TR 73548
ISSUE A

June 1990

BELLSOUTH®

Derived Channel Access Service
Digital Data Over Voice
Network Interface Specifications

Technical
Reference

NOTICE

This Technical Reference is published by BellSouth Services Incorporated and defines the network interface and operational requirements for a Digital Data Over Voice (DDOV) technology used in BellSouth's Derived Channel Access Service (DCAS). This specification is written to establish a standard interface to this technology offering.

BellSouth Telecommunications, Inc. reserves the right to revise this document for any reason, including but not limited to, conformity with standards promulgated by various governmental or regulatory agencies, utilization of advances in the state of the technical arts, or the reflection of changes in the design of any equipment, techniques, or procedures described or referred to herein. Liability to anyone arising out of use or reliance upon any information set forth herein is expressly disclaimed, and no representations of warranties, expressed or implied, are made with respect to the accuracy or utility of any information set forth herein.

This document is not to be construed as a suggestion to any manufacturer to modify or change any of it products, nor does this document represent any commitment by BellSouth Telecommunications, Inc. to purchase any product whether or not it provides the described characteristics.

Nothing contained herein shall be construed as conferring by implication, estoppel or otherwise, any license or right under any patent, whether or not the use of any information herein necessarily employs an invention of any existing or later issued patent.

If further information is required, please contact:

Director - Transport Systems Engineering
BellSouth Telecommunications, Inc.
1884 Data Drive
Birmingham, Alabama 35244

DERIVED CHANNEL ACCESS SERVICE
DIGITAL DATA OVER VOICE
NETWORK INTERFACE SPECIFICATION

CONTENTS

DERIVED CHANNEL ACCESS SERVICE DIGITAL DATA OVER VOICE NETWORK INTERFACE SPECIFICATION

1. INTRODUCTION

1.01 General

This Technical Reference defines the network interface and operational requirements for a Digital Data Over Voice (DDOV) technology used in BellSouth's Derived Channel Access Service (DCAS). This specification is written to establish a standard interface to this technology offering. Availability of this service will be dependent on both facility and tariff limitations. Consult the appropriate state or federal tariffs to ascertain availability of Derived Channel Access Service.

The DDOV access arrangement will operate in conjunction with single party analog voice services (i.e., POTS, Centrex, etc.) or on a data only mode basis. The voice portion of this arrangement will connect to the subscriber line side of Class 5 Central Office switches while the data channel will be connected to a tariffed data service offering.

The intent of DDOV access is to provide a common method of access to dedicated, multiplexed, packet switched, or channel switched service offerings via a transparent synchronous digital data transmission path operating at specific speeds up to 19.2 kb/s.

1.02 Scope of Document

This technical publication is intended as a guide for designers and manufacturers of DDOV multiplexer–type equipment. It identifies those engineering requirements that shall be met in order to provide Remote Data Voice Multiplexer compatibility with the DDOV access arrangements. This publication may also be of value to purchasers, operators, and users of equipment.

The parameters specified in this publication are intended to protect the network service, telephone company personnel, and telephone users from hazardous conditions that might be introduced by its operation, and to provide for equipment compatibility and system flexibility.

An objective of this specification is to make it possible for a customer to use products from a number of manufacturers in any given system. It is intended to accommodate innovation in such products as long as they comply with the minimum interoperability and protection requirements of this document.

This publication is not intended to provide complete design specification for the Remote Data Voice Multiplexer, nor will it assure the quality of performance of the CPE nor serve as a procurement specification.

1.03 Document Terminology

The terms "shall be" and "required" are used throughout this publication to indicate mandatory criteria and to differentiate from those parameters that are recommendations. Recommendations are identified by words "may be" and "recommended".

1.04 Organization of Document

Following the Introduction, this technical reference contains sections which address the following topics:

Section 2 – SERVICE DESCRIPTION
Describes Derived Channel Access Service. Describes DDOV access architecture, capabilities, and maintenance features.

Section 3 – METHOD OF OPERATION
Describes signaling, activation/deactivation, synchronization, line coding, and frame construction.

Section 4 – PHYSICAL SPECIFICATIONS
Provides transmission and signaling specifications at Network interface.

Section 5 – DDOV DATA STRUCTURE
Describes frame structure for transmitted signal.

Section 6 – MAINTENANCE CONSIDERATIONS
Describes remote test capabilities that are used to verify line integrity, DDOV integrity, and verification of data integrity being transmitted to the DTE.

Appendix A is attached to this document to include EIA data interchange functional interface requirements. Also, a list of acronyms and a reference list of related publications and associated ordering instructions are provided.

2. SERVICE DESCRIPTION

Derived Channel Access Service provides data channel facilities (full–duplex asynchronous or synchronous) between a customer's premises and a central office. The data channel shall be a 56 kb/s Time Compression Multiplexing (TCM) signal. TCM is a multiplexing scheme that alternately sends and receives bursts of data at approximately 2 and 1/4 times the customer data rate. A quiet interval is provided between signal bursts to allow the line to become free of interference from the previous burst. The resultant signal from this multiplexing scheme, as perceived by the sub–scriber, shall be a virtual full duplex channel (up to 19.2 kb/s). The data channel provides access to other data services of the BellSouth operating telephone companies. It operates concurrently with baseband voice operation over a single non–loaded telephone facility utilizing data/voice multiplexing technology.

