

U S WEST

Technical Publication

U S WEST Digital Data Service

Technical Description

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Issue F
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U S WEST

Technical Publication

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Technical Description

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This publication provides technical disclosure information for the Network Channel Interfaces used with the U S WEST Digital Data Service. Included are the electrical interfaces at both customer premises and at U S WEST central offices. This publication supports the U S WEST Digital Data Service as described in the U S WEST Service Publication 77204, *U S WEST Digital Data Service Product Description, Applications, and Interface Combinations*.

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1. Introduction

1.1 General

This publication provides technical disclosure information for the Network Channel Interfaces used with the U S WEST Digital Data Service. Included are the electrical interfaces at both customer premises and at U S WEST central offices. This publication supports the U S WEST Digital Data Service as described in the U S WEST Service Publication 77204, *U S WEST Digital Data Service Product Description, Applications, and Interface Combinations*.

1.2 Reason For Reissue

This publication is being reissued to:

- Update the information about Network Interfaces with Certified Local Exchange Carriers (Chapter 4).
- Update the References (Chapter 7).

1.3 Purpose

This publication defines interfaces and technical requirements for the U S WEST Digital Data Service for both Special Access and Non-Access. The publication provides quantitative and qualitative descriptive information along with references to other publications. Descriptions of the Carrier, End-User, and U S WEST central office interfaces are included.

1.4 Access, Non-Access Service

The reader needs a partial understanding of the differences between Access and Non-Access to understand the contents of this publication.

Access service is available in the interstate Federal Communications Commission (FCC) Tariff number Five (#5, formerly FCC #1) and in the various state tariffs or price catalogs. However, Non-Access service is available only in the intrastate jurisdiction.

The U S WEST Access Service may be used for Intra Local Access and Transport Area (IntraLATA) applications or as access to another Carrier. The service may go between various combinations of End-Users or Carriers. A carrier may be a Local Exchange Carrier or an Interexchange Carrier. State tariff or catalogs often refer to Access as "End-Link" or "Mid-Link" as opposed to "End-to-End".

Non-Access applies to intraLATA applications only. Normally, an Interexchange Carrier is not involved. The circuits would connect either two End-Users or a U S WEST Interface and an End-User. State tariffs or catalogs usually refer to non-access as "End-to-End".

1.5 Publication Organization

This publication is organized as follows:

<u>Chapter</u>	<u>Contents</u>
1	General information about this document.
2	A brief description of the U S WEST Digital Data Service.
3	Network Channel Interface (NCI) codes used with U S WEST Digital Data Service
4	Technical requirements, service objectives, and technical descriptions of the service and it's options.
5	The Network Interfaces as described by the NCI codes.
6	Definitions including acronyms and a glossary.
7	References, ordering and copyright information.

1.6 Terminology

In this publication, the term "End Office" shall mean a DDS End Office. The reader should not confuse the term with definitions used with switched service applications which refer to a switch. DDS is a non-switched service.

1.7 DIGICOM[®] I AND DIGICOM[®] II Services

The U S WEST Digital Data Service is replacing two older services, DIGICOM[®] I and DIGICOM[®] II. These older services may still be available in some state jurisdictions. The new service parameters generally match those of the former DIGICOM[®] II offering. DIGICOM[®] I may differ slightly with the descriptions in this publication. This document or the respective state tariff should note any differences. The descriptions of the Network Interfaces in this document apply to both DIGICOM[®] services unless otherwise noted.

1.8 Applicability of Technical Requirements

This publication supersedes the contents of Section VII of the U S WEST Technical Publication 77320, *U S WEST Private Line Services*.

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2. Service Description

2.1 General

This chapter contains a brief description of the U S WEST Digital Data Service. Service Publication 77204 contains additional information about the service.

The U S WEST Digital Data Service provides a channel with the capability of transmitting digital data. The available data rates are 2.4, 4.8, 9.6, 19.2, 56 and 64 kbit/s. The 19.2 and 64 kbit/s data rates may not be available in all jurisdictions.

The service provides full-duplex 4-Wire transmission of synchronous serial data between two End-Users or between an End-User and another carrier. U S WEST provides timing for this service through facilities to the End-User on the received bit stream. Digital Data Service (DDS) is only available between locations connectable through compatible digital facilities.

2.2 Optional Features

The following is a list of the optional service features of U S WEST Digital Data Service.

2.2.1 Bridging Arrangement

A bridging arrangement is used for multipoint circuits. The option is available only at selected offices identified in Federal Communications Commission (FCC) #4 National Exchange Carrier Association tariff as a "DDS Hub". Additional bridging locations are available in some states (for intrastate applications only) in offices identified as "DDS Nodes".

2.2.2 Secondary Channel

Secondary Channel provides an independent lower-data rate channel that the customer may use to control or monitor their own network. The specific application is dependent on the customer owned Channel Service Unit/Data Service Unit (CSU/DSU). This option is available at the 2.4 through 56.0 kbit/s data rates. See ANSI T1.410-1992, *Carrier-to-Customer Metallic Interface -- Digital Data at 64 kbit/s and Subrates*, for further information.

2.2.3 COMMAND A LINKSM

This feature allows the customer to control the reconfiguration of a network consisting of U S WEST Digital Data Service circuits on a near real-time basis. The reconfiguration is done by using an Intelligent Network Element such as a Digital Cross-connect System (DCS).

The circuits purchased to work with COMMAND A LINKSM go from a customer location to the COMMAND A LINKSM device located in a U S WEST central office. This service is available only at selected locations. See Technical Publication 77371, *COMMAND A LINKSM Technical Description And Interface Combinations*, for further information.

2.2.4 Direct Digital Access Line

Public Switched Digital Service (PSDS) is a switched-service offering that provides the customer with the capability of establishing (by way of a PSDS network) a 56 kbit/s digital circuit.

U S WEST 's version of PSDS, SwitchNet 56[®], is described in the U S WEST Technical Publication 77329, *SwitchNet 56[®], Switched 56 kb/s Digital Service*. U S WEST provides the switch with SwitchNet 56[®].

The Direct Digital Access Line (DDAL) DDS option provides a 56 kbit/s access channel with the added capability of carrying signaling for a PSDS circuit. A DDAL line may also be used with a private switched digital network. The switch will not be provided by U S WEST with DDAL.

The document ANSI/TIA/EIA 596-1992, *Network Channel Terminating Equipment for Public Switched Digital Service*, describes the PSDS service. The ANSI document identifies the DDAL option as "Type I."

Customers needing information about a specific PSDS service should contact their PSDS service provider.

2.3 Subrated DS0 Service

This service is used to provide DS0-to-Subrate (i.e., DS0-A-to-DS0-B) multiplexing and the interoffice transport of the DS0-B. The service is available in both interstate and intrastate jurisdictions. Subrate multiplexing is available only in a DDS Hub.

The Subrated DS0 service should not be confused with the newer 64 kbit/s DDS service. The DS0-B channel format is described in ANSI T1.107-1995, *Digital Hierarchy — Formats Specifications*. The DS0-B does not require a DS1 with Clear Channel Capabilities for interoffice transport.

A mileage element is available with the Subrated DS0 Service. The DS1-to-DS0 multiplexing might be done in one hub and the DS0-to-Subrate multiplexing could be done in a different (DDS) Hub. The mileage charge would apply between the Hubs.

A new option is available that allows a customer to order a Subrated DS0 Service with subrate multiplexing in a DDS Hub at one end. The other end would terminate at a customer location. The customer will provide the other subrate multiplexer on their premises. Figure 2-1 illustrates the application. This alternative was previously available only with DS1 or above interfaces.

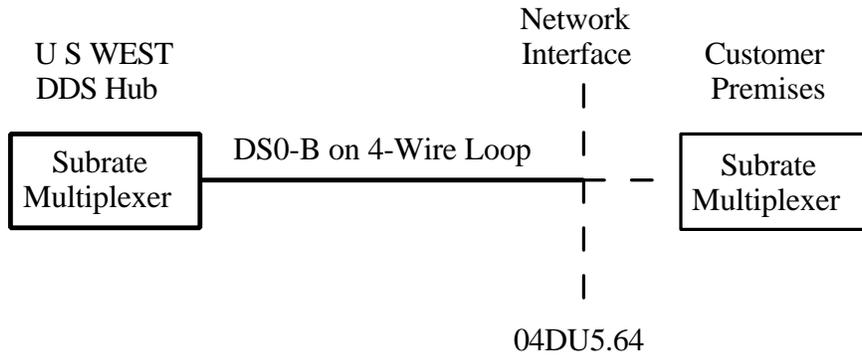


Figure 2-1 Subrated DS0 Channel With 64 kbit/s Interface

The Network Interface will be the same interface used by the DDS 64 kbit/s channel. This interface, described by the Network Channel Interface (NCI) code 04DU5.64, is described in Chapter 5.

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3. Network Channel Interface (NCI) Codes

Electrical signal specifications at an interface are encoded into Network Channel Interface (NCI) codes. The DDS NCI codes describe the Network Interface located at a customer premise or in a U S WEST central office.

This chapter provides information about the DDS NCI codes. The technical specifications of each Network Interface represented by an NCI code are in Chapter 5.

Other NCI codes may be encountered when ordering DDS service. These codes may be DS1, DS3 or some other service. These codes are beyond the scope of this document. The companion document, Service Publication 77204, does include references to other commonly encountered NCI codes.

3.1 NCI Code Function

The optional functions described by the DDS NCI codes include:

At End-User interfaces:

- Data Rate (2.4, 4.8, 9.6, 19.2, 56 or 64 kbit/s)
- Secondary Channel

At U S WEST central office interfaces:

- Data Rate for Bridging

3.2 NCI Code Form and Components

This section gives a brief description of the NCI format. A complete description of the NCI codes can be found in ANSI T1.223-1997, *Information Interchange — Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*.

3.2.1 NCI Code Form

The NCI code format has fields not used for digital services. Only those fields relevant to DDS interfaces are discussed here. A DDS NCI code has the form 04DU5.56. The period between the 5 and 56 is a delimiter used for improved clarity. It causes the Protocol Option Code, discussed later, to stand-out. An NCI code has no dashes (-).

3.2.2 NCI Code Components

A DDS NCI code has four components as illustrated in Figure 3-1.

This example of an NCI code is a DDS End-User standard 56 kbit/s interface.

