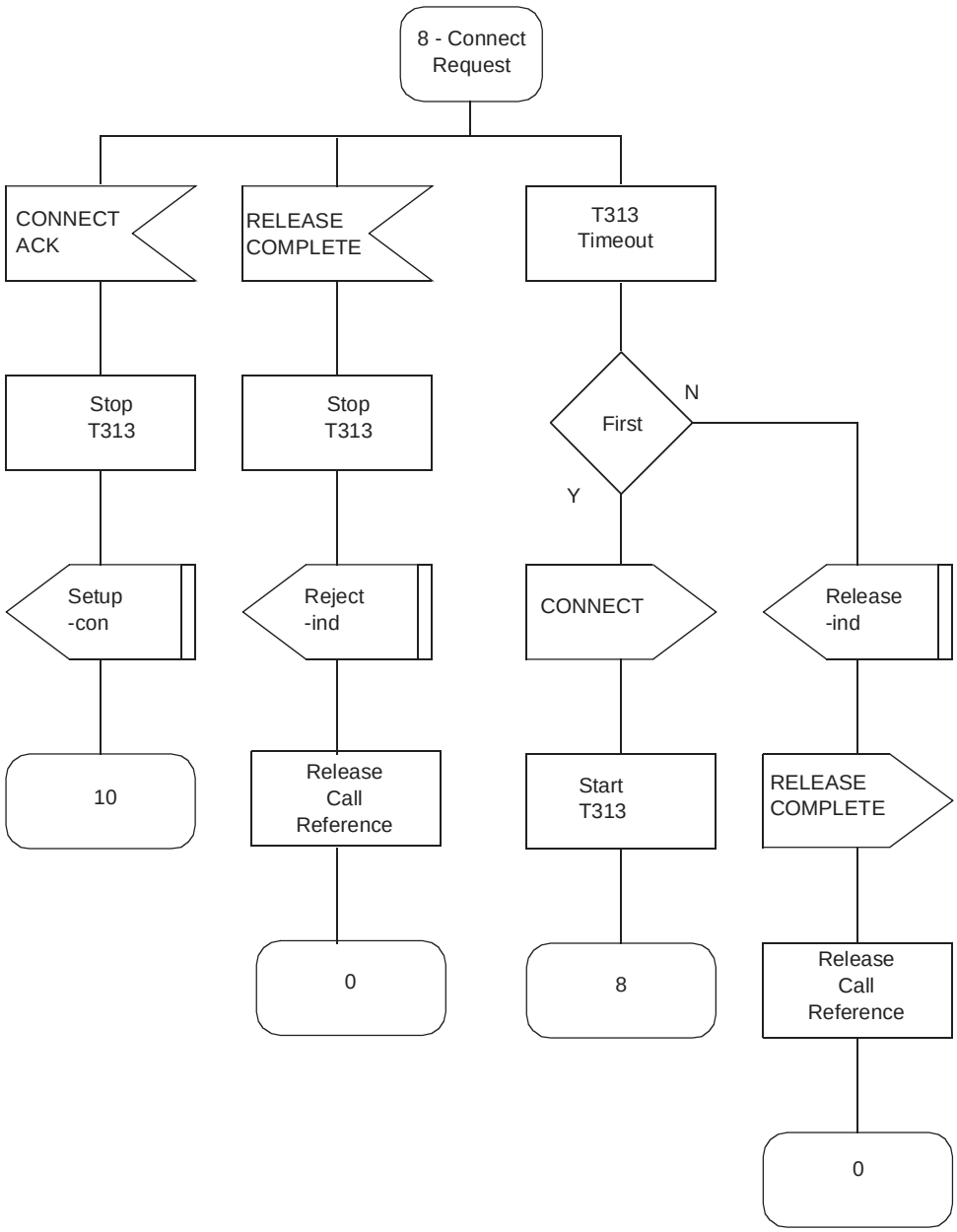


Figure 12-27. Connect Request State - IDT

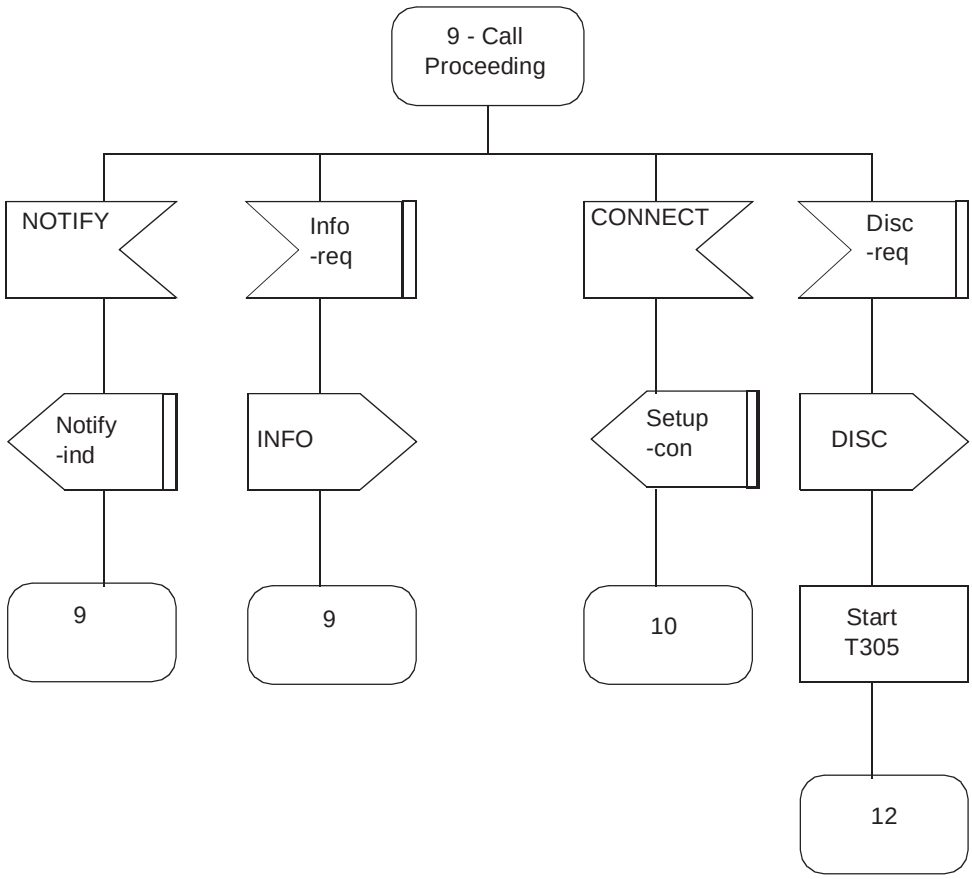


Figure 12-28. Call Proceeding State - IDT

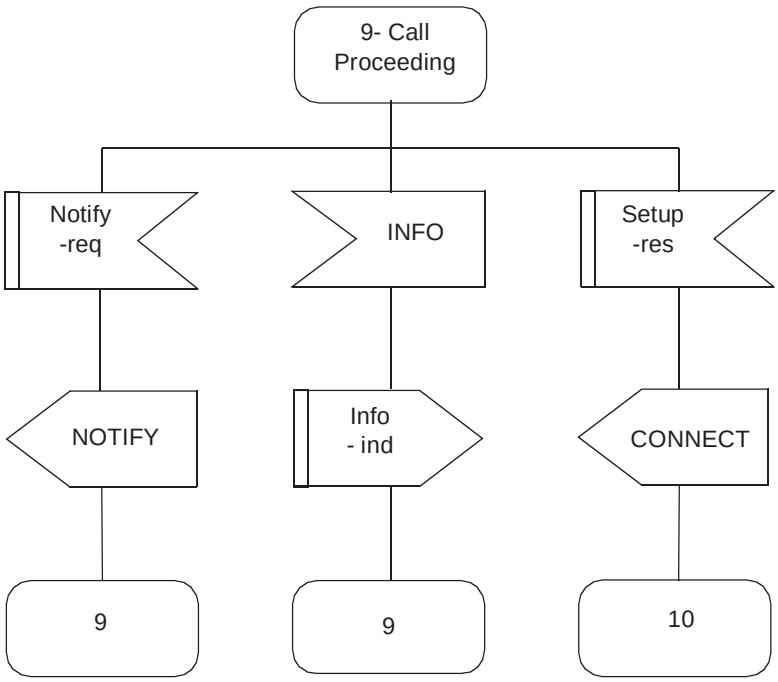


Figure 12-29. Call Proceeding State - RDT

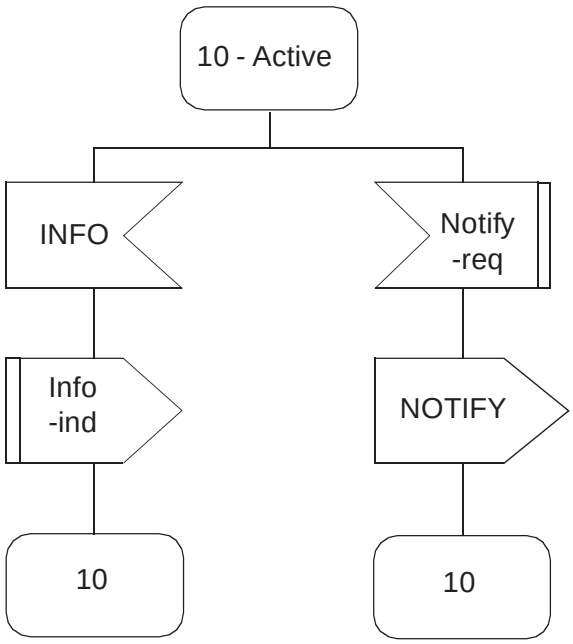


Figure 12-30. Active State - IDT

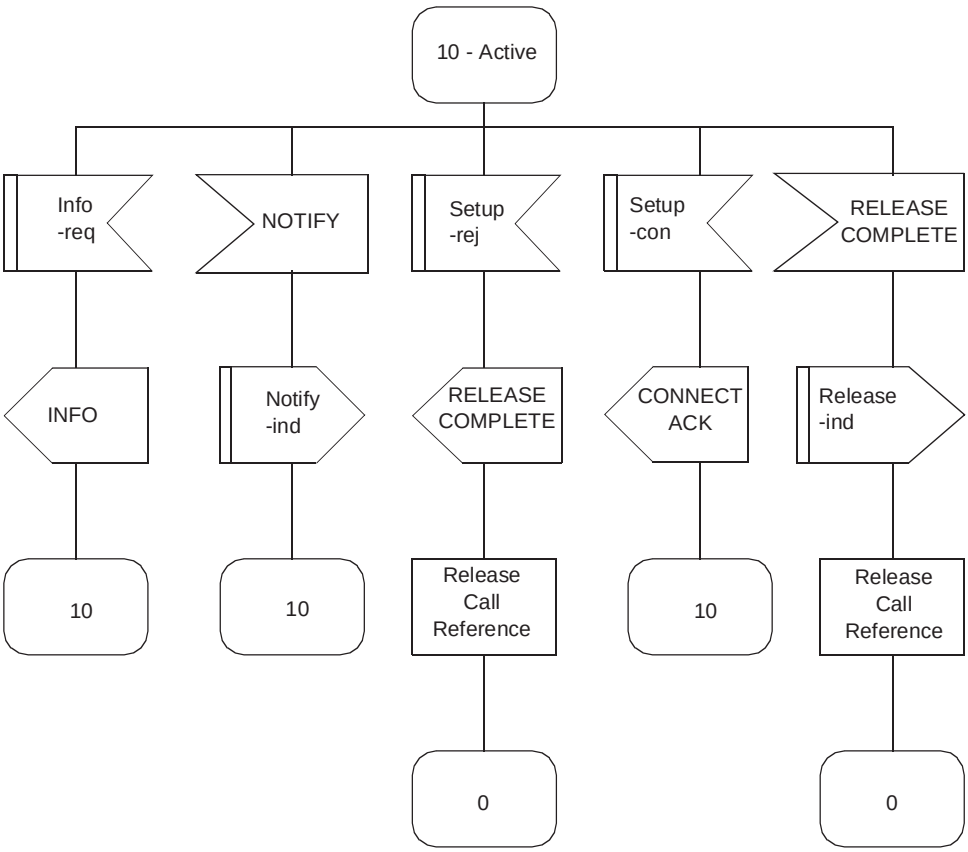


Figure 12-31. Active State - RDT

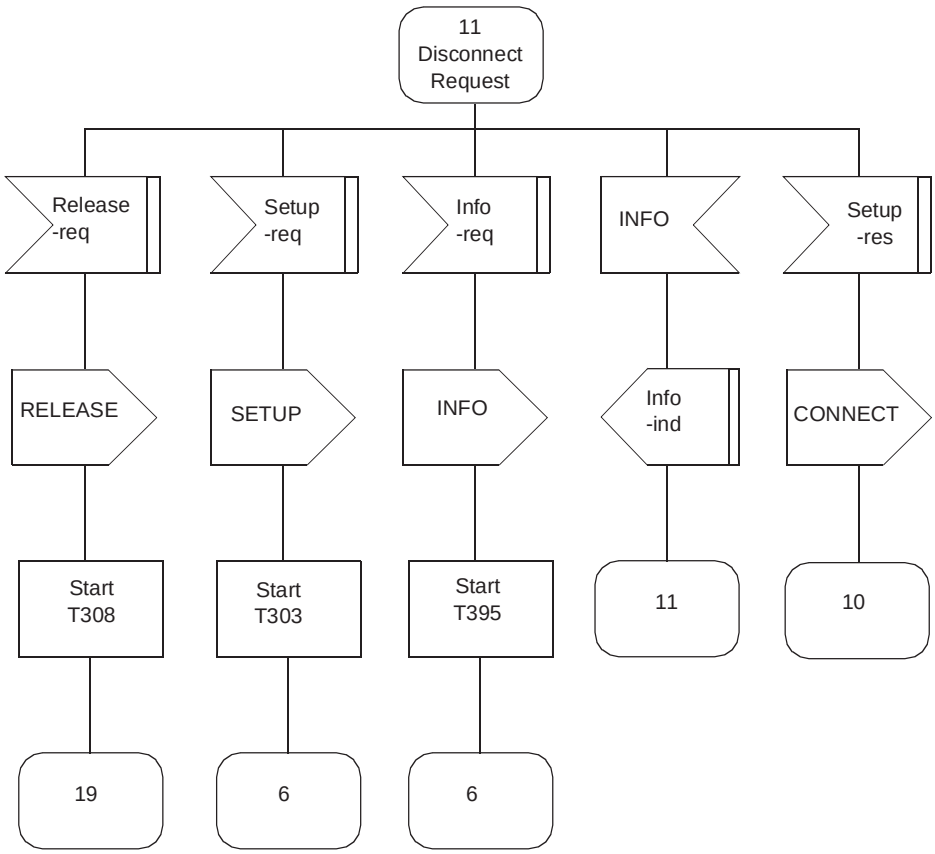


Figure 12-32. Disconnect Request State - IDT

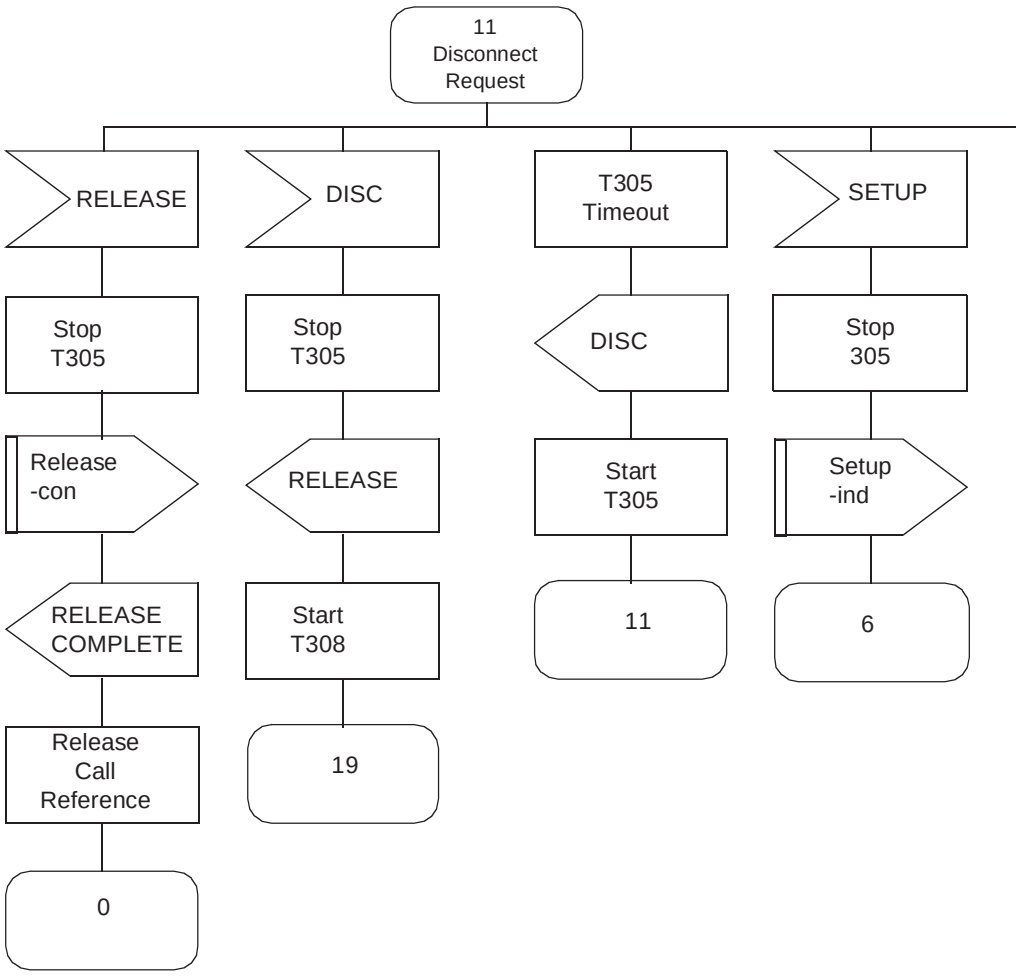


Figure 12-33. Disconnect Request State - RDT

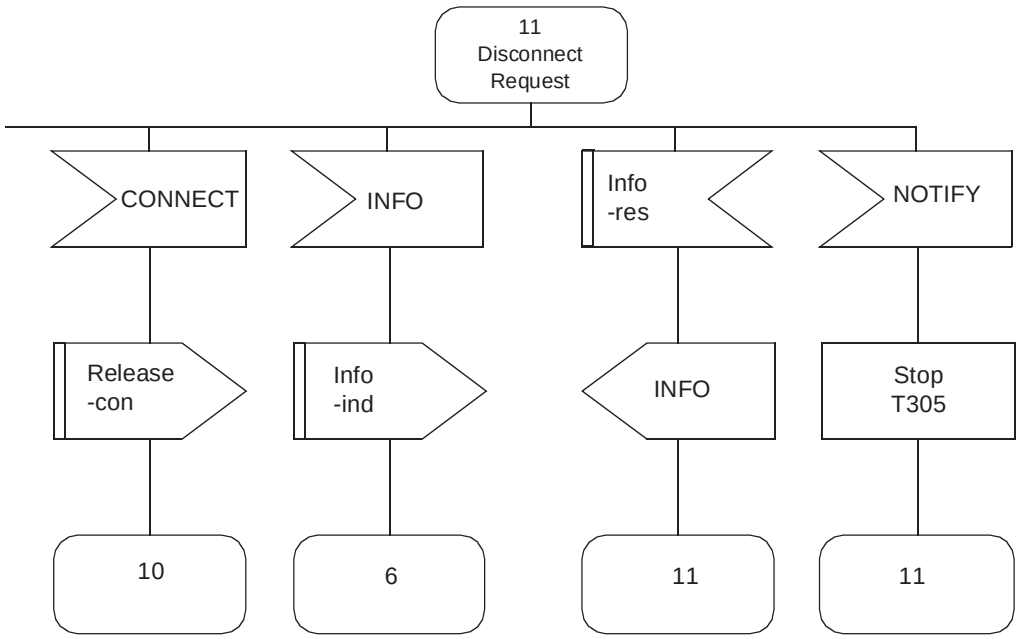


Figure 12-33. Disconnect Request State - RDT (Continued)

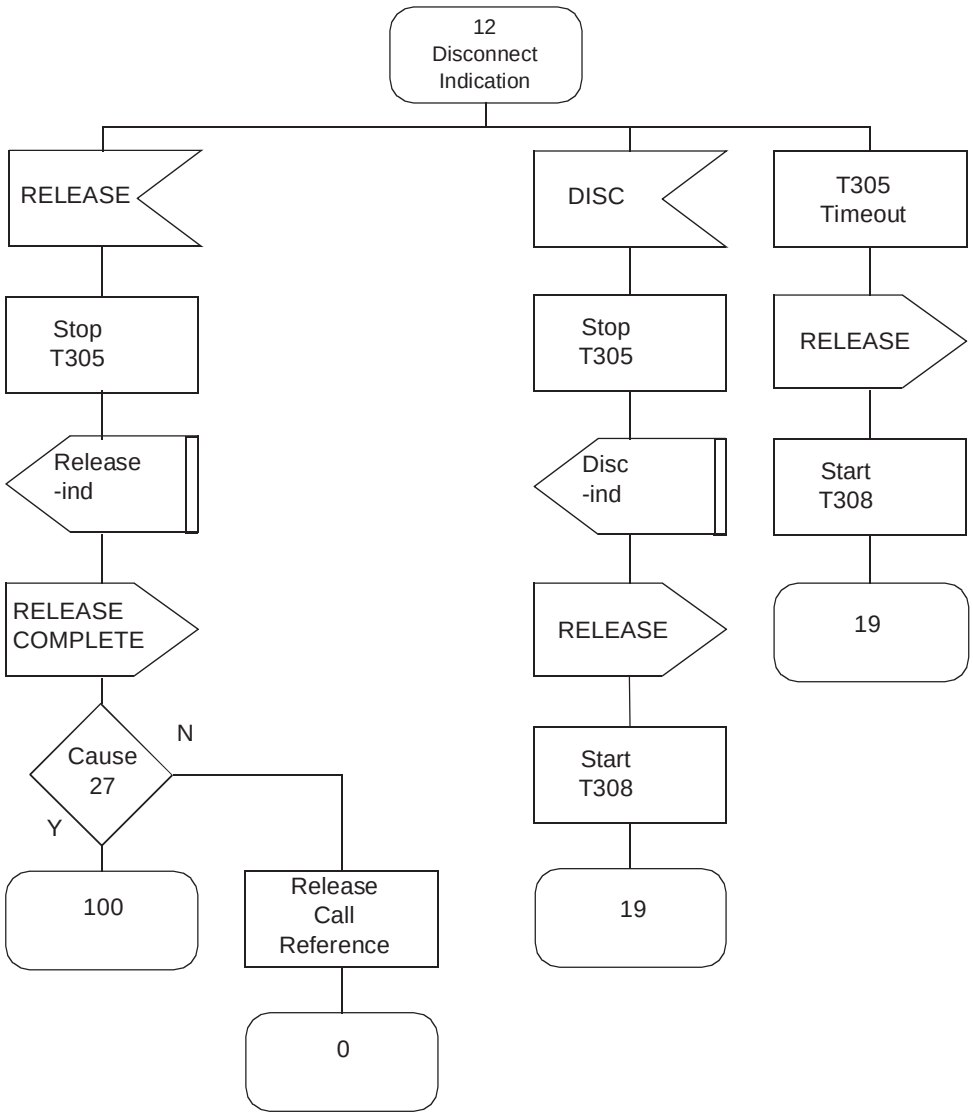


Figure 12-34. Disconnect Indication State - IDT

Figure 12-35. Disconnect Indication State - RDT

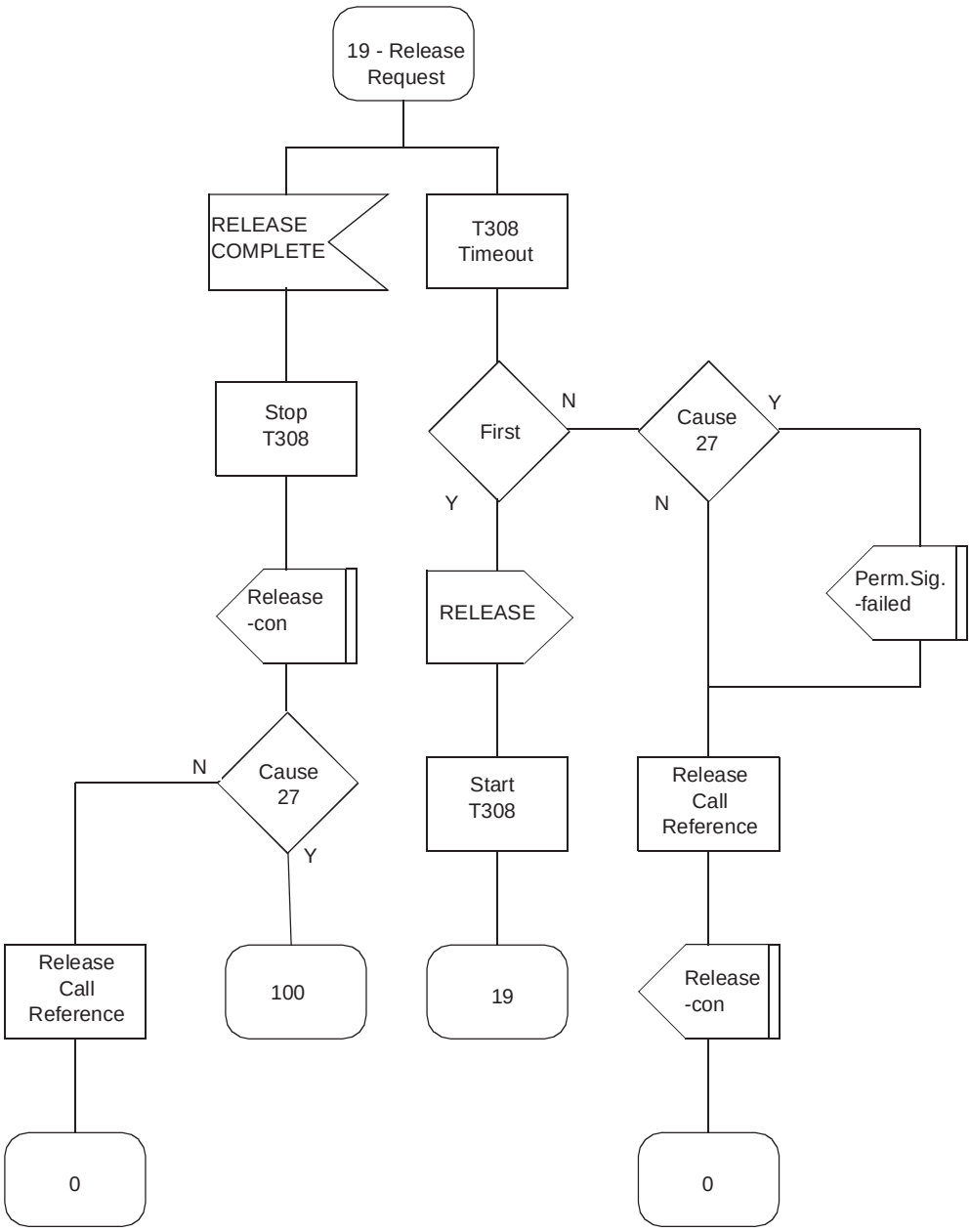


Figure 12-36. Release Request State - IDT

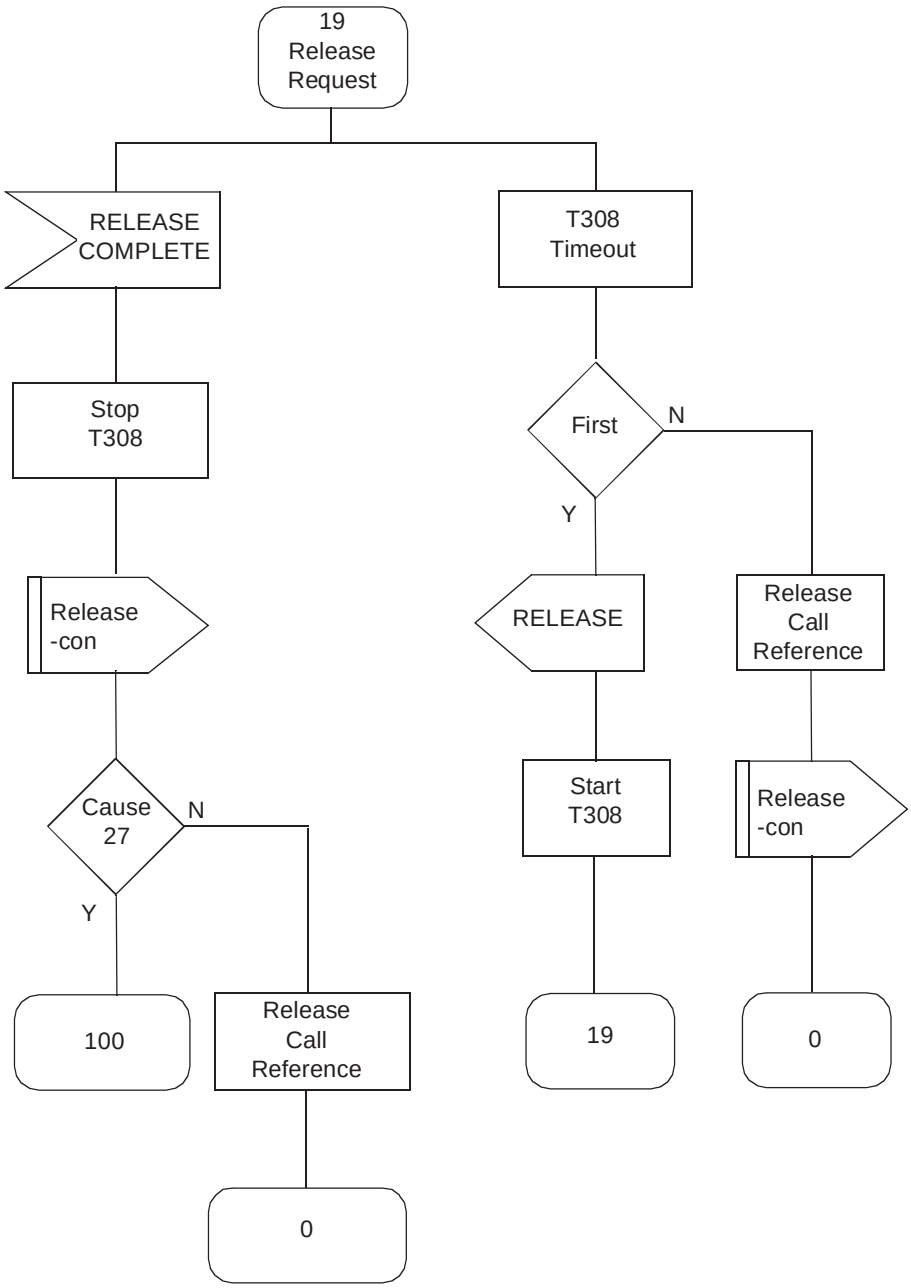
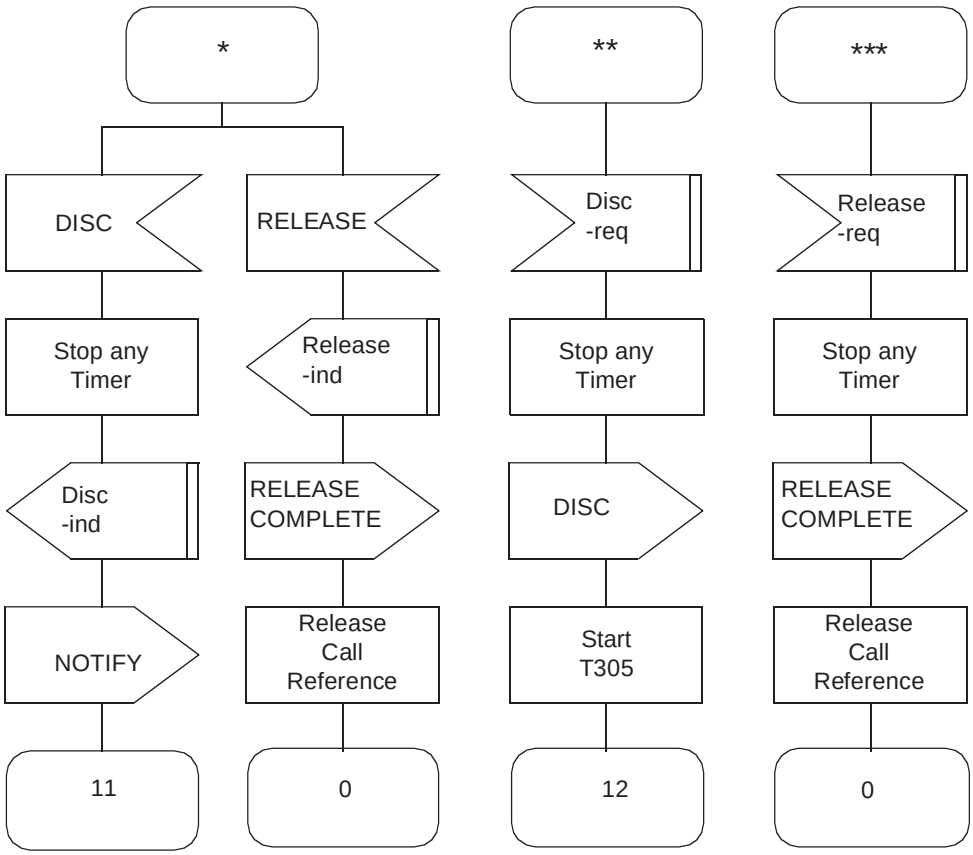