Derived Channel Access Service is provided to the customer by means of a DDOV access channel. The DDOV access channel, as depicted in Figure 1, is a transparent synchronous transmission system that provides simultaneous voice and data transmission over a single, non–loaded copper subscriber cable pair.

At the serving central office, the transmission system provides for interconnection to other services via either EIA–232D or DSO physical layer interfaces. For the latter, the data output will contain the extra information (bit stuffing) needed to satisfy the DSO format requirements.

2.01 DDOV Architecture

The DDOV access channel consists of two principal units as shown in Figure 1:

1. The Central Office Data Voice Multiplexer (CDVM), located in a BellSouth central office, terminates the central office end of the DDOV.

2. The Remote Data Voice Multiplexer (RDVM) is typically collocated with the subscriber Data Terminal Equipment (DTE). The RDVM terminates the customer end of the DDOV access channel and is considered to be CPE.

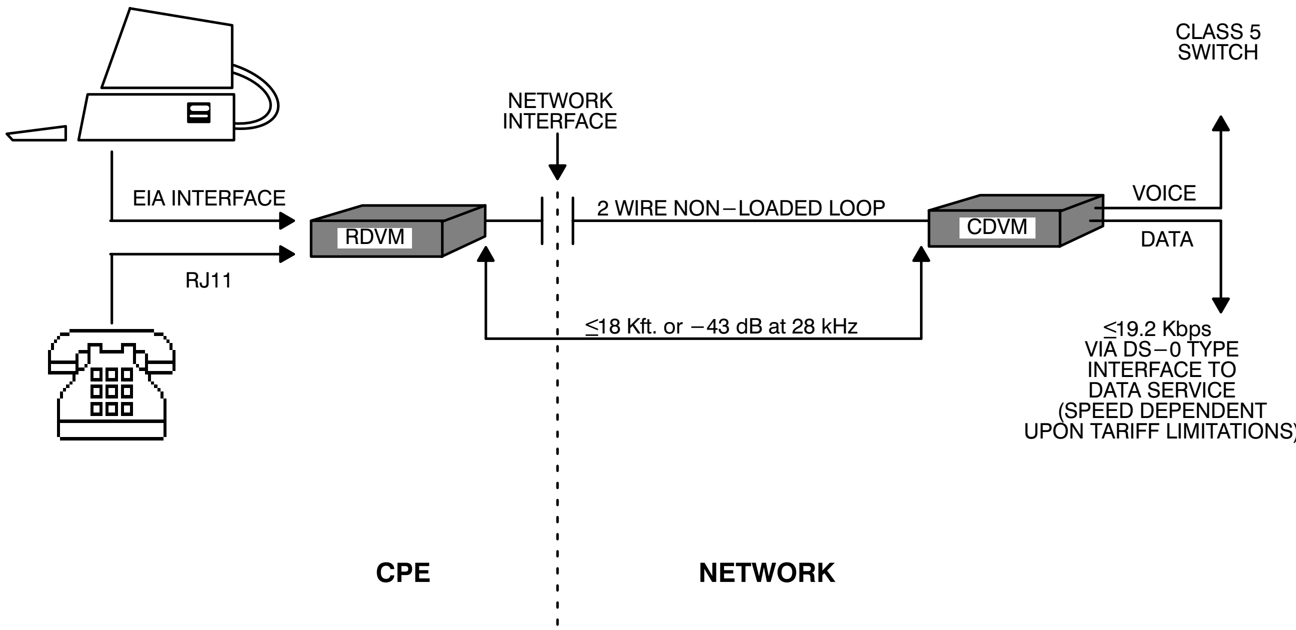


FIGURE 1 − DCAS SYSTEM ARCHITECTURE

Subscriber or customer ownership of the RDVM and its associated equipment is assumed throughout this publication, as written. Equipment designed and manufactured for connection to this service must comply with the requirements and specifications set forth in this publication.

2.02 DDOV Capabilities

The DDOV provides full duplex data transmission in association with normal voice services over a single non−loaded metallic telephone cable pair with up to 1500 ohms of DC resistance. The data portion accommodates specific asynchronous and synchronous speeds up to and including 19.2 kb/s. Voice service is not degraded to any service affecting degree relative to normal operation without the DDOV.

The DDOV access line carries synchronized baseband digital information. It will accommodate both bit synchronous and byte asynchronous user data, but operates as a synchronous−only system, with the RDVM synchronized to the clock of the incoming data for all applications (network timed). RDVM devices designed to meet asynchronous applications must meet the data mapping requirements found in section 5.04 of this document.

The derived data channel can be used in association with various compatible data network services. This service will operate in conjunction with single party analog voice services such as POTS, Centrex, WATS, etc. In the central office, the voice channel connects to the subscriber line side of the central office switch.

2.03 DDOV Maintenance

Localization of Trouble

Maintenance and installation testing of the telephone line will be performed according to local BellSouth policy. BellSouth's line testing responsibility is limited to the Network Interface.

Trouble Isolation and Testing

Maintenance of station equipment belonging to the Derived Channel Access Service subscriber is the responsibility of the subscriber. The subscriber is responsible for testing the RDVM before reporting trouble conditions to the telephone company.

Data Loopback – Remote Test Capability

The DDOV access channel supports remote testing by way of two different data loop arrangements, each of which is dependent upon RDVM functionality.

1. The Channel Service Unit (CSU) loopback shall be located at the closest possible point to the Network Interface. It is used to determine the "well–being" of the loop.
2. The second is a Data Service Unit (DSU) loopback which shall be located at the closest possible point to the customer's data terminal equipment. It is intended to determine the "well–being" of the RDVM itself.