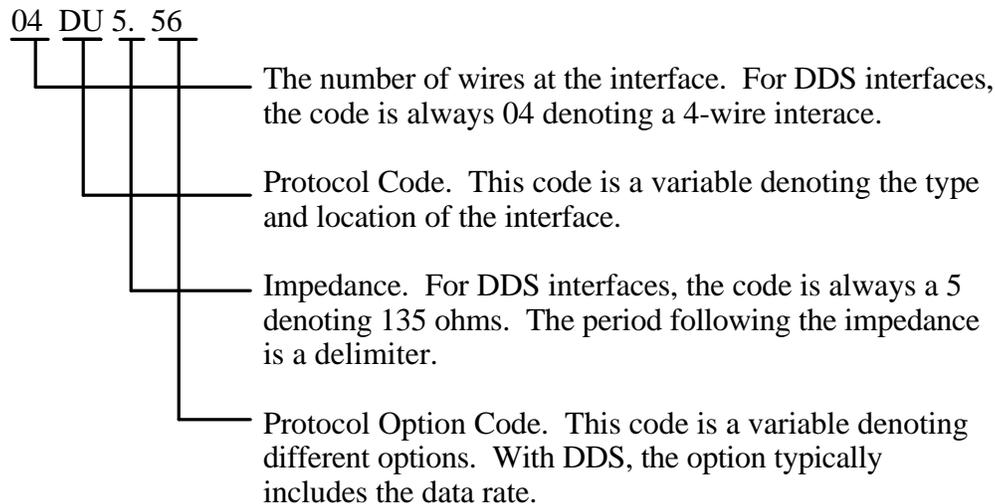


Figure 3-1 NCI Code Components

3.3 Applicable NCI Codes

The NCI codes used with U S WEST Digital Data Service are listed in Table 3-1. The interface descriptions are in Chapter 5.

The End-User NCI codes (DU) are occasionally ordered at an Interexchange Carrier - Point of Termination (IC-POT). The DU interface code requires that the carrier provide a Channel Service Unit/Data Service Unit (CSU/DSU), or the functional equivalent, on their side of the Network Interface for proper usage. A carrier using the 04DU5 interface at the IC-POT would be treated like an End-User.

U S WEST does not currently use the 04BD5 NCI code. However, the code is included to identify the interface in Chapter 5. The code is also used in PUB 77204 to list the valid NC/NCI combinations.

There are no DS0 level Network Interfaces with an Access Customer available with DDS except for a Collocated Interconnector in a U S WEST wire center. All Access Customer interfaces are at the DS1 level or above. Descriptions of these interfaces is beyond the scope of this document.

Network Interfaces with Collocated Interconnectors are discussed in Chapter 4.

Table 3-1 DDS Network Channel Interface Codes

NCI Code	Description
End-User Interfaces	
04DU5.24	2.4 kbit/s
04DU5.24S	2.4 kbit/s with Secondary Channel
04DU5.48	4.8 kbit/s
04DU5.48S	4.8 kbit/s with Secondary Channel
04DU5.96	9.6 kbit/s
04DU5.96S	9.6 kbit/s with Secondary Channel
04DU5.19 *	19.2 kbit/s
04DU5.19S *	19.2 kbit/s with Secondary Channel
04DU5.56	56.0 kbit/s
04DU5.56C *	Non-U S WEST switched service (i.e., switched 56 kbit/s DDAL). U S WEST performs call completion test from End-User premises Network Interface.
04DU5.56S	56.0 kbit/s with Secondary Channel
04DU5.64 *	64.0 kbit/s (Near Clear Channel if transported on DS1 with CCC)
04DU5.64A *	64.0 kbit/s (Non-Clear Channel)
U S WEST Central Office (CO) Interfaces	
04BD5.24	CO Bridging (MJU), 2.4 kbit/s
04BD5.48	CO Bridging (MJU), 4.8 kbit/s
04BD5.96	CO Bridging (MJU), 9.6 kbit/s
04BD5.19	CO Bridging (MJU), 19.2 kbit/s
04BD5.56	CO Bridging (MJU), 56.0 kbit/s
04DO5.A †	Digital Interface at Digital Signal Level Zero (DS0-A) - 2.4 kbit/s
04DO5.B †	Digital Interface at Digital Signal Level Zero (DS0-A) - 4.8 kbit/s
04DO5.C †	Digital Interface at Digital Signal Level Zero (DS0-A) - 9.6 kbit/s
04DO5.D †	Digital Interface at Digital Signal Level Zero (DS0-A) - 19.2 kbit/s
04DO5.E †	Digital Interface at Digital Signal Level Zero (DS0-A) - 56.0 kbit/s
04DO5.F †	Digital Interface at Digital Signal Level Zero (DS0-A) - 64.0 kbit/s
04QC5.OOJ †	Manual Cross-connect Termination - 2.4 kbit/s
04QC5.OOK †	Manual Cross-connect Termination - 4.8 kbit/s
04QC5.OOL †	Manual Cross-connect Termination - 9.6 kbit/s
04QC5.OOM †	Manual Cross-connect Termination - 19.2 kbit/s
04QC5.OOP †	Manual Cross-connect Termination - 56.0 kbit/s
04QC5.OOQ †	Manual Cross-connect Termination - 64.0 kbit/s

* Not available in all jurisdictions at the time of publication.

† See Section 4.12.

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4. Technical Requirements

This chapter contains information about the technical description of the U S WEST Digital Data Service (DDS). Two American National Standards Institute (ANSI) documents are now available to describe technical parameters of the service. The documents are:

- ANSI T1.107-1995 *Digital Hierarchy —Formats Specifications*
- ANSI T1.410-1992 *Carrier-to-Customer Metallic Interface — Digital Data at 64 kbit/s and Subrates*

The information in this chapter is in addition to the two documents. Some information may be repeated to reinforce certain key requirements. Appendix A contains some general information about delay.

4.1 Metallic Loop Design

4.1.1 Basic Designs

The local loop used with U S WEST Digital Data Service is a 4-Wire loop without inductive loading and with limited bridged tap.

Bridged tap is limited to a total of 1000 feet (with a maximum of 750 feet for the longest single bridge tap) for 56 and 72 kbit/s loop rates. The 72 kbit/s loop rate applies for 56 kbit/s with secondary channel and for 64 kbit/s data rates. The maximum bridged tap for other rates is 6000 feet. Customer's need to be aware that any bridged tap on their side of the NI will contribute to signal degradation.

The designed loop goes from an Office Channel Unit (OCU) located in the central office to the Data Service Unit (DSU). The DSU is customer provided equipment and is located on their side of the End-User Network Interface (NI). Customer provided equipment and wiring is also known as the Customer Installation. The NI at the customer's location is also known as the Customer Interface.

The DSU and the OCU must compensate for a wide range of cable conditions. Most of the technical issues concerning loop design and the related DSU and OCU are beyond the scope of this document. Those needing such information should refer to ANSI T1.410-1992.

Normal loop design limits the length of the loop to an Actual Measured Loss (AML) insertion loss of 34 dB at the Nyquist Frequency (see Table 4-1) measured using a 135 ohm termination between the OCU and the DSU.

Several options exist to serve a customer beyond 34 dB including Digital Loop Carrier (DLC), extended range OCUs, or baseband loop repeaters. These options will be used at U S WEST's discretion where available. DLC moves the OCU closer to the NI. There is no effect on the customer because of these options since the loop still appears to be 34 dB or less at the NI.

4.1.2 Allocation of Loss to the Customer

Two (2.0) dB of the loop loss budget is allocated to the customer for their side of the NI. The balance of the total loss is allocated to U S WEST. This allocation should allow the customer to reach any DSU locations beyond the NI except in the largest buildings or in large campus environments at the higher data rates. Depending on the customer's cable gauge and type, lengths of 800 to 2200 feet should be acceptable at 19.2 kbit/s data rates and below. Cable lengths for 56 and 64 kbit/s data rates range from 800 to 1800 feet.

Table 4-1 Nyquist Frequencies

Basic Channel Rate (kbit/s)	Standard		With Secondary Channel	
	Loop Data Rate (kbit/s)	Nyquist Frequency (kHz)	Loop Data Rate (kbit/s)	Nyquist Frequency (kHz)
2.4	2.4	1.2	3.2	1.6
4.8	4.8	2.4	6.4	3.2
9.6	9.6	4.8	12.8	6.4
19.2	19.2	9.6	25.6	12.8
56.0	56.0	28.0	72.0	36.0
64.0	72.0	36.0	N/A	N/A

4.1.3 Customers Requiring Additional Loss

There are several alternatives available for customers requiring more than 2 dB of the total loss budget.

The customer is welcome to use any unused portion of the loss budget available at no cost as long as there is no added cost to U S WEST. The customer will pay additional charges for any solutions (if available) requiring U S WEST to place additional equipment in the loop plant. Some long loop designs may preclude U S WEST placing any additional equipment on the loop plant.

The customer may also place one or more locally powered regenerators on their side of the NI. This alternative would not involve U S WEST except that an unexpected regenerator or a non-standard type of regenerator could cause confusion when testing the circuit.

4.1.4 Special Issues for Direct Digital Access Line Service

Due to equipment limitations, the maximum loop loss for the Direct Digital Access Line (DDAL) service may be limited to 40 dB in length including the 2 dB allocated to the customer.

4.2 Special Requirements for Secondary Channel

The document ANSI T1.410-1992 describes the coding protocols for secondary channel. Some key requirements are included in this section. There are two important requirements for 56 kbit/s with secondary channel. They are known as Coding restrictions A and B. The byte format at the NI of this type of channel is:

$$D_1D_2D_3D_4D_5D_6D_7FC'$$

where: D = Primary Channel Data Bits
F = Framing Bit (101100 repeated)
C' = (Secondary channel) Modulated carrier or network control sequence

Further information may be found in Section 8 of the ANSI document.

Multipoint 56 kbit/s circuits with Secondary Channel must meet the following restrictions:

- A station cannot transmit binary zeros in all seven D-bits of a byte.
- The interoffice portion of the master leg of such a circuit must be transported on a DS1 with Clear Channel Capability (CCC).

Two point 56 kbit/s circuits must meet either the above restrictions or the following:

- A station cannot transmit binary zeros in all seven D-bits while transmitting a C-bit of zero within the same byte.

These restrictions are to ensure that an all-zeros network byte does not occur. A DS1 terminal would overwrite the all zeros byte with the Unassigned Mux Code (UMC) and the original data would be lost.

Only one remote station can be active on the upstream secondary channel at any time. More than one would result in the unsatisfactory transmission of data. Polling procedures on the secondary channel should take no-zero differential delay between primary and secondary channels into account.

4.3 Multipoint Circuit Requirements

Bridging is used to create multipoint circuits. The multipoint circuit is a full duplex system in which there is one master station (usually a computer) and two or more simultaneously connected remote stations. All stations operate at the same data rate. The circuit legs are bridged together with Multipoint Junction Units (MJUs). Bridging is provided only in a "DDS Hub" or, in the case of an intrastate circuit in some states, in a "DDS Node".