Figure 12-37. Release Request State - RDT

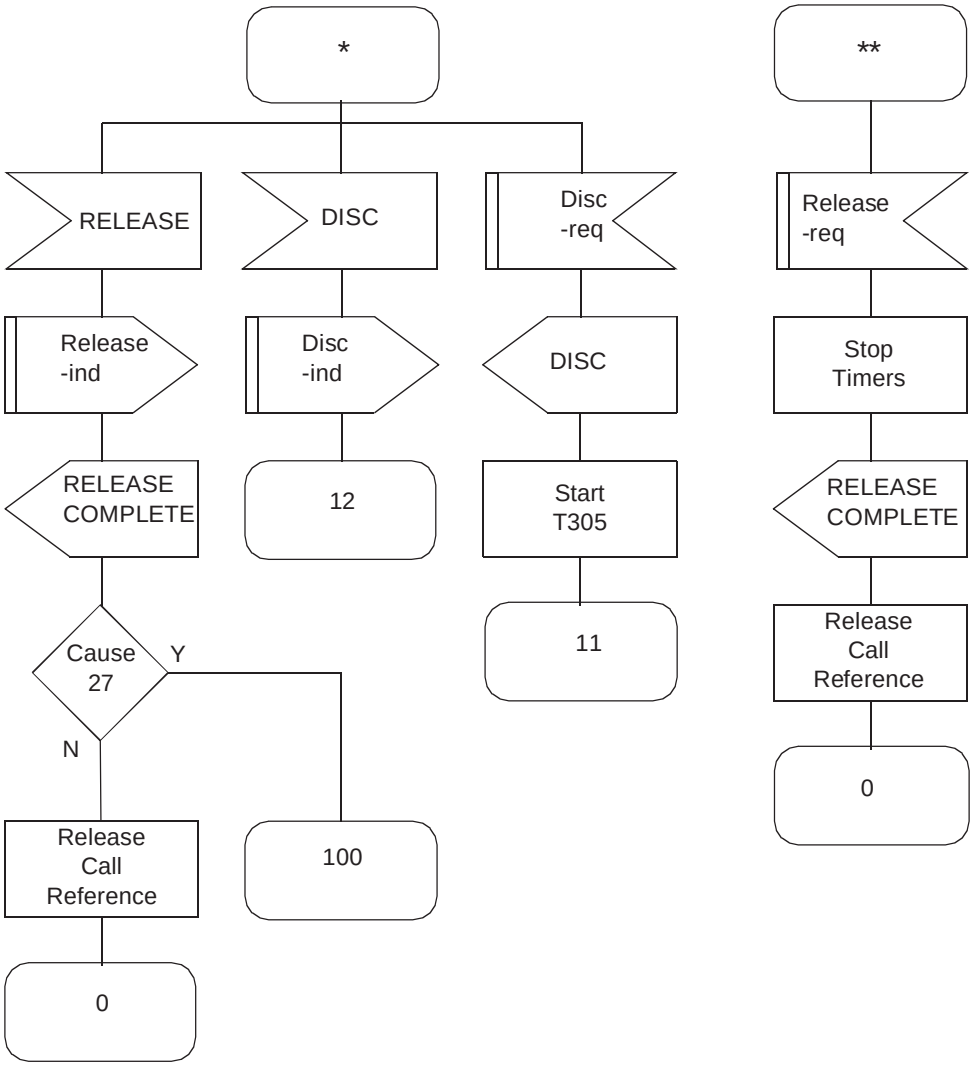


* This can be any state **except 0, 11, 12, or 100**.

** This can be any state **except 0, 6, 9, 11, 12, 19, or 100**.

*** This can **only** be state **1, 6, or 8**.

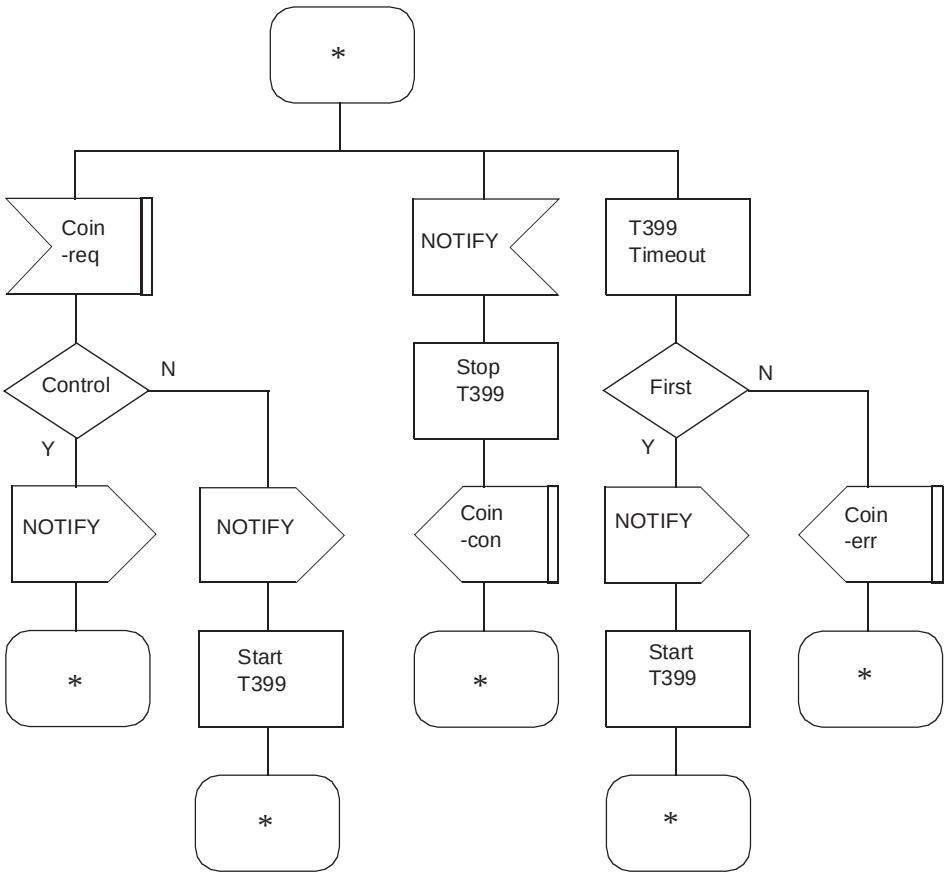
Figure 12-38. Call Clearing - IDT



* This can be any state **except** 0, 1, 6, 11, 12, 19, or 100.

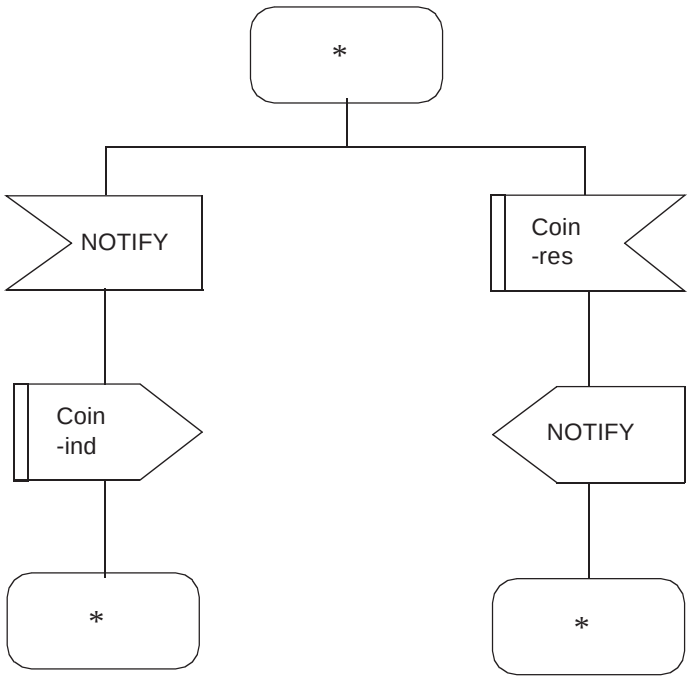
** This can **only** be state 1 or 6.

Figure 12-39. Call Clearing - RDT



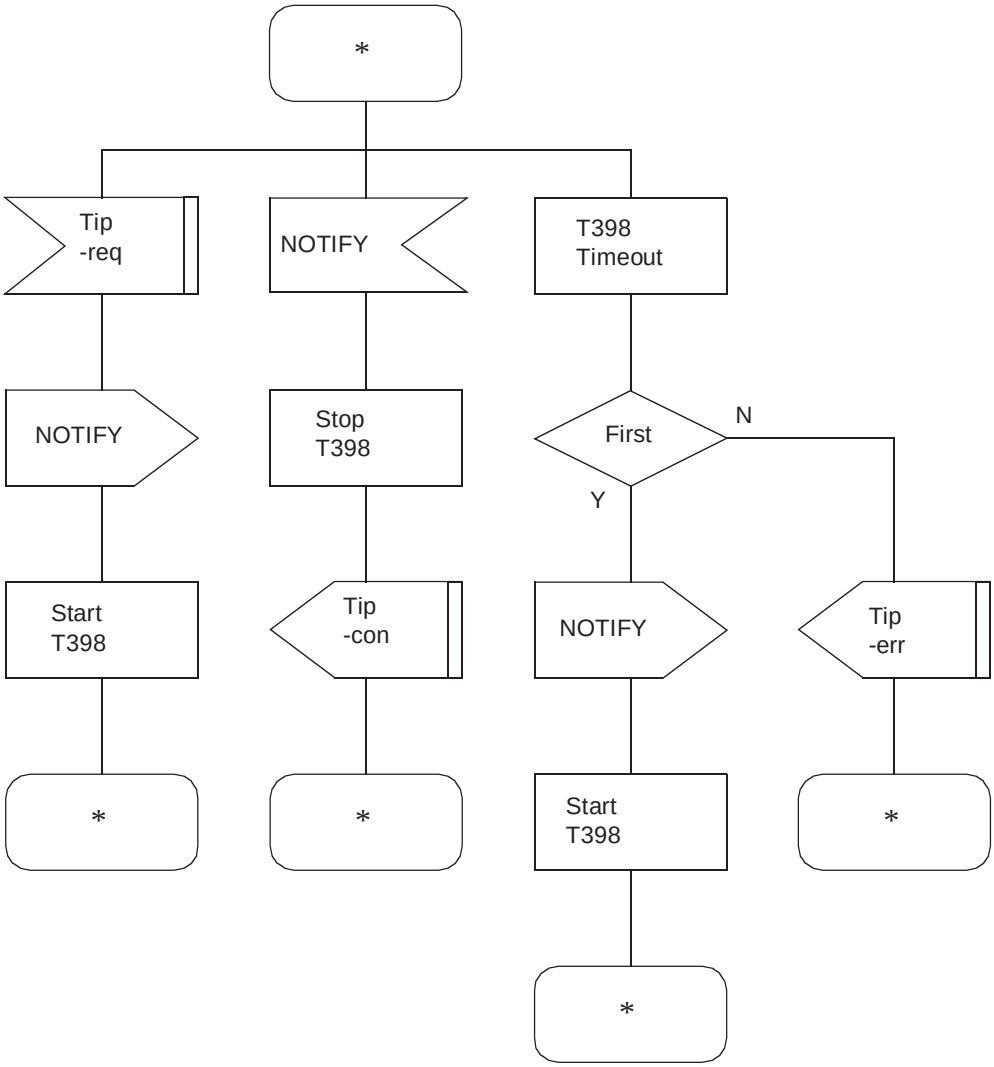
* May be any state.

Figure 12-40. Coin Procedures - IDT



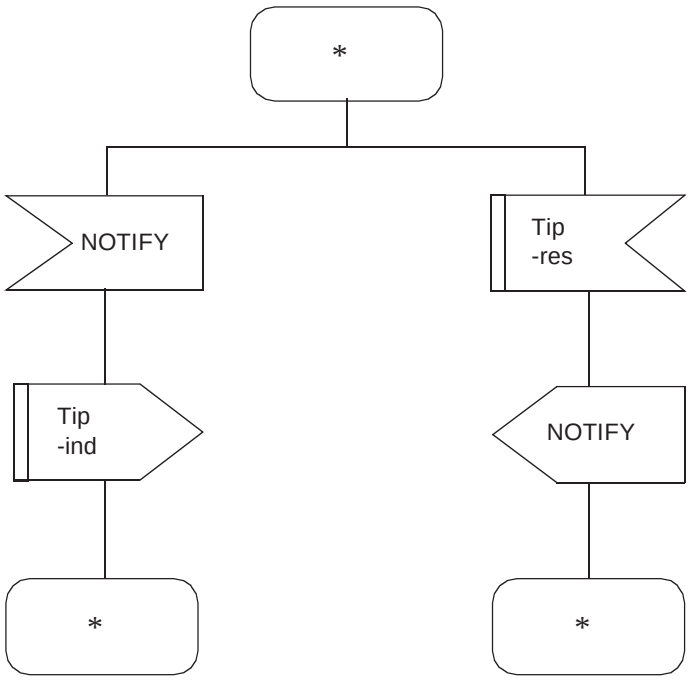
* May be any state.

Figure 12-41. Coin Procedures - RDT



* This can be either state 1 or 2.

Figure 12-42. Tip Party Test - IDT



* This can be either state 1 or state 2

Figure 12-43. Tip Party Test - RDT

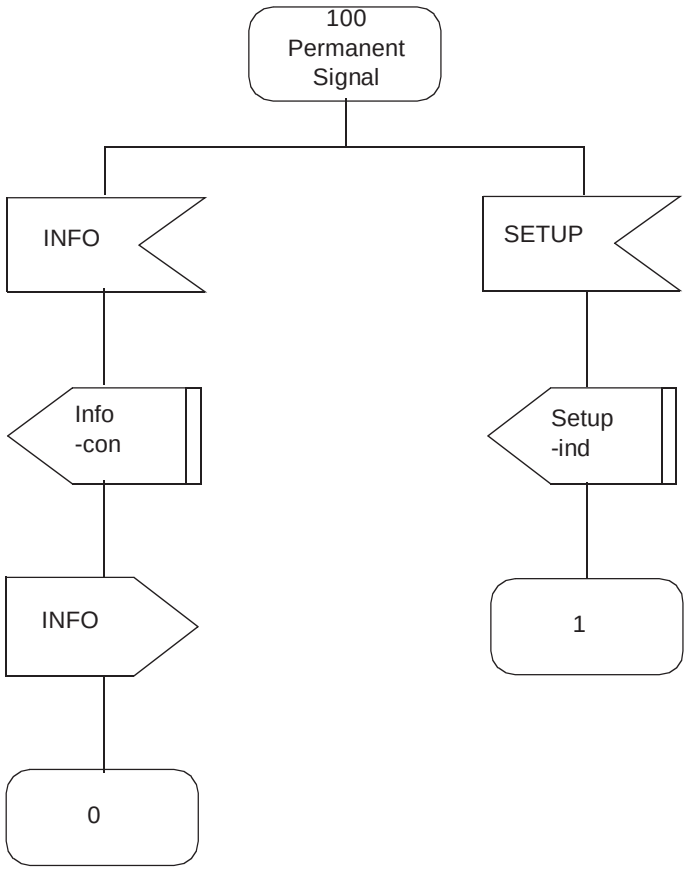


Figure 12-44. Permanent Signal State - IDT

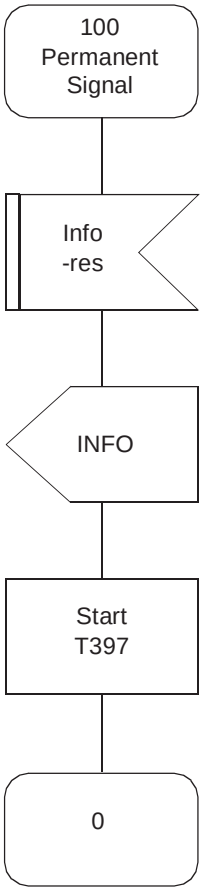


Figure 12-45. Permanent Signal State - RDT

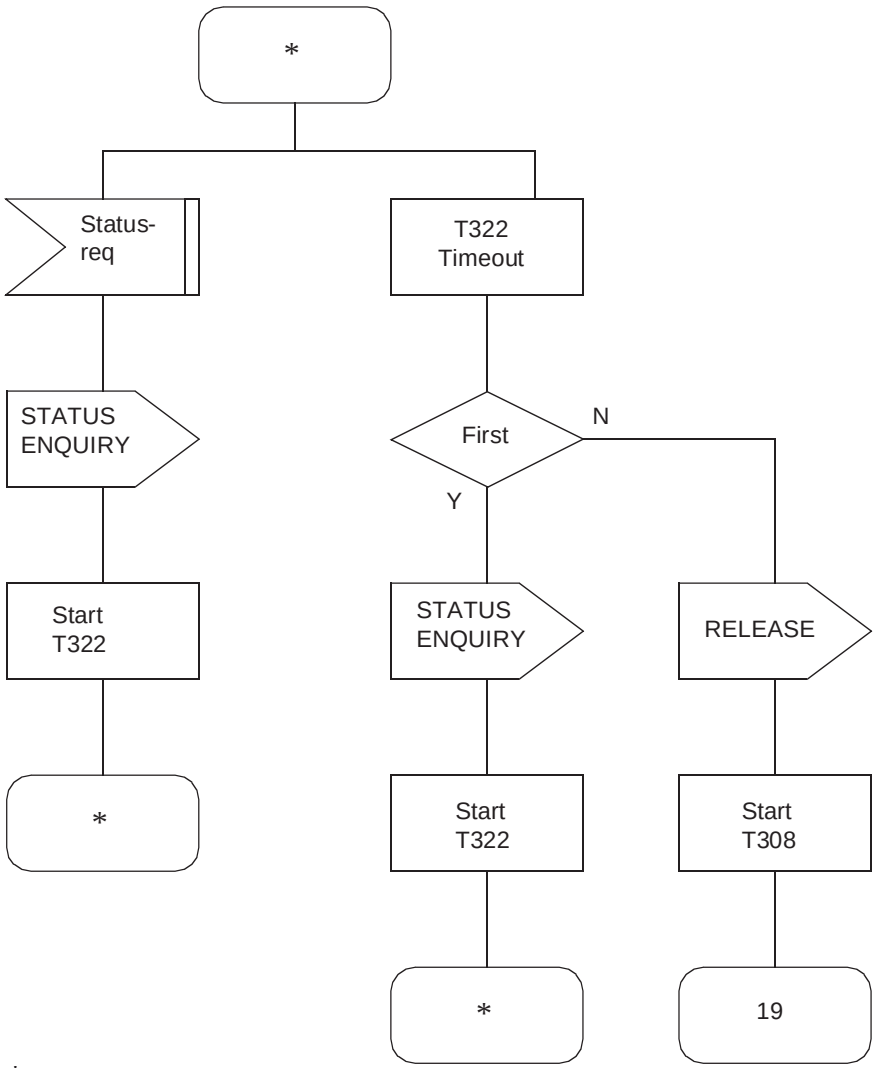


Figure 12-46. Call State Mismatch Procedure - IDT

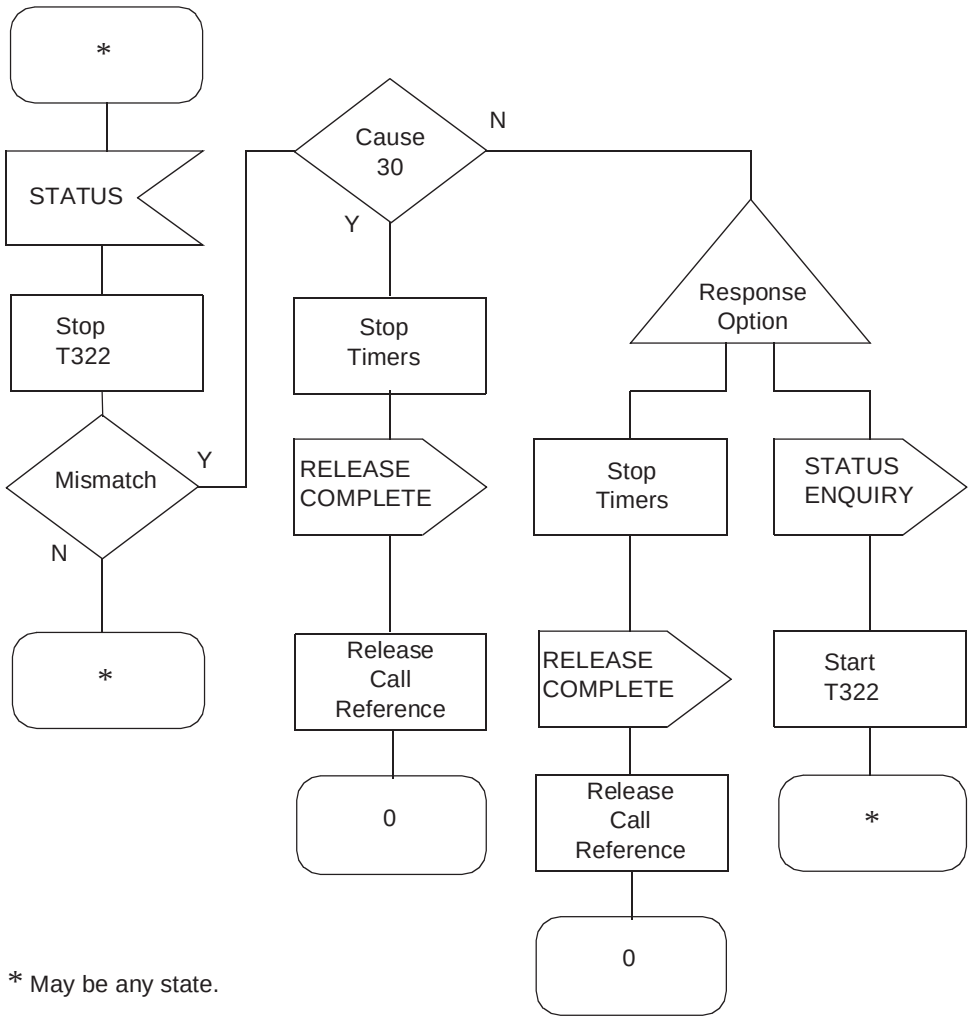
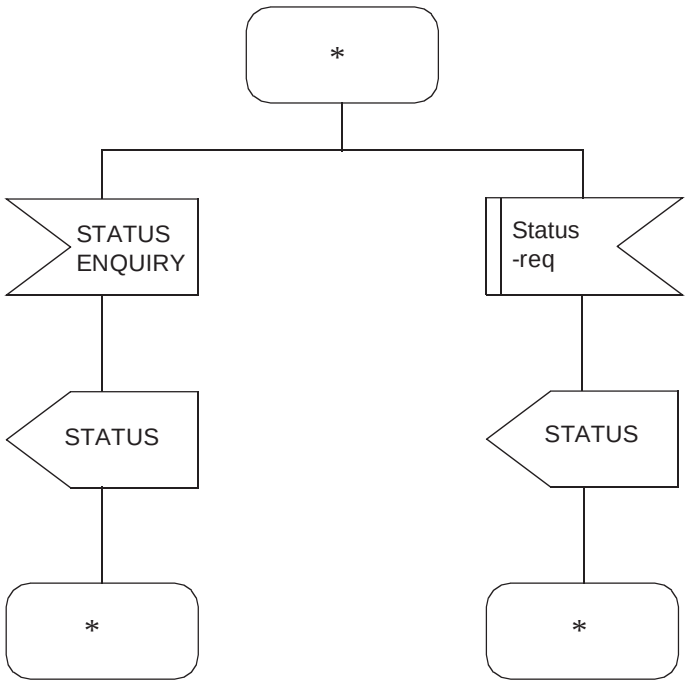


Figure 12-46. Call State Mismatch Procedure - IDT (Continued)



* May be any state.