Both of the loopbacks are toward the central office.

3. METHOD OF OPERATION

3.01 Voice Channel

The voice portion of the DDOV access channel will be provided in accordance with the normal design rules of the associated service, i.e., POTS, ESSX service®, etc. CPE is assumed to comply with FCC Part 68, and with ANSI T1.401–1988 as they are presently published for switched voice service. Signaling on the voice channel is by switch hook, dial pulses, DTMF and ringing generator. Failure or loss of power to the CDVM or RDVM will not interrupt the voice connectivity or call processing.

3.02 DDOV Data Channel

The data section of the service provides a transparent transmission channel (bit–in, bit–out) for digital pulses with rates up to and including 19.2 kb/s.

3.03 Activation/Deactivation of Data Channel

The DDOV access channel is activated when power is applied to the RDVM. The DDOV subscriber line carries synchronous baseband digital information and the RDVM is synchronized to the network clock of the incoming data (loop–timed).

The RDVM must disable its transmitter if it cannot synchronize with the CDVM. When such synchronization is lost, the RDVM lowers carrier detect until the incoming data clock is available and valid data is detected.

The data channel is multiplexed above the voice channel, employing a partial response technique of Time Compression Multiplexing that operates independent of the voice channel. The DDOV receivers shall use a loop filter in the voice frequency path to isolate the energy resulting from signals transmitted on the data channels.

®Registered service mark of BellSouth Corporation.

3.04 Operational Requirements

Data Channel Line Rate and Throughput

The local loop operates as a full−duplex 19.2 kb/s synchronous data link using TCM technology with a line baud rate of 56 kb/s. Data is transmitted constantly with a control idle code transmitted during the idle state.

Data Terminal Equipment (DTE) Disruption

Should the connection between the RDVM and the user's DTE be disrupted or the user's DTE not be powered, the RDVM shall send, within 200 milliseconds after detection of the disruption of the DTE, a steady Control Mode Idle (CMI) code (see section 5.05) to the CDVM for the duration of that situation.

3.05 Failure Mode

The failure mode refers to the state when the RDVM is not operational due to a fault condition or power loss in the RDVM. The RDVM, when in a failure mode must not affect normal telephone operation as specified in section 4.01 of this document.

3.06 Power

The RDVM must be powered locally; power is not provided via the Network Interface. Voice telephone circuit connectivity must be maintained and function normally (as specified in section 4) when the RDVM is not powered or fails.

4. PHYSICAL SPECIFICATIONS

This section specifies the voice and data transmission requirements at the Network Interface. The DDOV should appear transparent to the switched network for the voice channel and must not impair the normal transmission and signaling functions of the telephone circuit. Summaries of the interface specifications for the voice and data portions of the DDOV are listed below:

VOICE CHANNEL

Bandwidth	200 to 3000 Hz, nominal
Impedance	900 ohms, nominal
Insertion Loss (@ 1kHz)	$\leq$ 10 dB
Added Insertion Loss (by RDVM)	Less than 0.75 dB at 1004 Hz
Added Slope (by RDVM)	$\pm$1 dB of 1004 Hz loss between frequency range of 400 to 2800 Hz
Loop Resistance (effective)	$\leq$ 1500 ohms
Added Loop Resistance (by RDVM)	50 ohms or less
Ringer Equivalent (RDVM)	2 or less

Signaling	Loop or ground start (see ANSI T1.401−1988)
Idle Circuit Noise	$\leq$ 20 dBrnc (See ANSI/IEEE Standard 743−1984 and PUB 61100)
Longitudinal Balance	Greater than 65 dB at 1 KHz
Call Processing	Same as the switched network (see TR−TSY−000505)
Network Interface	Miniature 6−position jack

DATA CHANNEL

Asynchronous	300, 600, 1200, 2400, 4800, 9600, and 19200 bps
Synchronous	2400, 4800, 9600, and 19200 bps
Loop Transmission	
Rate	2−wire baseband, TCM Multiplexing at 56 kb/s synchronous
Format	digital, bipolar pulse, burst−mode transmission, 2.5 ms burst
Impedance	135 ohms
Signal Level	+ 12.5 dBm $\pm$1 dBm into 135 ohms across the frequency band of 10 kHz−112 kHz
Dynamic Operating Limit	43 dB line loss at 28 kHz
Performance Objective	99.5% EFS over 24 hr. period
Modulation	Baseband Alternate Mark Inversion using pulse shape specified in Figure 4.
Interface Connection	Miniature 6−position jack
Active leads	Tip and Ring (leads 3 & 4) See Figure 2

4.01 Mechanical Interface

The RDVM may connect to the network via any of the wiring configurations (RJXX) suitable for 2−wire switched network access. The RJ11 configuration is assumed. Specifications for this jack are defined in FCC rules 47CFR68.500 (Part 68, Subpart F, Section 68.500).

The miniature 6−position jack is shown schematically in Figure 2. This jack is equipped with six contacts; the center two contacts (positions 3 and 4) are used for the tip and ring.