The control or master station broadcasts downstream to the remote offices while the remote offices transmit upstream to the control station. Since each remote station receives the same signal, the master station must provide coding for address identification. This is necessary to prevent simultaneous transmission from more than one remote station back to the master station at any given time. The result of multiple transmissions would be garble since the MJU functions as an adder.

Bridging is available, with or without secondary channel, at all data rates except 64 kbit/s.

The interoffice portion of a master leg of a 56 kbit/s with secondary channel multipoint circuit must be transported on a DS1 with CCC. This is necessary to avoid potential errors in the upstream direction if the independent primary and secondary channels from the different remote stations are both all zeros at the same time.

4.4 Service Objectives

The U S WEST Digital Data Service is a high quality and reliable service. Service objectives have been established to maintain the quality and reliability.

Two primary service objectives that address transmission requirements are accuracy and availability. The accuracy objective is a measure of the number of errors that might be introduced by the transmission facility between Network Interfaces. Availability is a measure of how much time the circuit is available for use.

These objectives are comparable in the Access and Non-Access jurisdictions even though numerically different. The End-User should observe no difference between the U S WEST provided non-access end-to-end service and the end-to-end access service provided by an Interexchange Carrier, U S WEST, and another Local Exchange Carrier (which could also be U S WEST). Section 1.4 in Chapter 1 contained a discussion of Access and Non-Access.

Overall performance of the circuits is dependent on the equipment provided by both U S WEST and the customer. The required standards for Customer Provided Equipment (CPE) are briefly addressed in Section 4.6.

Each leg, either to a control station or a remote station, of a multipoint circuit is considered a single circuit for the purposes of these service objectives. The objectives do not apply to an entire multi-legged circuit.

The primary measure of transmission quality is Error Free Seconds (EFS). An EFS is one second during which there are no errors.

4.4.1 Transmission Quality

The parameter EFS is used with digital data rather than the Bit Error Ratio. The EFS objective is used with DDS since the errors tend to occur in bursts. The Bit Error Ratio approach, used with analog data, assumes that errors are completely independent and random. This is not normally the case with DDS. An Automatic Protection Switch, for example, would cause a brief burst of errors when switching. These protection switches are often used on high capacity transmission systems (including the modern fiber-cable based systems) to improve availability.

The U S WEST Digital Data Service is designed to provide an average performance exceeding 99.9 percent EFS for Special Access (i.e., End-User to Carrier) applications. The objectives for non-access, 99.8 percent EFS, will apply when U S WEST has End-User to End-User responsibility for a channel.

The service EFS objective for Access (End-User to Carrier) is, while in service, the channel will perform at a monthly average level equal to or greater than 99.9 percent EFS.

The end-to-end (access or non-access service) EFS objective is that, while in service, the channel will perform at a monthly average level equal to or greater than 99.8 percent EFS. This assumes that there are two access links and one transit link.

4.4.2 Service Acceptance Limit

U S WEST Digital Data Service circuits will be considered acceptable for service turn-up when zero (0) errors are observed during a 15 minute channel loopback test or, if one (1) error occurs in the first 15 minutes and the test is continued for an additional 15-minute period and there are no more than two (2) errors in the total time of 30 minutes.

4.4.3 Availability

The availability of a circuit is a measure of the time the service is usable by a customer. Availability is expressed as a percent of the time that the channel is both connected through and meeting the above limits over a rolling twelve (12) month period. This percentage is expressed as:

$$\text{Availability (\%)} = \frac{(\text{Total Time} - \text{Outage Time}) \times 100}{\text{Total Time}}$$

A circuit is assumed to be unavailable when the Bit Error Ratio in each second is worse than 10^{-3} for a period of ten (10) consecutive seconds.

The total time is 12 months and the outage time is expressed in similar units. The non-access availability objective is 99.65 percent. The corresponding access value is 99.9 percent.

Table 4-2 Summary of Service Objectives

Objective	Access (End Link/Mid Link)	Non-Access (End-To-End)
EFS	99.9 %	99.8 %
Availability	99.9 %	99.65 %

4.5 Non-Hub Functions

All digital circuits provided in the U S WEST Digital Data Service have certain minimum required functions or characteristics.

- A customer provided DSU (or the functional equivalent) at both ends of a two point circuit or on each leg of a multipoint circuit. This function/equipment is also known by several other names including the combined CSU/DSU name.
- A facility from the Central Office (CO) to the customer premise (EU-POT).
- An OCU in the CO, or in the remote terminal of a Digital Loop Carrier (DLC) system, to each metallic loop.
- Interoffice facilities as required.
- External synchronization to time all equipment from the same clock source (see Section 4.9).
- Test access on the circuit, preferably remote test access, for both analog loop tests and overall digital circuit tests.

Other functions may be required and are normally provided only at a Hub. Hub functions are described in Section 4.12. The above non-Hub functions will also be provided in a Hub.

4.6 Customer Provided Equipment

The customer must provide the digital Network Channel Terminating Equipment (NCTE) on the customer side of the NI at the EU-POT. This will be a Channel Service Unit/Data Serviced Unit (CSU/DSU) combined equipment or the functional equivalent. The functions required to insure compatible operation include:

- Balance the loop terminations,
- Arrangements for rapid remote loopback testing of channel by U S WEST,
- Coding and decoding of signal,
- Timing recovery,
- Synchronous sampling,
- Formatting,
- Generation and recognition of control signals.

There was an interim period of time when the DSU functions were split between two units. The first unit was the customer provided DSU. The second unit was the exchange carrier provided CSU. Then, at a somewhat later date, it was ruled that the Local Exchange Carrier could not provide the CSU and that the CSU must be CPE.

Now, the situation has returned to almost the original arrangement where both functions are normally provided in a single unit called the DSU. The only difference is that now the DSU is CPE, while years ago it was provided by the carrier. Some customers may still be using the split CSUs and DSUs.

This publication uses the acronym DSU to mean the combined CSU/DSU function.

Figure 4-1 illustrates a typical DSU without secondary channel capabilities.

The transmitting logic circuits provide the logic for zero substitution and idle-code generation. The line driver provides amplification and filtering.

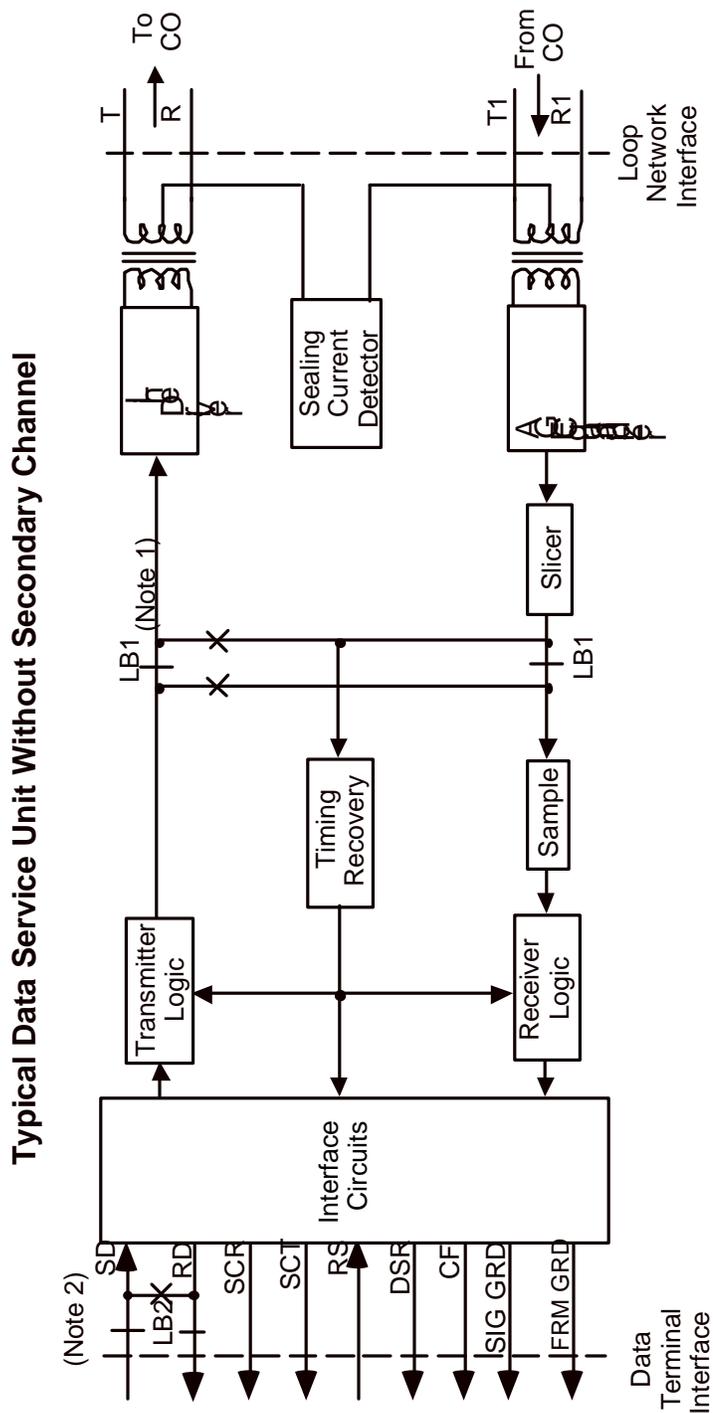
The receiving circuit contains logic for recognizing the DSU loopback code, ZCS code, idle code, and the trouble code. The receiver also recovers network timing information from the recovered data-bit positions, and makes the timing available to its transmitter (used for the loop-timed option of the DSU), and to the business machine interface.

Automatic Gain Control (AGC), equalization, and slicing circuitry recover and reconstitute the received signal.

Those DSUs that have secondary channel capabilities also function as a two channel multiplexer to derive the second channel. Other functions that may take advantage of the second channel to provide various functions (such a maintenance capabilities) may also be included.

The DSU contains a sealing current detector. A reversal of the dc sealing current causes the CSU/DSU to establish a CSU loopback for testing. The current reversal is generated by the OCU in response to a control code received from a test center.

The DSU illustrated in Figure 4-1 is designed with the preferred method of looping the DSU. The operation of relay LB1 loops the regenerated receive signal back to the line driver on the transmit side of the circuits. Some models of DSUs do the loopback of the non-regenerated signal at the line transformers. The latter design is not desirable since improper test results may be obtained from the non-regenerated signal.



- Notes:**
1. Relay LB1 operates manually or by reversal of sealing current for loopback tests in both directions.
 2. Relay LB2 operates manually or control code from a test center to loopback toward the test center.

CO = Central Office
 AGC = Automatic Gain Control

Figure 4-1 Typical DSU Without Secondary Channel

Any DSU to be used with DDS must meet the requirements listed in ANSI T1.410-1992.