Figure 12-47. Call State Mismatch Procedure - RDT

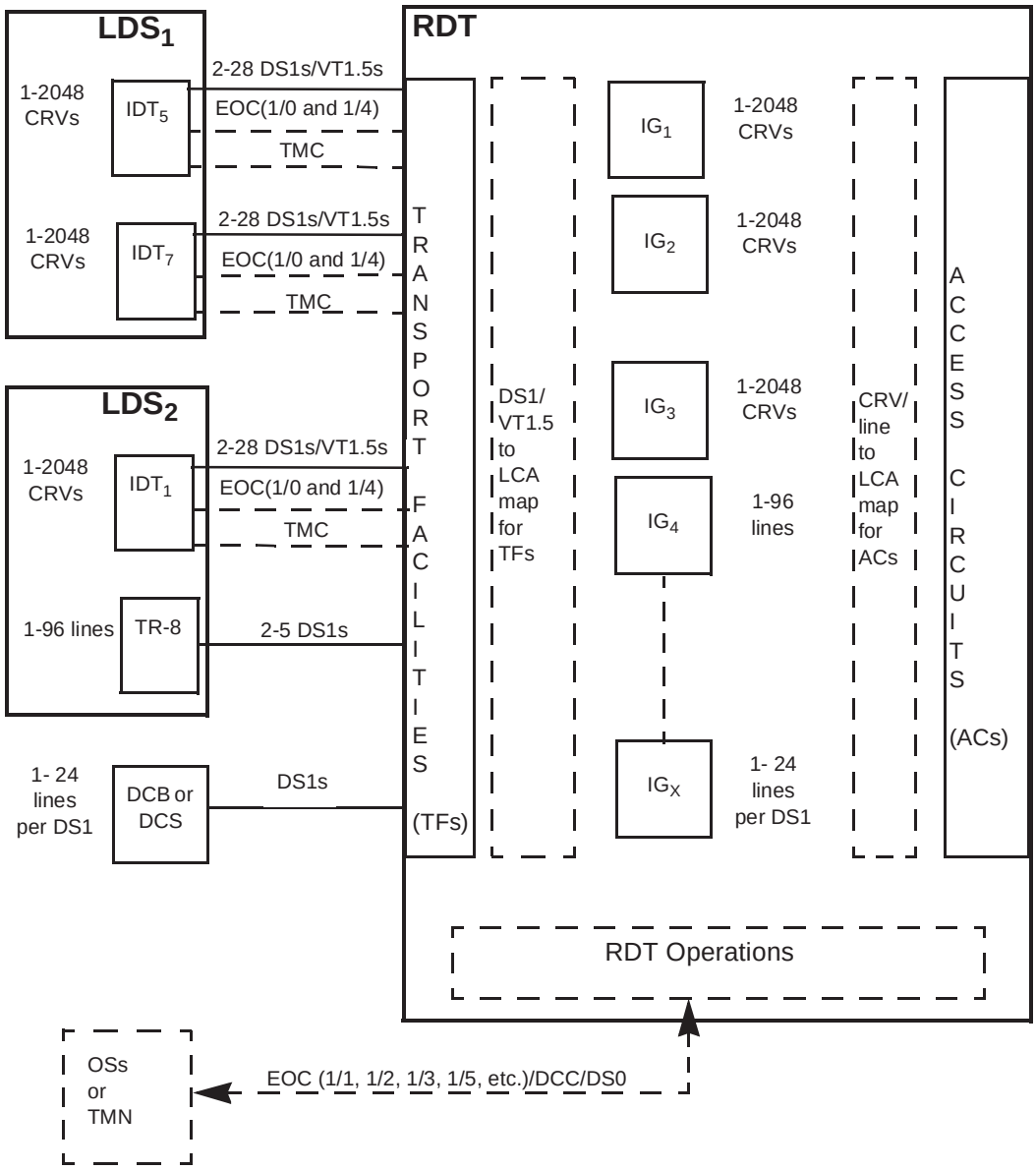


Figure 12-48. Example of GR-303-CORE Multi-IG Feature

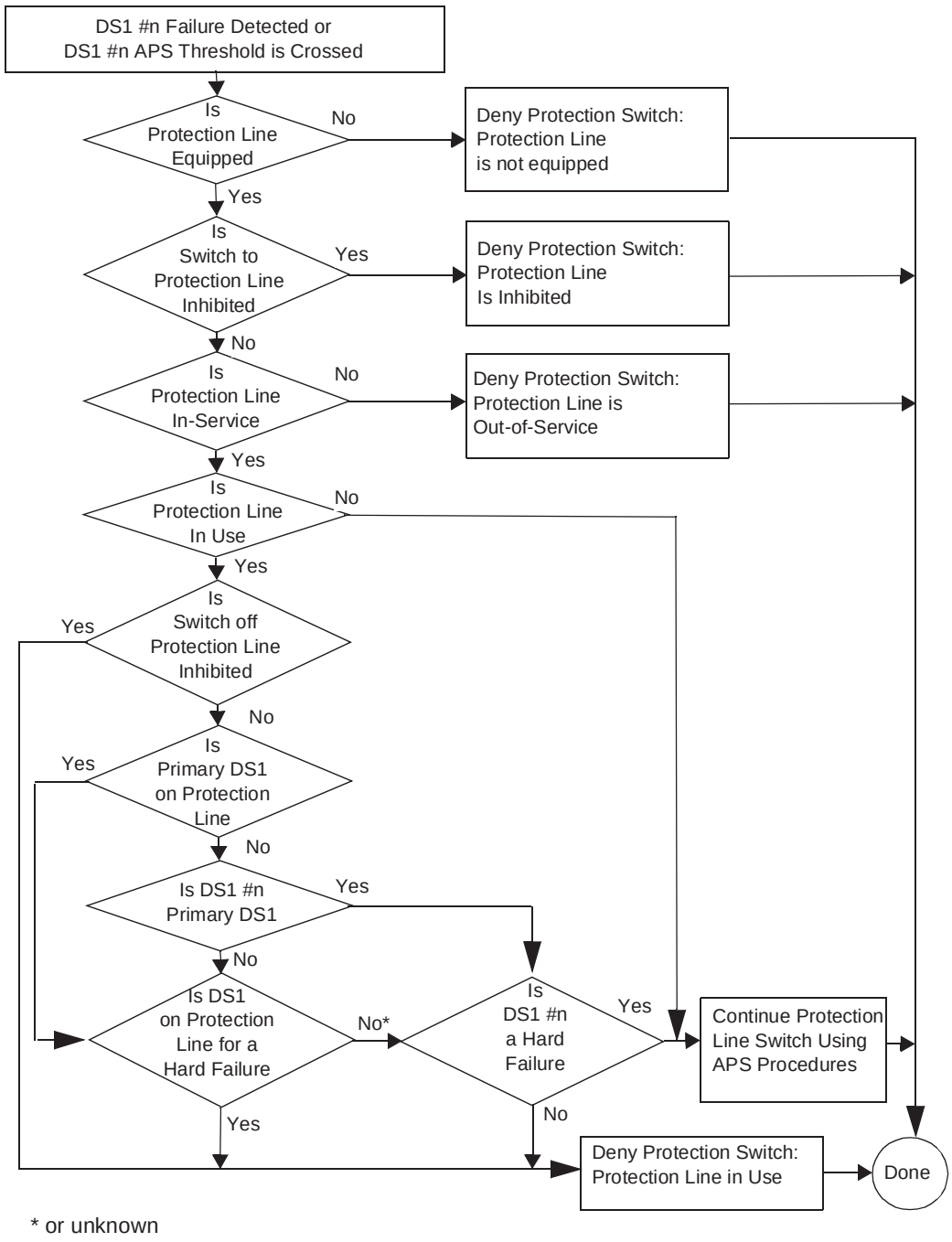


Figure 12-49. Automatic Protection Switch Initialization - Near End

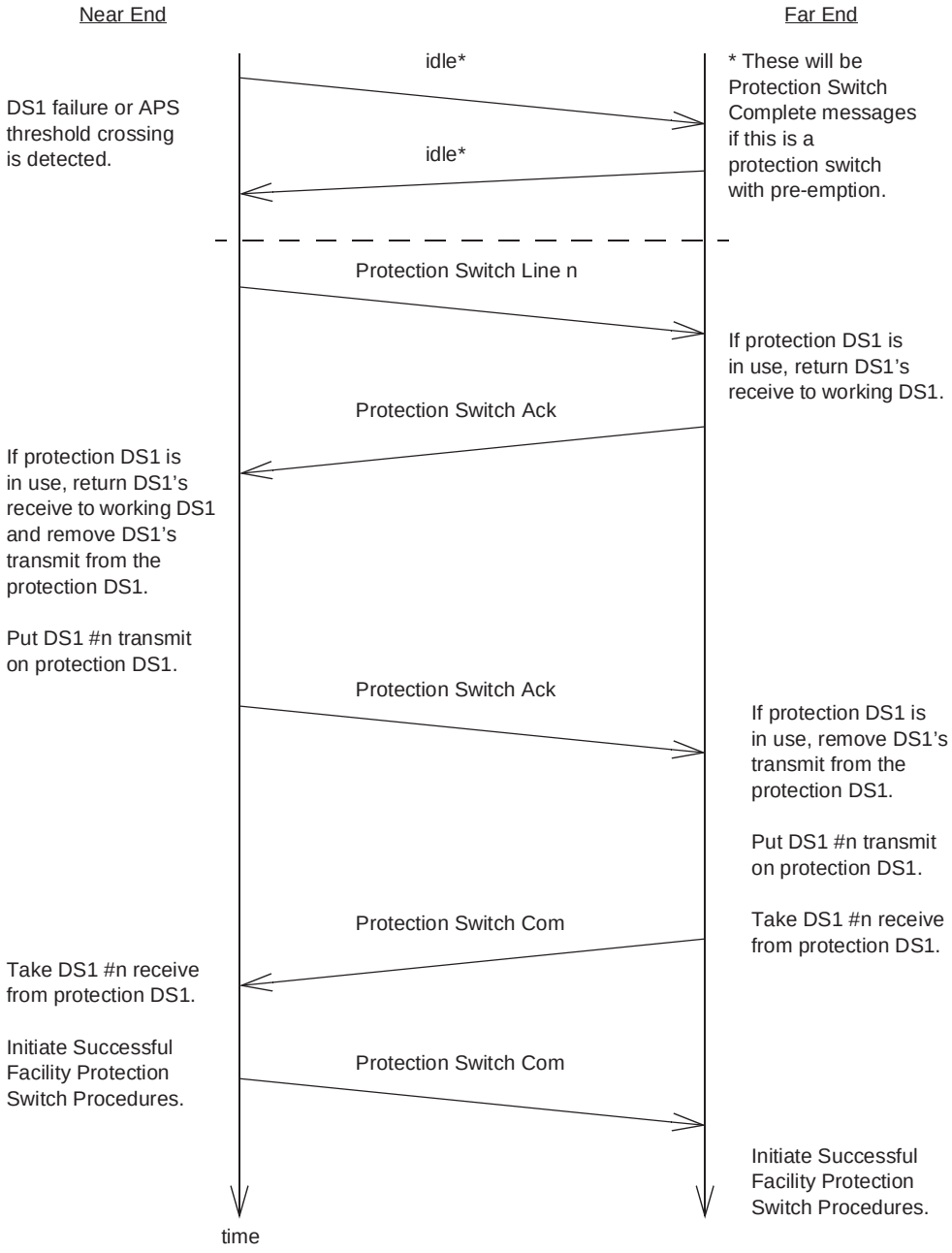


Figure 12-50. DS1 #n Facility Protection Switch

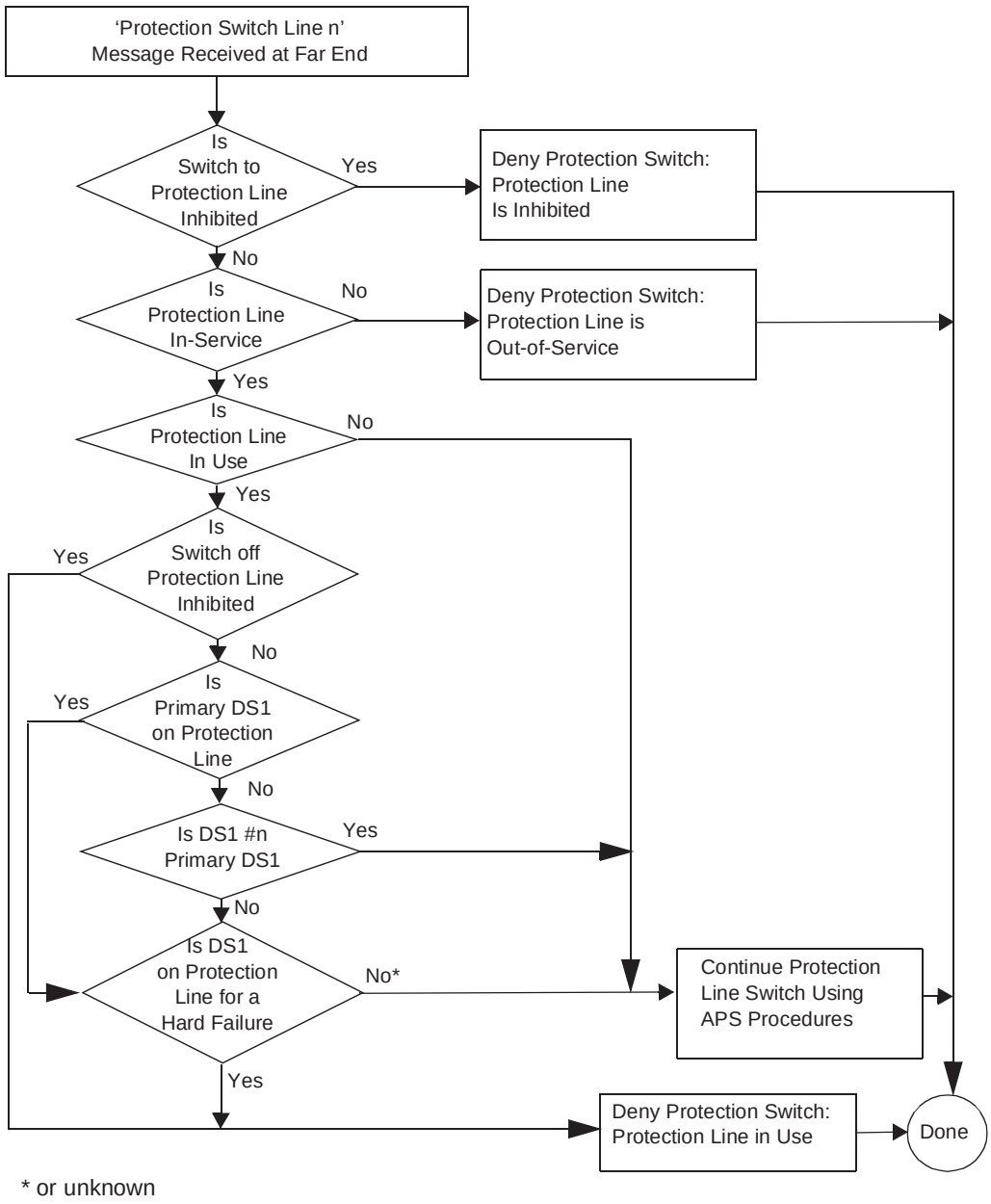


Figure 12-51. Automatic Protection Switch Initialization - Far End

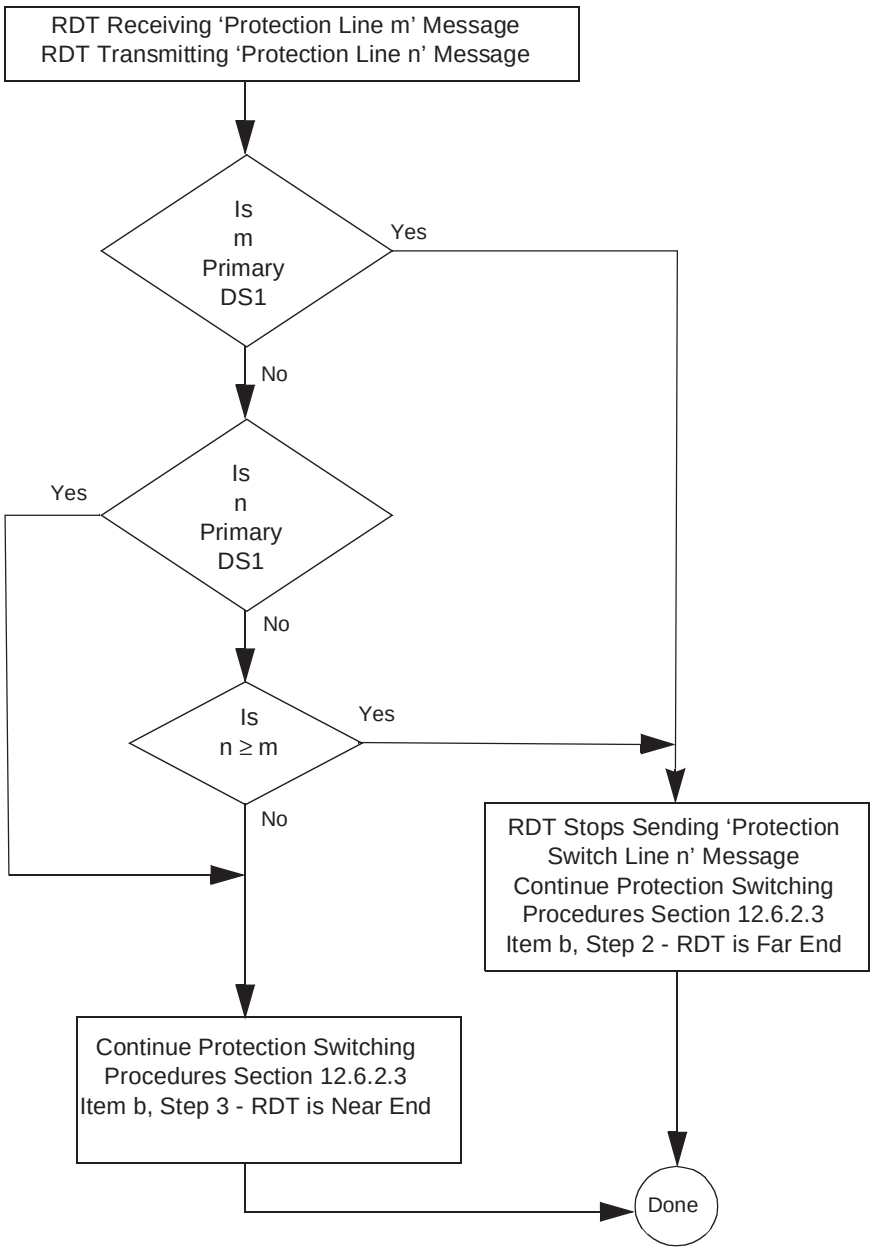


Figure 12-52. Resolution of Contention for Protection DS1 at RDT

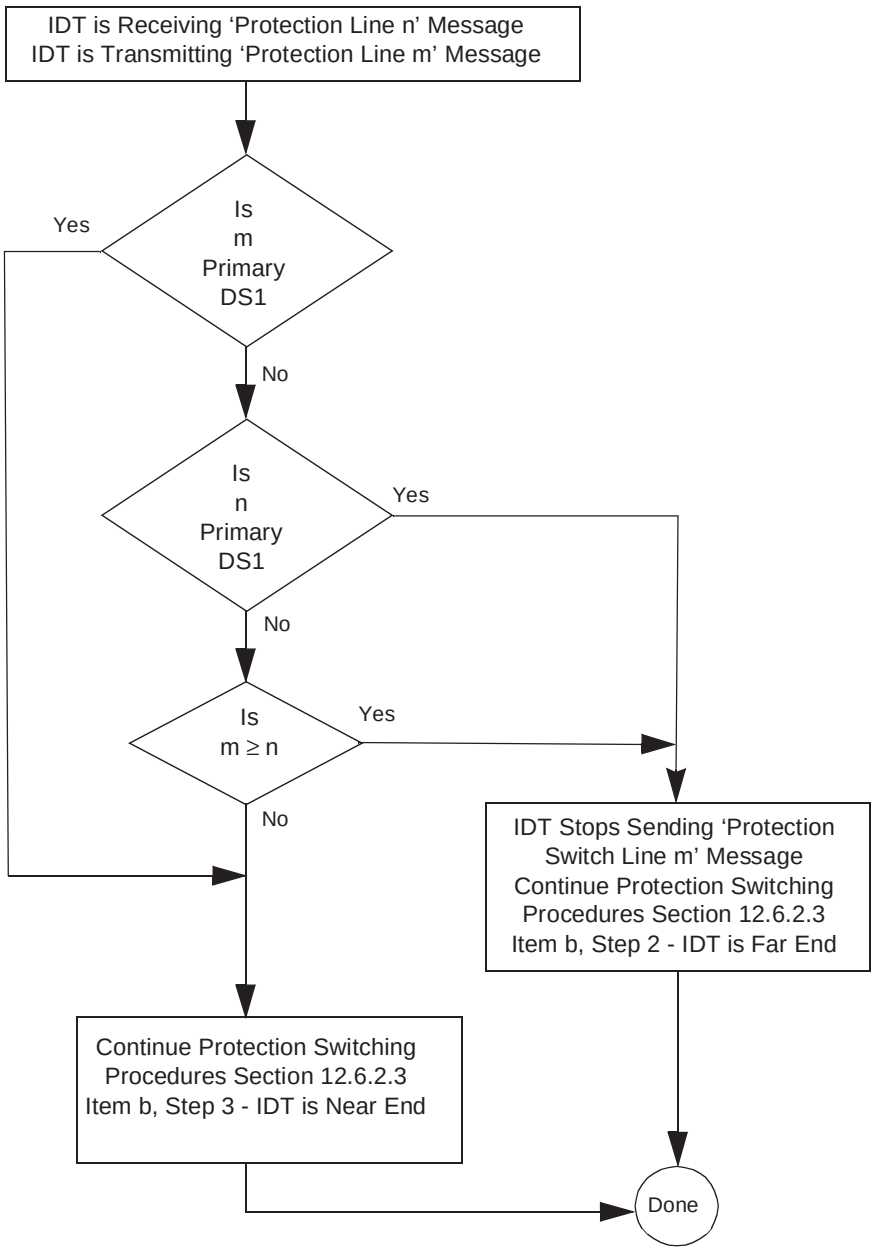


Figure 12-53. Resolution of Contention for Protection DS1 at IDT

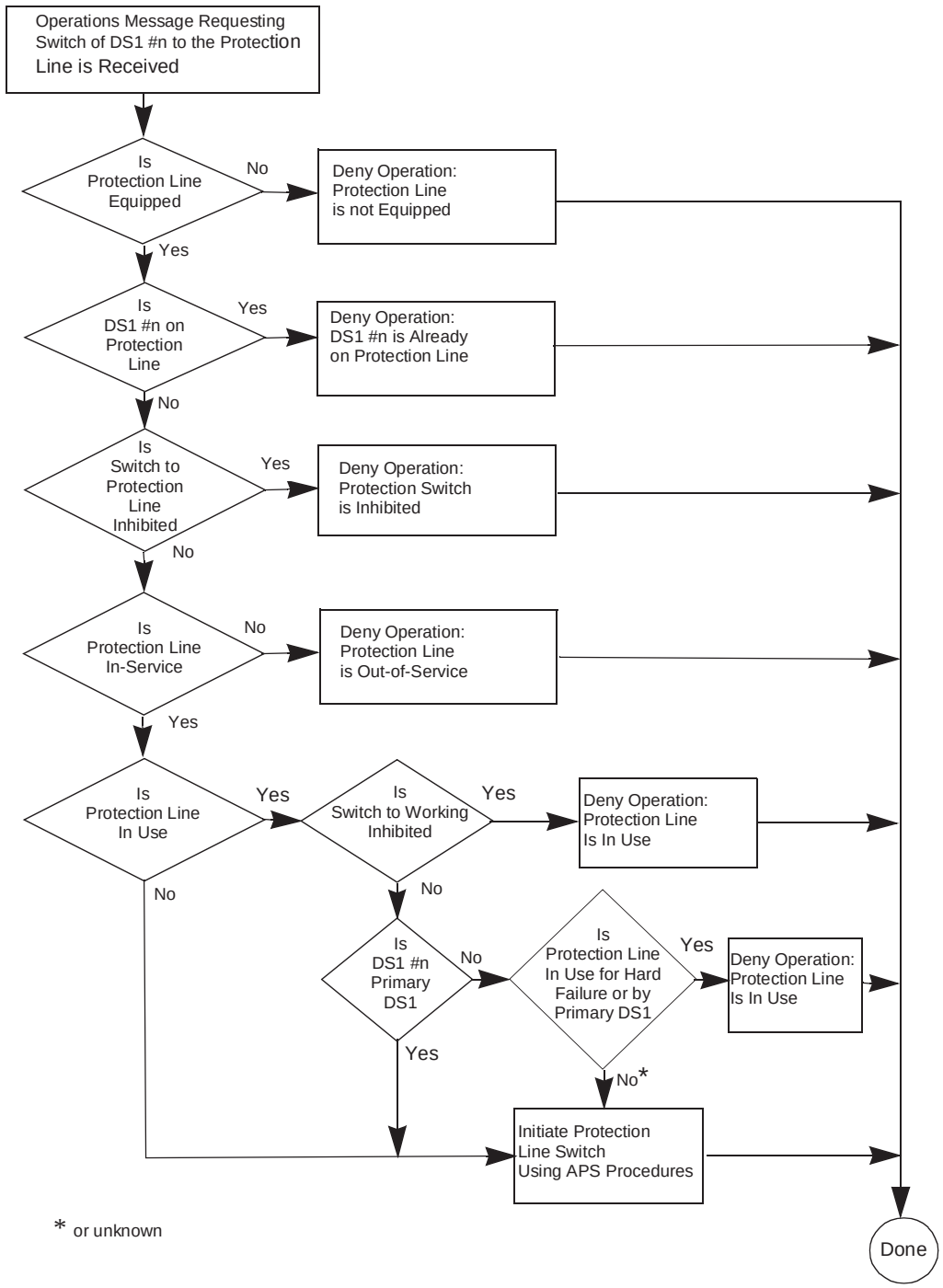


Figure 12-54. Manual Switch to Protection Line

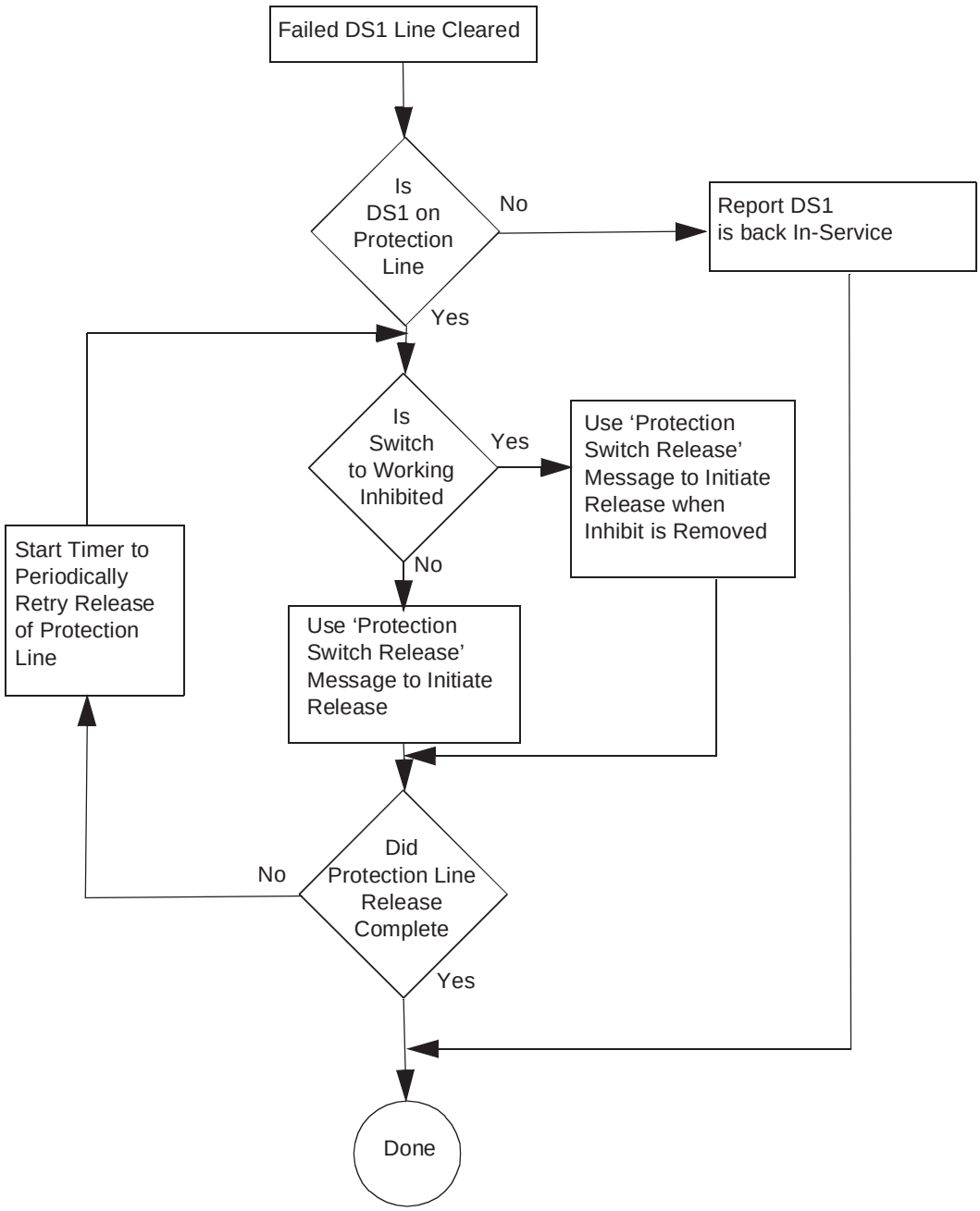


Figure 12-55. Automatic Protection Switch Release

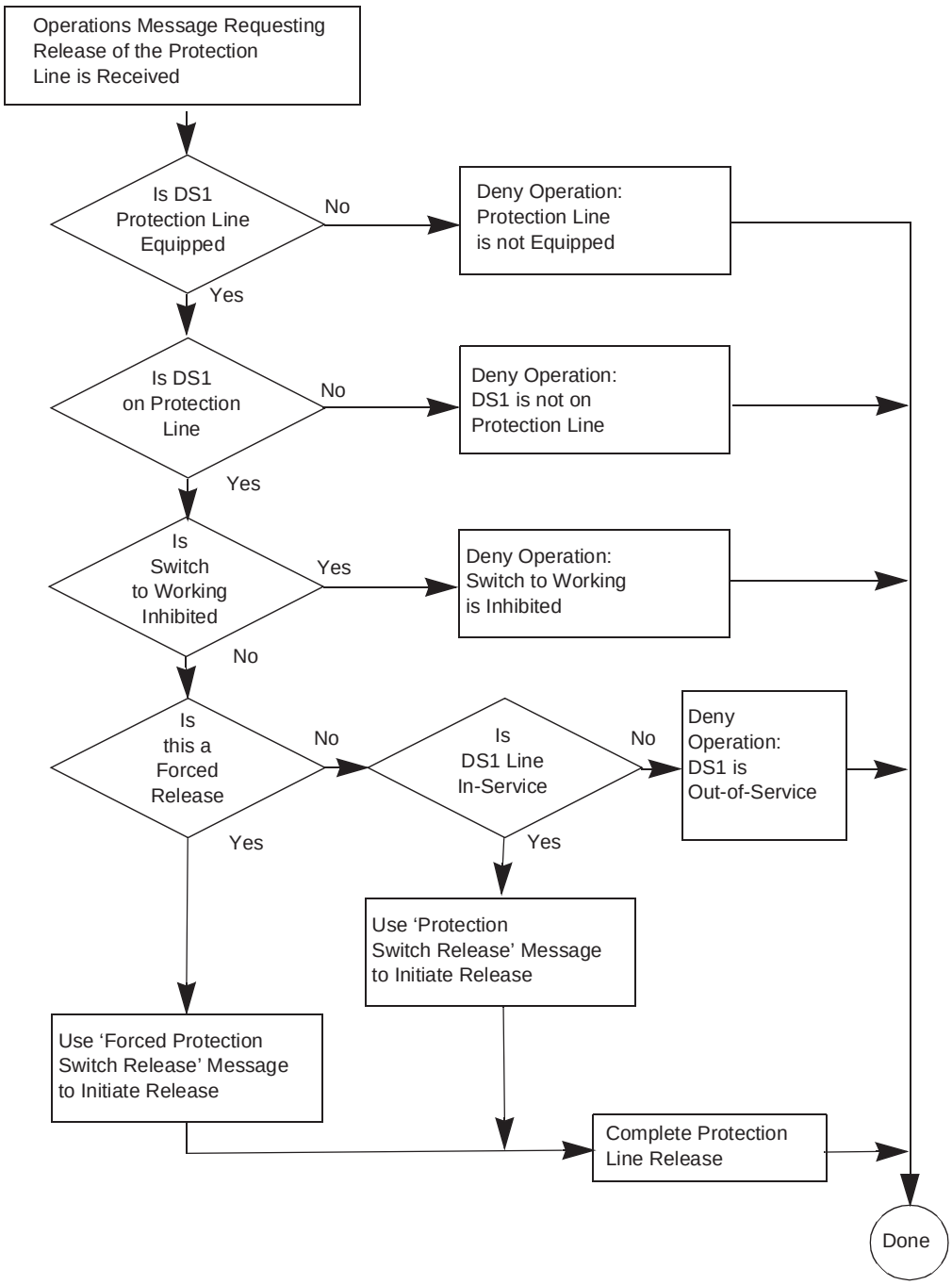


Figure 12-56. Manual Release of Protection Line

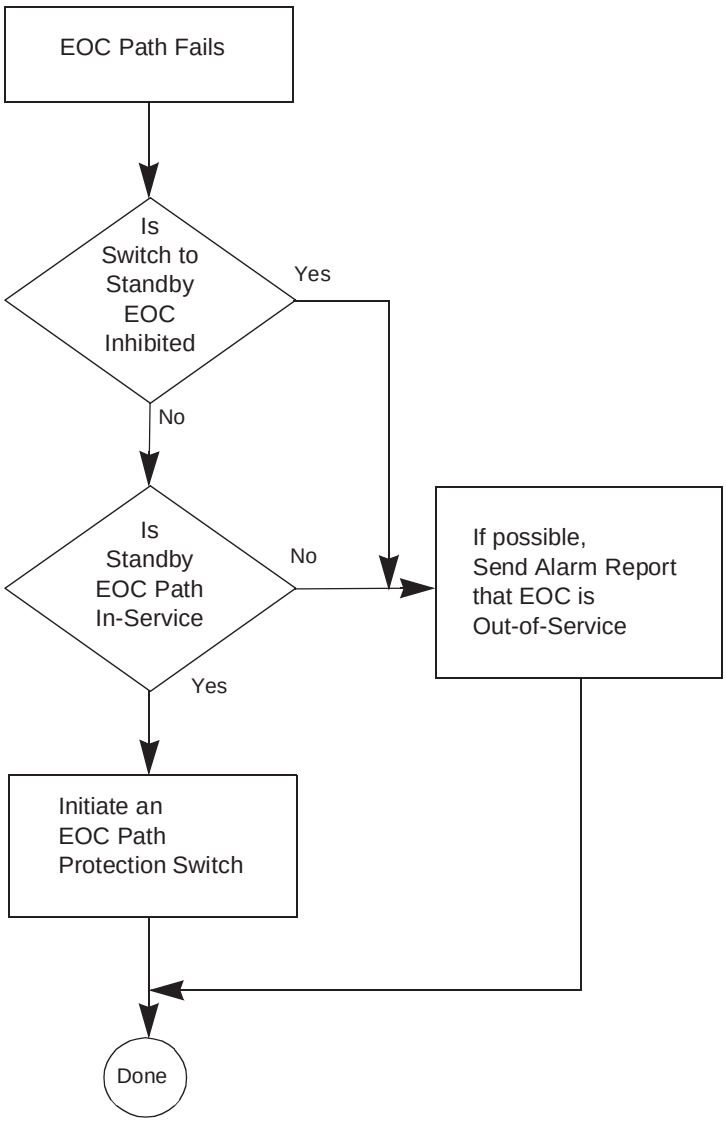


Figure 12-57. EOC Path Failure

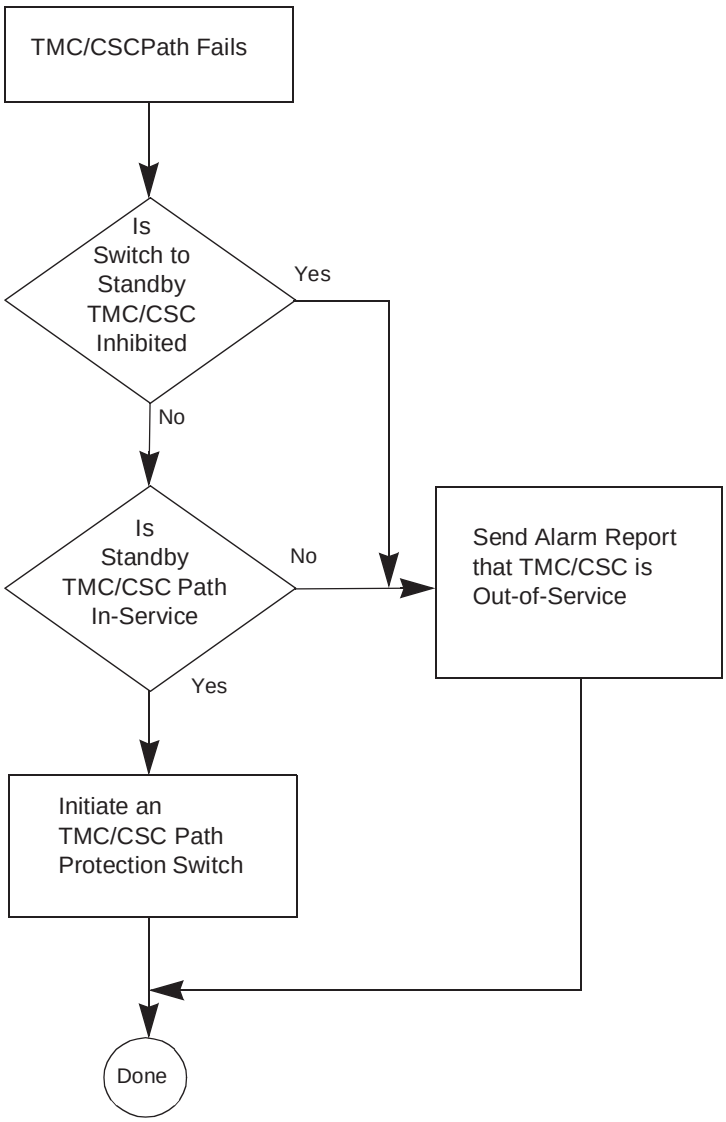


Figure 12-58. TMC/CSC Path Failure

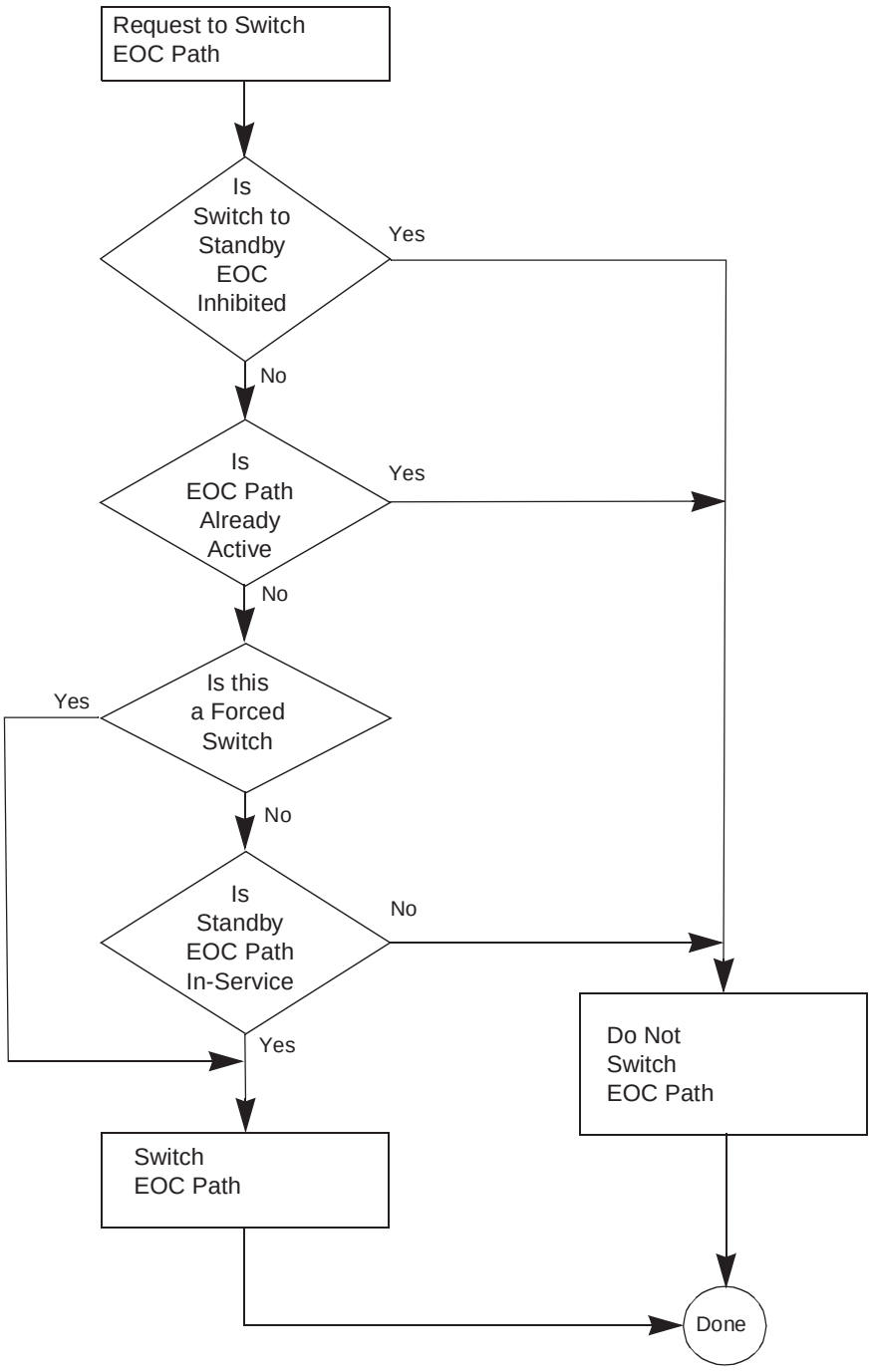


Figure 12-59. Request to Switch EOC Path

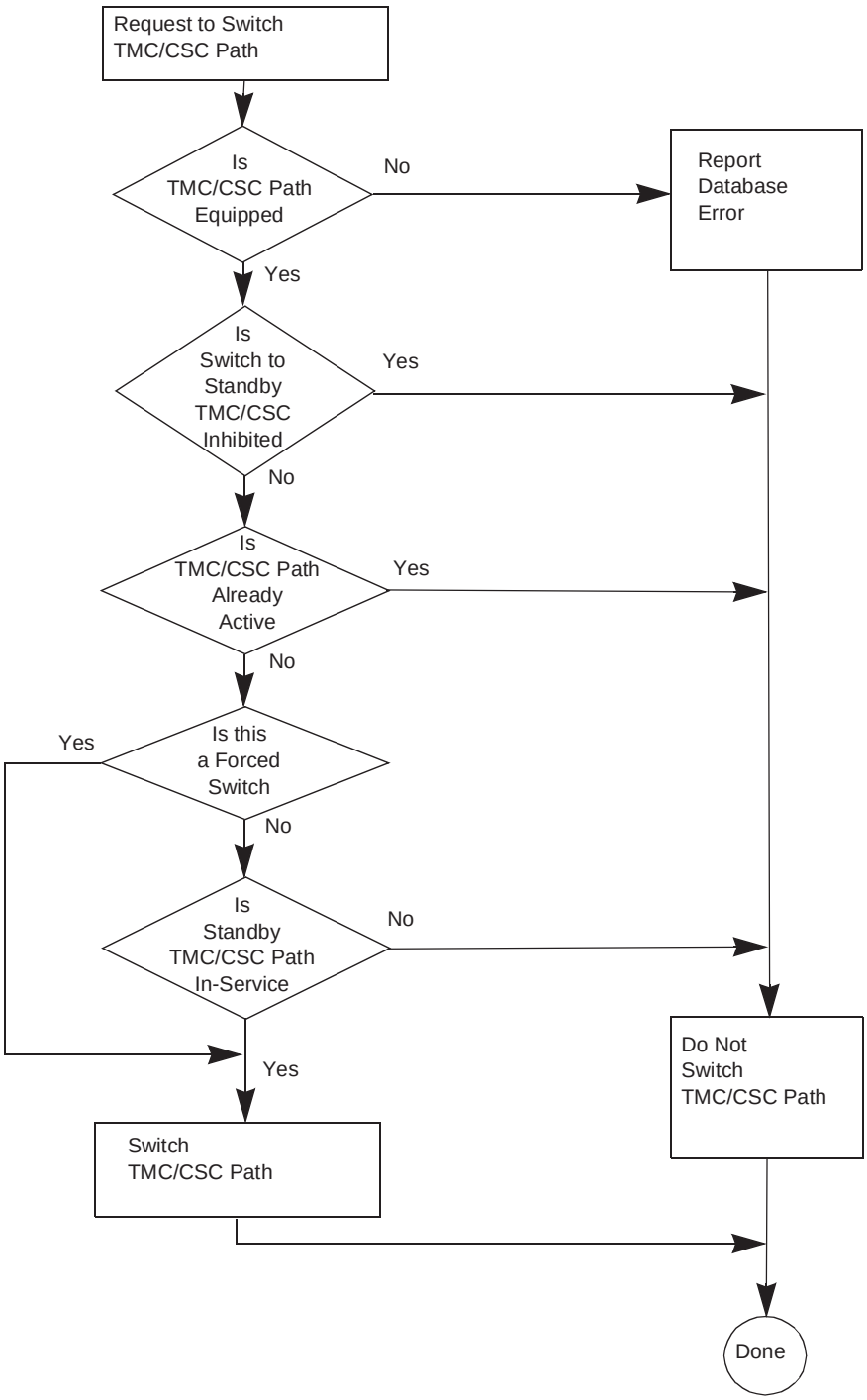


Figure 12-60. Request to Switch TMC/CSC Path

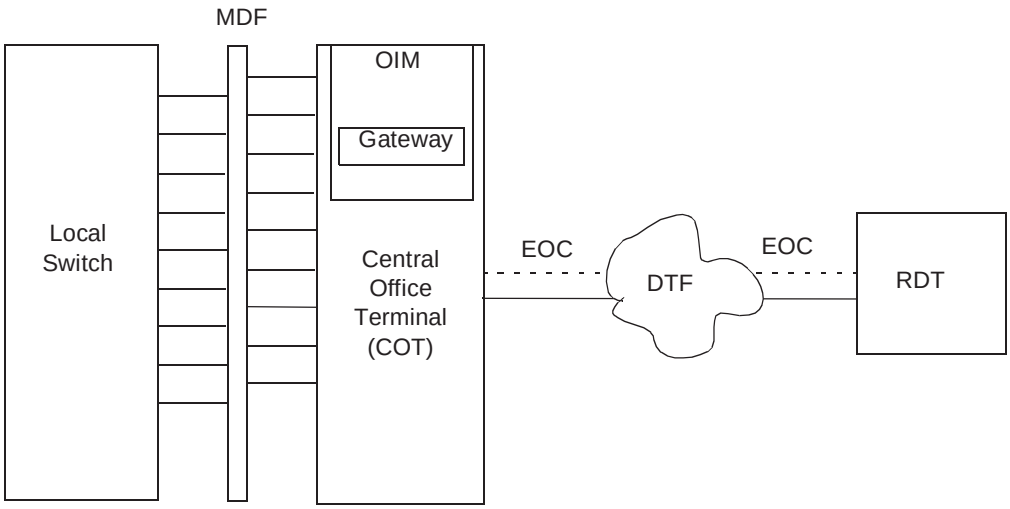
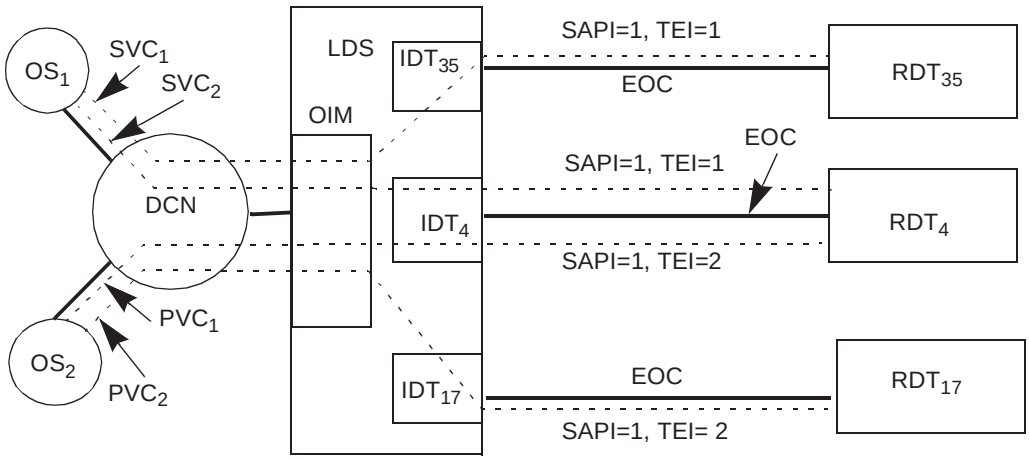


Figure 12-61. Universal Digital Loop Carrier System



DCN - Data Communications Network
EOC - Embedded Operations Channel
LDS - Local Digital Switch
OIM - Operations Interface Module
OS - Operations System
PVC - Permanent Virtual Circuit
RDT - Remote Digital Terminal
SAPI - Service Access Point Identifier
SVC - Switched Virtual Circuit
TEI - Terminal Endpoint Identifier

Figure 12-62. OIM Mappings

Table 12-1. SAPI/TEI Addressing Conventions for EOCs

SAPI	TEI	Data-Link Function
1	0	EOC Path Switching Operations
1	1	RDT - Provisioning/Memory Administration OS
1	2	RDT - Maintenance/Surveillance OS
1	3	RDT - Testing OS
1	4	RDT - IDT
1	5	RDT - Test System Controller 1
1	6	RDT - Test System Controller 2 (if required)
1	7	RDT - Test System Controller 3 (if required)
1	8	user assignable
1	9	user assignable
1	10	user assignable
1	11	user assignable

Table 12-2. SAPI/TEI Addressing Conventions for TMCs/CSCs

SAPI	TEI	Data-Link Function
0	0	Call Processing
1	0	TMC/CSC Path Switching Operations

Table 12-3. ABCD Codes for Locally Switched Circuits (IDT → RDT)

ABCD Code	Loop Start	Ground Start	Loop Reverse Battery	Coin		Multi-party
				CF	DTF	
0000	-R ringing	-R ringing		-R ringing	-R ringing	-R ringing
0001						
0010	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0011						
0100	RLCF	RLCF		RLCF	RLCF	
0101	LCF	LCF	LO	LCF	LCF	LCF
0110						
0111	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1000	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1001	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1010				Pos. Coin Check	Pos. Coin Check	+R ringing
1011				Neg. Coin Check	Neg. Coin Check	Tip Party Test
1100				Pos. Coin Control	Pos. Coin Control	+T ringing
1101	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1110				Neg. Coin Control	Neg. Coin Control	-T ringing
1111	LCFO	LCFO	LC	LCFO	LCFO	LCFO

Legend for Table 12-3

Acronym	Meaning
LC	Loop Closure
LO	Loop Open
LCF	Loop Current Feed
RLCF	Reverse Loop Current Feed
LCFO	Loop Current Feed Open
DNE	Digital Network Element
Reserved (1000)	for SF-ESF signaling translation concerns
Reserved (1101)	for SF-ESF signaling translation concerns
Reserved (1001)	for DS0 clear channel identification in SONET VTs

Bellcore currently has no planned use for unassigned ABCD codes.

Table 12-4. ABCD Codes for Locally Switched Circuits (RDT→ IDT)

ABCD Code	Loop Start	Ground Start	Loop Reverse Battery	Coin		Multi-party
				CF	DTF	
0000		Ring Ground				
0001						
0010	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0011						
0100			RLCF			
0101	LO	LO	LCF	LO	LO	LO
0110						
0111	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1000	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1001	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1010						
1011						
1100						
1101	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1110				Coin Ground	Coin Ground	Tip Party Ground
1111	LC	LC		LC	LC	LC

Table 12-5. ABCD Codes for Non-Locally Switched (Including Non-Switched) Circuits (DNE → RDT)

ABCD Code	FXS at RDT		FXO at RDT		All others per PUB 43801 A=C and B=D
	Loop Start	Ground Start	Loop Start	Ground Start	
0000	-R ringing	-R ringing	LO	Ring Ground	Possible Use
0001	-R ringing	-R ringing			
0010	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0011					
0100	RLCF	RLCF			
0101	LCF	LCF	LO	LO	Possible Use
0110					
0111	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1000					
1001	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1010					Possible Use
1011					
1100					
1101					
1110					
1111	LCFO	LCFO	LC	LC	Possible Use

Table 12-6. ABCD Codes for Non-Locally Switched (Including Non-Switched) Circuits (RDT→ DNE)

ABCD Code	FXS at RDT		FXO at RDT		All others per PUB 43801 A=C and B=D
	Loop Start	Ground Start	Loop Start	Ground Start	
0000		Ring Ground	-R ringing	-R ringing	Possible Use
0001					
0010	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS	DS0 AIS
0011					
0100					
0101	LO	LO	LCF	LCF	Possible Use
0110					
0111	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow	DS0 Yellow
1000					
1001	*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*
1010					Possible Use
1011					
1100					
1101					
1110					
1111	LC	LC	LCFO	LCFO	Possible Use

Table 12-7. Coding of the Message Type Element

Message Type	Coding 7 6 5 4 3 2 1
ALERTING	0 0 0 0 0 0 1
CALL PROCEEDING	0 0 0 0 0 1 0
CONNECT	0 0 0 0 1 1 1
CONNECT ACKNOWLEDGE	0 0 0 1 1 1 1
DISCONNECT	1 0 0 0 1 0 1
INFORMATION	1 1 1 1 0 1 1
NOTIFY	1 1 0 1 1 1 0
RELEASE	1 0 0 1 1 0 1
RELEASE COMPLETE	1 0 1 1 0 1 0
SETUP	0 0 0 0 1 0 1
SETUP ACKNOWLEDGE	0 0 0 1 1 0 1
STATUS	1 1 1 1 1 0 1
STATUS ENQUIRY	1 1 1 0 1 0 1

Table 12-8. Cause Values

Number	Cause Value 7 6 5 4 3 2 1	Event	Diagnostic (octet 5)
16	0 0 1 0 0 0 0	Normal Clearing	All Zeros
27	0 0 1 1 0 1 1	Destination Out of Service	All Zeros
30	0 0 1 1 1 1 0	Response to STATUS ENQUIRY	All Zeros
34	0 1 0 0 0 1 0	Channel Unavailable	All Zeros
35	0 1 0 0 0 1 1	Distribution Channel Unavailable	All Zeros
41	0 1 0 1 0 0 1	Temporary Failure	All Zeros
44	0 1 0 1 1 0 0	Line Unit Unavailable	All Zeros
47	0 1 0 1 1 1 1	Ring Failure	All Zeros
81	1 0 1 0 0 0 1	Invalid Call Reference	All Zeros
96	1 1 0 0 0 0 0	Mandatory Element Missing	Element Identifier*
97	1 1 0 0 0 0 1	Message Unimplemented	Message Type
99	1 1 0 0 0 1 1	Information Element Unimplemented	Element Identifier
100	1 1 0 0 1 0 0	Invalid Information Element Contents	Element Identifier

* “Element Identifier”: the first octet of the information element; “Memory Type”: the octet identifying the message.

Table 12-9. Notification Description Coding

Notification Description	Coding 8 7 6 5 4 3 2 1
Start Dial	1 0 0 0 1 0 1 1
Toll Diversion	1 0 0 0 1 1 0 0
Connect Dial Pulse Detector	1 0 0 0 1 1 0 1
Disconnect Dial Pulse Detector	1 0 0 0 1 1 1 0
Silent Interval	1 0 0 0 1 1 1 1
Timed Negative Coin Check	1 0 0 1 0 0 1 1
Timed Positive Coin Check	1 0 0 1 0 1 0 0
Timed Positive Coin Control	1 0 0 1 0 1 0 1
Timed Negative Coin Control	1 0 0 1 0 1 1 0
Coin Ground	1 0 0 1 0 1 1 1
No Coin Ground	1 0 0 1 1 0 0 0
Tip Party Test	1 0 1 0 0 1 0 0
Tip Party Ground	1 0 1 0 0 1 0 1
No Tip Party Ground	1 0 1 0 0 1 1 0
Flash Enable	1 0 1 1 0 0 1 0
Flash Disable	1 0 1 1 0 0 1 1

Table 12-10. Keypad Information Coding

Keypad Information	Coding 7 6 5 4 3 2 1
Flashhook	0 0 0 0 0 0 0
Digit 0	0 1 1 0 0 0 0
Digit 1	0 1 1 0 0 0 1
Digit 2	0 1 1 0 0 1 0
Digit 3	0 1 1 0 0 1 1
Digit 4	0 1 1 0 1 0 0
Digit 5	0 1 1 0 1 0 1
Digit 6	0 1 1 0 1 1 0
Digit 7	0 1 1 0 1 1 1
Digit 8	0 1 1 1 0 0 0
Digit 9	0 1 1 1 0 0 1

Table 12-11. Signal Value Coding

Signal Value	Coding 8 7 6 5 4 3 2 1	Reference
-R Ringing	0 1 0 0 0 0 0 0	TR-NWT-000057
Reminder Ring	0 1 0 0 0 0 0 1	TR-NWT-000057
Pattern A	0 1 0 0 0 0 1 0	TR-NWT-000057
Pattern B	0 1 0 0 0 0 1 1	TR-NWT-000057
Pattern C	0 1 0 0 0 1 0 0	TR-NWT-000057
Pattern D	0 1 0 0 0 1 0 1	TR-NWT-000057
Pattern E	0 1 0 0 0 1 1 0	TR-NWT-000057
Pattern F	0 1 0 0 0 1 1 1	TR-NWT-000057