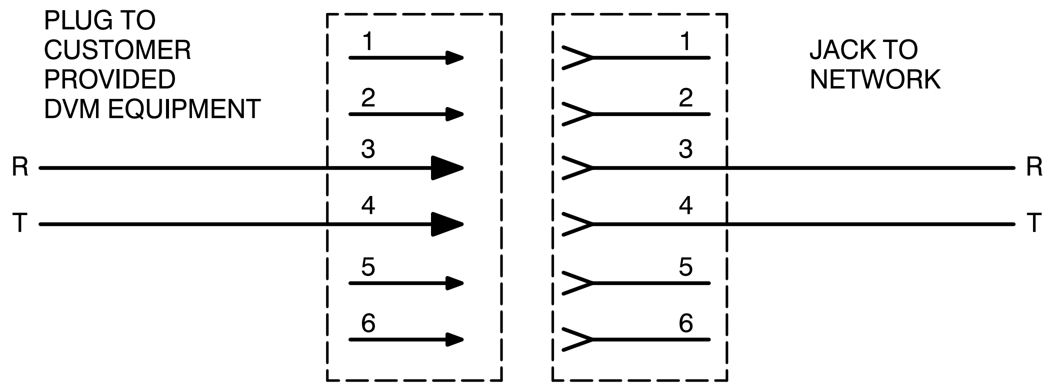


FIGURE 2 − NETWORK INTERFACE − MINIATURE 6−POSITION JACK

4.02 DDOV Pulse Characteristics

Data transmission in the DDOV shall use baseband Pulse Amplitude Modulation (PAM) signaling in conjunction with Alternate Mark Inversion (AMI) encoding. In this sense, the transmission scheme is similar to DDS transmission as outlined in Bellcore PUB 62310. To eliminate data signal energy in the VF band, the pulse shape used for data transmission shall be coded as specified later in this section.

Tip/ring reversal at the RDVM can happen and should be automatically corrected in the transceiver. The start of every burst in the RDVM shall begin with the first mark having the same polarity as the first mark coming from the CDVM.

Figure 3 shows the model of the transmitter which shall be used with the PAM transmission. Both the CDVM and the RDVM shall transmit PAM bursts at the rate of 400 Hz (referenced to the serving central office clock). The transmission is fully symmetric, i.e., each direction shall use the same pulse shape and an identical format (explained later in this section).

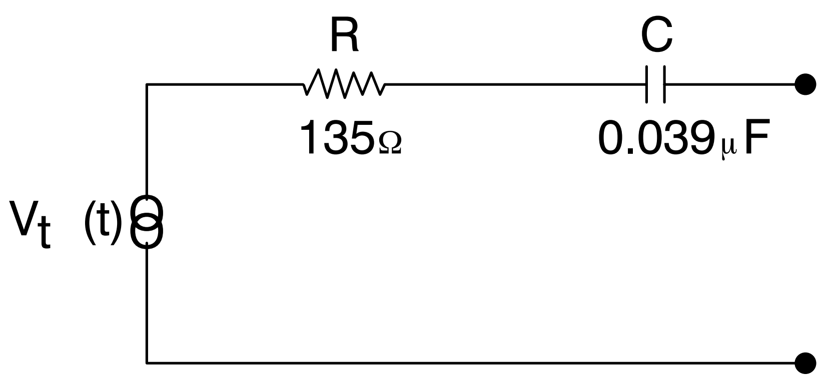


FIGURE 3 − PAM TRANSMITTER MODEL

4.03 AMI Symbol Encoding

If the AMI data burst to be transmitted is $[a_0, a_1, a_2, a,...a_N]$, where ai is either −1, 0 or +1 in accordance with the rules of AMI. If the raw data burst to be transmitted is $[|a_0|, |a_1|, |a_2|, |a_3|,...|a_N|]$, and if the bit rate is 1/T Hz (nominally 56,000 Hz), then the transmit signal must be:

$$V_t(t) = \sum_{i=0}^{N} a_i * p(t-iT)$$

Where p(t) is the single pulse as shown in Figure 4.

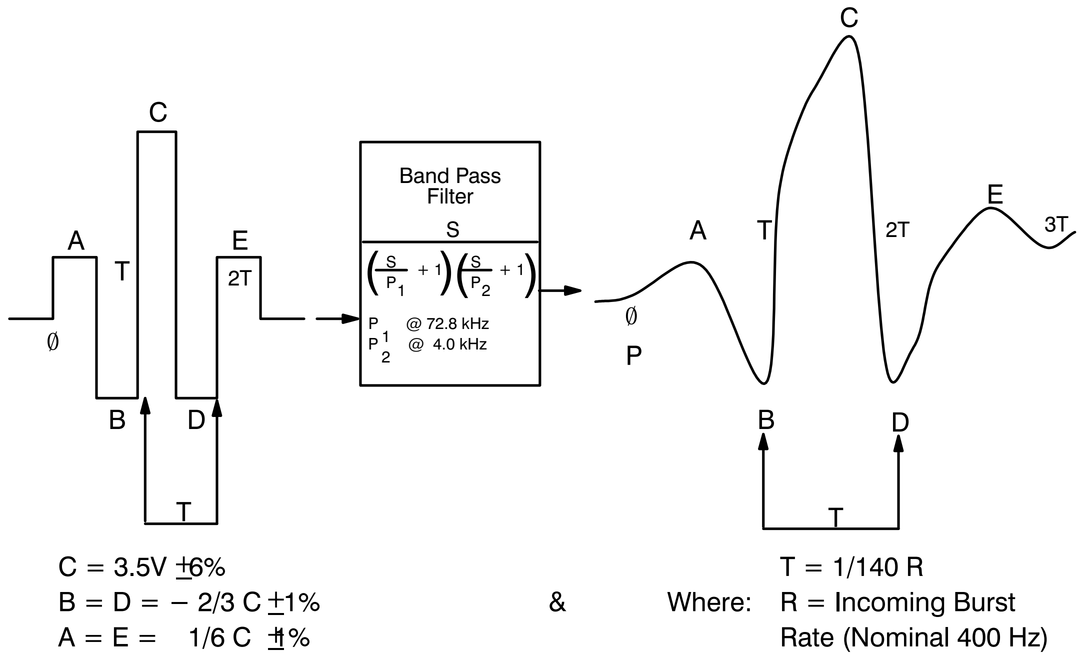


FIGURE 4 − PAM/AMI SYMBOL SPECTRUM

The transmitter must have a source impedance as shown in Figure 3.