4.7 Office Channel Unit (OCU)

The OCU provides the interface between the 4-Wire loop and the network. The OCU functions are:

- Transmit outgoing loop signals to the customer station.
- Reshape, re-time, and regenerate incoming loop signals.
- Provides dc sealing current for the loop.
- Provides OCU loopback test capability at the local loop side of the CO.
- Responds to a CSU loopback code and reverses the sealing current to the CSU. The current reversal is detected by the CSU as a signal to loopback the loop facility at the CSU. This test, however, is sometimes inconclusive. The DSU loopback is a more conclusive test.
- Convert the customer data range BPRZ signal required on the loop to the 64 kbit/s BPNRZ signal used in the DDS network. The network signal is called a DS0-A format.

The OCU is located in the DDS End Office or at the customer end of a digital subscriber carrier system. Further information on the DS0-A signal may be found in the Bellcore Technical Reference TR-TSY-000458, *Digital Signal Zero "A" (DS-0A 64 kb/s) Systems Interconnection*.

4.8 Synchronization

All equipment used in providing U S WEST Digital Data Service is timed from a hierarchical timing arrangement that is derived from a Primary Reference Standard. This source is a Stratum I clock and is accurate to one part in 10^{11} . This provides synchronous transmission that is virtually slip-free. The timing system is designed so that phase jitter and phase hits do not propagate through the network. Further information on the network synchronization plan may be found in the Bellcore Technical Advisory GR-436-CORE, *Digital Synchronization Network Plan*.

There may be some Digital Islands where the Stratum I timing is not available. In this situation, the highest quality clock available is used to provide the timing. Once the area ceases being a digital island, Stratum I timing will be provided.

The means of synchronization is a signal within the CO called Composite Clock. The Composite Clock timing signal is a 64 kHz, 5/8-duty-cycle, Return-to-Zero, bipolar signal with a bipolar violation every eighth bit. The Composite Clock signal is restricted by distance limitations to the confines of the CO. Those requiring further information should consult GR-378-CORE, *Timing Signal Generator (TSG) Requirements and Objectives*. Composite Clock must be considered by Interconnectors as discussed in Section 4.12.

The bipolar loop signal has enough pulse density to permit the DSU (see Section 4.7) to recover timing for sampling the received signal and for generating the transmitted signal.

4.9 Interoffice Transport

The transport facilities used between Central Offices (COs) may be one of several digital transport systems using the North American standard digital transmission hierarchy. The basic DS1 carrier systems may utilize Time Division Multiplexers, cross-connects (including DCSs), and transmission facilities, including metallic-based systems such as T1, fiber-based systems, and digital radio.

4.10 Testing

Test access on U S WEST Digital Data Service circuits is of two types: analog and digital. Each loop has analog test access to measure analog criteria such as the Nyquist frequency loop loss, impulse noise, etc. Normally, the testing is done remotely from centralized test centers.

Each circuit also has one or more digital test access points. One or more of these are usually tested remotely. These digital access points are used to loop back various equipment elements, such as the OCU and DSU, to locate and then correct the problem in a timely manner.

Customers suspecting a trouble condition should note the symptoms and notify their service provider. The identification of which stations are experiencing trouble on multipoint circuits is especially useful. Since most circuit maintenance tests are intrusive, it is expected that the customer will release the circuit for testing if required.

4.11 Digital Data Service (DDS) Hub/Node Functions

A Central Office (CO) or wire center designated as a "DDS Hub" in the FCC # 4 National Exchange Carrier Association (NECA) tariff has several capabilities in addition to those listed in Section 4.6. The additions include the multiplexing and bridging functions. Hubs must have remote test capabilities. Any circuit requiring bridging or multiplexing (either DS1 to DS0 or DS0 to Subrate) must go through a DDS Hub. Standard two point circuits, including those using DS1 to Voice and Digital Data (Section 4.11.1) multiplexing, do not have to go through a DDS Hub.

U S WEST Digital Data Service typically has more than one DDS Hub per LATA. This has become economically justifiable with the newer and more flexible hardware used in place of the older T1DM/SRDM generation of equipment.

The concept of a DDS Node has been added in some Intrastate jurisdictions to provide additional offices at which Hub functions may be purchased.

The following sections describe some of the differences between Hubbed and Non-Hubbed functions as described in Sections 4.6 through 4.11.

4.11.1 Multiplexing

Multiplexing is a process in which two or more channels are combined (multiplexed) together into a high capacity facility. The channels are then split apart (demultiplexed) again at the far end. This is done to reduce the cost of transporting several channels over a distance.

The two most common techniques of multiplexing are frequency-division multiplexing and time-division multiplexing. Frequency-division multiplexing is most often used with analog carrier and radio systems while the time-division technique is used in digital carrier and radio systems. A detailed description of these techniques is beyond the scope of this publication.

The multiplexing used with U S WEST Digital Data Service is synchronous time-division multiplexing. Several types may be encountered either as part of U S WEST's interoffice network or purchased by a customer. Table 4-3 summarizes some of the types which may be encountered. Multiplexing above the DS1 level need not be done at a DDS Hub, but restrictions may apply. Other publications should be referenced for information above the DS1 level.

The primary type of multiplexing done at a DDS Hub is to multiplex (and demultiplex) several DS0 channels together into a single DS1 channel. There are two types of DS1 to DS0 multiplexing done in a DDS Hub. Customers using the older T1DM formatted high-capacity channel with CO multiplexing would multiplex 23 DS0 channels into the DS1. Those using the newer type of DS1 would multiplex 24 channels. The DS0 carried by these two multiplexer types can be either a DS0-A (single circuit) or a DS0-B (multiple circuit with subrate multiplexing). These two types of multiplexing are being phased out and customers should order the "DS1 to Voice and Digital Data" as follows.

A third type of DS1 to DS0 CO multiplexing that may be used with the U S WEST Digital Data Service is the "DS1 to Voice or Digital Data" multiplexing option. An externally timed multiplex of this type is intended to carry both analog voice circuits as well as a few digital data circuits. This multiplexing option is not restricted to having the multiplexer in a DDS Hub. The before mentioned NECA tariff lists the locations where the "DS1 to Voice and Digital Data" option may be ordered.

Each of these DS0 channels would carry one bit and byte stuffed circuit as created by the OCU. The DS0-A signal contains the basic channel and, if applicable, the second channel. The previously mentioned ANSI documents discuss the signal formats.

Table 4-3 Multiplexing Encountered With U S WEST Digital Data Service

Multiplex Type	Digital Signal Level & Bit Rates				Quantity of Lower Level	Sold Under U S WES T Service
	Higher Level		Lower Level			
DS3 - DS1	DS3	44.736 Mbit/s	DS1	1.544 Mbit/s	28	DS3 ***
DS1 - DS0 †	DS1	1.544 Mbit/s	DS0	64. kbit/s	24	DS1 **
DS1-DS0 (T1DM) †	DS1	1.544 Mbit/s	DS0	64. kbit/s	23	DS1 **
DS1-Voice and Digital Data	DS1	1.544 Mbit/s	DS0	64. kbit/s	24 *	DS1 **
DS0-Subrate						
2.4 kbit/s	DS0-B	64.0 kbit/s	DS0-A #	64. kbit/s	20	DDS
4.8 kbit/s	DS0-B	64.0 kbit/s	DS0-A #	64. kbit/s	10	DDS
9.6 kbit/s	DS0-B	64.0 kbit/s	DS0-A #	64. kbit/s	5	DDS

- * DS1 to Voice and Digital Data allows voice channels to mix with data channels on the DS1.
- ** U S WEST DS1 Service was formerly sold under the name of DIGICOM® III.
- *** U S WEST DS3 Service was formerly sold under the name of DIGICOM® 45. U S WEST Technical Publication 77324, *U S WEST DS3 Service*, discusses this service in greater details.
- † Existing services only.
- # The tariffs refer to these as "subrates" rather than DS0-As.

There may be circumstances where it may be economical to also multiplex several subrate (2.4, 4.8, or 9.6 kbit/s) channels into a single DS0-B signal. This is commonly called "Subrate Multiplexing" (SRMX). Further information on subrate multiplexers may be found in Bellcore Technical Advisory TA-TSY-000189, *Generic Requirements for the Subrate Multiplexer* (see Chapter 7). Subrate Multiplexing is available only in a DDS Hub or DDS Node.

An additional type of multiplexing, (not listed in Table 4-3) that is encountered with DDS involves secondary channel. This situation is somewhat different in that the multiplexing/demultiplexing is done by the customer's DSU. Two channels, the basic data channel and the lower rate "secondary" channel, are multiplexed together into a single data stream. More information on this subject is found in ANSI T1.410-1992.

4.11.2 Bridging

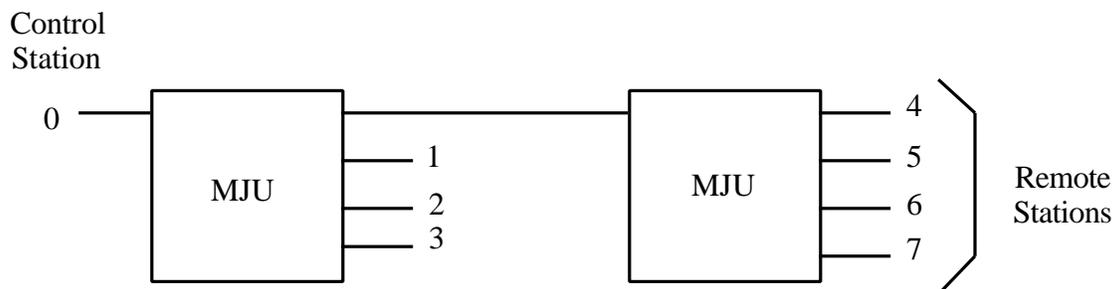
A specific type of bridge, the Multipoint Junction Unit or MJU, is used to provide multipoint circuits for U S WEST Digital Data Service. Figure 4-2 illustrates a typical multipoint circuit.

The customer's control station broadcasts downstream from the control station to the remote or branch stations. The MJUs combine the bit streams transmitted by the remote stations in the upstream direction towards a single control station. It is the responsibility of the data customer to provide the appropriate protocol to insure that collisions do not occur in the upstream direction. A polling technique is often used by the customer to allow only one remote station to transmit at a time.

The MJU provides full duplex transmission (i.e., simultaneous transmission in both directions) at all DDS data rates except 64 kbit/s. The interface with stand-alone MJUs is a DS0-A signal. The MJU function can be provided by several types of hardware.

The MJUs now being used provide for one control leg and four branch legs. The MJUs may be cascaded together for larger networks. When cascading MJUs, the control leg of the additional MJUs are connected to branch legs of a previous MJU.