-T Ringing	0 1 0 0 1 0 0 0	TR-NWT-000057
+R Ringing	0 1 0 0 1 0 0 1	TR-NWT-000057
+T Ringing	0 1 0 0 1 0 1 0	TR-NWT-000057
Pattern G	0 1 0 0 1 0 1 1	TR-NWT-000057
Alerting Off	0 1 0 0 1 1 1 1	No Reference

Note: Table 5-1 of TR-NWT-000057 defines Distinctive Alerting Patterns (A-G)

Table 12-12. Default values for Application Entity

Default AE-title values	OS/Manager Functional Types
{organizationName=[locally assigned] commonName=memoryAdministration commonName=memoryAdministration1}	Memory Administration /Provisioning
{organizationName=[locally assigned] commonName=maintenance commonName=maintenance1}	Maintenance/ Surveillance
{organizationName=[locally assigned] commonName=test commonName=test1}	Testing OS
{organizationName=[locally assigned] commonName=testController commonName=testController1}	Test Controller
{organizationName=[locally assigned] commonName=testController commonName=testController2}	Test Controller
{organizationName=[locally assigned] commonName=testController commonName=testController3}	Test Controller

13. Feature Set C - SONET Interface

This section was previously published as TR-NWT-000303, Issue 2, Supplement 1, December 1993. The internal section cross-references used in the Supplement have been retained here in the heading of each section starting with Section 13.3. This cross-reference points to the companion section in this GR that discusses the DS1-based interface and the Generic IDLC interface.

13.1 Introduction

13.1.1 Purpose, Scope, and Assumptions

Sections 1 through 12 of GR-303-CORE describe Bellcore's view of the overall system criteria required for terminating a Remote Digital Terminal (RDT) directly in a Local Digital Switch (LDS) via a DS1-based interface. Those sections are considered “Feature Set A” for IDLC systems and provide criteria for DS1-based IDLC systems and for a generic implementation of its interface, known as the Generic IDLC Interface. “Feature Set B” for IDLC systems, was released as a Technical Advisory in July 1987, was integrated into Issue 2 of TR-NWT-000303 in December 1992, and contains requirements for integrated network access, integration with an RSU, and RTU integration into an RDT.

This section replaces TR-NWT-000303, Issue 2, Supplement 1 (December 1993), and contains “Feature Set C,” which provides the generic requirements for interfacing an RDT to an LDS via the SONET format. The generic implementation of this interface, presented in this section, is known as the Generic SONET-IDLC Interface, is based on the requirements of GR-253-CORE, and is compatible with the SONET format as specified in the American National Standard ANSI T1.105.

This section further illustrates Bellcore's commitment to the introduction of additional features into our Transport Technology generic requirements that enhance applications and increase cost savings with transport systems. With respect to the layered structure of the Generic IDLC Interface requirements of GR-303-CORE, only physical-layer transport, termination, and operations requirements have changed to support the SONET-based IDLC interface, thus maintaining compatibility with GR-303-based equipment at all layers above the physical layer.

Where appropriate, this section defines applications for the SONET interface feature. However, these applications should only be considered as possible guidelines. A BCC may wish to apply these or other optional features in applications not anticipated in this section.

The generic requirements proposed in this section are aimed at the forward-looking environment characterized by an increased emphasis on new digital services, such as those based on ISDN and a new OS environment. The new OS environment includes operations centers that deploy OSs dedicated to network performance monitoring and analysis, circuit

testing of both switched and nonlocally switched/nonswitched circuits, and automated remote provisioning of network elements. These OSs communicate with new generation NEs using generic interfaces, protocols, and languages, as specified in other Bellcore TAs, TRs, and GRs. However, it is also recognized that transition to such a modern service and operations environment will not be instantaneous.

The underlying assumption that motivates this section is that there may be economic benefits to BCCs in utilizing the SONET interfacing feature in an IDLC system.

13.1.2 Differences from TR-NWT-000303, Issue 2, Supplement 1

Section 1.6 identifies the significant differences for the entire GR.

13.1.3 A Summary of this Section (Feature Set C)

13.1.3.1 SONET: An IDLC Physical-Layer Alternative

Sections 1 through 12 of this document define a direct DS1 interface to the LDS for IDLC applications. While a DS1 interface is necessary to fit into existing LDS and IDLC system architectures, Bellcore's clients have expressed strong interest in Bellcore setting forth a direct high-speed interface to the LDS *in addition to* the DS1 interface. Emerging technology is making high-speed terminating, multiplexing, and switching equipment economically attractive when compared to multiple DS1-rate interfaces and is resulting in escalated deployment of fiber optics in the loop. The concept of SONET and the use of its generically defined interfaces has received general acceptance, is approved as an American National Standard, and SONET products are being widely deployed in telecommunications networks today.

The SONET-based interface specified in this section will accommodate the high-speed access architectures of the not-so-distant future, and offers both the potential for immediate equipment-cost-savings and the potential for future revenue-generation for its users. The Generic SONET-IDLC Interface takes advantage of technology being developed for the Broadband Integrated Services Digital Network (B-ISDN) while maintaining compatibility with the Generic IDLC Interface defined in “Feature Set A” of this document.

It is important to note that the SONET-based IDLC interface is a physical-layer alternative to the DS1-based IDLC interface defined in “Feature Set A.” As illustrated in Figure 13-1, the DS1-based IDLC interface is comprised of up to 28 DS1 lines, each terminating at a Line Termination (LT), and the SONET-based IDLC interface is comprised of up to 28 SONET VT1.5 channels, each terminating at a Channel Termination (CT). A VT1.5 channel is not a defined line signal and must be derived from an acceptable SONET line signal; therefore, SONET Line Terminations (an electrical STS-1, an optical OC-3, and an

optical OC-12) are illustrated in Figure 13-1. Only the OC-3 will be discussed in the remainder of this section, but everything discussed also applies to the STS-1 and OC-12 line terminations except that each can support a different quantity of VT channels. Because an OC-3 can carry up to 84 VT1.5s, a VT crossconnect (XC) function is also illustrated in Figure 13-1 to derive up to 28 VT1.5 channels from the OC-3 line signal. For the Generic IDLC Interface to be applicable for the SONET-based IDLC interface, the VT1.5 channels must be identified within the IDLC system as VT1.5 channels 1 through 28. Call processing messages between the RDT and IDT of an IDLC system refer to DS1s numbered 1 through 28 and for SONET-based IDLC systems will refer to VT1.5s numbered 1 through 28.

The following summarize some important IDLC interface characteristics:

- If the physical-layer terminations are comprised of DS1 LTs, all IDLC system and interface criteria are provided in Sections 1 through 12.
- If the physical-layer terminations are comprised of VT1.5 CTs, the SONET interface criteria are provided in this section and all other criteria are provided in Sections 1 through 12.
- Because the DS1-based and SONET-based interface criteria are the same at layers above the physical layer, IDLC system inter-operability is ensured even when one end of the system is DS1-based and the other end is SONET-based. For such a system configuration, a SONET-defined conversion between the DS1 and VT1.5 channels must be provided between the IDT and RDT. It is this IDLC system capability to inter-operate, and the inherent transport flexibility of the SONET architecture, that make the access opportunities discussed in Section 13.1.3.3 possible.