4.04 Transmission Media

The DDOV system is expected to operate on subscriber loops designed to non−loaded POTS criteria. A subscriber loop is a single, non−loaded, twisted cable pair, with a minimum wire size of 26 gauge copper or an equivalent. The non−loaded loop (including central office and customer wiring) may be 26, 24, 22, or 19 gauge wire, or a mix of gauges with a length range of up to 18 kft. The maximum allowable bridged−tap is 6000 feet. The non−loaded loop insertion loss plus the bridged tap loss between the CDVM and RDVM shall not exceed 43 dB at 28 kHz. Non−loaded cables having nominal DC resistance up to 1500 ohms may be encountered. Since the system supports POTS and must be non−loaded, cable length will normally not exceed 18 kft.

The cable characteristics for the subscriber loop can be found in either ANSI T1.403−1989 or T1.601−1988. The nominal impedance of the loop, at the Nyquist frequency of 28 kHz, is considered to be 135 ohms resistive. All sections of this publication which reference loop loss, receiver sensitivity, etc., require that measurements and calculations use this nominal value.

Network transmission characteristics, considerations, and performance are addressed in Bellcore PUB 41005 and TR−TSY−000507. Transmission characteristics are addressed in Bellcore TA−NPL−000912.

4.05 Data Channel Synchronization

The transit data of the RDVM must be loop timed from the incoming timing from the CDVM. The CDVM is connected to network timing. The CDVM acts as the master and initiates synchronization to the CPE RDVM, which is the slave.

4.06 Framing Requirements

The RDVM must synchronize from the incoming bursts from the CDVM. Detailed requirements follow in section 5. The RDVM must not transmit its bursts whenever it is out of frame.

4.07 DTE Timing

In synchronous operation, the RDVM must supply timing to the data terminal equipment (DTE). The clock for the DTE shall be provided at the bit rate that is frequency−locked to the TCM burst rate. In this mode, the RDVM's received clock must meet the requirements specified in section 9 of PUB 62310.

4.08 Receiver Requirements

The receiver shall be able to equalize the frequency dependent attenuation caused by the local loop cable. This equalizer should be able to accommodate the full anticipated range of the non−loaded loop plant, providing a loss range of zero to 43 dB at 28 kHz.

5. DDOV DATA STRUCTURE

TCM Frame

The RDVM must support a TCM frame that is composed of two TCM bursts; a transmitted burst, and a received burst.

Each TCM frame must be 2.5 milliseconds long, creating a frame rate of 400 Hz. During normal operation, (i.e., when both ends of a data circuit are synchronized), one TCM burst is required to be transmitted and received every frame. The RDVM must transmit its burst within 10 bit periods (approximately 178 microseconds) after receipt of the last bit from an incoming burst from the CDVM.

TCM Burst

The bit rate of a TCM burst must be 56 kb/s, synchronized with the network clock. Each TCM burst must be sent as shown below and is composed of three basic parts:

the Header . . . . shown as H

the Data Word portion of the frame . . . . shown as DW

the Tail . . . . shown as T

$$H|DW_1|DW_2|DW_3|DW_4|DW_5|DW_6|DW_7|DW_8|T$$

TCM Burst Header

The TCM Burst Header must always be two bits long and both bits are always set to a "1".

TCM Burst Word

The TCM Data Portion will be 56 bits long and will carry customer data. The 56 bits are grouped into eight seven−bit TCM words. Each word is comprised of six data bits and a control bit with the first bit being the most significant and the control bit being the least significant bit within each Data Word. Therefore, the structure for each of the eight Data Words within a TCM Burst would be:

|ddddddc| Where: d=one bit of customer data, and c=the control bit.

TCM Burst Tail

The Burst Tail is composed of two bits: the first bit (P) is a parity bit, used to produce even parity; the second bit of the tail is the last bit of the frame which is always set to "1". The P bit produces even parity over the whole burst, including the "1" at the end.

The even parity ensures that the whole burst (including header and tail) has an even number of marks. This guarantees zero volts DC per burst.

|−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−TCM
Burst−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−|

11| ddddddc| ddddddc| ddddddc| ddddddc| ddddddc| ddddddc| ddddddc| ddddddc P1

The seventh bit of every Data Word must correspond functionally to the network control bit as discussed in paragraph 5.05 of this publication and described in Bellcore TA−TSY−000055 and TA−TSY−000077. The structure of the received and transmitted bursts must be the same.

5.01 Synchronization Framing

Frame synchronization should be acquired in less than 500 milliseconds. During the time that synchronization takes place, the RDVM should refrain from sending any transmit bursts. Once synchronization is established, the RDVM may initiate its transmit bursts. The synchronization algorithm must minimally be sufficiently robust to maintain synchronization under the worst subscriber loop conditions.