Figure 4-2 illustrates an eight point circuit with 1 control and 7 branch stations. In general, a circuit with N MJUs will result in $3N+1$ downstream branches or remote stations. The connection between the two MJUs is a DS0-A which would be appropriately multiplexed for interoffice transmission should the two MJUs be in different locations.



Numbers designate port numbers.

Figure 4-2 Eight Point Circuit Arrangement

The MJUs are synchronized by a source traceable to a Stratum I clock as outlined in Section 4.9.

A delay will be introduced by the MJUs in both the upstream and downstream directions. Table 4-4 lists some typical delays. Cascading MJUs will increase the delay. The customer's data protocol will have to accommodate this, and other delays.

Table 4-4 Typical MJU Delay

Data Rate (kbit/s)	Bytes Delay
2.4	20
4.8	10
9.6	5
56.0	1

There are coding restrictions for 56 kbit/s circuits using secondary channel. These restrictions were discussed in Section 4.2

Further information on MJU bridges may be found in ANSI T1.410-1992, (see Chapter 7).

4.11.3 Cross-connecting

Cross-connecting is a function used to connect channels from one previously established multiplexed carrier system to other previously established multiplexed carrier systems. The function is used internally by U S WEST for the interoffice transport of DDS circuits and is also available to the customer in the form of a Central Office Connecting Channel (COCC) or Mux-to-Mux connecting arrangement.

Several examples of the Mux-to-Mux Connecting Arrangement, or Thru-Connection Service, are in Service PUB 77204. The NC codes used may include the HS and the XA, XB, etc.

The actual cross-connecting may be done using a variety of equipment depending on availability in the particular DDS Hub. The commonly used methods include the use of a DCS (if available), the traditional quad terminal panels used in the older T1DM vintage equipment, or jumpers (wires) on a frame.

4.12 Connections With Certified Local Exchange Carriers

Customers who have transmission equipment in a U S WEST wire center through some type of collocation agreement for interconnection to U S WEST's Services such as DDS, will be termed "Interconnectors." These customers are Certified Local Exchange Carriers (CLECs). Equipment under control of a CLEC, whether for Physical Collocation or Virtual Collocation, will be called "Interconnector Designated Equipment" (IDE).

A CLEC may collocate IDE in a U S WEST wire center to connect with U S WEST Finished Services. Typically, in this context, the service connects the CLEC to the customer location. Further information about Collocated Interconnection may be found in PUB 77386, *Interconnection and Collocation for Transport And Switched Unbundled Network Elements and Finished Services*. Chapter 10 specifically discusses the DDS applications. Chapter 13 discusses synchronization.

The NI with an Interconnector is a CLEC Point of Termination (CLEC-POT) as discussed in PUB 77386. The NI is described by the Network Channel Interface (NCI) codes similar to those generally used with Interexchange Carriers plus the addition of the "DO" NCI code. The "DO" NI is described in Section 5.7.

PUB 77204 lists the NCI codes that are available with the U S WEST Digital Data Service. Other publications describe other services which may use the NCI codes described in this publication.

The "DO" interface requires that the Interconnector obtain Composite Clock (Section 4.8) from U S WEST to synchronize their multiplexer or channel bank to the same clock source as the channel bank or DLC Central Office Terminal (COT) provided by U S WEST. Some IDE may also require a DS1 clock signal. PUB 77386 (Issue B or later) should be consulted for further information.

The Interconnector must provide a channel unit generically known as a DS0-DP unit to meet this interface. U S WEST will provide a matching DS0-DP (or functional equivalent) in the channel bank, DLC COT, or other equipment on their side of the interface.

The connected service will be similar to any other U S WEST DDS service. The primary difference in a service going directly out to an End-User's location is that the digital test access (Section 4.10) is less likely to be remote test access.

Section 5.8 describes Network Interfaces used with Unbundled Network Elements.

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5. Network Interfaces

This chapter illustrates the interfaces between U S WEST and the customer used to provide U S WEST Digital Data Service. The interfaces apply in both Access and Non-Access jurisdictions. The central office interfaces for bridging and transfer arrangement are also included.

The 04DU5 interfaces are the traditional OCU-metallic facility-CSU/DSU arrangement. Those who need detailed information concerning these interfaces should consult ANSI T1.410-1992.

5.1 RJ48 AND SJA JACKS

There are two jacks of registration, the RJ48S and RJ48T, involved with U S WEST Digital Data Service. There are also two equivalent jacks not of registration, the SJA56 and SJA57 jacks respectively. These jacks serve as the physical part of the Network Interface (NI) or Customer Interface (CI). The RJ48 and SJA jacks may be used interchangeably.

The RJ48S and SJA56 are eight-position keyed jacks that carry the Tip/Ring and Tip1/Ring1 conductors of a single circuit. The NCI codes that would apply are of the form 04DU5.xx or 04DU5.xxS where xx indicates the data rate on the facility. Figure 5-1 illustrates the wiring connections.

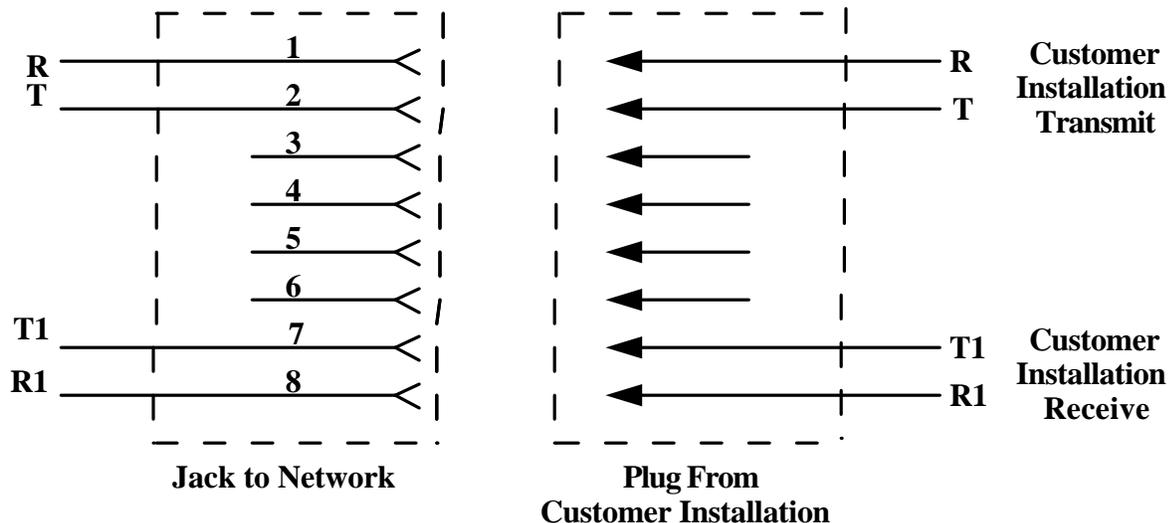
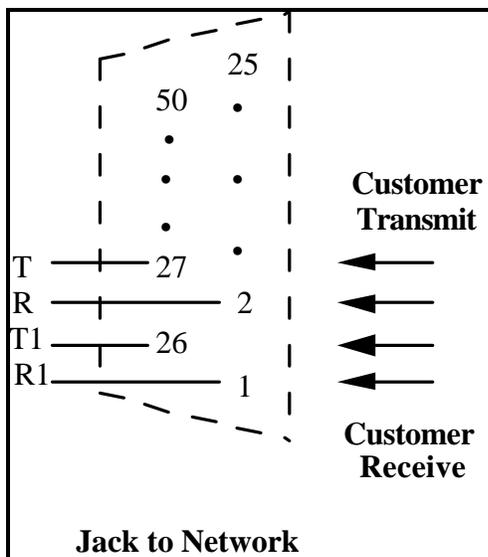


Figure 5-1 RJ48S or SJA56 Wiring Diagram

The RJ48T and SJA57 jacks are fifty-position miniature ribbon jacks which provide for twelve Tip/Ring and Tip1/Ring1 connections. The NCI codes that would apply are of the form 04DU5.xx or 04DU5.xxS where xx indicates the data rate on the facility. Figure 5-2 illustrates the wiring diagram.



Line	Customer Receive		Customer Transmit	
	T1	R1	T	R
1	26	1	27	2
2	28	3	29	4
3	30	5	31	6
4	32	7	33	8
5	35	9	35	10
6	36	11	37	12
7	38	13	39	14
8	40	15	41	16
9	42	17	43	18
10	44	19	45	20
11	46	21	47	22
12	48	23	49	24

Figure 5-2 RJ48T or SJA57 Wiring Diagram

5.2 Standard 04DU5 Interface

APPLICATION:	Digital data
PHYSICAL DESCRIPTION:	4-Wire (T, R, T1, R1). See Table 5-1 for jack.
ELECTRICAL FEATURES:	
IMPEDANCE:	135 ohms.
LEVELS:	Digital signal levels at the interface must comply with ANSI T1.410-1992.
DATA RATE:	Bipolar Return to Zero (BPRZ), with timing on the signal from U S WEST to the customer.

Table 5-1 Network Channel Codes and Jacks

Interface	Data Rate	Applicable Jack
04DU5.19	19.2 kbit/s	SJA56 or SJA57
04DU5.24	2.4 kbit/s	RJ48S or RJ48T
04DU5.48	4.8 kbit/s	RJ48S or RJ48T
04DU5.56	56.0 kbit/s	RJ48S or RJ48T
04DU5.64 04DU5.64A *	64.0 kbit/s	SJA56 or SJA57
04DU5.96	9.6 kbit/s	RJ48S or RJ48T

* The 04DU5.64 interface is a near-clear channel interface subject to the coding restrictions described in Section 5.3. The 04DU4.64A is not a clear channel interface. See Technical Publication 77204 for usage.

5.3 64 kbit/s Coding Restrictions

Transmission on 64 kbit/s circuits is subject to coding restrictions to ensure that the customer interface does not activate mapping in a network-latching loopback device or accidentally activate a latching loopback.

The following coding restriction shall apply: A DTE/DSU shall not transmit more than 29 loopback enable (LBE) bytes (N101011F0) out of any 40 consecutive bytes.

See ANSI T1.410-1992 for further information.

5.4 Standard 04DU5 Interface With Secondary Channel

APPLICATION: Digital data with Secondary Channel.

PHYSICAL DESCRIPTION: 4-Wire (T, R, T1, R1) SJA56 or SJA57 Jack.

ELECTRICAL FEATURES:

IMPEDANCE: 135 ohms.

LEVELS: Digital signal levels at the interface must comply with ANSI T1.410-1992.

DATA RATE: Bipolar Return to Zero (BPRZ), with timing on the signal from U S WEST to the customer.