As discussed above, the SONET-based IDLC interface is comprised of up to 28 VT1.5s that are derived from the SONET line termination. This section proposes that either a SONET OC-3 or STS-1 line termination be provided at the switch and that either a SONET OC-3 or OC-12 line termination be provided at the network element containing the RDT. Previously, the RDT was considered to be the entire network element including the SONET line termination functions. But that was in 1989 and much has happened in the marketplace since then.

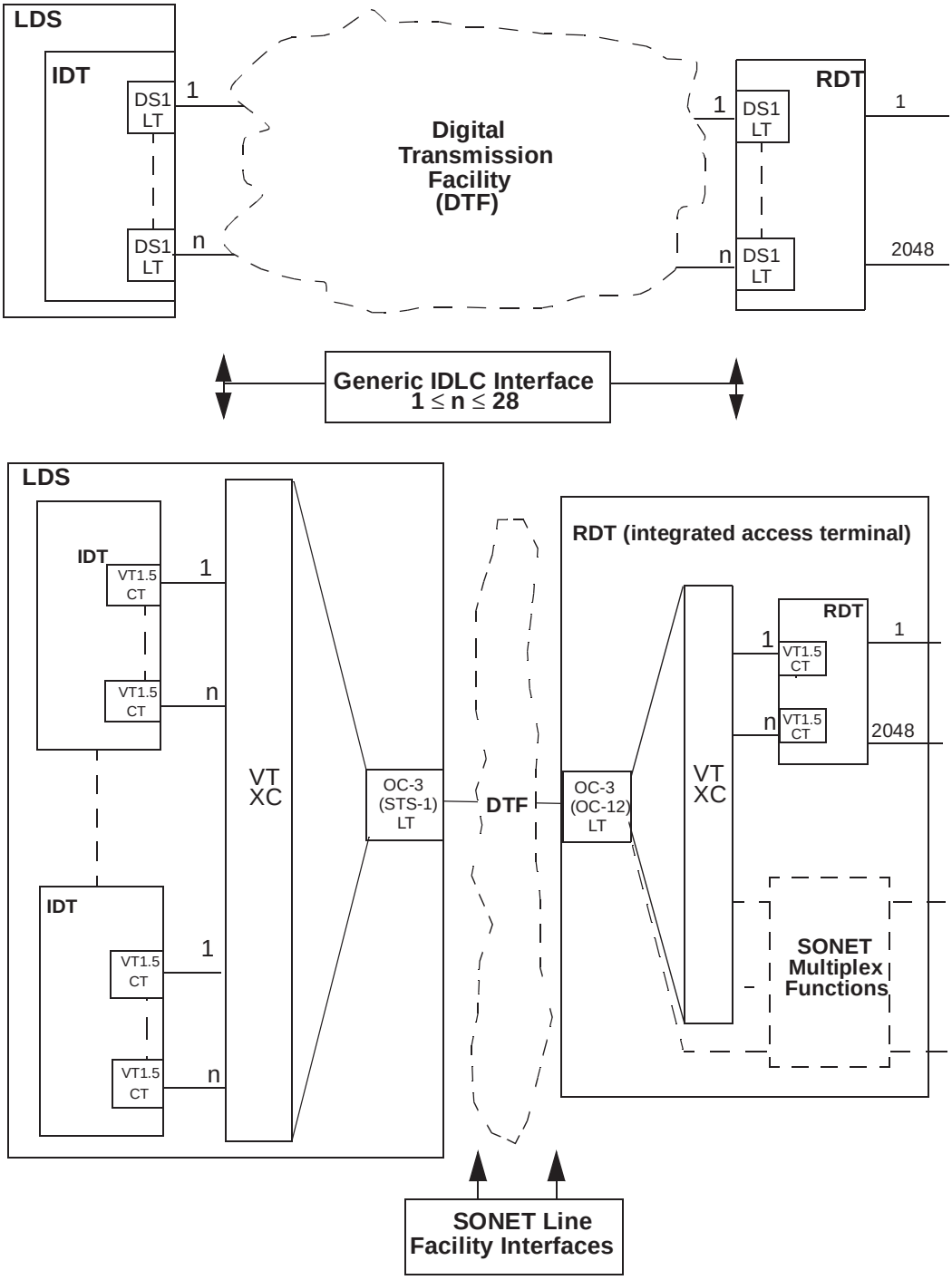


Figure 13-1. DS1-Based and SONET-Based IDLC Architectures

Products based on DLC, FITL, and SONET technologies have historically been built and operated as stand-alone network elements, e.g., an RDT, a Host Digital Terminal (HDT), and a SONET ADM. The requirements for these technologies have been written and analyzed for separate network elements. As observed in the marketplace today, many access system suppliers have developed new multi-functional network elements that have a SONET interface on the feeder side (supporting SONET transport to the wire center) and fiber, copper, and/or coax terminations on the line side (supporting DLC, FITL, and HFC applications). Bellcore has been studying the impact of these multi-functional network elements (see "Multiple Technologies in a Single Access Platform") and some changes in appropriate GRs have already been made to better accommodate these multi-functional network elements.

Some of the criteria in Section 13 are specifically aimed at accommodating multi-functional network elements by

- Maintaining IDLC system inter-operability between DS1-based and SONET-based IDTs/RDTs
- Maximizing the opportunity for multi-functional network elements to take advantage of SONET transport capabilities to provide innovative and efficient access
- Providing sufficient criteria to allow multi-functional network elements to efficiently interface with changing OSs via changing operations data networking architectures.

The following three sections discuss each of the above items in detail.

13.1.3.2 IDLC System Inter-Operability

The SONET-based IDLC interface is defined as up to 28 VT1.5 channels and is directly inter-operable with the DS1-based IDLC interface proposed in Sections 1 through 12. Inter-operability is accomplished by maintaining consistent criteria at all layers above the physical layer for

- IDLC system operations
- Call processing
- Information transport.

13.1.3.2.1 IDLC System Operations

SONET-based IDLC equipment is required to satisfy the same IDLC system operations criteria as DS1-based IDLC equipment. All applicable IDLC system operations criteria are provided, or identified, in Sections 1 through 12. The IDLC system's EOC is always carried in DS0 #12 of a VT1.5 channel; each IDLC system has an active and standby EOC, both in DS0 #12 but always on different VT1.5s. Thus, at the LDS, there will be two EOCs for each

IDLC system. For example, a SONET line termination supporting three IDLC systems will have six EOCs, each being carried in DS0 #12 of six different VT1.5s.

13.1.3.2.2 Call Processing

SONET-based IDLC equipment is required to satisfy the same IDLC call processing criteria as DS1-based IDLC equipment. All applicable IDLC call processing criteria are provided, or identified, in Sections 1 through 12. The IDLC system's TMC or CSC is always carried in DS0 #24 of a VT1.5 channel; each IDLC system has an active and standby TMC/CSC, both in DS0 #24 but always on different VT1.5s. Thus, at the LDS, there will be two TMCs/CSCs for each IDLC system. For example, a SONET line termination supporting three IDLC systems will have six TMCs/CSCs, each being carried in DS0 #24 of six different VT1.5s.

Call processing, associated with locally switched services, for both SONET-based and DS1-based IDLC systems, uses either the hybrid signaling method or a CSC, per the criteria provided in Sections 1 through 12.

- When the hybrid signaling method is implemented, a TMC is used to interchange messages between the IDT and RDT for connecting and disconnecting line units and DS0s on a per-call basis. While the line unit is connected to a DS0, “ABCD” signaling is used for actual call supervision. The “ABCD” codes defined in Sections 1 through 12 apply across a SONET-based IDLC interface as well as across a DS1-based IDLC interface. However, the ABCD codes will be carried via SONET’s “out-slot” signaling transfer method (i.e., in the S1-S4 bits of the VT1.5 overhead) across SONET-based IDLC interfaces instead of in-slot (robbed-bit) as is the case in DS1-based IDLC systems. Facility equipment located between RDTs and IDTs will be required to convert between ABCD in-slot and ABCD out-slot signaling when the access architecture requires inter-connection between DS1-based and SONET-based IDLC interfaces; i.e., an interface conversion between a DS1 (ESF formatted) and a VT1.5 (byte-synchronously mapped in floating mode) is needed (see the GLOBECOM'92 paper, “SONET-based TR-303 RDTs: Transitional Interoperability Concerns and Solutions.”
- When the CSC method is implemented, a CSC is used to interchange messages between the IDT and RDT for connecting and disconnecting line units and DS0s on a per-call basis. While the line unit is connected to a DS0, the CSC is also used for actual call supervision.

Call processing associated with non-locally switched services is accomplished via the ABCD codes defined in Sections 1 through 12 for both the SONET-based and DS1-based IDLC interfaces. However, as mentioned above, the ABCD codes will be carried via SONET’s out-slot signaling transfer method across SONET-based IDLC interfaces instead of in-slot (robbed-bit) as is the case in DS1-based IDLC systems.

13.1.3.2.3 Information Transport

DS0s are carried byte-synchronously within VT1.5 channels at the SONET-based IDLC interface. The VT1.5 structure closely resembles the DS1 signals defined in Sections 1 through 12 and allows all Generic IDLC Interface procedures/scenarios to remain as specified in those sections. With respect to the Generic IDLC Interface, only physical layer transport, termination, and operations have changed to support the SONET-based IDLC interface.

13.1.3.3 Access Opportunities

13.1.3.3.1 General Discussion

The maximum size of an IDLC system interface is 672 DS0 time slots, and the maximum line size of an RDT is 2048, irrespective of whether it is DS1-based or SONET-based. For the SONET-based IDLC interface, up to 28 VT1.5 channels can be supported across the interface. Groups of 24 DS0s are byte-synchronously mapped into VT1.5 channels, using SONET-defined procedures, and are transported in the SONET-defined floating mode of operation.

For IDLC applications, the SONET option to *directly* map DS0s byte-synchronously into virtual tributaries (i.e., without a DS1 framing format) provides the greatest benefits. In the byte-synchronous mode, the DS0s are transported every 125μseconds, which accommodates digitally encoded voice services. Also, because of the capability of the byte-synchronous mode to carry ABCD signaling out-slot, DS0 clear-channel-capabilities are inherent. But the greatest benefit of the byte-synchronous mode for IDLC is the elimination of any intermediate DS1 framing structure; this equates to real equipment and administration cost savings due to the elimination of DS1 terminating circuits.

Up to 28 VT1.5s can be carried in an STS-1 and three STS-1s are multiplexed to obtain an STS-3, which is the electrical equivalent of the optical OC-3 signal before line scrambling. Detailed descriptions of the STS-3, STS-1, and VT1.5 format structures are provided in Section 13.4.4. An overview of the SONET-based IDLC architecture being defined in this section, and its relationship to the DS1-based IDLC architecture defined in Sections 1 through 12, is illustrated in Figure 13-1. The one-to-one correspondence between the IDT and RDT entities of an IDLC system, as specified in Sections 1 through 12, is maintained across the SONET-based IDLC interface. The IDT entity of the IDLC system can terminate up to 28 VT1.5 channels and is contained within an LDS, which terminates the SONET line signal carrying the VT1.5 channels for the IDT. Likewise, the TR-303 Generic IDLC Interface entity of the RDT (integrated access terminal) can also terminate up to 28 VT1.5 channels from the SONET line signal carrying the VT1.5 channels for the RDT. It is advantageous to de-couple the SONET-based IDLC interface definition from the product that terminates the SONET line signal. Any network element can integrate IDLC

technology into its product and, by following the requirements in this document, can maintain IDLC IDT-RDT interoperability. An access product that combines a SONET-based RDT with SONET line termination functions is called an RDT (integrated access terminal), sometimes abbreviated as RDT(IAT) in this section to differentiate between RDT(IAT) and RDT criteria, just as LDS is used to differentiate between LDS and IDT criteria.

At an RDT (integrated access terminal) with an OC-3 line termination, several internal architectures are valid (i.e., supported by Bellcore generic requirements), including the following:

- An RDT, as illustrated in Figure 13-1, terminating up to 28 VT1.5 channels and serving up to 2048 lines via its TR-303 Generic IDLC Interface entity, with the remaining bandwidth of the OC-3 being unequipped or being used to support low-speed interfaces to a SONET multiplex function in the IAT.
- An RDT with multiple Interface Groups (IGs - see Section 12.5.10 for criteria associated with the multi-IG feature), as illustrated in Figure 13-2, each IG terminating up to 28 VT1.5 channels and serving up to 2048 lines, with the remaining bandwidth of the OC-3 being unequipped or being used to support low-speed interfaces to a SONET multiplex function in the IAT. Suppliers may decide to market such an IAT with an OC-12 line termination.

  Detailed discussions of access opportunities at the feeder and distribution sides of the IAT illustrated in Figure 13-2 are provided in Sections 13.1.3.3.2 and 13.1.3.3.3, respectively.

At an LDS with an OC-3 line interface, several IDTs will have full access to the 84 VT1.5 channels being carried in the OC-3 signal, but no more than 28 VT1.5s will be associated with any one IDT. At IDLC system provisioning, the assignment of VT1.5 channels to each IDT will be made. A full access capability is important to allow any VT1.5 to be assigned to any IDT; this accommodates growth in any IDLC system without requiring a total re-assignment of all VT1.5s at the LDS OC-3 interface. For some configurations the capacity of the OC-3 signal may not be fully utilized at an LDS. The architecture of an LDS should be such that the resources of an LDS that may be left stranded by such configurations are minimal. The capability to grow to full utilization should be provided.

With companion SONET facility-equipment [e.g., the SONET ADM (see TR-NWT-000496) and the Wideband DCS (see TR-NWT-000233)], the SONET-based IDLC architecture described in this section will allow several RDTs (both DS1-based and SONET-based) to access SONET nodes along a fiber route. Figure 13-3 illustrates a SONET-IDLC access example for a linear taper topology where partially filled OC-3s from SONET-based RDTs and/or DS1s from DS1-based RDTs are terminated on SONET ADMs distributed along a fiber route.

In Figure 13-3, unused VT1.5s within the OC-3s from RDTs 1, 2, and 4 are ignored at the ADMs; i.e., only utilized VT1.5s are carried on the fiber route's OC-M signal. Also

illustrated in Figure 13-3 are some IAT opportunities where RDTs 1, 2, and 4 could be integrated (i.e., becoming IGs) into a single network element that also provides the ADM function. Similarly, DS1s from RDTs 3 and 5 are byte-synchronously mapped into VT1.5 at their interface to the ADMs, and are carried on the OC-M signal toward the CO. A pair of terminal-ADMs may also appear along such a fiber route (as shown in Figure 13-3) to multiplex a number of OC-M signals up to a higher-rate OC-N signal for transport to the CO. At the CO, a W-DCS is illustrated to accomplish VT1.5 grooming such that the OC-3 signal to the LDS is fully utilized and non-locally switched traffic is routed away from the LDS.

Figure 13-4 illustrates an access capability similar to that illustrated in Figure 13-3, except that a ring topology is illustrated in this example. Again, some IAT opportunities are illustrated.

Any of the RDTs illustrated in Figures 13-3 and 13-4 could also be a Host Digital Terminal (HDT) serving a number of Optical Network Units (ONUs) of an integrated Fiber-In-The-Loop (FITL) system as specified in TA-NWT-000909. The access opportunities discussed above would apply to these HDTs to the same extent as they apply to RDTs because both RDTs and HDTs support the Generic IDLC Interface when interfacing directly to a LDS.

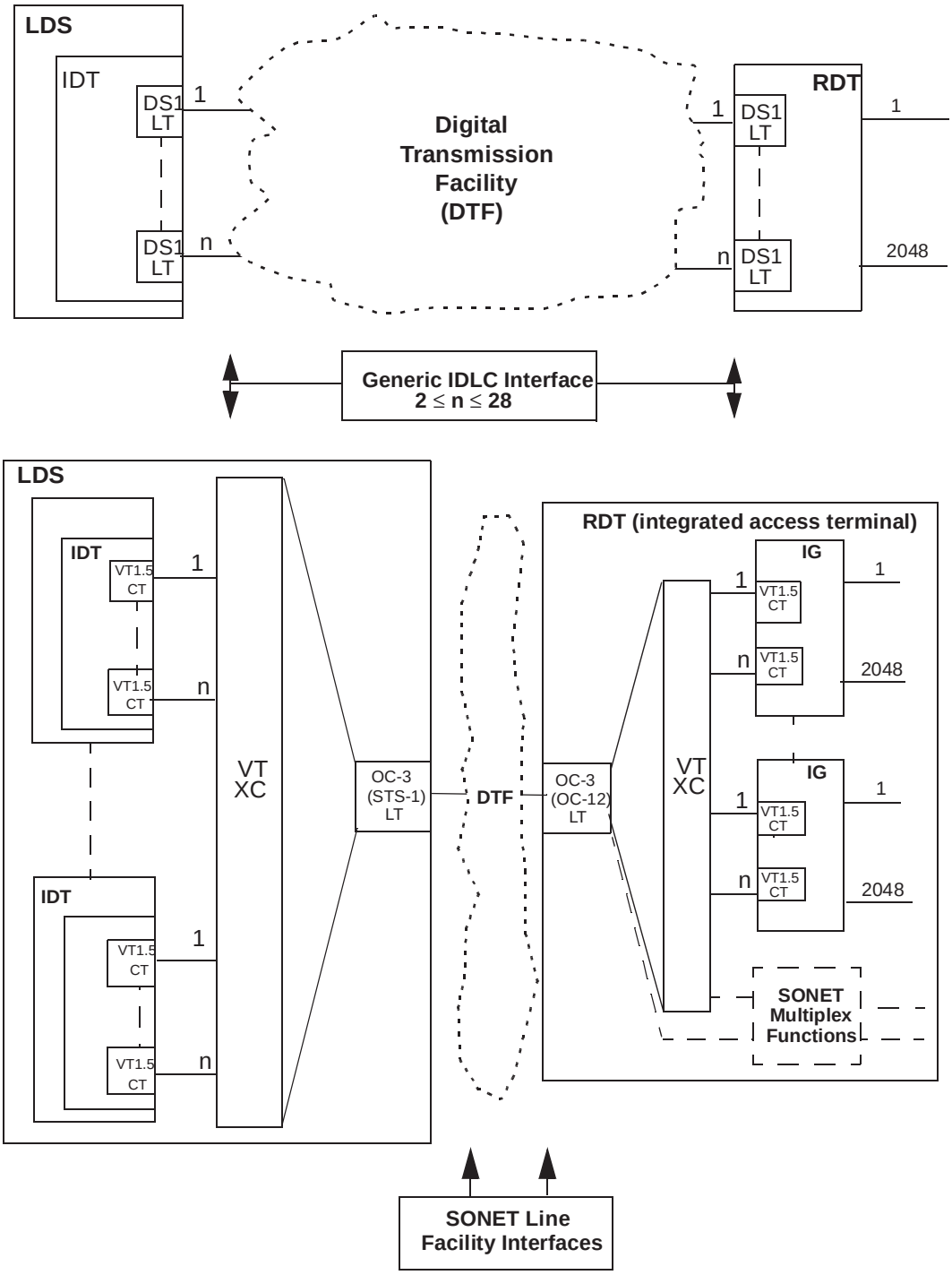


Figure 13-2. DS1-Based and SONET-Based (multiple IGs) IDLC Architectures

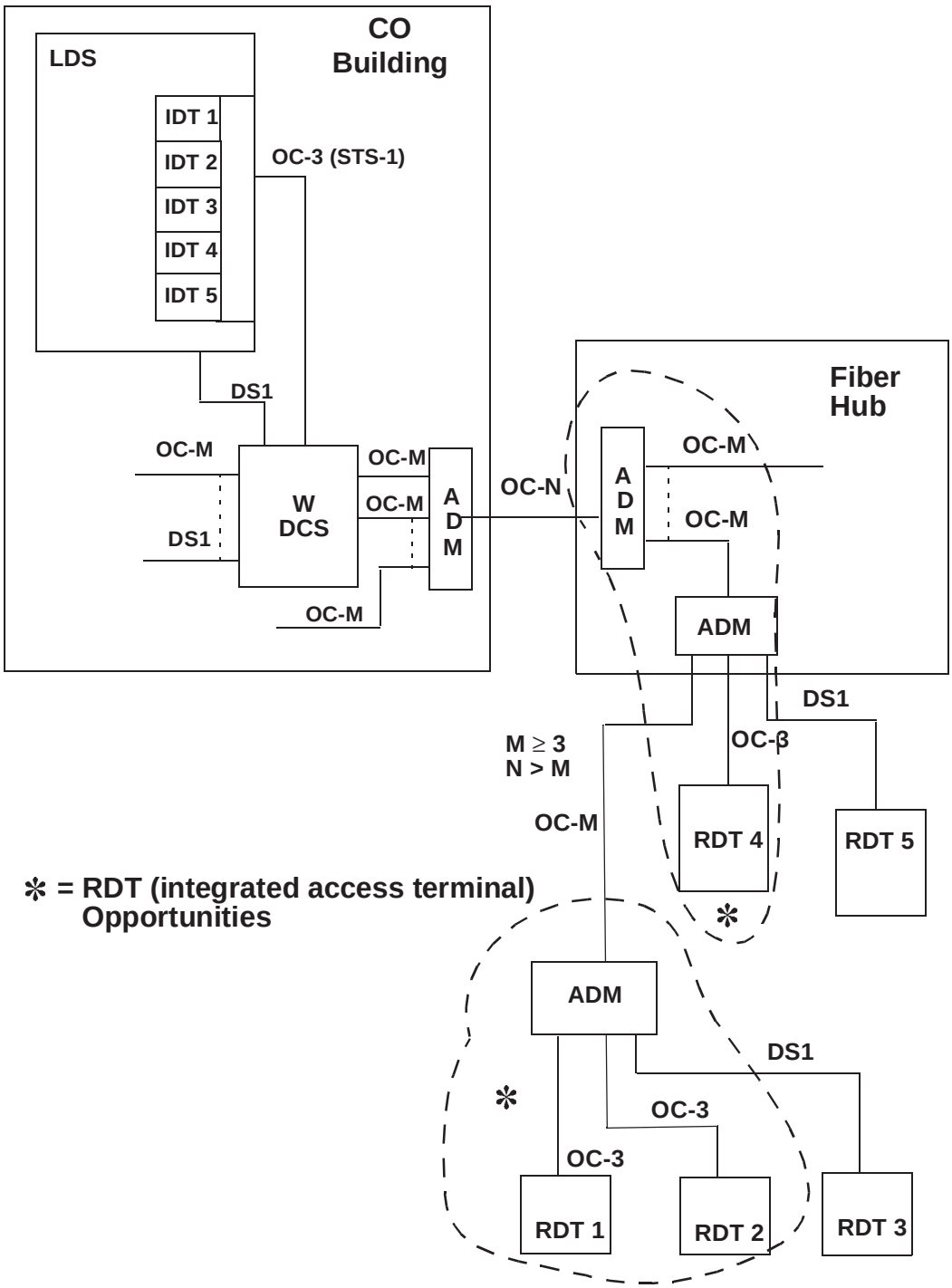


Figure 13-3. SONET- IDLC Access Example: Linear Taper Topology

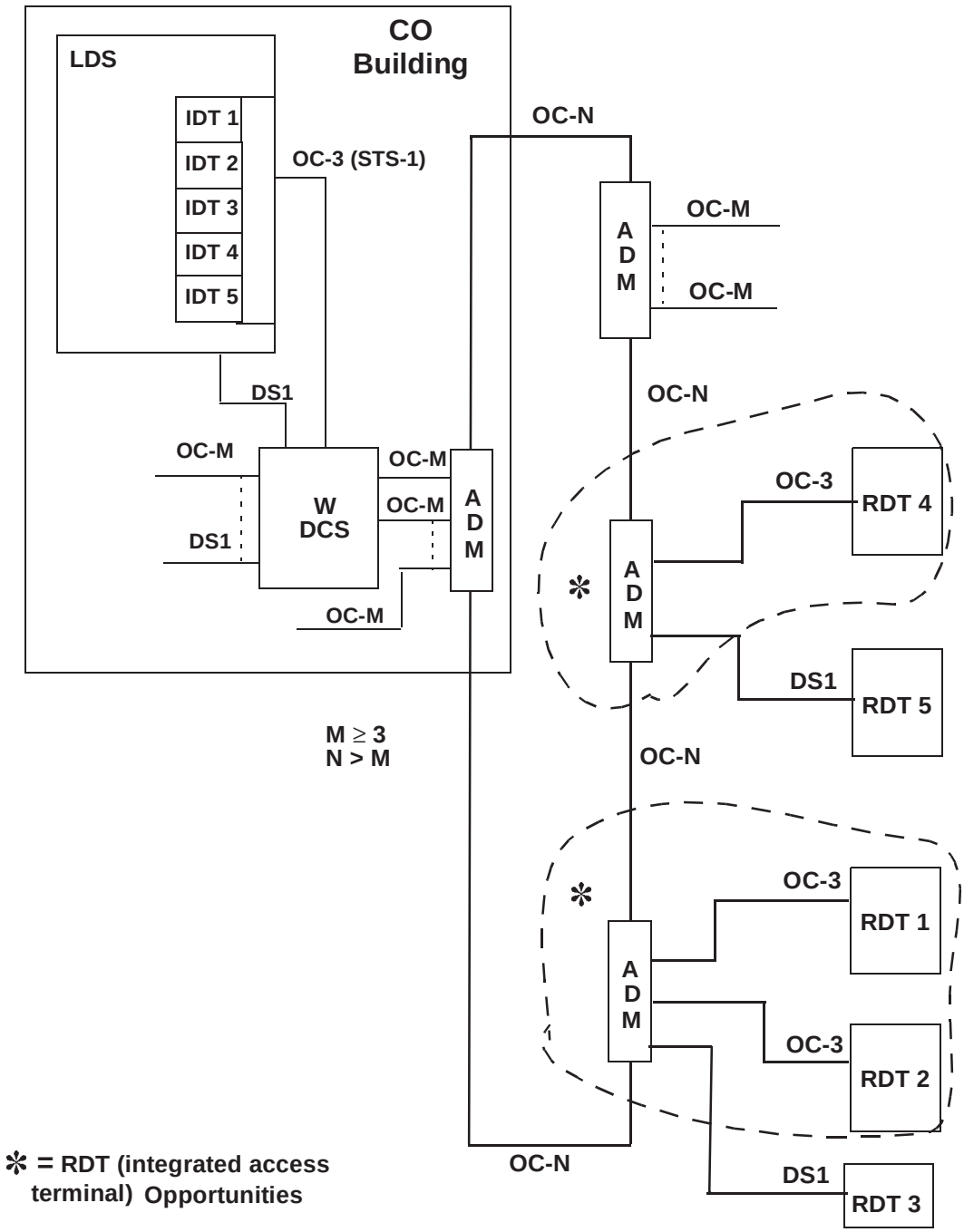


Figure 13-4. SONET- IDLC Access Example: Ring Topology

13.1.3.3.2 RDT(IAT) - Feeder-Side Discussion

As illustrated in Figure 13-2, each IG of an RDT (IAT) must have “n” VT1.5 channels on its feeder side (i.e., toward the CO); where “n” can be from 1 through 28. The logical addresses of these VT1.5 channels must be unique and an integer from 1 through 28; needed for both operations and call-processing functions across the Generic IDLC Interface.

In Figure 13-2, a Virtual Tributary (VT) Crossconnect (XC) is illustrated to cover a full range of capabilities:

- Some IATs may only support a maximum of 28 VT1.5 channels to a single IG. This would not require a VT-crossconnect capability because the SONET line facility interface can be directly demultiplexed to provide the IG with its 28 VT1.5 channels logically numbered from 1 through 28.
- Some IATs may support more than 28 VT1.5 channels to more than one IG. This may require a VT-crossconnect capability to allow any VT channel at the SONET line facility interface to be used as a VT1.5 channel to any of the IGs within the IAT. Once assigned to an IG, a VT1.5 channel has a logical number from 1 through 28, relative to that IG.
- Some IATs may provide SONET multiplex functions in addition to IG functions. This may or may not require a VT-crossconnect, depending on the specific architecture of the IAT.

13.1.3.3.3 RDT(IAT) - Distribution-Side Discussion

On the distribution side of an IAT are the actual line units providing the customer interfaces needed to support specific access services; e.g., POTS, Coin, DDS, ISDN BRA, DS1 Extension, FITL, etc. Each of these line units has a physical address indicating the actual location of the line unit in the IAT; some line units can support more than one line circuit. As illustrated in Figure 13-2, each IG of an IAT can support up to 2048 line circuits on its distribution side. The logical addresses of these line circuits must be unique and an integer from 1 through 2048; needed for both operations and call-processing functions across the Generic IDLC Interface.

In Figure 13-2, a VT XC is illustrated to cover a full range of capabilities for IGs and IATs, on the feeder side of the IG(s). Similarly, on the distribution side of the IG(s), there needs to be a capability to assign specific line circuits to a logical line (1 through 2048) of an IG.

- Some IATs may only support a single IG. A fixed association between the logical lines (1 through 2048) of an IG and the actual line circuits may be possible.

- Some IATs may support more than one IG. This would require an assignment capability that allowed specific line circuits to be associated with specific logical lines (1 through 2048) of each IG.
  - — Some suppliers may partition the IAT such that a physical group of line units will only have full access to all DS0 timeslots supported by a specific IG in the IAT. A fixed association between the logical lines (1 through 2048) of each IG and each group of actual line circuits may be possible.
  - — Some suppliers may not partition the IAT and all line circuits of all line units will have full access to all DS0 timeslots supported by all IGs in the IAT. For such architectures, a capability to assign any line circuit to any logical line (1 through 2048) of any IG will be required.
- Some IATs may provide SONET multiplex functions in addition to IG functions. This may or may not require an assignment capability to associate the SONET multiplex function with an actual line unit, or circuit on a line unit, depending on the specific architecture of the IAT.

13.1.3.4 Operations Strategy

13.1.3.4.1 Facility Operations

The SONET line signals (STS-1, OC-3, and OC-12) are monitored for both hard and soft failure conditions. If thresholds are exceeded on the working line signal, an automatic switch to the protection line signal will be initiated. Automatic Protection Switching (APS) coordination will be performed via standardized SONET procedures to ensure compatibility with companion SONET facility-equipment (e.g., ADMs and W-DCSs).

Because of the number of circuits carried on a SONET line signal and the need to protect critical IDLC-system data links, a 1+1 unidirectional non-revertive APS mechanism is required in support of the SONET-based IDLC interface. A 1+1 system implies that data is transmitted identically on both transmit lines. The receiver monitors both receive lines and selects one. If that output goes bad, it autonomously switches from the working receive line to the protection receive line. The other end of the facility is not forced to also switch; thus, the terminology “unidirectional.”