5.02 Data Throughput

Based on the structure of the TCM Burst Rate of 400 times per second and associated Data Word structure of eight data words per burst and six data bits (not counting control bits), the effective throughput capability of the DDOV access channel is 19.2 kb/s. When operating at less than 19.2 kb/s, data words are repeated and concatenated to match the desired rate.

5.03 Synchronous Data within TCM Transmission

The RDVM shall be capable of supporting four possible synchronous data rates within the TCM transmission. These include: 19.2, 9.6, 4.8, and 2.4 kb/s. The transmission of data rates less than 19.2 kb/s should be accomplished by repeating and concatenating the data in the following in the following manner: 9.6 kb/s − each Data Word must be sent two times; 4.8 kb/s − each Data Word must be sent four times; and 2.4 kb/s − each data word must be sent eight times. The changing of data rates should be similar to the method used for DDS, requiring a manual setting in the CDVM and RDVM.

The RDVM should arbitrarily split the data into six−bit chunks that are packed into the first six bits of the seven−bit TCM words described in section 5 of this publication.

5.04 Asynchronous Data Within TCM Transmission

The RDVM should be capable of supporting the seven asynchronous data speeds within the TCM transmission. These include: 19.2, 9.6, 4.8, 2.4, 1.2, .6, and .3 kb/s. In order to support these rates, the RDVM must strip/insert the start and stop data bits and map/demap the data bits to/from one of the synchronous data speeds described in 5.03. Data transmission at rates less than 19.2 kb/s is repeated in the same manner as for synchronous data to maintain the fixed signaling rate of 19.2 kb/s. Data must have the following format:

– one start bit (space),

– an eight–bit byte, and

– one stop bit (mark).

The CDVM places no interpretation on the eight–bit byte, thus, these bits may be used for parity bits and/or additional stop bits in lieu of actual user data.

When no customer data is available for transmission, an eight–bit synchronization byte must be repeatedly sent on the synchronized DDOV channel. This byte is B1111110, where: the B bit is used to signal a break condition by setting the B bit to a one when a break is received from the DTE.

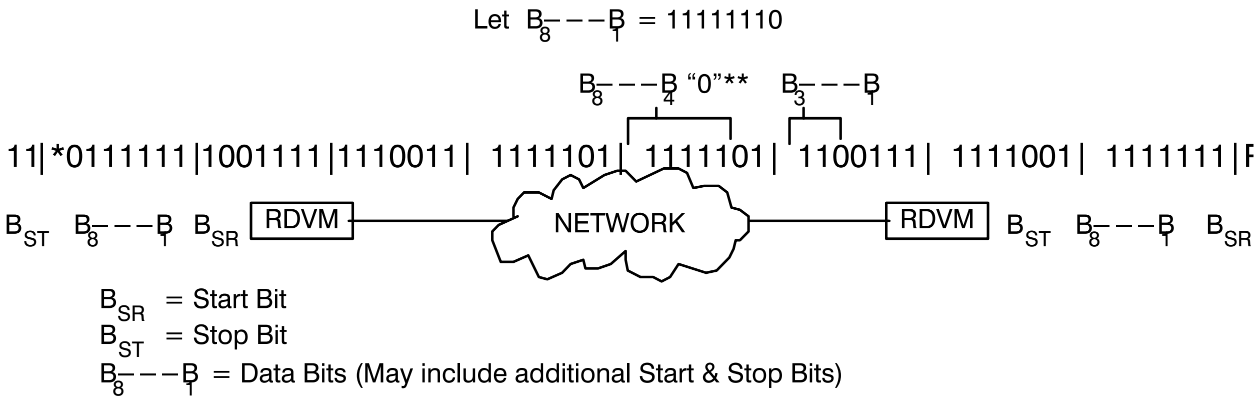
Products that support autobaud operation must use the synchronization sequence character B1111110FAX. The B bit is as described above. The F bit is used for flow control and is set to a 1 to stop the CDVM from sending data. The A bit is used for autobaud and is normally set to a 1. The CDVM data rate can be changed by sending the following sequence of A bits.

Data Rate	A Bit Sequence
300	00000100
600	00101110
1200	01001000
2400	01100010
4800	01110100
9600	01011110
19200	00111000

The X bit is a spare and is not currently defined.

When data bytes received from the DTE and sent to the CDVM are concatenated, a zero must be inserted after every group of five one bits in order to avoid sending a synchronization character. In the reverse direction, the zero which appears after every five ones must be discarded before dividing the bits up into the eight–bit bytes. Received synchronization characters are used to identify byte boundaries.

An example of how the RDVM must accommodate the asynchronous data while operating as a synchronous–only system is shown in Figure 5. A single start/stop user data byte is shown preceded and followed by synchronization characters.



* Beginning of a TCM burst need not coincide with the beginning of a synch character and is shown here for ease of explanation.

** Zero is shown inserted to prevent emulating synch character.

FIGURE 5 – EXAMPLE OF INSERTION/REMOVAL OF START AND STOP BITS FOR ASYNCHRONOUS DATA IN TCM TRANSMISSION

In all cases, the synchronous rate used must be greater than or equal to the asynchronous rate to ensure proper framing.

5.05 DDOV Channel Service Network Controls

As previously mentioned, the TCM burst must contain eight words of seven bits each. These seven bits consist of six data bits followed by a network control bit. When the control bit is set to one, the six data bits contain customer data. When the control bit is set to zero, the six data bits represent one of 64 network control codes. For example, the CMI code is 1111110. The CSU and DSU loopback codes are addressed in Section 6.02. Additional information on these controls can be found in Bellcore TA–TSY–000055 and TA–TSY–000077.