Table 5-2 Network Interfaces With Secondary Channel

Interface	Primary Channel Data Rate (bit/s)	2-Point and Downstream Multipoint Secondary Channel (bit/s)	Upstream Multipoint Secondary Channel (bit/s)	Loop Rate (bit/s)
04DU5.19S	19200	3200/N	1066 2/3	25600
04DU5.24S	2400	400/N	133 1/3	3200
04DU5.48S	4800	800/N	266 2/3	6400
04DU5.56S	56000	8000/N	666 1/3	72000
04DU5.96S	9600	1600/N	533 1/3	12800

NOTE:
The Secondary Channel is derived by replacing every Nth C-bit with an encoded Secondary Channel bit. $N \geq 3$ is arbitrary on 2-point and downstream multipoint circuits. Upstream on multipoint circuits, the MJU assumes that $N = 3$.

5.5 Standard 04DU5.56C Interface

APPLICATION:	Digital Data Access Line (DDAL)
PHYSICAL DESCRIPTION:	4-Wire (T, R, T1, R1). SJA56 or SJA57 jack.
ELECTRICAL FEATURES:	
IMPEDANCE:	135 ohms.
LEVELS:	Digital signal levels at the interface must comply with ANSI T1.410-1992.
DATA RATE:	Bipolar Return to Zero (BPRZ), with timing on the signal from U S WEST to the customer.
PROTOCOLS:	Signaling and operation as described in ANSI/TIA/EIA-596-1992.

The 04DU5.56C interface is used for the U S WEST 's DDAL service. Specifically, it is for a non-U S WEST 56 kbit/s switched service. That is, another carrier performs the switching function. U S WEST provides only the 56 kbit/s access line where U S WEST performs testing from the End-user premises NI.

5.6 Interface Type 04BD5

DESCRIPTION: Central Office bridging arrangement

OPERATING MODE:

Table 5-3 Bridging Arrangement Interfaces

Data Rate (kbit/s)	NCI Code
2.4	04BD5.24
4.8	04BD5.48
9.6	04BD5.96
19.2	04BD5.19
56.0	04BD5.56

PHYSICAL DESCRIPTION: 4-Wire (T, R, T1, R1)

IMPEDANCE: 135 ohms

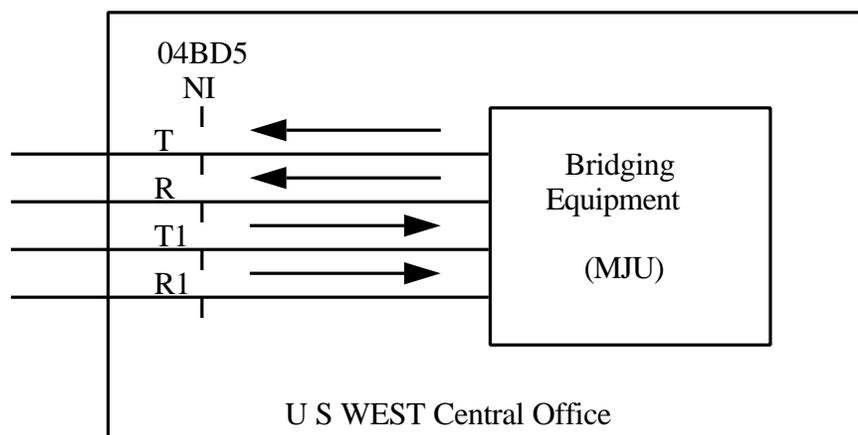


Figure 5-3 Interface Type 04BD5

The signal at the 04BD5 interface is a DS0-A signal formatted as described in ANSI T1.107-1995. The channel data rate imbedded in the DS0-A is at the data rate designated in the table. These NCI codes may not be used in all jurisdictions at this time.

5.7 Interface Type 04DO5

DESCRIPTION: Digital Interface at the Digital Signal Level Zero (DS0)

OPERATING MODE:

Table 5-4 Digital Interface at the Digital Signal Level Zero

DS0 type (kbit/s)	NCI Code
DS0-A at 2.4	04DO5.A
DS0-A at 4.8	04DO5.B
DS0-A at 9.6	04DO5.C
DS0-A at 19.2	04DO5.D
DS0-A at 56.0	04DO5.E
DS0-A at 64.0	04DO5.F
DS0-B	04DO5.L

PHYSICAL DESCRIPTION: 4-Wire (T, R, T1, R1)

IMPEDANCE: 135 ohms

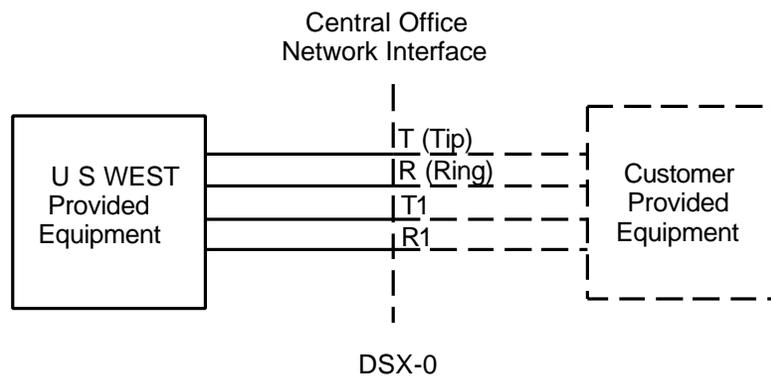


Figure 5-4 Interface Type 04DO5

The DS0-A and DS0-B signals are described in Section 6.4 of ANSI T1.107-1995. DS0-A signals carry data for only one station. DS0-B signals carry data for several stations which operate at the 2.4, 4.8 or 9.6 kbit/s data rate. The DSX-0 is a digital cross-connect used to interconnect equipment at the DS0 (64 kbit/s) level.

The 04DO5 interface will normally require synchronization.

5.7.1 Electrical Requirements

The DS0 signal used to interconnect between digital (64 kbit/s) terminal equipment within an office has a bipolar nonreturn-to-zero format. The nominal 64 kbit/s DS0 signal clocking is controlled by bit and byte clocks derived from a Composite Clock signal.

The Composite Clock Signal is described in Chapter 9 of PUB 77386, Issue B or later. Composite Clock is available only to Collocated Interconnectors in U S WEST Central Offices.

The transmitted signal at the output port should meet the following specifications:

Amplitude -	Zero: < 0.7 volts One: > 3.0 volts, \leq 5.5 volts
Pulse shape:	Rectangular (nominal) Rise/fall time < 0.5 microseconds Width = 15.6 microseconds (nominal)
Jitter:	Not worse than Composite Clock
Impedance:	135 ohms resistive
Amplitude Ratio:	0.95 to 1.05 for positive and negative pulses at the center of the pulse interval 0.95 to 1.05 for pulses of like polarity
Width ratio:	0.95 to 1.05 of positive and negative pulses at the nominal half amplitude point

The received signal at the interconnection must be able to accept the above signal modified by the characteristics of from 0 to 1500 feet of 24 AWG unshielded CO cable.

These requirements limit the distance between drivers and terminators to 1500 feet. The DSX-0 cross-connect may be located anywhere within this 1500 foot limitation. Specific information about lengths for a specific CO will be provided by U S WEST to the Interconnector when negotiating the Collocation agreement.

These rigidly defined maximums are based on propagation times rather than attenuation. The 1500 foot maximum controls transmission delays to ensure that bit transitions at the receiving point will not overlap the local clock sampling instants.

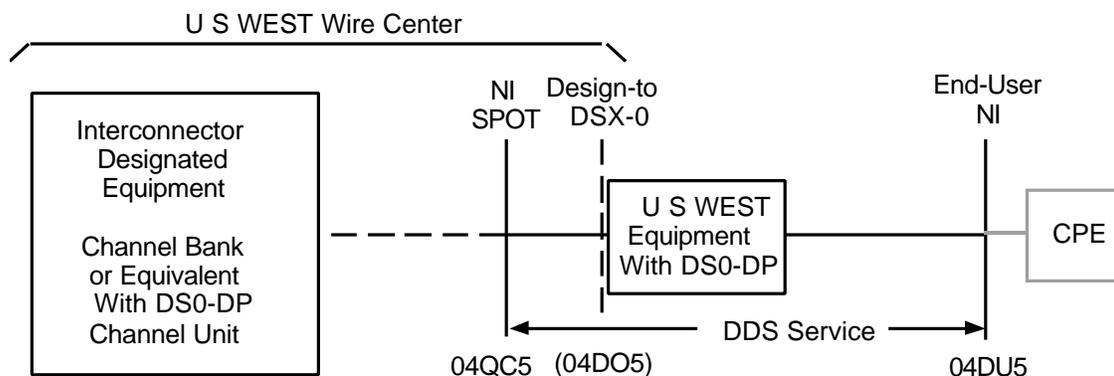
5.7.2 Synchronization Requirements

Two levels of synchronization are important for digital transmission: bit synchronization and byte synchronization. Bit synchronization refers to the transmitter and the receiver operating at the same rate. Byte synchronization refers to the transmitter and receiver achieving proper alignment by identifying the beginning and end of a frame or byte. Digital signals are synchronized by a concept (Building Integrated Timing Supply or BITS) described in GR-436-CORE. A BITS distributes all DS1 and DS0 timing required by other clocks within that building.

DS0 synchronization is provided via a composite clock signal, which is a 64 kHz, nominal 5/8 duty cycle, bipolar return-to-zero signal with a bipolar violation every eighth pulse. The existing network terminals (i.e., channel banks) with DS0 inputs do not have buffer storage to maintain byte synchronization variations as they are at the DS1 inputs. Thus these variations are accommodated by requiring that signals at all DS0 level interconnections be synchronized by a single composite clock source.

5.7.3 Applicability

The 04DO5 interfaces are used when Collocated Interconnectors wish to connect to U S WEST 's Digital Data Service. The Network Interface (NI) uses the "QC" NCI codes (Section 5.8). The "DO" interface functions as a "Design-To" point (Figure 5-5). The channel from the Interconnector Designated Equipment, through the NI, and on to the "Design-To" point is such that the signal at the DSX-0 cross-connect is a templated signal as described by the 04DO5 NCI code. See Section 4.12 and PUB 77386 for further information.