There are several advantages of the 1+1 unidirectional non-revertive automatic protection strategy:

- Only the end detecting a failure activates a local switch. There are no coordination problems between switching both ends of the facility gracefully.
- Only the direction of transmission experiencing the failure may experience data errors. The opposite direction continues to run essentially error free.

- Continued operation, even under certain double failure situations, is possible with 1+1 unidirectional automatic protection switching.

Performance monitoring is also required at the photonic, section, and line layers to provide an early warning of any facility degradation. Threshold Crossing Alert (TCA) messages will be generated when a pre-defined user-settable threshold is crossed. Default values for parameters being monitored are provided in Section 13.4.6.2.

An RDT(integrated access terminal) may also be an integrated part of a SONET ring architecture supporting a revertive or non-revertive, unidirectional path or bidirectional line, protection switching capability.

13.1.3.4.2 Signal Path Operations

Each STS-1 and VT1.5 path terminating at a SONET line interface is monitored to ensure that satisfactory path transport is being provided. TCAs will be generated when a pre-defined user-settable threshold is crossed. Default values for all parameters being monitored are provided in Section 13.4.6.2.

The generation of a threshold-crossing-alert message is an early warning to OSs that a problem may be developing.

13.1.3.4.3 RDT(integrated access terminal) Operations

Section 13.1.3.2.1 discusses the IDLC system operations capabilities needed to maintain IDT-RDT inter-operability between SONET-based and DS1-based IDLC interfaces. Currently, the capabilities needed to support the operations needs of an IAT depend on the technologies being integrated (e.g., IDLC, SONET, FITL, etc.), on the line terminations (e.g., DS1 or SONET), on the capabilities available in the switch [e.g., Operations Interface Module (OIM), SONET gateway, or neither], and on the deployment strategies of the BCCs.

Suppliers either are offering, or are planning to offer, network elements geared for loop applications that combine SONET, FITL, and IDLC technologies into a single product, herein called an IAT. An important issue impacting both a BCCs network evolution plans, and a supplier's development plans, is the alignment of the operations communications messages and architecture for this IAT.

As one of the steps Bellcore is taking to resolve this issue, Bellcore published an IDLC/FITL-specific CMISE information model based on GR-836-CORE in 1994; i.e., GR-2833-CORE. Bellcore has targeted support for this IDLC/FITL CMISE model (GR-2833-CORE), **not** TR-TSY-000303, Supplement 3, in its OSs/EMs by year-end 1996.

The following objectives are intended to alert the switch and IAT supplier community of the BCCs intentions to move to the target standard CMISE information model as operations

support for the target becomes available. These objectives should not be construed as an immediate replacement for the current IDLC operations communications environment (including TR-TSY-000303, Supplement 3). Some BCCs may choose not to implement an operations communications environment employing the IDLC/FITL-specific CMISE information model based on GR-2833-CORE in the 1996 timeframe. However, it is recognized that to take advantage of the business opportunities realized by an access platform that combines SONET, FITL, and IDLC functionality, a unified operations communications architecture is a priority.

A SONET-based RDT and its associated IAT should support, by year-end 1996, a CMISE interface based on GR-2833-CORE, and the following operations communications capabilities:

1. For communicating with the LDS:
    - Supplement 3 of TR-TSY-000303 will continue to be supported on the IDLC EOC using a LAPD interface per this document **during a controlled migration to**
    - A CMISE interface based on GR-2833-CORE, using the IDLC EOC and LAPD per this document.
2. For communicating with OSs:
    - The EOC and LAPD per this document, if an OIM is available.
    - The DCC and OSI per GR-253-CORE, if a SONET gateway to the OSs is available, or
    - A DS0 (other than the IDLC EOC) and OSI per GR-828-CORE, if neither an OIM nor SONET gateway to the OSs is available.
3. For communicating with SONET-NEs:
    - The DCC and OSI per GR-253-CORE.

As part of its 1995 to 1996 work program, Bellcore will work together with BCCs, switch, and IAT suppliers to map a controlled migration from the current operations communications architecture of the separate SONET, FITL, and IDLC platforms, to the convergent target architecture that supports a cost-effective IAT. An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.

This section (i.e., Section 13 of this GR) provides criteria for an RDT(integrated access terminal) aimed at achieving a common target operations communications solution for all IAT configurations. This section also provides criteria needed by an RDT(integrated access terminal) in today's operations communications environment. All operations communications criteria for an RDT(integrated access terminal) are specified/identified in Section 13.5.

13.1.4 Organization of this Section

Following this introduction, Section 13.2 defines some terms/notations used throughout Section 13, and Sections 13.3 through 13.12 describe, in detail, specific SONET-based IDLC requirements and objectives. Many of the subsections in Section 13 cross-reference the DS1-based IDLC system material given in Sections 3 through 12 and discuss the specific changes needed to accommodate SONET-based IDLC systems. Therefore, the section headings in Sections 13.3 through 13.12 contain cross-references to the appropriate subsections in Sections 1 through 12. For example, Section 13.3.1, “Requirements for DS1 Extensions - Option (Section 3.7.4),” cross-references and augments material given in Section 3.7.4. Subsections in Sections 1 through 12 that are not mentioned in this section are applicable as written for both SONET-based and DS1-based IDLC systems.

13.2 Definition of Terms

13.2.1 Network Architecture and Definitions

Sections 1 through 12 provide definitions of terms for DS1-based IDLC systems. For SONET-based IDLC systems, several new terms are defined below.

13.2.1.1 SONET

A Synchronous Optical Network (SONET) is a transmission network constructed as a progressive hierarchy of synchronously interleaved tributary signals. In SONET, the optical interfaces are standardized so that the fiber optic equipment of one supplier can communicate optically with that of another supplier.

13.2.1.2 SONET ADM

A SONET Add-Drop Multiplex (SONET ADM) is classified with respect to its functional configuration: add-drop or terminal.

- The add-drop configuration provides access to lower-rate signals contained in the OC-N optical signal. This access allows the lower-rate signals to be extracted (dropped) and transported on different facilities (electrical or optical). Such access also provides for a lower-rate signal to be inserted (added) appropriately into the higher-rate OC-N signal.
- The terminal configuration provides the multiplex functions for multiplexing between the DS1 or higher-signal level and the SONET OC-N level.

SONET ADM equipment generic requirements and objectives are provided in TR-NWT-000496.

13.2.1.3 W-DCS

A Wideband Digital Cross-connect System (W-DCS) interfaces SONET signals, DS3s and DS1s, and has the basic functionality of a floating Virtual Tributary VT1.5 and DS1 cross-connect. W-DCS generic requirements and objectives are provided in TR-NWT-000233.

13.2.1.4 B-DCS

A Broadband Digital Cross-connect System (B-DCS) interfaces SONET signals and DS3s, and has the basic functionality of a Synchronous Transport Signal STS-1 and DS3 cross-connect. B-DCS generic requirements and objectives are provided in TR-NWT-000233.

13.2.1.5 RDT(IAT)

An RDT(integrated access terminal) [sometimes abbreviated as RDT(IAT) in this section], is a single Network Element that is comprised of multiple technologies; i.e., a SONET ADM and IDLC RDT integrated into a single product. Other combinations of technologies (e.g., DLC, SONET, FITL, etc.) are possible within an IAT, but this section is concerned with the combination of SONET and IDLC technologies within an RDT(integrated access terminal).

13.3 Requirements and Options for Customer Services (Section 3)

R13-1 **[1669]** All criteria specified in Section 3 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

The section numbers in parentheses indicate the appropriate section numbers in Section 3.

13.3.1 Requirements for DS1 Extensions - Option (Section 3.7.4)

Section 3.7.4 defines the requirements for accommodating DS1 extensions. It is **an optional RDT feature**. DS1 extensions are defined as those DS1 terminations at the RDT that do not terminate at the IDT. On the customer's side of the RDT they terminate at Customer Premises Equipment (CPE), and on the network side of the RDT they terminate at Digital Network Elements (DNEs) located in a hub or a CO.

For SONET-based IDLC systems, DS1 extensions on the customer's side of the RDT remain **an optional feature**. DS1 extensions on the network side of the RDT do not exist; rather, they are defined as VT1.5 type virtual tributaries of the SONET-based IDLC interface. These VT1.5 virtual tributaries can be easily routed via SONET facility-equipment (e.g., SONET ADM or W-DCS) located between the RDT and the LDS, or via a VT-cross-connect capability in the LDS.

For a SONET-based RDT providing DS1-extension capabilities, the following criteria apply.

R13-2 **[1670]** The capability to byte-synchronously transport DS0s of a DS1 extension that will experience DS0 grooming (i.e., a DS0 cross-connect function) at the RDT, shall be provided and the requirements of Section 3.7.4 shall be satisfied.

R13-3 **[1671]** Also, for byte-synchronous transport of DS0s, the DS0 to floating VT1.5 mapping requirements of Section 13.4.4.2 shall apply. Any robbed-bit-signaling on the DS1 extension shall be converted to VT1.5 out-slot signaling, on a per-DS0 basis.

All DS1-path and VT1.5-path performance monitoring terminates at the RDT for the above byte-synchronous interface.

R13-4 **[1672]** A DS1 asynchronous capability shall be provided at the SONET-based RDT to accommodate DS1 transport not requiring the byte-synchronous capability defined above. The generic requirements for asynchronously mapping DS1s into floating VT1.5s is defined in TR-NWT-000496 and shall be satisfied. This asynchronous transport mode can support both asynchronous and synchronous DS1s, and can be used in most applications requiring DS1 clear channel transport.

CR13-5 **[1673]** For an RDT(integrated access terminal), as illustrated in Figure 13-1, the DS1 asynchronous transport capability may be provided as part of the SONET multiplex function of the IAT rather than as part of the SONET-based RDT function.

CR13-6 **[1674]** For an RDT(integrated access terminal), as illustrated in Figure 13-1, other low-speed asynchronous transport capabilities may also be supported per the interface and mapping requirements of TR-NWT-000496.

13.4 Requirements Supporting Interfacing to the Digital Network (Section 4)

R13-7 **[1675]** All criteria specified in Section 4 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

The section numbers in parentheses indicate the appropriate section numbers in Section 4.

This section includes the SONET criteria needed to support SONET-based IDLC systems. The criteria is being updated for interoperability with SONET transport systems based on GR-253-CORE.

13.4.1 Physical Interface (Section 4.1)

Sections 1 through 12 define the DS1 interface requirements at the IDT and RDT. For IDTs and RDTs providing the SONET-based IDLC interface, the following physical interface criteria apply.

R13-8 **[1676]** As discussed in Section 13.1.3, and as illustrated in Figure 13-1, the SONET-based IDLC interface shall be comprised of up to 28 VT1.5 channels and the VT1.5 criteria of Section 13.4.4.2 shall be satisfied on each VT1.5 channel.

R13-9 **[1677]** The VT1.5 channels that constitute the SONET-based IDT interface shall be derived from either a SONET OC-3 or STS-1 line termination on the LDS.

CR13-10 **[1678]** An LDS may be required to provide a SONET OC-3 line termination.

CR13-11 **[1679]** An LDS may be required to provide a SONET STS-1 line termination.

R13-12 **[1680]** The VT1.5 channels that constitute the SONET-based RDT interface shall be derived from either a SONET OC-3 or OC-12 line termination on the RDT(integrated access terminal).

Criteria not specific to the RDT functions (i.e., support of the IDLC system) of the RDT(integrated access terminal) may be referred to as RDT(IAT) criteria when needed for clarity in this section.

CR13-13 **[1681]** An RDT(IAT) may be required to provide a SONET OC-3 line termination.

CR13-14 **[1682]** An RDT(IAT) may be required to provide a SONET OC-12 line termination.

R13-15 **[1683]** For the SONET line termination provided, the applicable criteria in Section 4, "Physical Layer," of GR-253-CORE shall be satisfied.

R13-16 **[1684]** The minimum SONET physical interface at both the LDS and RDT(IAT) shall be four SONET lines; a transmit and receive for the working line and a transmit and receive for the protection line.

R13-17 **[1685]** Any failed transmitter or receiver shall be repairable/replaceable without disrupting any of the services being carried on the SONET-based IDLC system.

Facility protection switching criteria is specified in Sections 13.6.4 and 13.12.4.2, in support of SONET-based IDLC interfaces.

13.4.2 Synchronization (Section 4.2)

Section 4.2 defines IDT and RDT synchronization requirements for DS1-based IDLC systems. The following criteria identify the synchronization requirements in support of SONET-based IDLC systems.

R13-18 **[1686]** Under non-failure conditions, both the IDT and RDT shall derive timing from a signal that is traceable to a stratum 1 timing source.

… a. The IDT shall acquire synchronization from its associated LDS, which is a stratum 3 (or better) node.

… b. The RDT shall acquire synchronization from the working SONET line interface of the RDT(IAT) (OC-3 or OC-12). Each transmit SONET line interface at the RDT(IAT) shall be timed from a clock signal synchronized to the timing derived from the working SONET line interface being received at the RDT(IAT).

R13-19 **[1687]** The performance requirements for short-term stability of SONET clocks, as stated in Section 5.4, "Network Synchronization," of GR-253-CORE, shall be satisfied at both the IDT and RDT(IAT).

R13-20 **[1688]** If the working SONET line interface fails, the automatic protection switching (1+1 unidirectional non-revertive) capabilities of the SONET line interface (see Section 13.6.4) shall establish the protection SONET line interface as the synchronization reference for the RDT(IAT).

CR13-21 **[1689]** For an RDT(IAT) providing an integrated fiber ring access capability, the capability to select the active reference by using synchronization status messages shall be provided, as proposed in Section 5.4, “Network Synchronization,” of GR-253-CORE.

R13-22 **[1690]** If both SONET line interfaces fail, the internal clock at the RDT(IAT) shall be capable of maintaining a minimum long-term free-running accuracy as specified in Section 5.4, “Network Synchronization,” of GR-253-CORE.

R13-23 **[1691]** Generic synchronization requirements for all types of SONET equipment are defined in Section 5.4, “Network Synchronization,” of GR-253-CORE, and all additional criteria applicable to the SONET-IDLC synchronization strategy specified above shall be satisfied.

CR13-24 **[1692]** An RDT(IAT) may be required in some BCC applications to provide a derived DS1 for timing distribution purposes as described in Section 5.4.5, “Timing Distribution” of GR-253-CORE.

13.4.3 Jitter (Section 4.3)

Section 4.3 defines the restrictions on jitter generation and the requirements on jitter accommodation at DS1-based IDLC interfaces.

R13-25 **[1693]** For SONET-based IDLC equipment, the jitter requirements of Section 5.6, “Jitter,” of GR-253-CORE shall be satisfied as follows:

… a. *Category I* requirements shall be satisfied at DS1 interfaces where asynchronous mapping is used.

… b. *Category II* requirements shall be satisfied at the SONET line interfaces and at DS1 interfaces where byte-synchronous mapping is used.

13.4.4 Signal Format (Section 4.4)

Section 4.4 defines the signal format for a DS1-based IDLC system. For the SONET-based IDLC systems, most of this section changes. As discussed in Section 13.1.3, and as illustrated in Figure 13-1, the DS1-based IDLC interface is comprised of up to 28 DS1 line signals whereas the SONET-based IDLC interface is comprised of up to 28 VT1.5 channels that are derived from SONET line signals. The requirements of this section are consistent with the generic signal format requirements of GR-253-CORE. This section is intended to

not replace any of the signal format requirements of GR-253-CORE, but to define the specific IDLC utilization of the SONET signal format.

13.4.4.1 SONET Line Signal Format (Section 4.4.1)

This section is titled “DS1 Framing Format” in Section 4.4.1.

The STS-1 is the basic modular signal of the SONET synchronous hierarchy; its rate is 51.840 Mb/s. The optical counterpart of the STS-1 is the OC-1 signal, which is the result of a direct optical conversion of the STS-1 after frame synchronous scrambling. The definitions of the first levels (STS-1 and OC-1) define the entire hierarchy of SONET signals because the higher-level signals are obtained by synchronously multiplexing lower-level signals.

R13-26 **[1694]** STS-1 frame formation and the multiplex procedure to compose a STS-1, OC-3, or OC-12 line signal in support of SONET-based IDLC interfaces shall satisfy the requirements of Section 3, “Rates And Formats,” of GR-253-CORE.

R13-27 **[1695]** A valid pointer (H1, H2) shall be generated for all “unequipped” STS-1s in the SONET line signal.

Table 13-1 defines the use of the SONET overhead channels for SONET-based IDLC applications. GR-253-CORE defines *each* SONET overhead channel. This section only provides coding specifications that are needed uniquely for SONET-based IDLC applications or that aid in the understanding of SONET-based IDLC interface functions.

Table 13-1. SONET Overhead for IDLC Applications

SONET Overhead Bytes	SONET Functions (see GR-253)	SONET-IDLC Applications	SONET-IDLC Requirements	
			XMT	RCV
Section Layer				
A1,A2	Framing (F628 Hex)	Same	G	P
B1	Section BIP-8	Maintenance	G	P
C1	STS-1 ID	Same	G	P
D1-D3	Section Data Com. (DCC)	Architecture Dependent	G	P
E1	Local Orderwire	Under Study	A	A
F1	Section User Channel	Optional	A	A
Line Layer				
B2	Line BIP-8	Maintenance	G	P
D4-D12	Line Data Com.	Optional	A	A
E2	Express Orderwire	Under Study	A	A
H1, H2	Pointer Action/AIS-P	Same	G	P
H3	Pointer Action Byte	Same	G	P
K1,K2	APS Channel	1+1 Unidirectional	G	P
K2(bits 6-8)	AIS-L	Same	G	P
K2(bits 6-8)	RDI-L	Same	G	P
Z1,Z2	Growth	Not Defined	A	A
MO,M1	FEBE-L	Same	G	P
STS-1 Path				
B3	Path BIP-8	Maintenance	G	P
C2	STS Path Signal Label	Same	G	P
F2	Path User Channel	Optional	A	A
G1(bits 1-4)	FEBE-P	Same	G	P
G1(bit 5,6)	RDI-P	Same	G	P
H4	Indicator Byte	Floating Superframe Structure (simplified coding sequence)	G	P
J1	STS Path Trace	Same	G	P
Z3-Z5	Growth	Not Defined	A	A
VT Path (Floating)				
V1,V2	VT Pointer	Same	G	P
	AIS-V	Same	G	P
V3	VT Pointer Action	Same	G	P
V4	VT Reserved	Not Defined	A	A
V5(bits 1-2)	VT BIP-2	Same	G	P
V5(bit 3)	FEBE-V	Same	G	P
V5(bit 4)*	RDI-V	Same	G	P
V5(bits 5-7)	VT Signal Label	Same	G	P
V5(bit 8)	RDI-V	Same	G	P
J2	VT Path Trace	Not Defined	A	A
Z6,Z7	VT Path Growth	Not Defined	A	A
Z7 (bit 8)	RFI-V*	Yellow-for Byte-Sync*	G	P
$P_1P_0S_1S_2S_3S_4FR$	Out-Slot Signaling	ABCD Signaling	G	P
	F-bit Carriage	Not Supported	A	A

A = Access to/from the bytes is all that is required.
G = Generation of valid data to the bytes is required.
P = Processing and interpretation of data from the bytes is required.
* = This function/application is expected to be redefined to use bit 4 of the V5 byte; see Issue 253-25 of GR-253-ILR.

R13-28 **[1696]** The transmit (XMT) and receive (RCV) requirements of Table 13-1 for access, generation, and processing of SONET overhead bytes shall be satisfied at all SONET line terminations that support SONET-based IDLC interfaces.

13.4.4.2 VT1.5 IDLC Channel Format (Section 4.4.2)

This section is titled “Frame Organization,” in Section 4.4.2.

R13-29 **[1697]** At the SONET-based IDLC interface, up to 28 VT1.5 channels in the floating VT mode, per the criteria of Section 3.4.1, “Sub-STS-1 Mappings” of GR-253-CORE, shall be accommodated.

GR-253-CORE, Section 3 defines and illustrates the VT1.5 IDLC channel format.

CR13-30 **[1698]** The SONET line signal of an RDT(integrated access terminal) may also be used to support VT2, VT3, and/or VT6 channels in addition to the VT1.5 channels associated with the SONET-based IDLC interface.

O13-31 **[1699]** To allow an RDT(integrated access terminal) maximum flexibility to utilize its SONET line interface for the transport of VT2, VT3, and/or VT6 channels, it is desirable that the SONET-based IDLC system grow on a group-by-group basis rather than on a VT basis; i.e., if growing by four VTs, assign all four VTs of a group to the IDLC interface rather than a VT from four different groups.

R13-32 **[1700]** For the Generic IDLC Interface to be applicable for the SONET-based IDLC interface, and to maintain IDT-RDT interoperability between DS1-based and SONET-based IDLC equipment, the VT1.5 channels must be identified/managed (i.e., numbered) within the IDLC system as VT1.5 channels 1 through 28, irrespective of which STSs carry them in the SONET line signal. Thus, SONET-based IDLC equipment must maintain a mapping of the IDLC VT1.5s numbered 1 through 28 to the STS/VT channel in which they are carried.

CR13-33 **[1701]** If a VT cross-connect function is required to allow the VTs of the SONET line signal to be identified/numbered as VT1.5 channels 1 through 28 for IDT-RDT interoperability, it shall satisfy the VT cross-connect criteria of TR-NWT-000233.

In the floating VT mode, four consecutive VT frames are organized into a 500-µsec superframe structure as illustrated in Figure 3-20 of GR-253-CORE. The phase of the VT superframe is indicated by the indicator byte (H4) in the STS-1 Path Overhead (POH), as

illustrated in Figure 3-23 of GR-253-CORE, such that the location of bytes V1, V2, V3, and V4 of Figure 3-20 of GR-253-CORE can be determined.

R13-34 **[1702]** Because the SONET-based IDLC interface is only required to support the floating VT mode, a simplified H4 coding (defined in Figure 3-26 of GR-253-CORE) shall be used as illustrated in Figure 3-20 of GR-253-CORE, where the "x" bits of the H4 byte are all set to "1."

Bytes V1 and V2 of each of the VT1.5 superframes indicate the offset from byte V2 to the beginning of that specific VT1.5 SPE. The interpretation of V1 and V2 for determining a VT1.5 pointer offset is illustrated in Figures 3-41 and 3-42 of GR-253-CORE. The first byte of the VT1.5 SPE is the VT1.5 Path Overhead (V5), as illustrated in Figure 3-21of GR-253-CORE; V5 interpretation is illustrated in Figure 3-25 of GR-253-CORE.

O13-35 **[1703]** As an objective, when generating a SONET signal, "0s" should be inserted (before scrambling) into all unassigned, unspecified, or reserved bits and bytes of the SONET signal format.

R13-36 **[1704]** A valid pointer (V1, V2) shall be generated for all unequipped VT1.5s.

R13-37 **[1705]** At the SONET-based IDLC interface, DS0s shall be byte-synchronously mapped *directly* (i.e., without a DS1 interface) to and from the VT1.5 channels, per the applicable criteria in Section 3.4.1 of GR-253-CORE.

CR13-38 **[1706]** If per DS0, ABCD signaling codes need to be transported across a SONET-based IDLC interface, they shall be carried out-slot via the out-slot signaling transfer mode defined in Section 3.4.1 of GR-253-CORE.

It will take six VT superframes (i.e., 24 frames; 3 ms) to complete a signaling cycle for all 24 DS0s of a VT1.5 virtual tributary. Bits $S_1S_2S_3S_4$ are carried in the byte following V5, then every 26th byte thereafter, within that VT1.5 SPE; there are 104 bytes in each superframe for the VT1.5 SPE (bytes V1 to V4 are not included in the VT1.5 SPE). The $S_1S_2S_3S_4$ bits are used to transport the signaling bits for the 24 DS0 circuits. The phase of the signaling bits is indicated by the P_1P_0 bits, as defined below.

P_1P_0=00 indicates the "A" signaling phase
P_1P_0=01 indicates the "B" signaling phase
P_1P_0=10 indicates the "C" signaling phase
P_1P_0=11 indicates the "D" signaling phase

(refer to Figure 3-28 of GR-253-CORE for ABCD-to-DS0 coordination)

13.4.4.3 Delay (Section 4.4.3)

Delay is a serious concern for IDLC systems and is one of the reasons for requiring the floating VT mode. In the floating VT mode, pointers associated with each VT1.5 virtual tributary maintain self-synchronization of that VT as it is groomed with other VTs from other RDTs to provide a highly utilized SONET interface to the LDS. The floating VT mode eliminates the need to frame-align/buffer (i.e., delay) the VT1.5 as it passes through intermediate SONET nodes (i.e., those nodes doing the VT-grooming).

R13-39 **[1707]** Echo-path-delay requirements shall be the same as specified in Section 4.4.3.

The delay requirements in Section 4.4.3 essentially limit the maximum echo-path-delay of an IDLC system to 3.25 ms from the center of the switch to the 2-wire line termination at the RDT. This limit is based on a switch loss plan that inserts no loss (i.e., 0 dB) for intra-office connections. Recent changes in ANSI Standard T1-508 allow network loss values from 0 to 6 dB (typically 0, 3, or 6 dB) for intraLATA connections involving the same exchange carrier. If such a network loss plan is implemented, additional delay would be available for an IDLC system; the amount of additional delay is a function of the amount of network loss inserted on intraLATA connections involving the same exchange carrier. The distribution of such additional delay between digital signal processing (for added equipment functionality) and facility propagation (for extended deployment range) will be dictated by the architecture of each BCC access network.

CR13-40 **[1708]** If the LDS serving an IDLC system implements a network loss plan that inserts a loss (greater than 0 dB) for intra-office connections, then the echo path delay of that IDLC system shall not exceed the guidelines in ANSI T1.508.

13.4.4.4 Reframe Time (Section 4.4.4)

R13-41 **[1709]** At SONET-based IDLC interfaces, the framing requirements of Section 5.5, “Framing For SONET Signals” of GR-253-CORE shall be satisfied.

13.4.4.5 DS0 Channel-to-Time-Slot Numbering (Section 4.4.10)

R13-42 **[1710]** For the SONET-based IDLC interface, DS0 channels are assigned to time-slots of VT1.5 virtual tributaries instead of DS1 facilities. The same numbering strategy defined in Section 4.4.10 shall be used.

As illustrated in Figures 13-1 and 13-2, DS0 channels served by an IG must have unique logical numbers from 1 through 2048 relative to that IG.

CR13-43 **[1711]** For an IAT supporting more than one IG, each line circuit (e.g., DS0 channel) of each line unit shall have full access to all the DS0 time slots supported by the IG to which the line circuit is associated.

13.4.5 Digital Transmission Facility Maintenance (Section 4.5)

Facility maintenance requirements for DS1 facilities are provided in Section 4.5. Similar facility maintenance strategies/capabilities are needed for line facilities supporting SONET-based IDLC systems, as follows:

a. **Single-Ended Fault Location**

Once a fault has been determined to be in the SONET line facility, the capability to locate the fault on the SONET line facility by tests performed from one end of the SONET line facility, is required. Section 13.6.3 specifies requirements for single-ended fault location on SONET line facilities.

b. **Test Access**

R13-44 **[1712]** Test access capabilities at SONET line facility interfaces shall meet the generic test access requirements in Section 6.2.3.1, “Test Access” of GR-253-CORE.

c. **Order Wire**

R13-45 **[1713]** The SONET format provides two order-wire bytes in its overhead structure. Byte E1, in the Section overhead, is allocated for use as a local order-wire channel and byte E2, in the Line overhead, is allocated for use as an express order-wire channel. Byte E2 provides for communications between Line Termination Equipment (LTE). Byte E1 provides for communications between regenerators, hubs, and remote terminal locations. For SONET-based IDLC systems, *access* [1]shall be provided to both of these order wires (E1 and E2).

CR13-46 **[1714]** If order-wire functionality is required for a specific application, the criteria in Section 5.2.2, “Orderwire (OW)” of GR-253-CORE shall be met.

1. *Access* of SONET overhead bytes requires only the capability of obtaining data from, and placing data into, overhead locations. Processing, or interpretation, of the data may or may not be required, depending on the specific application.

d. **Manual Control**

R13-47 **[1715]** SONET-based IDLC systems shall provide the capability to remove any of its SONET VT1.5 channels from service. The capability to activate these manual controls locally and remotely shall be provided.

The capability to inhibit switching of SONET line facilities and to manually initiate a switch of SONET line facilities is discussed in Section 13.6.4.

13.4.6 Digital Transmission Facility Performance (Section 4.6)

Section 4.6 provides parameter definitions, data storage requirements, and alert declaration requirements for DS1-based IDLC systems. This section summarizes the parameter definitions, data storage requirements, and alert declaration requirements to accomplish performance monitoring at SONET-based IDLC interfaces.

Section 6.2.2, “Performance Monitoring (PM)” of GR-253-CORE provides generic performance monitoring requirements for all SONET equipment and is used to specify specific SONET-based IDLC requirements in the following subsections.

13.4.6.1 Parameters and Data Storage Requirements (Section 4.6.1)

R13-48 **[1716]** All criteria in Section 6.2.2, “Performance Monitoring (PM)” of GR-253-CORE for

… a. General Accumulation and Thresholding Requirements

… b. Physical Layer PM

… c. Section Layer PM

… d. Line Layer PM

… e. Near End STS Path Layer PM

… f. Near End VT Path Layer PM

… g. PM During Troubles

… shall be met at all SONET-based IDLC interfaces (i.e., VT-path layer PM) and the associated SONET facility line interfaces (i.e.; physical, section, line, and STS-path layer PM).

R13-49 **[1717]** The generic data storage requirements in Section 6.2.2.1 of GR-253-CORE shall apply to SONET-based IDLC equipment as follows:

… a. They shall apply to all working and protection lines/paths

… b. For STS-path PM, data storage is only required for the near-end parameters

… c. For STS-path PM, data storage is only required for equipped STS-1 path terminations

… d. For VT-path PM, data storage is only required for the near-end parameters

… e. For VT-path PM, data storage is only required for equipped VT path terminations.

R13-50 **[1718]** When any register capacity is exceeded, the register shall not roll over but shall be pegged at the maximum value.

13.4.6.2 Alert-Declaration and Protection-Switching Threshold Requirements (Section 4.6.2)

This section presents requirements addressing default values for SONET-based IDLC system alert declarations (see Table 4-1 for default values for DS1 alert declarations).

R13-51 **[1719]** In addition to the threshold register requirements in Section 6.2.2.1, “General Accumulation and Thresholding Requirements” of GR-253-CORE, the VT-path terminations that constitute the SONET-based IDLC interface shall utilize as defaults the defaults specified in Table 4-1 for DS1-based IDLC interfaces to achieve similar levels of IDLC system performance, as follows:

… a. For VT-path ESs: 648/day and 65/15-min.