5.06 DTE Control Interchange

The DDOV channel supports interchange of three control signals normally associated with DTE operations. It is recommended that the CPE DTE hold, or the RDVM force, Data Terminal Ready, Ready to Send, and Spare Transit Control channel function active in order to transmit data. If any of these leads are inactive, a DCE–to DCE control code indicating the status of these leads should be sent to the CDVM. The DCE–to–DCE control codes are as follows in Table A:

DTR	RTS	T–Channel	Code
off	off	off	1111110
off	off	on	1111100
off	on	off	1111010
off	on	on	1111000
on	off	off	1110110
on	off	on	1110100
on	on	off	1110010

TABLE A
DCE–to–DCE Control codes

5.07 Additional End−to−End Data Interchange

Depending on the particular application, additional data interchange algorithms may be required. It is desirable that the CPE also implement data interchange based on compatibility with DDS.

6. MAINTENANCE CONSIDERATIONS

An RDVM, when accessed by routine and automatic BellSouth testing systems, shall not provide false indications to these testing systems. The RDVM shall not impair, or interfere with, the operation of any existing network systems.

6.01 Test Voltages

Voltages applied to the loop at the central office for testing with the station equipment on−hook may reach a maximum of ±200 volts DC between the tip and ring or between either conductor and ground. AC maintenance testing signals of up to 10 volts rms may also be applied from either tip−to−ring, tip−to−ground, in the frequency range of 5 to 1000 Hz. This does not include ringing voltage which could be as high as 150 volts rms at frequencies of 15 to 68 Hz. Refer to ANSI T1.401−1988 for more detail.

6.02 Loopback Tests

The RDVM should minimally be capable of supporting CSU and DSU loopbacks, described in Bellcore TA−TSY−000077, Issue 3, and TA−TSY−000083, Generic Requirements for the DDS Network − Office Channel Unit. These loopbacks should be activated when either a CSU loopback code or a DSU loopback code is received from the network.

The RDVM should also be equipped with both a latching local loopback (toward the DTE) and Network Digital Loopback. The network control code for the non−latching loopbacks are:

CSU	0101000
DSU	0101100

Support to other in−band and network control arrangements are permitted as long as their operation is non−interferring, and/or compatible with the 64 network controls described in Bellcore TA−TSY−000077.

APPENDIX A

EIA DATA INTERCHANGE FUNCTIONAL INTERFACE REQUIREMENTS

1.01 The vendor is responsible for selecting the type of DTE physical interface to be supported by the RDVM. The functionality noted in this section is primarily based on the Consultative Committee for International Telegraphy and Telephony (CCITT) − V.24 requirements necessary to provide single channel dedicated, channel switched and packet switched data communication links. The recommended physical interface for an RDVM is the ANSI EIA−232−D and subset RS232−C interface, as described in ANSI/EIA publication EIA−232−D−1986.

This section also defines the bit format for supporting this functionality on an end−to−end basis for asynchronous and synchronous applications via the DDOV transmission channel described in section 5 of this publication.

1.02 EIA Interface Functionality − DCE (RDVM) Source Signals

The RDVM should be capable of transmitting the following data interchange signals:

A: Protective Ground (Frame Ground)

The RDVM should be equipped with a protective ground that is electrically bonded to the equipment frame and connected to an external ground (e.g., through the third wire of the power cord.

B: Signal Ground (AB)

The RDVM should be equipped with the CCITT interchange circuit 102. This circuit is used to establish a common ground reference potential for all interchange circuits within the RDVM. The AB circuit can be connected to the Protective Ground in accordance with EIA−422−A requirements.

C: Received Data Signal (BB)

The RDVM should be equipped with the CCITT interchange circuit 104. Signals on this circuit transfer data received by the RDVM via the DDOV channel to the DTE. It is highly recommended that the use, and necessary responses, of this circuit follow all relevant EIA conventions.

When a synchronization sequence character with a B bit set to one is received, the BB lead should be set to “space” until a data character is received or a synchronous character with the B bit set to zero is received.

D: Clear to Send (CB) Recommendations

The RDVM should be equipped with the CCITT interchange circuit 106. This circuit is used to signal the DTE that the RDVM is ready to transmit data via the DDOV channel. The RDVM should hold the CB function active unless the TCM link loses synchronization, a CSU or DSU loopback is received from the network, or one of the following control codes is received from the network: 111x1xo: where the “x” can be either a 0 or 1 bit.

E: Data Set Ready (CC) Recommendations

The RDVM should be equipped with the CCITT interchange circuit 107. This circuit is used to signal the status of the RDVM to the DTE. The RDVM should be designed to hold the CC function active unless the TCM link loses synchronization or a CSU or DSU loopback is received from the network.

F: Received Line Signal Detector (CF) Recommendations

The RDVM should be equipped with the CCITT interchange circuit 109. This circuit is used to signal the DTE that the RDVM is receiving a suitable TCM signal. The RDVM should hold the CF function active unless the TCM link loses synchronization, a CSU or CSU loopback is received from the network, or one of the following control codes is received from the network; 1111xx0; where “x” can be either a 0 or 1 bit.

G: Transmitter Signal Element Timing (DB)

The RDVM should be equipped with the CCITT interchange circuit 114. This circuit is used to provide the DTE with transmit signal element timing information from the network.