Key
 NI = Network Interface
 SPOT= Single Point of Termination (Bay/Frame)
 CPE = Customer Premise Equipment

Figure 5-5 Typical Collocated Interconnector Design

5.8 Interface Type 04QC5

DESCRIPTION: Manual Cross-Connect DS0 Termination for Digital Service

OPERATING MODE:

Table 5-5 Manual Cross-Connect DS0 Termination Interface

Data Rate (kbit/s)	NCI Code
2.4	04QC5.OOJ
4.8	04QC5.OOK
9.6	04QC5.OOL
19.2	04QC5.OOM
56.0	04QC5.OOP
64.0	04QC5.OOQ

PHYSICAL DESCRIPTION: 4-Wire (T, R, T1, R1)

IMPEDANCE: 135 ohms

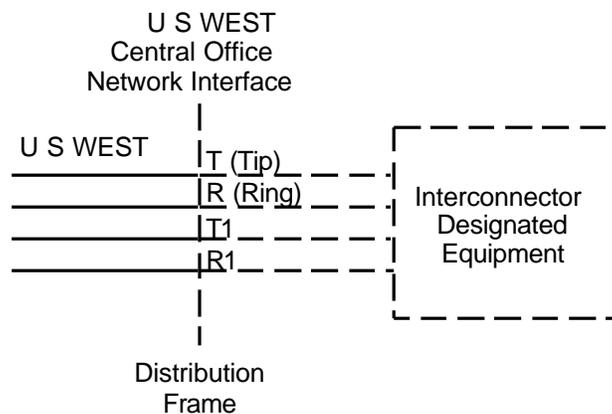


Figure 5-6 Interface Type 04QC5 and 04QB5.00

5.8.1 Electrical Requirements

The 04QC5 network interfaces apply when connecting to a Collocated Interconnector as discussed in Section 4.12. The application is illustrated in Figure 5-5.

5.8.2 Synchronization Requirements

The Collocated Interconnector must obtain synchronization from U S WEST with this interface arrangement.

5.8.3 Availability

The 04QC5 interfaces are available only to Collocated Interconnectors in U S WEST Central Offices.

5.9 Interface Type 04QB5.00

DESCRIPTION: Manual Cross-Connect DS0 Termination with no subrating capability

OPERATING MODE: Main Distribution Frame Cross-Connect

PHYSICAL DESCRIPTION: 4-Wire (T, R, T1, R1)

IMPEDANCE: 135 ohms

This interface is a generic DS0 interface at a manual Cross-Connect frame. No standards for electrical requirements exist other than normal limits placed for health and safety as may be described in other publications.

The interface is illustrated in Figure 5-6.

Synchronization may or may not be required depending on the signal requirements.

The 04QB5.00 interface is available only to Collocated Interconnectors in U S WEST Central Offices.

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6. Definitions

6.1 Acronyms

AGC	Automatic Gain Control
ANSI	America National Standards Institute
AWG	American Wire Gauge
B8ZS	Bipolar with 8 Zero Substitution
BIT	Binary Digit
B8ZS	Bipolar With 8 Zero Substitution
BPRZ	Bipolar Return to Zero
BPNRZ	Bipolar Non-Return to Zero
CCC	Clear Channel Capability
CLEC	Certified Local Exchange Carrier
CO	Central Office
CPE	Customer Provided Equipment
CSU	Channel Service Unit
dB	decibel
dc	Direct Current
DCS	Digital Cross-Connect System
DDAL	Direct Digital Access Line
DDS	Digital Data Service
DLC	Digital Loop Carrier
DP	Data Port
DS1	High Capacity 1.544 Mbit/s Service Digital Signal Level 1 (1.544 Mbit/s)
DS0	Digital Signal Level 0 (64 kbit/s) (1 voice channel)
DSU	Data Service Unit
EFS	Error Free Seconds
EIA	Electronic Industries Association
ES	Errored Second(s)
EU	End User
EU-POT	End-User-Point of Termination

FCC	Federal Communications Commission
HERTZ	Cycles per Second
Hz	1 Hertz (formerly 1 cycle per second)
IC	Interexchange Carrier (or IEC)
IntraLATA	Intra Local Access and Transport Area
kbit/s	kilobits per second (1,000 bit/s)
kHz	Kilohertz (1,000 Cycles Per Second)
LATA	Local Access and Transport Area
LEC	Local Exchange Carrier
MUX	Multiplexer
NCI	Network Channel Interface
NCTE	Network Channel Terminating Equipment
NECA	National Exchange Carrier Association
NI	Network Interface
OCU	Office Channel Unit
POT	Point Of Termination
PSDS	Public Switched Digital Services
SRDM	Subrate Data Multiplexing
SRMX	Subrate Multiplexer
TIA	Telecommunications Industry Association

6.2 Glossary

Acceptance Limit

The maximum deviation from a design parameter that is allowed at service turnup or customer acceptance.

Actual Measured Loss

The actual measured insertion loss of a circuit at a given frequency (see Insertion Loss).

Alternate Mark Inversion (AMI)

A one (mark) pulse which is the opposite polarity as its predecessor

American National Standard Institute (ANSI)

An organization supported by the telecommunications industry to establish performance and interface standards.

Automatic Gain Control (AGC)

The process by which gain is automatically adjusted in a specified manner as a function of input or other specified parameters.

Automatic Protection Switch

A device which monitors a channel and automatically switches the channel to another facility whenever the channel fails or when specified parameters go beyond a specified threshold.

Availability

The relative amount of time that a service is "usable" by a customer, represented as a percentage over a consecutive 12 month period.

Bipolar With 8 Zero Substitution (B8ZS)

Bipolar 8 Zero Substitution is an application of BPRZ and is an exception to the Alternate Mark Inversion (AMI) line-code rule. It is one method of providing bit independence for digital transmission by providing a minimum 1s density of 1 in 8 bits.

Bit (Binary Digit)

A binary unit of information. It is represented by one of two possible conditions, such as the value 0 or 1, on or off, high potential or low potential, conducting or not conducting, magnetized or demagnetized. A Bit is the smallest unit of information, by definition.

Bits/second (bit/s)

Bits per second, e.g., 1200 bit/s. In data transmission, it is the number of binary zero and one bits transmitted in 1 second. Modern terminology uses "bit/s" e.g., 1200 bit/s.

Bit Error Rate

The ratio of the number of bit errors to the total number of bits transmitted in a given time interval.

Bridging (MULTIPOINT-SERVICE)

Denotes the process of connecting three or more customer locations.

Byte

A consecutive number of bits usually constituting a complete character or symbol. If the length of the byte is not specified, it is conventionally assumed to have a length of 8-bits. In the Digital Data System, a byte refers to an arbitrary group of 8 consecutive bits; it does not correspond to a byte of customer data.

Carrier

An organization whose function is to provide telecommunications services. Examples are: Local Exchange Carriers, Interexchange Carriers, Cellular Carriers, etc.

Central Office (CO)

A local switching system (or a portion thereof) and its associated equipment located at a wire center.

Channel

An electrical or photonic, in the case of fiber optic based transmission systems, communications path between two or more points of termination.

Channel Service Unit (CSU)

This unit provides regeneration of the signal received from the network, controls the pulse shape and amplitude for transmission of the signal into the network, and possibly provides loop-back. the CSU function is frequently found within a Data Service Unit (DSU).

Clear Channel Capability (CCC)

A characteristic of a transmission path in which the bit positions allocated for customer data may represent any combination of zeroes and ones.

Customers

Denotes any individual, partnership or corporation who subscribes to the services provided by U S WEST customers are divided into two distinct and separate categories: (1) carriers, who provide interexchange services for hire for others, and (2) end-users, who request services only for their own use.

Customer Installation (CI)

Equipment and wiring at the customer's location on the customer side of the Network Interface.

Customer Interface

The interface with a customer at a point of termination.

Customer Premises

Denotes a building or portion(s) of a building occupied by a single customer or end-user either as a place of business or residence. Adjacent buildings and the buildings on the same continuous property occupied by the customer and not separated by a public thoroughfare, are also considered the customer's premises.

Customer Provided Equipment (CPE)

Equipment owned and maintained by the customer and located on their side of the End-User Point of Termination (EU-POT) network interface. In the U S WEST Digital Data Service application, CPE typically includes the DSU (CSU/DSU) and data terminal equipment which are connected to the channel.

Data Service Unit (DSU)

Digital, customer premises equipment used to recover timing from a baseband BPRZ signal, and which converts from BPRZ line signals to a business machine interface signal such as V.35. At 64 kbit/s and below, DSU and Channel Service Unit (CSU) functions are, in modern equipment, combined in a single unit sometimes called a General Service Unit (GSU), Basic Service Unit (BSU) or Data Service Unit-A (DSU-A) so that it is part of the Data Communications Equipment (DCE). Above 64 kbit/s, DSU functions are frequently contained in the Data Terminal Equipment (DTE). the DSU usually contains circuitry to recognize, and respond to, loop-back commands from the serving test center.

DDS End Office

A central office which provides all DDS Hub functions except for subrate multiplexing and bridging functions.

DDS Hub

A Hub, identified in the FCC #4 (NECA) tariff, used to provide multiplexing, test access, cross-connecting and bridging functions for U S WEST Digital Data Service (DDS) or DDS like services.

Decibel (dB)

A unit measurement of transmission loss, gain, or relative level. It is the logarithmic unit of signal power ratio most commonly used in telephony. It is used to express the relationship between two signal powers, usually between two acoustic, electrical, or optical signals; it is equal to ten times the common logarithm of the ratio of the two signal powers.

Demultiplexing

The opposite of multiplexing. That is, the multiplexer combines signals and the demultiplexer takes them apart again. Also see Multiplexing.

Digital Cross-Connect System (DCS)

An intelligent (processor controlled) digital terminal that provides the capability to perform electronic cross-connects on digital channels operating at or below the bit rate of the transport systems terminated on the unit. This unit may also provide other features, e.g., bridging.

Digital Data Service (DDS)

While DATAPHONE® Digital Service is a registered brand name for AT&T's Digital Data Service, common usage has come to use the DDS generically to mean the digital data service offering at 64 kbit/s and below.

Digital Hierarchy Level

The level in the digital hierarchy. The levels and the respective bit rates are:

<u>Level</u>	<u>Bit Rate</u>	<u>Level</u>	<u>Bit Rate</u>
DS0	64.0 kbit/s	DS3	44.736 Mbit/s
DS1	1.544 Mbit/s	DS4NA	139.264 Mbit/s
DS1C	3.152 Mbit/s	DS4	274.176 Mbit/s
DS2	6.312 Mbit/s		

Digital Island

A single central office (or two or more central offices connected with digital interoffice transport facilities) that has (have) no digital connectivity beyond the office(s).

Digital Loop Carrier (DLC)

A digital transport facility used to carry circuits or channels on part of all of the loop between the serving wire center and the customer's location. Copper or fiber is normally used as the transport medium.

DS0-A

A DS0 signal that carries data for only one signal.

DS0-B

A DS0 signal that carries data multiplexed from several subrate signals.

DS1 Clear Channel

Denotes that 1.535 Mbit/s of a 1.544 Mbit/s DS1 facility are available for customer information. The remaining 8 kilobits, or overhead, are for error correction, framing, and network performance/status/information.