… b. For VT-path SESs: 100/day and 10/15-min.

… c. All other SONET PM defaults shall be provided and documented by the NE supplier.

R13-52 **[1720]** To initiate facility protection switching at SONET line terminations supporting SONET-based IDLC interfaces, the criteria in Section 5.3.3, “Switch Initiation and Completion Criteria” of GR-253-CORE shall be met as follows:

… Automatic switching shall be initiated by either

… • A Signal Fail (SF) condition, as defined in Section 5.3.3 of GR-253-CORE, or

… • A Signal Degrade (SD) condition with the default for the BER threshold being 10^{-5}.

CR13-53 **[1721]** For an RDT(IAT) providing an integrated fiber ring access capability, the ability to initiate path protection switching on receipt of an unequipped Signal Label for an in-service VT or STS-1 shall be provided, in addition to the criteria in TR-NWT-000496.

13.4.7 Carrier Group Alarm (Section 4.7)

Section 4.7 defines a Carrier Group Alarm (CGA) strategy for DS1-based IDLC systems. For the SONET-based IDLC systems, a similar strategy is specified that satisfies the GR-303-CORE philosophy for providing a CGA capability and is consistent with the SONET maintenance strategies being implemented in companion SONET facility-equipment (e.g., ADM and W-DCS).

R13-54 **[1722]** The criteria in Section 6.2.1, “Alarm Surveillance” of GR-253-CORE shall be met by all SONET-based IDLC equipment. The remainder of this subsection helps associate the requirements of GR-253-CORE with the DS1-based requirements of Section 4.

CFA Declaration

When a red alarm is declared, as specified in Section 4, to indicate a Carrier Failure Alarm (CFA), the detecting terminal (RDT or LDS) transmits a DS1 yellow alarm (RAI) signal in the outgoing DS1 bitstream to notify the far-end terminal of the detected failure. For SONET-based systems, there are several signals defined in Section 13.4.9.1 to accomplish a similar report to the far-end terminal.

Trunk Conditioning

As specified in Section 4, upon declaration of a CFA, per-channel conditioning is initiated to achieve the following:

a. Minimize the chance of a false billing and prevent attempts to use IDT-RDT channels for new calls by giving appropriate signaling indications to the LDS/RDT.

b. Automatically restore IDT-RDT channels to service in a coordinated manner after the trouble is cleared.

R13-55 **[1723]** For the SONET-based IDLC interface, per-channel conditioning shall be initiated in response to detected conditions/signals on the incoming SONET lines or on any of its constituent STSs, VTs, or DS0s as specified in Section 6.2.1 of GR-253-CORE.

13.4.8 SONET Overhead For Facility Maintenance (Section 4.8)

This section is titled “ESF Data-Link For Facility Maintenance” in Section 4.8.

Section 4.8 discusses the use of the DS1 Extended Super Frame (ESF) Facility Data Link (FDL) to accomplish facility alarms and performance reporting strategies for DS1-based IDLC systems.

R13-56 **[1724]** For the SONET-based IDLC interface, SONET overhead bytes (see Table 13-1) shall be used to accomplish all facility maintenance strategies for SONET-based IDLC systems. Section 13.4.9 defines the specific use of SONET overhead bytes to accomplish facility alarms and far-end facility performance reporting.

13.4.9 Facility Alarm/Performance Indications Via SONET Overhead (Section 4.9)

This section is titled “Facility Alarm/Performance Indications Via DS1” in Section 4.9.

This section defines how the SONET Overhead bytes are used across the SONET-based IDLC interface to accomplish SONET facility alarming and far-end performance reporting.

R13-57 **[1725]** Alarms shall be reported from the RDT/IDT detecting a fault to the appropriate OS, via the requirements of Section s 13.5 and 5.

R13-58 **[1726]** An operations message shall also be sent, from the RDT/IDT that detected the fault to the appropriate OS, when the alarm condition has cleared, via the requirements of Sections 13.5 and 5.

13.4.9.1 RDI/RFI/RAI Signals (Section 4.9.1)

The Remote Defect Indication (RDI) signal is used to indicate to the far end of the DTF that a local (incoming signal) defect has been detected. The Remote Failure Indication (RFI) and Remote Alarm Indication (RAI) signals are used to indicate to the far end of the DTF that a local failure/alarm has been declared.signals are used to indicate to the far end of the DTF that a local failure/alarm has been declared.

R13-59 **[1727]** To allow compatibility with other SONET equipment, the requirements in Section 6.2.1, “Alarm Surveillance” of GR-253-CORE shall be met for the following signals, at all SONET-based IDLC interfaces.

… a. **Line RDI (RDI-L)** - uses bits 6, 7, 8 of the K2 byte. RFI-L is derived from RDI-L at the receiving end.

… b. **STS Path RDI (RDI-P)** - uses bits 5, 6 of the G1 byte. RFI-P is derived from RDI-P at the receiving end.

… c. **VT Path RFI (RFI-V)** - uses bit 8 of the Z7 byte for the byte-synchronously mapped interface defined herein. Due to recent agreements reached in the ANSI and ITU standards bodies, it is expected that RFI-V will be redefined to use bit 4 of the V5 byte; see Issue 253-25 of the GR-253-ILR.

… d. **DS0 RAI (Yellow)** - is defined as a "0111" code in the ABCD signaling bits.

13.4.9.2 Alarm Indication Signal (Section 4.9.2)

The Alarm Indication Signal (AIS) indicates to the receiving terminal that a trouble condition exists in the DTF, but that the trouble is not located in the adjacent link (i.e., equipment between the IDT and RDT has detected the failure and replaced the failed line, STS, VT, or DS0 signal with an AIS).

R13-60 **[1728]** To allow compatibility with other SONET equipment, the requirements in Section 6.2.1, "Alarm Surveillance" of GR-253-CORE shall be met for the following signals, at all SONET-based IDLC interfaces.

… a. **Line AIS (AIS-L)** - uses bits 6, 7, and 8 of the K2 byte.

… b. **STS Path AIS (AIS-P)**- uses the H1 and H2 bytes.

… c. **VT Path AIS (AIS-V)** - uses the V1 and V2 bytes.

… d. **DS0 AIS** - is defined as a "0010" code in the ABCD signaling bits.

13.4.9.3 Far End Performance Data (Section 4.9.4)

As defined in Section 4.9.4, all DS1 interfaces at the IDT and RDT generate and transmit Performance Report Messages (PRMs) on the Facility Data Link (FDL) of each DS1. However, it is only an option for DS1s between the RDT and IDT to interpret, store, and threshold received PRMs. For the SONET-based IDLC interface, a similar philosophy applies.

R13-61 **[1729]** For SONET, the PRMs discussed in Section 4 have been replaced by Far End Block Error (FEBE) reports, and when required in this section,

the criteria in Section 6.2.2, “Performance Monitoring (PM)” of GR-253-CORE shall be met.

R13-62 **[1730]** Line FEBEs (FEBE-L) shall always be generated and transmitted on both the “working” and “protection” lines, as specified in GR-253-CORE; uses the M0/M1 byte.

CR13-63 **[1731]** If line FEBEs (FEBE-L) are monitored, then the criteria for far-end line PM in Section 6.2.2.4 of GR-253-CORE shall be satisfied.

R13-64 **[1732]** STS-path FEBEs (FEBE-P) shall always be generated and transmitted on all “equipped” STS-1 paths, as specified in GR-253-CORE; uses bits 1 through 4 of the G1 overhead byte.

CR13-65 **[1733]** If STS-path FEBEs (FEBE-P) are monitored, then the criteria for far-end STS-path PM in Section 6.2.2.5, “STS Path Layer PM” of GR-253-CORE shall be satisfied.

R13-66 **[1734]** VT-path FEBEs (FEBE-V) shall always be generated and transmitted on all “equipped” VT1.5 paths, as specified in GR-253-CORE; uses bit 3 of the V5 VT-Path overhead byte.

CR13-67 **[1735]** If VT-path FEBEs (FEBE-V) are monitored, then the criteria for far-end VT-path PM in Section 6.2.2.6, “VT Path Layer PM” of GR-253-CORE shall be satisfied.

13.5 Operations System Interfaces (Section 5)

The criteria specified in Section 5 applies for OS interfaces to an IDLC system. It applies for both the DS1-based IDLC system specified in Section 5 and for the SONET-based IDLC system specified in this section.

R13-68 **[1736]** All criteria specified in Section 5 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

For an IDLC system utilizing the Generic IDLC Interface, the criteria specified in Section 12 applies for both the DS1-based IDLC system specified in Section 5 and for the SONET-based IDLC system specified in this section.

CR13-69 **[1737]** When the Generic IDLC Interface is provided, all operations criteria specified in Section 12 for DS1-based IDLC equipment shall be

supported by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section and Section 13.12

The above two requirements can be summarized as follows with respect to operations communications requirements on SONET-based IDLC equipment:

1. An Operations Interface Module (OIM) is required in the LDS containing the IDLC system's IDT.
2. The management services and information model defined in GR-2833-CORE shall be used to accomplish the functional requirements specified in Sections 5 and 12. On an interim basis, the services and information model defined in Supplement 3 of TR-TSY-000303 may be used to support management functions between the IDT and RDT. An operations migration strategy from Supplement 3 of TR-TSY-000303 to GR-2833-CORE is proposed in SR-3581.
3. When the OIM interfaces to OSs that manage RDTs are not available or the OSs do not provide the required functionality, a supervisory system should be provided that conforms to the criteria in SR-NWT-002166 to provide or supplement the functionality of the OSs.
4. Across the Generic IDLC Interface, an Embedded Operations Channel (EOC) using a dedicated DS0 (DS0 #12 of a VT1.5 channel) and the LAPD link layer protocol shall be used to support operations communications between the IDT and RDT.

Additional criteria are needed for the SONET functionality used to support a SONET-based IDLC system. A SONET-based IDLC system is defined as an IDT and RDT interconnected by SONET byte-synchronously mapped VT1.5 channels. The additional object classes required specifically to manage the physical layer (i.e., VT1.5 channels) functionality of such SONET-based IDLC systems are not included in Supplement 3 of TR-TSY-000303.

O13-70 **[1738]** SONET-based IDLC equipment should accommodate CMIS services to the DS1 managed objects, as currently supported in Supplement 3 of TR-TSY-000303, such that the Generic IDLC Interface can be managed even though the interface is actually comprised of VT1.5 channels.

The criteria above have discussed and specified operations communications between IDT-OS, RDT-OS, and RDT-IDT. SONET-based RDTs are defined in this section as being part of an IAT and some criteria in this section may be designated as RDT(IAT) criteria to distinguish it from the RDT criteria needed to support the Generic IDLC Interface. As illustrated in Figure 13.2, one or more SONET-based IGs, in addition to SONET line terminations, VT crossconnects, and multiplex functions can be supported in an IAT, where resources can be shared. Fiber-In-The-Loop (FITL) (see TA-NWT-000909) systems can also be part of such IATs, either in addition to an IG or instead of the IG. IATs supporting the criteria of this section should be able to support the IDLC-type features of a FITL system. TA-NWT-000909 provides the complete set of criteria for FITL systems.

As stated above, an IAT may provide several features in addition to the SONET-based RDT feature. The only additional features currently specified in this section are the SONET line termination (as an end NE or an optional Intermediate NE), VT cross-connect, and SONET multiplex functions.

R13-71 **[1739]** To support its SONET functions, an IAT providing a SONET-based RDT shall support the OS/NE language requirements of GR-253-CORE via one of the following path and interface alternatives:

… a. The SONET Data Communications Channel (DCC) using an OS/NE protocol stack, as described in GR-253-CORE.

… b. The IDLC EOC using a LAPD interface, if OIM functionality is available at the LDS serving the SONET-based RDT.

CR13-72 **[1740]** In some access architectures neither OIM functionality in the LDS, nor DCC connectivity to the OSs, can provide the required functionality, and access to a supervisory system that conforms to the criteria of SR-NWT-002166 will be required.

CR13-73 **[1741]** In support of its SONET functions, in an access architecture where SONET-NEs need to communicate with each other, [2]an IAT providing a SONET-based RDT shall support the NE/NE language, path, and interface requirements of GR-253-CORE.

CR13-74 **[1742]** If the SONET DCC and OS/NE protocol stack (per GR-253-CORE) are supported by an IAT, then that path shall be capable of supporting all operations communications with OSs; i.e., not just for the SONET functions but also for the RDT functions.

The following conditional objective are intended to alert the supplier community of the BCCs intentions to move to a CMISE information model based on GR-2833-CORE for all RDT communications, in the 1996 timeframe. As part of its 1995 to 1996 work programs, Bellcore will work together with BCCs and suppliers to map a controlled migration from a TR-TSY-000303 Supplement 3 to this GR-2833-CORE CMISE interface.Bellcore has proposed a TR-NWT-000303 operations migration strategy in SR-3581.

CO13-75 **[1743]** By year-end 1996, a SONET-based RDT should begin to support **a controlled migration to** an IDT-RDT CMISE interface based on GR-2833-CORE, using the IDLC EOC and LAPD per this document.

2. Examples of such communications include remote login to/from another SONET NE and the operations communications required for some ring protection switching architectures.

CO13-76 **[1744]** By year-end 1996, a SONET-based RDT should support a CMISE interface based on GR-2833-CORE, for communicating with OSs (or Element Managers) and SONET NEs, using the following path and interface alternatives:

… • For communicating with OSs:

… — The EOC and LAPD per this document, if an OIM is available.

… — The DCC and OSI per GR-253-CORE, if a SONET gateway to the OSs is available, or

… — A DS0 (other than the IDLC EOC) and OSI per GR-828-CORE, if neither an OIM nor SONET gateway to the OSs is available.

… • For communicating with SONET-NEs:

… — The DCC and OSI per GR-253-CORE.

13.6 IDLC System Capabilities: Requirements and Options (Section 6)

R13-77 **[1745]** All criteria specified in Section 6 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

13.6.1 Equipment Maintenance (Section 6.1.3)

13.6.1.1 Trouble-Notification Coordination (Section 6.1.3.4)

Trouble notification alerts a technician, either directly or through an OS, to the existence and severity of system/equipment troubles. Trouble indications aid the technician to restore service using spare facilities, to sectionalize the trouble for efficient scheduling and dispatch of repair personnel, and to determine the nature of the trouble and the units likely to be the cause of the trouble. Section 6.1.3.4 specifies requirements for two types of trouble notifications: alarmed trouble notifications and non-alarmed trouble notifications.

When multiple technologies are combined in a single NE (i.e., an IAT), that IAT may be required to send specific trouble notifications to specific locations and, in some cases, to multiple locations. The important thing is that the trouble notification gets to the right technician(s) so that the trouble can be fixed without initiating an uncoordinated duplication of efforts.

CR13-78 **[1746]** RDT(integrated access terminals) that provide multiple operations channels shall provide the capability for the user to designate the operations channel to be used in sending trouble notifications to an OS and/or LDS, by trouble notification type.

13.6.2 Data-Link Protection (Section 6.1.4)

13.6.2.1 General (Section 6.1.4.1)

An operations data link between the Integrated Digital Terminal (IDT) and the Remote Digital Terminal (RDT) is used to transport operations messages between an OS and the RDT and between the IDT and RDT. For a SONET-based IDLC system, the operations data link will use bandwidth (e.g., a DS0 channel) within the SONET payload.

IDLC systems also use a data link to transport call processing control information between the IDT and RDT for locally switched services. For a SONET-based IDLC system, the signaling data link will also use bandwidth (e.g., a DS0 channel) within the SONET payload.

13.6.2.2 Requirements (Section 6.1.4.2)

The requirements specified in Section 6.1.4 are, in general, applicable to both the operations and signaling data links in a SONET-based IDLC system.

R13-79 **[1747]** For SONET-based IDLC systems, the operations and signaling data links shall each occupy bandwidth (e.g., DS0s) within the SONET payload. All other requirements specified in Section 6.1.4.2 are applicable.

13.6.3 Single Ended Fault Locating (Section 6.1.5)

13.6.3.1 General (Section 6.1.5.1)

Section 6.1.5 provides Single Ended Fault Locating (SEFL) requirements for DS1 facilities. Similar capabilities are needed for SONET line facilities.

For SONET line facilities supporting SONET-based IDLC systems, fault location will be accomplished by taking advantage of the overhead capabilities of the SONET format, in most situations. Some situations, however, may require local test access and loopback capabilities.

13.6.3.2 Requirements (Section 6.1.5.2)

The following five layers of performance monitoring are defined in Section 13.4.6.1:

- Physical Layer
- Section Layer
- Line Layer
- STS-Path Layer
- VT-Path Layer.

R13-80 **[1748]** All five layers of PM data shall be available (locally for near-end data and remotely for far-end data) to allow for single-ended fault locating. Testing requirements are in Section 6.2.3, “Testing Process” of GR-253-CORE and shall be met at both ends of a SONET line facility supporting SONET-based IDLC systems, to provide local test access and loopback capabilities.

13.6.4 Facility Protection Switching (Section 6.2.1)

13.6.4.1 General

Facility protection switching is an option for DS1-based IDLC systems because a multi-DS1 IDLC system allows the operations and call processing data links to be duplicated on separate DS1 facilities without providing facility protection switching. This facility diversification is not possible on a fiber optic system that uses a single fiber optic pair. Therefore, facility protection switching is required for SONET-based IDLC systems.

The protection switching requirements for a SONET-based IDLC system are given in the following section.

13.6.4.2 Requirements (Section 6.2.1.2)

For IDLC systems with a proprietary interface between the RDT and IDT, the details of the protection switching procedures are, in general, supplier specific. However all supplier-specific procedures shall include the following:

R13-81 **[1749]** A 1+1 protection switching scheme shall be used; i.e., both the “protection” and “working” fiber optic facilities shall carry the same signal.

R13-82 **[1750]** Protection switching shall be unidirectional; i.e., only the direction of transmission that fails shall switch.

R13-83 **[1751]** Protection switching shall be non-revertive; i.e., the IDLC system shall not switch back automatically when the failed facility becomes acceptable again.

R13-84 **[1752]** The requirements specified in Section 6.2.1 that are not in conflict with the above requirements shall also be applicable to SONET-based IDLC systems.

A supplier-specific protection switching scheme may limit the application of an IDLC system. For example, an RDT of an IDLC system in an integrated network access configuration may interface a Wideband Digital Cross-Connect System (W-DCS) before terminating on the IDT. A supplier-specific protection switching scheme may not allow protection switching to be implemented between the RDT and W-DCS and between the W-DCS and IDT.

O13-85 **[1753]** Therefore, it is highly *desirable* that a supplier's protection switching scheme meet the requirements of the generic protection switching scheme discussed in Section 5.3, “Automatic Protection Switching” of GR-253-CORE, subject to the thresholding criteria in Section 13.4.6.2.

CO13-86 **[1754]** For an RDT(integrated access terminal) providing an integrated fiber ring access capability and unidirectional path protection switching, it is desirable that the criteria of GR-1400-CORE, *SONET Dual-Fed Unidirectional Path Switch Ring (UPSR) Equipment,* be satisfied. (GR-1400-CORE replaces TR-TSY-000496, Supplement 1, September 1991.)

CO13-87 **[1755]** For an RDT(integrated access terminal) providing an integrated fiber ring access capability and bidirectional line protection switching, it is desirable that the criteria of GR-1230-CORE be satisfied.

13.7 Requirements Supporting Craftsperson Interfacing to IDLC (Section 7)

R13-88 **[1756]** All criteria specified in Section 7 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

CR13-89 **[1757]** For NEs supporting multiple technologies (i.e., IATs), all craft activities shall be available via a single user system interface (i.e., craft interface) at the IAT.

13.8 Requirements Supporting IDLC Administration (Section 8)

R13-90 **[1758]** All criteria specified in Section 8 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section.

13.9 Requirements Supporting System Turn-up (Section 9)

R13-91 **[1759]** All criteria specified in Section 9 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

13.9.1 System Turn-up Requirements (Section 9.1.2)

R13-92 **[1760]** The requirements in Section 9.1.2 shall apply to SONET-based IDLC systems with the following changes to address the fact that the interface is SONET-based VT1.5s rather than DS1s:

… a. A SONET-based IDT shall go to a stable state without an active RDT (either SONET- or DS1-based) terminating the far end of the IDLC interface.

… b. The SONET-based RDT shall go to a stable state without an active IDT (either SONET- or DS1-based) terminating the far end of the IDLC interface.

… c. The SONET PM storage registers identified in Section 13.4.6.1 shall be set to zero on power-up.

R13-93 **[1761]** SONET-based IDLC systems have the following additional requirements:

… a. For protection switching purposes, the RDT and IDT shall initialize with one of its SONET line facilities identified as “channel 0” and the other identified as “channel 1.”

… b. At system turn-up, “channel 1” channel shall be designated the “working” channel and “channel 0” the “protection” channel.

13.9.2 Memory Administration Data Initialization Requirements (Section 9.1.3)

R13-94 **[1762]** The requirements in Section 9.1.3 shall apply to SONET-based IDLC systems with the exception of the SONET performance monitoring values (defaults) for Threshold Crossing Alerts (TCAs) and Automatic Protection Switching (APS), which are specified in Section 13.4.6.2.

13.10 Miscellaneous (Section 10)

R13-95 **[1763]** All criteria specified in Section 10 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this revision, except as modified/augmented in this section.

13.10.1 Powering and Safety (Section 10.2)

This section is titled “Powering and Electrical Safety” in Section 10.2.

R13-96 **[1764]** For the SONET-based IDLC interface, the fiber optic safety precautions and requirements of Section 7.4, “Safety” of GR-253-CORE shall be met, in addition to the powering and electrical safety requirements in Section 10.2.

13.10.2 Quality and Reliability (Section 10.3)

The end-to-end availability objective for subscriber lines is 99.99% or, equivalently, 0.01% maximum unavailability (53 minutes/year downtime). Because network reliability as perceived by the customer must not be jeopardized by IAT deployment, IATs need to meet these same objectives.

R13-97 **[1765]** An RDT, whether a stand-alone NE or part of an IAT, shall provide levels of reliability/availability equivalent or better than those specified in Section 10.3 for DS1-based IDLC equipment.

Currently, an RDT has its own reliability/availability requirements. Hopefully, when combined with other technologies within an IAT, a better level of reliability/availability can be realized.

13.11 IDLC System Transition Considerations (Section 11)

R13-98 **[1766]** All criteria specified in Section 11 for DS1-based IDLC equipment shall be satisfied by the SONET-based IDLC equipment defined in this section.

13.12 LDS-RDT Generic Interface - Requirements and Options (Section 12)

Section 12 provides the Generic IDLC Interface requirements for DS1-based IDLC systems. As discussed in Section 13.4, the SONET-based IDLC interface is comprised of 28 floating byte-synchronously-mapped VT1.5 channels, irrespective of the physical SONET line termination. The criteria in this section focus on the use of VT1.5 channels rather than DS1s at the physical layer of the Generic IDLC Interface. Most of the details associated with the use of VT1.5 channels rather than DS1s is provided in Section 13.4. All layers above the physical layer of the Generic IDLC Interface are unaffected by the SONET-based IDLC interface, but some of the criteria may be re-stated in this section to add clarity to its application at SONET-based IDLC interfaces.

R13-99 **[1767]** All criteria specified in Section 12 for DS1-based IDLC equipment and its Generic IDLC Interface shall be satisfied by the SONET-based IDLC equipment defined in this section, except as modified/augmented in this section.

13.12.1 Generic IDLC Interface Requirements - Executive Summary (Section 12.2)

As illustrated in Figures 13-1 and 13-2, the DS1-based IDLC interface is comprised of up to 28 DS1 lines and the SONET-based IDLC interface is comprised of up to 28 SONET VT1.5 channels. A VT1.5 channel is not a defined line signal and must be derived from an acceptable SONET line signal; therefore, SONET line terminations are illustrated in Figures 13-1 and 13-2. Because an OC-3 and OC-12 can carry more than 28 VT1.5s, a VT cross-connect (XC) function is also illustrated in Figures 13-1 and 13-2 to derive up to 28 VT1.5 channels from the SONET line signal. For all Layers above the physical layer, the Generic IDLC Interface is completely applicable for the SONET-based IDLC interface.

Section 13 proposes that either a SONET OC-3 or STS-1 line termination be provided at the LDS and that either a SONET OC-3 or OC-12 line termination be provided at the RDT(integrated access terminal). Automatic protection switching is required at all SONET line interfaces that support a SONET-based IDLC interface.

Also, for the SONET-based IDLC interface, the EOC is carried in DS0 #12 of the primary VT1.5 channel, the TMC/CSC is carried in DS0 #24 of the primary VT1.5 channel, and all

"ABCD" signaling codes (for Hybrid signaling and support of non-locally switched circuits) are carried via SONET's "out-slot" signaling transfer method.

13.12.2 Interface Functionality (Section 12.4)

13.12.2.1 Generic Implementation of Interface Functions (Section 12.4.2)

To emphasize the interoperability of SONET(VT1.5)-based IDLC equipment with DS1-based IDLC equipment, Section 13.12.2.1 is rewritten from the DS1-based version in Section 12.4.2 and provided here as the SONET(VT1.5)-based version.

13.12.2.1.1 SONET Facility Operations (Section 12.4.2.1)

As specified in Section 13.12.2.1.4, the SONET floating byte-synchronously-mapped VT1.5 format shall be used across the Generic IDLC Interface. Within the definition of the SONET transport format is the capability to provide line/STS/VT/DS0 alarms (AIS, RAI, RDI, and RFI) and far-end line/STS/VT performance monitoring (FEBEs).

13.12.2.1.2 IDLC System/Terminal Operations (Section 12.4.2.2)

As specified in Section 13.12.4.1, the Generic IDLC Interface shall support all IDLC system/terminal operations via a DS0 data link (DS0 #12 of a VT1.5 channel) dedicated to operations. Details on the physical, protocol, language, and message interface requirements are provided throughout Sections 5 and 12.

Some additional criteria is provided in Section 13.5 for IATs providing the SONET(VT1.5)-based RDT functionality.

13.12.2.1.3 Call Processing (Section 12.4.2.3)

R13-100 **[1768]** The LDS shall support call processing across its SONET(VT1.5)-based IDLC interfaces by either the Hybrid (TMC with ABCD codes) or CSC signaling method.

CR13-101 **[1769]** In some BCC access architectures, the LDS may be required to support the Hybrid signaling method across its SONET(VT1.5)-based IDLC interfaces; i.e., ABCD-coded signaling on a per-channel basis with the TMC being used for all dynamic time-slot management needs.

CR13-102 [1770] In some BCC access architectures, the LDS may be required to support the CSC signaling method across its SONET(VT1.5)-based IDLC interfaces; i.e., the CSC is used for all per-channel signaling and dynamic time-slot management needs.

CR13-103 [1771] In some BCC access architectures, the LDS may be required to support the Hybrid signaling method at some of its IDTs and the CSC signaling method at some of its other IDTs.

The use of the CSC across the DS1-based Generic IDLC Interface allows all DS0s to be transported as clear-channel DS0s (i.e., DS0s without ABCD robbed-bit-signaling) between the RDT and the LDS. The transport of DS0s as clear channels allows for more flexibility, and simplifies operations and administration, in the DTF between the RDT and the LDS. SONET-based IDLC equipment meeting the requirements of this section transports ABCD codes, not in-band using robbed-bit-signaling but out-of-band using bits in the SONET VT overhead, thus allowing DS0s to be transported as clear channels even when the CSC is not used.

R13-104 [1772] The RDT shall either support hybrid signaling, or out-of-band signaling using a CSC.

Requirements for implementing the Time-slot Management Channel (TMC) and Common Signaling Channel (CSC) are provided in Section 12.5.1 through Section 12.5.5. The ABCD codes (as defined in Section 12.5.2.1) used in the Hybrid signaling method, are implemented as described in Section 12.6.1.3.1.

13.12.2.1.4 Information Transport (Section 12.4.2.4)

R13-105 [1773] The method of transporting information across the SONET(VT1.5)-based Generic IDLC Interface shall be via DS0 time-slots of the SONET floating byte-synchronously-mapped VT1.5 format.

R13-106 [1774] The out-slot signaling transfer mode of the SONET floating byte-synchronously-mapped VT1.5 format shall be used to transport all ABCD codes across the SONET(VT1.5)-based IDLC interface. This signaling transfer mode allows all DS0s to be transported as 64-kb/s clear channels.

Section 12.5.8 gives specifics on division of IDLC transmission requirements between the LDS and the RDT.

13.12.2.1.5 Loop Testing (Section 12.4.2.5)

To support proprietary testing protocols between a TSC and its remote measuring unit, one or more DS0 channels may be needed between the RDT and LDS. Since the channel requirements are the same as those for customer information transport, no further requirements are included in the Generic IDLC Interface.

13.12.2.1.6 Summary (Section 12.4.2.6)

This section (13.12.2.1) identified the functionality across the Generic IDLC Interface that will satisfy the IDLC system requirements/features of Sections 13.3 through 13.11. The remaining subsections of Section 13 describe the requirements needed in addition to those of Section 12 at both the LDS and RDT to satisfy the SONET (VT1.5)-based Generic IDLC Interface.

13.12.3 Requirements and Options Supporting Customer Services (Section 12.5)

13.12.3.1 Call Processing Techniques (Section 12.5.1)

13.12.3.1.1 Hybrid Signaling (Section 12.5.1.1)

In some BCC access architectures today, SONET-based RDTs using the Hybrid signaling method need to interface to DS1-based switches thus requiring an intermediate conversion between byte-synchronous SONET VT1.5s and DS1s. (A detailed analysis of this interoperability concern is available in “SONET-based TR-303 RDTs: Transitional Interoperability Concerns and Solutions, IEEE Global Telecommunications Conference [GLOBECOM `92].”)

As a Generic IDLC Interface solution to the above interoperability concern, the following criteria need to be supported.

CR13-107 [1775] If the Hybrid signaling method is being used across the SONET(VT1.5)-based IDLC interface, and a VT1.5 can be comprised of some mixture of DS0s (clear channel and with ABCD codes) that can dynamically change dependent on the calls being carried, then the clear-channel DS0s shall be identified within the byte-synchronously mapped VT1.5s by inserting the code ABCD=1001 into the S1-S4 bits of the SONET VT overhead of each DS0 clear channel.

… a. SONET(VT1.5)-based RDTs are required to support this requirement to interface to DS1-based IDTs.

… b. SONET(VT1.5)-based IDTs are required to support this requirement to interface to DS1-based RDTs.

… c. SONET(VT1.5)-based RDTs and IDTs are only required to insert ABCD=1001 into the S1-S4 bits of each DS0 clear channel; they are not required to interpret ABCD=1001 from the S1-S4 bits as meaning DS0 clear channel. Only the network element between the IDT and RDT that is converting between byte-synchronous SONET VT1.5s and DS1s, needs to be able to interpret ABCD=1001 from the S1-S4 bits as meaning DS0 clear channel and to treat that DS0 accordingly in both directions of transmission.

13.12.3.2 Call Processing Messages (Section 12.5.2)

13.12.3.2.1 ABCD Codes (Section 12.5.2.1)

R13-108 **[1776]** For the SONET(VT1.5)-based IDLC interface, bits *shall not* be robbed from DS0s to accomplish “ABCD” signaling code transport. All “ABCD” signaling codes shall be carried out-slot, as described in Sections 13.4 and 13.12.2.1.

This allows DS0s to retain a 64-kb/s CCC and precludes possible DS0 distortion due to robbed-bit-overwrites at tributary re-alignment nodes.

13.12.3.2.2 TMC and CSC Information Elements (Section 12.5.2.3)

13.12.3.2.3 Channel Identification (Section 12.5.2.3.7)

The channel identification element in Section 12.5.2.3.7 requires a DS1 number (within the range 1 to 28) and a DS0 number (within the range 1 to 24) when this element is used in either a TMC or CSC message.

R13-109 **[1777]** For the SONET(VT1.5)-based IDLC interface, a VT1.5 number (within the range 1 to 28) and a DS0 number (1 to 24) are required when this element is used in either a TMC or CSC message. As specified in Section 13.4.4.2, VT1.5 channels must be identified/managed (i.e., numbered) within the IDLC system as VT1.5 channels 1 through 28,

irrespective of which STSs carry them in the SONET line signal. Sequential numbering of VT1.5 channels within an IDLC system is *not required*.

13.12.3.3 Multiple Interface Group Feature (Section 12.5.10)

13.12.3.3.1 Synchronization in an RDT with Multi-IGs (Section 12.5.10.3.1)

Section 12.5.10 provides the criteria for providing a multi-IG feature in a DS1-based RDT.

R13-110 **[1778]** All criteria in Section 12.5.10 shall apply to a SONET(VT1.5)-based RDT providing a multi-IG feature with the following additional synchronization requirement for Section 12.5.10.3.1. The SONET(VT1.5)-based RDT shall be capable of reconciling any frequency difference between a VT1.5 channel (i.e., the VT1.5 Synchronous Payload Envelope, SPE) and the RDT clock without corrupting any of the data in the V5 Path Overhead byte or any of the signaling bytes.

13.12.4 Requirements and Options Supporting Interfacing to the Digital Network (Section 12.6)

13.12.4.1 Interface Requirements (Section 12.6.1)

R13-111 **[1779]** For the SONET(VT1.5)-based IDLC interface, all the criteria of this section shall apply as modified in Section 13.4. The main items to keep in mind for the criteria in this section are:

… • References to DS1 should be interpreted as VT1.5.

… • RDTs are IDLC functions supported by an IAT. The criteria in this section apply to the RDT function and should not restrict other functions supported by the IAT.

… • All criteria for the EOC apply; e.g., active & standby EOCs, datalink protocol, communications language, EOC path protection switching, etc.

… • All criteria for the TMC/CSC apply; e.g., active and standby TMCs/CSCs, datalink protocol, communications language, TMC/CSC path protection switching, etc.

R13-112 **[1780]** For multi-IG applications at an IAT, the IAT shall control common line functions (e.g., automatic protection switching) and shall be responsible for all SONET line maintenance requirements defined in this section.

O13-113 **[1781]** The architecture of an LDS should be such that the resources of an LDS that may be left stranded by any configuration that does not fully utilize the LDS's SONET line interface, are minimal. The capability to grow to full utilization should be provided.

13.12.4.2 SONET Line Facility Protection Switch (Section 12.6.2)

This section is titled "DS1 Facility Protection Switch" in Section 12.6.2. DS1 facility protection is an option.

R13-114 **[1782]** SONET line facility protection is required and shall meet the 1+1, unidirectional, non-revertive automatic protection switching requirements of Section 5.3, "Automatic Protection Switching" of GR-253-CORE.

CR13-115 **[1783]** If optional bidirectional switching is provided, the default operation shall be unidirectional switching and the associated criteria of Section 5.3 of GR-253-CORE shall be met.

CR13-116 **[1784]** For a combined NE supporting multiple technologies (i.e., an IAT) and providing an integrated fiber ring access capability, a unidirectional, dual-fed, path protection switched, self-healing ring implementation, as discussed in GR-1400-CORE, may be required.

CR13-117 **[1785]** For a combined NE supporting multiple technologies (i.e., an IAT) and providing an integrated fiber ring access capability, a bidirectional line switched ring implementation, as discussed in GR-1230-CORE, may be required.

13.12.4.3 EOC and TMC/CSC Path Protection Switching (Section 12.6.3)

R13-118 **[1786]** All criteria in Section 12.6.3 shall be supported across the SONET(VT1.5)-based IDLC interface.

13.12.5 Operations Requirements Across the Generic IDLC Interface (Section 12.7)

R13-119 **[1787]** All criteria in Section 12.7 shall be supported across the SONET(VT1.5)-based IDLC interface, except as altered by the additional criteria provided in Sections 5 and 13.5.

13.12.6 Requirements and Options Supporting System Turn-up (Section 12.8)

R13-120 **[1788]** All criteria in Section 12.8 shall be supported by SONET(VT1.5)-based IDLC equipment, except as altered by the additional criteria provided in Section 13.9.

R13-121 **[1789]** At system initialization, the RDT's VT1.5 channel #1 shall be designated as the "primary" VT1.5 for the purpose of establishing an EOC and TMC/CSC datalink capability across the SONET(VT1.5)-based IDLC interface.

13.12.7 Generic IDLC Interface Transition Considerations (Section 12.9)

The transition considerations in Section 12.9 are also appropriate for the SONET(VT1.5)-based IDLC interface.

Appendix A: Possible Load Balance Requirement Implementations

A.1 Introduction

In addition to the traffic management requirements provided in Section 8.1 of this GR, alternative proposals for IDLC traffic management are described in this appendix. These proposals define new features in hardware and switch processor tasks associated with an IDLC interface. Such new features will be a necessary part of an IDLC interface, although they may pose requirements for the LDS independent of the RDT. These proposals are presented only for purposes of discussion. They could be implemented separately or together. These proposals do not exhaust all possibilities; other proposals are indeed possible to address this issue.

The following sections first explain the traffic administration functions, and the role of the MDF in these operations. Subsequent sections then address the equivalent features that must be provided in the LDS when IDLC systems eliminate access to customer lines at the MDF.

A.2 Possible Load Balance Requirements Implementations

When a switch is placed into service, it typically has been engineered to provide subscriber service over some economic period before switch exhaust is reached. During this economic period, modular additions are often made until this ultimate design capacity is reached, at which point the switch may be replaced, or the serving area may be redefined.[1]

Both modular additions and switch replacement are costly undertakings. Much effort is directed at deferring such action for as long as possible. This deferment begins with careful engineering. Careful engineering is a preventive step in that early capacity exhaust problems are avoided. Capacity exhaust occurs when the actual cumulative traffic or line load reaches rated capacity. However, capacity exhaust can also occur on a modular level when a switch's load group exhausts, even when adjacent groups have spare capacity. Traffic administration focuses on, (1) additional preventive steps, (2) monitoring steps, and (3) corrective action steps to avoid these load imbalances by continually allocating existing switch capacity to maintain acceptable grades of service for as long as possible.

1. Much of the material in this appendix previously appeared in the August 4, 1986 issue of *Telephony* (211 No.5, pp. 52-64) as an article entitled “Main Frame Emulation Functions in IDLC Systems” by R. W. Gibson, and is reprinted here with permission.

A.2.1 Load Directed Assignments: the Preventive Step

Traffic administrators attempt to keep traffic balanced among load groups of a switch through the careful assignment of spare capacity. Balancing offered traffic provides a specified grade of service while avoiding the over-capacity that would otherwise be needed to meet a non-uniform load. Traffic administrators are aided in this process by OSs (e.g., COSMOS) that use load directed assignments to provision new service. This is a preventive step in that up-front assignments, which take expected traffic and current load into account, can prevent load imbalances.

Conventional metallic lines and derived lines from a UDLC system's COT can be spread across multiple load groups by the assigning OS. The spreading is done at the MDF by assigning each line to a switch termination selected with knowledge of the new line's expected traffic (by class of service) and the load group's current traffic load. Thus, as long as actual traffic follows the forecast, an even distribution of traffic can be maintained. However, since forecasts are never 100% accurate, continual monitoring of traffic load is required.

A.2.2 Traffic Monitoring

Once the load directed assignments have been made in the preventive step, traffic administrators must periodically monitor the actual traffic across the various load groups to determine if load imbalances or grade of service degradations have developed. If imbalances do exist, the source must be determined so appropriate corrective action can be provided.

For conventional metallic lines and for UDLC systems, monitoring is performed by the switch. Since corrective actions can be taken on a per-line basis at the MDF, Subscriber Line Usage (SLU) measurements on individual lines can direct corrective action to those lines creating the excess load. Since the other side of a corrective action is applied to a switch's load group, traffic measurements are provided for that element as well. Monitoring of an element is of value when the corrective actions that result can be applied to the same element on which the measurements have been made.

A.2.3 Rearrangements at the MDF: the Corrective Step

Since the load directed assignments of the preventive step are based on forecasts of traffic, load imbalances occasionally do occur. If significant imbalances among load groups are detected in the monitoring step, individual access lines can be moved. These rearrangements, or Line Equipment Transfers (LETs), consist of moving individual circuits from switch terminations on heavily loaded load groups to terminations on lightly loaded groups. This action is made possible by access to these lines at the MDF. This is the corrective step.

A.3 LDS Load Balancing Requirements for IDLC Systems

The preventive and corrective capabilities described above are lacking for present IDLC systems since the load of a single system cannot be spread across different load groups, and because individual line access is not available at the MDF. This leads to several potential operations penalties for IDLC systems. In the absence of preventive measures such as load directed assignment, for example, disruptive corrective measures may be more frequently invoked. For example, the assignment OS may have to resort to assignment restrictions on RDTs with high traffic. The result would be an under-utilization of RDTs. This would force an early addition of otherwise un-needed capacity in both the switch and in the OSP, additional IDLC systems, additional capital expended. As another example, large groups of DS1s, corresponding to whole RDTs, would have to be moved among switch load groups. Without a digital bridging feature, this would result in a temporary loss of both service and customer changeable translations. Even with a bridging feature, this would be disruptive and expensive.

IDLC systems present several new and interesting problems for load management at the LDS. While it is clear that this GR must communicate to the suppliers the need to provide enhanced traffic management capabilities for IDLC systems, Bellcore could not impose constraints on the supplier's proprietary internal switch operations. But, since the issues raised begged for innovative solutions and approaches, Bellcore sees no conflict in volunteering some untested, but plausible switch capabilities. Some of these, in fact, are viewed as extensions of known LDS capabilities.

The load management approaches that follow are directed at enhancing the capability to manage traffic for IDLC systems and recover the three-step traffic administration capability lost due to the functional elimination of the MDF. Specific requirements for measurement of IDLC system traffic to facilitate an effective monitoring step are provided in Section 8.1 of this GR. What follows are alternate proposals for two preventive steps and one corrective step. These traffic management capabilities - the measurement requirements in this GR and the following alternate proposals - will not replace the ability to rearrange individual customer access lines, lost with the loss of MDF access. However, they may provide alternate ways to achieve some of the same load balancing objectives. These preventive and corrective action steps are only offered as alternative concepts, for supplier consideration, **they are not requirements**.

A.3.1 LDS IDLC System Preventive Steps

Preventive steps are directed at keeping load groups in balance and minimizing the need for corrective measures. Preventive steps must therefore take into account forecasted traffic loads for classes of service and simulate - as closely as possible - the “random” terminations of conventional lines on the switch. The intent is to present a diverse mix of traffic to each of the load groups of the switch. For example, a load group containing a balanced mix of residential and business lines would take advantage of the different daily usage levels and

patterns typical of different classes of service. It would also be desirable if the load offered to the switch represented a geographically dispersed mix of traffic.

One arrangement meeting these criteria, Figure A-1, would provide full access from each IDT to all time-slots from many IDTs. Such an arrangement would require an interface among IDTs within the LDS, and sharable time-slot modules. This arrangement would lessen the need for load assignments and re-concentrations. In effect, this would increase the effective size of a load group from one IDT, to multiple IDT size. Larger load groups provide increased insensitivity to load variations, which is good. There would also be fewer load groups to administer. Since RDTs would have effective access to some of the resources of many IDTs, a geographical dispersion of traffic would result.

A variation on this procedure employs the common overflow principle (quite important in modern switching systems), in an arrangement where the load between IDTs overflows to adjacent time-slot groups. Figure A-2 shows this scheme, where excess load between adjacent IDT load groups is re-routed over a time-slot overflow path. This scheme would allow a traffic administrator - in response to a per-RDT measurement - to intervene in the allocation of time-slots between IDTs. This would be accomplished through an OS or switch software link. Instead of ordering LETs to rearrange individual lines at the MDF, as is the practice for analog lines, the switch capacity itself could be re-arranged, within limits.

This arrangement would also provide an opportunity for handling office busy hours and seasonal traffic peaks. One IDT could terminate an RDT that has primarily business traffic, with peak loads during mid-morning or afternoon. Another IDT could terminate an RDT with primarily residential service, with peak hours in the early evening as students and residents come home. On holidays there may be no traffic on the business RDT, while the other RDT may be experiencing a seasonal peak. They have different peaks, one is busy the other has idle capacity. This idle capacity could be dynamically allocated between adjacent IDTs by the logic of the switch software, or by pre-programmed OS commands.

A.3.2 LDS IDLC System Corrective Step

Effective corrective steps should characteristically not reduce planned capacity in any way. Thus, restricting customer assignments on RDTs is not an acceptable approach. Neither should customers be taken out-of-service. It is also desirable for corrective measures to be provided automatically, rather than require action by manual initiative. Measures based on the previously mentioned overflow arrangement would meet these objectives, especially if they featured, (1) dynamic reassignment of load between load groups and (or), (2) the dynamic assignment and disconnection of software controlled time-slot links. System traffic measurements could be used to set automatic thresholds to activate system overflow routines.

Corrective step measures could also be provided in an arrangement where time-slot modules can be added between the switch fabric and working IDTs, as the offered load increases. Figure A-3 represents three IDTs that may have up to three time-slot modules

assigned to each (this is an arbitrary number selected merely to illustrate this example). In the example, the first IDT has been provided with its complete complement, while middle and bottom IDT could have additional modules added. Such an arrangement may make economic sense. Time-slot modules are added as needed, as load growth occurs and as load imbalances occur. In the extreme, an IDT could be allowed enough time-slot modules to make it non-blocking.

Having this additional traffic handling flexibility becomes more important when the LDS has the Digital Cross-connect System (DCS) feature. Some IDTs may have large concentrations of NS-NLS circuits, and would need the additional traffic handling capacity provided by increasing the number of time-slot modules. Individual IDT traffic hot-spots could be accommodated, up to a limit, by adding additional traffic capacity to that IDT. However, the down side of this capability is that once the maximum number of time-slots allowed on the switch fabric is reached, no additional IDTs could be terminated. For instance, a switch module planned for say, ten IDTs in our example, but limited to fifteen time-slot modules, might in reality only terminate five IDTs. In a sense, a five IDT capacity would be stranded and additional switch modules would be needed.

A.4 Summary

The introduction of IDLC systems has removed some flexibility for operations at the MDF including the ability to use individual line terminations to balance the offered load. This Appendix described some proposed traffic management features designed to reclaim this lost flexibility. These load balancing proposals - and the traffic measurement requirements of Section 8.1 - provide, for IDLC traffic administration, the equivalent preventive, monitor, and corrective step measures that traditionally were performed at the MDF.

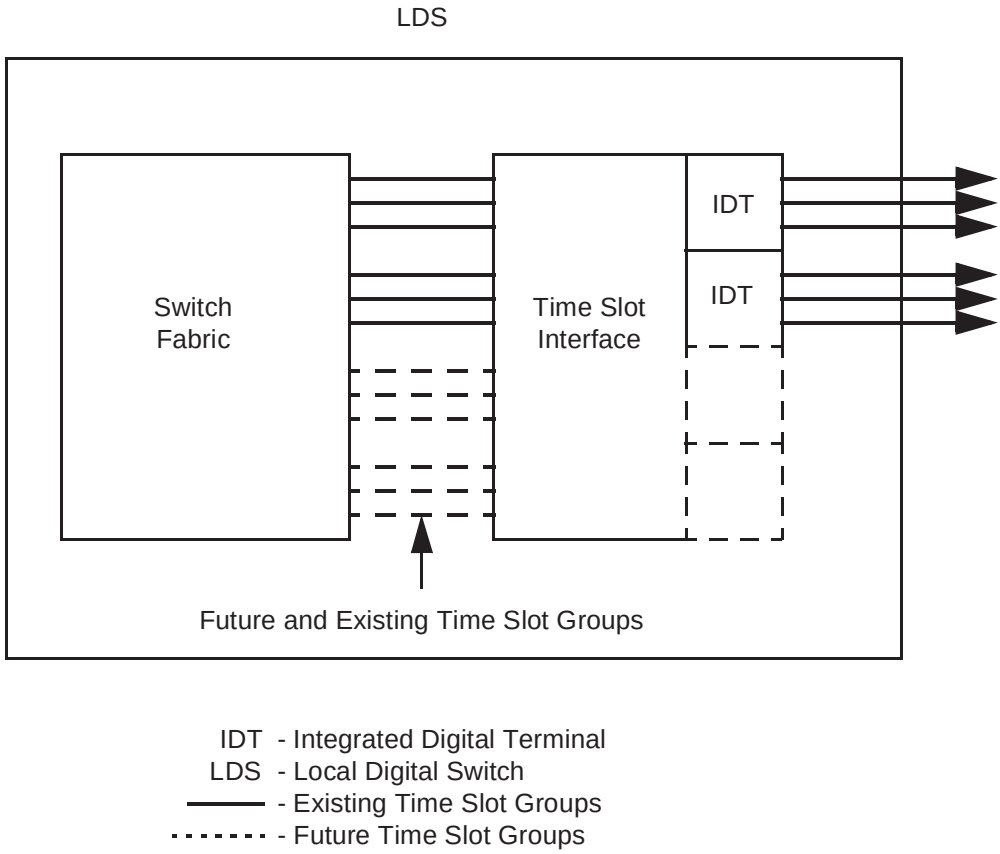


Figure A-1. Full Access to Time Slots

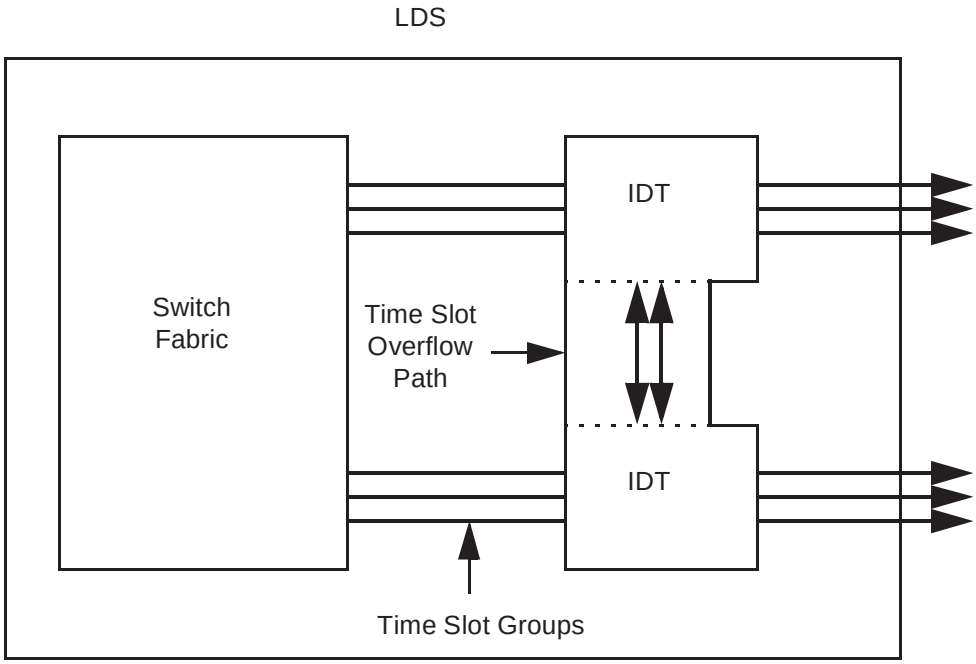
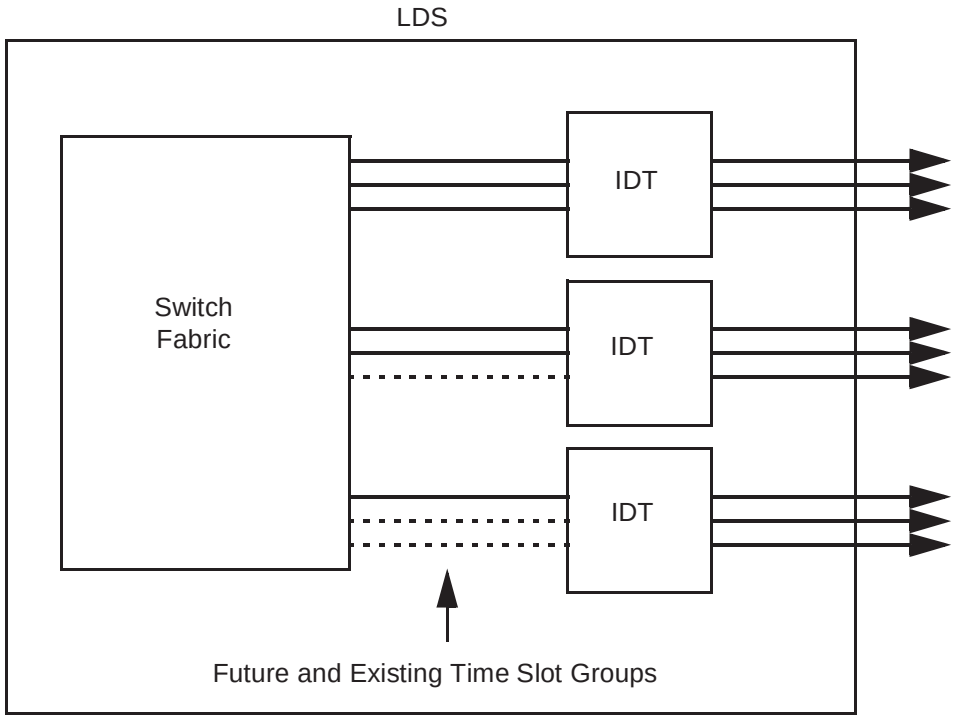


Figure A-2. Time Slot Overflow to Adjacent Load Group(s)



IDT - Integrated Digital Terminal
LDS - Local Digital Switch
——— - Existing Time Slot Groups
- - - - - - - - Future Time Slot Groups

Figure A-3. Modular Time Slot Groups

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Glossary

0TLP — Zero Transmission Level Point

ACD — Automatic Call Distribution

ACO — Alarm Cut Of

ADM — Add-Drop Multiplexer

ADTS — Automated Digital Terminal System

AFPS — Automatic Facility Protection Switching

AIS — Alarm Indication Signal

AIU — Analog Interface Unit

ALIT — Automatic Line Insulation Test

APR — Alarm Processing Remote

APS — Automatic Protection Switching

ASN.1 — Abstract Syntax Notation One

B-ISDN — Broadband ISDN

B8ZS — Bipolar with 8 Zero Substitution

BCC — Bellcore Client Company

BE — Block Error

BER — Basic Encoding Rules (for ASN.1)

BER — Bit Error Ratio

BIP — Bit Interleaved Parity

BPV — Bipolar Violation

BRA — Basic Rate Access

CAL — Customer Access Line

CCC — Clear Channel Capability

CCIS — Common Channel Inter-office Signaling

CCITT — International Telegraph and Telephone Consultative Committee

CCS — Hundred Call Seconds

CDO — Community Dial Office

CDS — Circuit Design System

CFA — Carrier Failure Alarm

CGA — Carrier Group Alarm

CID — Craft Interface Device

CMIP — Common Management Information Protocol

CMIS — Common Management Information Service

CMISE — Common Management Information Service Element

CMOS — Complementary Metal Oxide Silicon

CO — Central Office

COFA — Change Of Frame Alignment

COT — Central Office Terminal

CPE — Customer Premises Equipment

CRC — Cyclic Redundancy Check

CSA — Carrier Serving Area

CSC — Common Signaling Channel

CT — Channel Termination

CU — Channel Unit

CUG — Closed Users Group

CV — Coding Violation

DBN — Dial-Back Number

DCB — Digital Channel Bank

DCC — Data Communications Channel

DCE — Data Circuit terminating Equipment

DCN — Data Communications Network

DCS — Digital Cross-connect System

DDS — Digital Data System

DEMUX — DEMUltipleX

DL — Data-Link

DLC — Digital Loop Carrier

DLCI — Data-Link Connection Identifier

DMPB — Digital MultiPoint Bridging

DNE — Digital Network Element

DPBX — Digital Private Branch Exchange

DS0 — Digital Signal Level Zero (64 kbps)

DS1 — Digital Signal Level One (1.544 Mbps

DS3 — Digital Signal Level Three (44.7 Mbps

DSL — Digital Subscriber Line

DSX — Digital Signal Cross-connect

DTE — Digital Transmission Equipment

DTF — Digital Transmission Facility

DTMF — Dual Tone Multi-Frequency

ECL — Emitter Coupled Logic

ECSA — Exchange Carriers Standards Association

EFS — Error Free Second

EM — Element Manager

EOC — Embedded Operations Channel

ERL — Echo Return Loss

ES — Errored Second

ESF — Extended Super Frame

ESFDL — Extended Super Frame Data-Link

FDI — Feeder Distribution Interface

FDL — Facility Data-Link

FEBE — Far-End Block Error

FELB — Far-End Loop Back

FERF — Far-End Receiver Failure

FITL — Fiber In The Loop

FPS — Framing Pattern Sequence

FSD — Feature Specification Document

GaAs — Gallium Arsenide

GOS — Grade Of Service

HDT — Host Digital Terminal

HFC — Hybrid Fiber Coax

IAT — Integrated Access Terminal

ICL — Inserted Connection Loss

IDC — Information Distribution Company

IDLC — Integrated Digital Loop Carrier

IDT — Integrated Digital Terminal

IG — Interface Group

IO — Inter-Office

ISDN — Integrated Services Digital Network

ISO — International Standards Organization

ITU-T — International Telecommunication Union - Telecommunications Standardization Sector

LAN — Local Area Network

LAPB — Link Access Protocol Balanced

LAPD — Link Access Protocol D-channel

LATA — Local Access and Transport Area

LDS — Local Digital Switch

LED — Light Emitting Diode

LET — Line Equipment Transfer

LMC — Loop Maintenance Center

LOF — Loss Of Frame

LOP — Loss Of Pointer

LOS — Loss Of Signal

LOSW — Loss Of Synchronous Word

LRB — Loop Reverse Battery

LSSGR — LATA Switching Systems Generic Requirements

LT — Line Termination

LTE — Line Terminating Equipment

LULT — Line Unit/Line Termination

MDF — Main Distributing Frame

MDS — Mechanized Design System

MLHG — Multi-Line Hunt Group

MLM — Multi-Longitudinal Mode

MTAU — Metallic Test Access Unit

MTS — Message Telephone System

MUX — Multiplex

NE — Network Element

NI — Network Interface

NMA — Network Monitoring and Analysis

NOTE — Network Office Terminating Equipment

NSA — Non-Service Affecting

NTE — Network Terminating Equipment

OC-1 — Optical Carrier - Level 1 (51.840 Mb/s

OC-3 — Optical Carrier - Level 3 (155.520 Mb/s)

OC-12 — Optical Carrier - Level 12 (622.080 Mb/s)

OE — Originating Equipment

OIM — Operations Interface Module

OOF — Out-Of-Frame

OOS — Out-Of-Service

OPS/INE — Operations System/ Intelligent Network Element

OR — Office Repeater

ORB — Office Repeater Bay

OS — Operations System

OSI — Open System Interconnection

OSP — Outside Plant

OSS — Operations Support System

PA — Pointer Adjustment

PBX — Private Branch Exchange

PCM — Pulse Code Modulation

PCTF — Per-Call Test Failure

PJC — Pointer Justification Count

PM — Performance Monitoring

POH — Path Overhead

POT — Point Of Termination

POTS — Plain Old Telephone Service

QPA — Quality Performance Analysis

RAI — Remote Alarm Indication (or Yellow)

RALB — Resource All Busy

RCV — Receive

RDF — Remote Distributing Frame

RDI — Remote Defect Indication

RDT — Remote Digital Terminal

REN — Ringer Equivalent Number

RFI — Remote Failure Indication

RNR — Receiver Not Ready

ROS — Remote Operations Service

RSU — Remote Switching Unit

RTU — Remote Test Unit

SABME — Set Asynchronous Balance Mode Extender

SAP — Service Access Point

SAPI — Service Access Point Identifier

SCC — Switching Control Center

SCCS — Switching Control Center System

SEFL — Single Ended Fault Locating

SES — Severely Errored Second

SMC — Switch Maintenance Center

SMDF — Subscriber Main Distributing Frame

SONET — Synchronous Optical NETwork

SPC — Stored Program Control

SPCS — Stored Program Control System

SPE — Synchronous Payload Envelope

SRL — Singing Return Loss

SS — Supervisory System

STS-1 — Synchronous Transport Signal - Level 1 (51.840 Mb/s)

STS-3 — Synchronous Transport Signal - Level 3 (155.520 Mb/s)

SVC — Switched Virtual Circuit

SYNTRAN — SYNchronous TRANsmission

TAP — Test Access Path

TCA — Threshold Crossing Alert

TDM — Time Division Multiplex

TEI — Terminal End-point Identifier

THL — Trans-Hybrid Loss

TL1 — Transaction Language 1

TLP — Transmission Level Point

TMC — Time-slot Management Channel

TN — Telephone Number

TPI — Tip-Party Identification

TSC — Test System Controller

TSI — Time-Slot Interchanger

UAS — UnAvailable Seconds

UDC — Universal Digital Channel

UDLC — Universal Digital Loop Carrier

UNICODE — UNIversal trunk-out-of-service CODE

USI — User System Interface

UVCU — Universal Voicegrade Channel Unit

VC — Virtual Circuit

VDT — Visual Display Terminal

VF — Voice Frequency

VLSI — Very Large Scale Integration

VNL — Via Net Loss

VT — Virtual Tributary

VT1.5 — Virtual Tributary (for payloads of roughly 1.5 Mb/s)

W-DCS — Wideband Digital Crossconnect System

XC — Crossconnect

XMT — Transmit

XO — eXtended Office

ZBS — Zero Byte Substitution

ZBTSI — Zero Byte Time-Slot Interchange

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