End-User (EU)

The term "End-User" denotes any customer of telecommunications service that is not a carrier, except that a carrier shall be deemed to be an "End-User" to the extent that such carrier uses a telecommunications service for administrative purposes without making such service available to others, directly or indirectly. The term is frequently used to denote the difference between a Carrier interface and an interface subject to unique regulatory requirements at non-Carrier customer premises (FCC Part 68, etc.)

End-User POT (EU-POT)

The Network Interface at the End-User's premises at which U S WEST Communication, Inc.'s responsibility for the provision of service ends.

Error Free Second (EFS)

A one-second interval which does not contain any bit-errors. Usually expressed as a percent over a consecutive 24-hour period.

Errored Second (ES)

A one second interval with one or more bit errors.

Note - A period of no signal shall be considered a period of errored bits.

Full Duplex

Simultaneous transmission in both directions between two points.

Hub

A U S WEST designated serving wire center at which bridging and multiplexing functions are performed. See also Digital Data Service (DDS) Hub.

Impulse Noise

Any momentary occurrence of the noise on a channel significantly exceeding the normal noise peaks. It is evaluated by counting the number of occurrences that exceed a threshold.

Inserted Connection Loss

This term denotes the 1004 Hz power difference (in dB) between the maximum power available at the originating end, and the actual power reaching the terminating end through the inserted connection.

Insertion Loss

Insertion loss is the ratio (expressed in dB) of the power delivered to a specified load at the receiving interface by a specified source at the transmitting interface to the power delivered by the same source directly to an identical load.

Intelligent Network Element (INE)

A software programmable network component.

Interexchange Carrier (IC)/(IEC) or Interexchange Common Carrier

Any individual, partnership, association, joint-stock company, trust, governmental entity or corporation engaged for hire in interstate or foreign communication by wire or radio, between two LATA's.

Interface Code

See Network Channel Interface

Jitter

Random timing distortions of a digital signal, whereby the appearance of a pulse differs from where the pulse should occur relative to time.

Key Activated Transfer Arrangement

An arrangement that allows the customer to transfer a leg of a Private Line Transport Service to either spare or working channel that terminates in either the same or a different customer premises. A key activated control service is required to operate the transfer arrangement.

Kilobit/Second (kbit/s)

One thousand (1000) bits/second

Loaded Cable

Inductance, in the form of "Load Coils", is placed on longer metallic cables to improve the cable's voice transmission performance.

Local Access and Transport Area (LATA)

A geographic area for the provision and administration of communications service. It encompasses designated exchanges that are grouped to serve common social, economic and other purposes.

Local Exchange Carrier (LEC)

The regulated entity providing Access and Intra-LATA services.

Loopback

An out-of-service test procedure applied to a full duplex channel that causes a received signal to be returned to the source.

Master Station

Denotes the equipment located on the customer's premises which controls communications between the master station and remote stations.

Multiplex

See multiplexer

Multiplexer (Mux)

An equipment unit to multiplex, or do multiplexing: Multiplexing is a technique of modulating (analog) or interleaving (digital) multiple, relatively narrow bandwidth channels into a single channel having a wider bandwidth (analog) or higher bit-rate (digital). the term Multiplexer implies the demultiplexing function is present to reverse the process so it is not usually stated.

Network Channel Interface (NCI) Code

The Network Channel Interface (NCI) code is an encoded representation used to identify five (5) interface elements located at a Point of Termination (POT) at a central office or at the Network Interface at a customer location. The Interface code elements are: Total Conductors, Protocol, Impedances, Protocol Options, and Transmission Level Points (TLP). (At a digital interface, the TLP element of the NCI code is not used.)

Network Interface (NI)

The point of demarcation on the customer's premises at which U S WEST 's responsibility for the provision of service ends.

Ohm

The unit of electric resistance.

Phase Jitter

Intermittent, random displacements in time of digital bits, from their ideal placement in time.

Point of Termination (POT)

The physical telecommunications interface that establishes the technical interface, the test point(s), and the point(s) of operational responsibility. (See Network Interface).

Premises

Denotes a building or portion(s) of a building occupied by a single customer or end-user either as a place of business or residence.

Protocol

The rules for communication system operation which must be followed if communication is to be effected; the complete interaction of all possible series of messages across an interface. Protocols may govern portions of a network, types of service, or administrative procedures.

Protocol Code

The Protocol (character positions 3 and 4 or the Network Channel Interface [NCI] Code) is a two-character alpha code that defines requirements for the interface regarding signaling and transmission.

Service Acceptance Limit

The maximum deviation from a design parameter that is allowed at service turnup or customer acceptance.

Signaling

The transmission of information to establish, monitor, or release connections and/or provide Network Control.

Special Access Service

A service that provides a transmission path within a LATA to directly connect a Point Of Termination (POT) to an end-user premises or to another POT.

Synchronous Transmission

A transmission process such that between any two significant instants in the overall bit-stream there is always an integral number of unit intervals.

Transmission Path

Denotes a path capable of transporting signals within the range of the service offering. A transmission path is comprised of physical or derived facilities consisting of any form or configuration of plant typically used in the telecommunications industry.

Wire Center

A building in which one or more central offices, used for the provision of local exchange services, are located.

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7. References

7.1 American National Standards Institute Documents

- ANSI T1.107-1995 *Digital Hierarchy —Formats Specifications*
- ANSI T1.223-1997 *Information Interchange — Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System.*
- ANSI T1.410-1992 *Carrier-to-Customer Metallic Interface — Digital Data at 64 kbit/s and Subrates*
- ANSI T1.510-1994 *Network Performance Parameters for Dedicated Digital Services - Specifications.*
- ANSI/TIA/EIA 596-1992 *Network Channel Terminating Equipment for Public Switched Digital Service.*

7.2 Bellcore Documents

- TA-TSY-000189 *Generic Requirements for the Subrate Multiplexer.* Issue 1, April, 1986.
- TR-NWT-000341 *Digital Data Special Access Service Transmission Parameter Limits and Interface Combinations.* Issue 2, February, 1993.
- GR-378-CORE *Timing Signal Generator (TSG) Requirements and Objectives.* Issue 1, June, 1995.
- GR-436-CORE *Digital Network Synchronization Plan.* Issue 1, June, 1994 and Revision 1, June, 1996.
- TR-TSY-000458 *Digital Signal Zero "A" (DS-0A 64 kb/s) Systems Interconnection.* Issue 1, December, 1989.

7.3 U S WEST Technical Publications

- PUB 77204 *U S WEST Digital Data Service, Product Description, Applications, and Interface Combinations.* Issue D, October, 1998.
- PUB 77371 *COMMAND-A-LINKSM Technical Description And Interface Combinations.* Issue C, May, 1997.
- PUB 77386 *Interconnection and Collocation for Transport and Switched Unbundled Network Elements and Services.* Issue B, April, 1997. Issue C will be available in December 1998 or January 1999.

7.4 Ordering Information

All documents are subject to change and their citation in this document reflects the most current information available at the time of printing. Readers are advised to check status and availability of all documents.

Those who are not U S WEST employees may order;

American National Standards Institute (ANSI) documents from:

American National Standards Institute
Attn: Customer Service
11 West 42nd Street
New York, NY 10036
Phone: (212) 642-4900
Fax: (212) 302-1286

ANSI has a catalog available which describes their publications.

Bellcore documents from:

Bellcore Customer Relations
8 Corporate Place, PYA 3A-184
Piscataway, NJ 08854-4156
Fax: (908) 336-2559
Phone: (800) 521-CORE (2673) (U.S. and Canada)
Phone: (908) 699-5800 (Others)

International Telecommunications Union documents may be ordered from:

International Telecommunications Union
General Secretariat
Place des Nations, CH-1211
Geneva 20, SWITZERLAND

U S WEST Technical Publications from:

Faison Office Products Company
Suite 200
3251 Revere St.
Aurora, CO 80011
Phone: (800) 777-3672
Fax: (303) 340-1905

Federal Communications Commission (FCC) documents may be obtained from:

Superintendent of Documents
Government Printing Office
Washington, D. C. 20402
Phone: 202 783-3238

Ordering information for Employees of U S WEST Communications, Inc. Submit form RG 31-0033 to:

Information Resource Management (IRM) Group
1801 California St., Rm. 1340
Denver, CO 80202
Telephone: (303) 297-7620
Fax: (303) 896-7663

Most U S WEST publications are available to employees on the company network (E*MEDIA). Call the above number for further information.

7.5 Trademarks

COMMAND A LINK	Service Mark of U S WEST Communications, Inc.
Dataphone Digital Service	Registered Trademark of AT&T Technologies, Inc.
DIGICOM	Registered Trademark of U S WEST Communications, Inc.
SwitchNet 56	Registered Trademark of U S WEST Communications, Inc.

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A. Expected Delay

Information in this appendix is provided as general information and is not a part of the technical description included in this technical publication.

One of the technical issues encountered with DDS is delay. Delay can be an important issue to a customer, especially on multipoint circuits where delay can affect the protocol of polling devices.

The end-to-end propagation delay for U S WEST Digital Data Service circuits depends on the network elements involved with the circuit. Table A-1 lists some typical delay values for secondary channel circuits. InterLATA circuits also involve an Interexchange Carrier. The carrier section of the circuit will introduce additional delay depending on the type of transmission facility and length (e.g., terrestrial or satellite). Furthermore, there is no guarantee that the delay will remain constant since changes in routing, equipment, and multiplexer reframes will affect propagation time.

Table A-1 Approximate Maximum Propagation Delay

Network Element	Loop Rate (Primary Channel Rate)			
	3.2 kbit/s (2.4) (ms)	6.4 kbit/s (4.8) (ms)	12.8 kbit/s (9.6) (ms)	72 kbit/s (56) (ms)
Loop	1.98	2.0	1.0	0.175
Subrate Multiplexer	2.6	1.37	0.75	na
DS1 Multiplexer	0.5	0.5	0.5	0.5
MJU	0.125	0.125	0.125	0.125
Interoffice Facilities (per mile)	0.075	0.075	0.075	0.075

na = Not Applicable.

There is no differential delay between the primary and secondary channel on two-point circuits and in the downstream direction on multipoint circuits. The delay in the upstream direction of multipoint circuits should not exceed three bits (if the "majority of three consecutive bytes" algorithm is used) at the secondary channel rate for each MJU in the circuit. There could be additional differential delay as a result of differential lengths of downstream branches.

The maximum delay on a circuit cannot be specified due to the many variables. Delays longer than 50 ms for two-point circuits and 70 ms for multipoint circuits should not be expected.

Customers must insure that the delay between the Request-To-Send and Clear-To-Send is set long enough when using polling protocols on the network. A no-delay setting may

not allow time for the network and the CSU/DSU buffers to complete their control pattern sequences. The resulting data transmission will be garbled. This delay may be adjusted by setting the CSU/DSU option or the Data Terminal Equipment option.