H: Receiver Signal Element Timing (DD)

The RDVM should be equipped with the CCITT interchange circuit 115. This circuit is used to provide the DTE with received signal element timing information from the network.

I: Test Mode (TM)

The RDVM should be equipped with the CCITT interchange circuit 142. The RDVM should hold the TM function off unless a CSU or DSU loopback is received from the network or if a local loopback is initiated within the RDVM. If the Local Loopback lead is active, the RDVM should disconnect from the loop and perform a local loopback at the network disconnect from the loop and perform a local loopback at the network interface. This loopback should be toward the EIA physical interface.

J: Secondary Clear to Send as a Spare Receive Control Channel (R−Channel) Recommendations

The RDVM should be equipped with the R−Channel interchange circuit function which will provide a spare signaling channel in the same manner as a Secondary Clear to Send CCITT interchange circuit 121 and is used in conjunction with the T−Channel function that would be received from the CDVM.

The intent of the R−Channel functions is to provide a “CB−like” function for unique system implementations requiring and additional end−to−end control signal and should be used to signal the DTE that the RDVM is ready to transmit data via the DDOV channel. The RDVM should hold the R−Channel function active unless the TCM link loses synchronization, a CSU or DSU loopback is received from the network, or the following control codes are received from the network: 111xx10.

1.03 EIA Interface Functionality − DTE Source Signals

The RDVM should be capable of receiving and reacting to the following data interchange signals from the DTE:

A: Transmitted Data (BA)

The RDVM should be equipped with the CCITT interchange circuit 103. Signals on this circuit transfer data received from the DTE to the RDVM for transmission via the DDOV channel to the remote DCE and DTE.

B: Request to Send (CA)

The RDVM should be equipped with the CCITT interchange circuit 105. Signals on this circuit are transmitted by the DTE to condition the RDVM for data transmission over the DDOV channel.

C: DTE Ready (CD)

The RDVM should be equipped with the CCITT interchange circuit 108. Signals on this circuit are transmitted by the DTE to prepare the RDVM for data transmission over the DDOV channel and maintains the connection established by external means.

D: Local Loopback (LL)

The RDVM should be equipped with the CCITT interchange circuit 141. Signals on this circuit are transmitted by the DTE to initiate or control the LL condition described in paragraph 5.07 of this publication.

E: Secondary Request to Send as a Spare Transmit Control Channel (T−Channel)

The RDVM should be equipped with the T−Channel interchange circuit function which will provide a spare signaling channel in the same manner as the Secondary Request to Send CCITT interchange circuit 120 and is used in conjunction with the R−Channel function. The intent of the T−Channel function is to provide a second “CA−like” function for unique system implementations requiring an additional end−to−end control signal and should be used to signal the RDVM that the DTE is ready to transmit data.

ACRONYMS

AMI	Alternate Mark Inversion
CDVM	Central Office Data Voice Multiplexer
CMI	Control Mode Idle
CO	Central Office
CPE	Customer Premises Equipment
CSU	Channel Service Unit
DCAS	Digital Channel Access Service
DCE	Data Circuit−Terminating Equipment
DDS	Digital Data Service
DS0	Digital Signal − Level Zero
DTE	Data Terminal Equipment
DDOV	Digital Data Over Voice
DLC	Digital Loop Carrier
DSL	Digital Subscriber Line
DSU	Data Service Unit
DTE	Data Terminating Equipment
DVM	Data Voice Multiplexer
EFS	Error Free Seconds
EIA	Electronic Industries Association
FCC	Federal Communications Commission
ISDN	Integrated Services Digital Network
LTD	Local Test Desk
MDF	Main Distribution Frame
MLT	Mechanized Loop Test
PAM	Pulse Amplitude Modulation
POTS	Plain Old Telephone Service
RDVM	Remote Data Voice Multiplexer
TCM	Time Compression Multiplexing
WATS	Wide Area Telephone Service
VF	Voice Frequency

REFERENCES

ANSI/IEEE/EIA/FCC PUBLICATIONS

ANSI T1.401–1988 — American National Standards Institute (ANSI) Interface between Carriers and Customers Installations – Analog Voice Grade Switched Access Line Using Loop Start and Ground Start Signaling.

ANSI T1.403–1989 — Carrier–to–Customer Installation – DS1 Metallic Interface.

ANSI T1.601–1988 — Integrated Services Digital Network (ISDN) Basic Access Interface For Use on Metallic Loops For Application on the Network Side of the NT (layer 1 Specification).

ANSI/IEEE 743–1984 — IEEE Standard Method and Equipment for Measuring the Transmission Characteristics of Analog Voice Circuits.

ANSI/IEEE 455–1976 — IEEE Standard Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band.

EIA 232–D–1986 — Interface Between data Terminal Equipment and Data Circuit–Terminating Equipment Employing Serial Binary Data Interchange. November 1986.

FCC 47CFR68 — Code of Federal Regulations 47, Part 68, “Connection of Terminal Equipment to the Telephone Network”.

ANSI documents are published by American National Standards Institute, Inc. and may be purchased from ANSI, 1430 Broadway, New York, New York 10018.

ANSI/IEEE documents are published by the Institute of Electrical and Electronic Engineers and may be purchased from IEEE Service Center, 455 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855.

EIA documents are published by the Electronic Industries Association and may be purchased from EIA Standards Promotions, P.O. Box 57258, Washington, D.C. 20037–0258

FCC documents may be obtained from the Government Printing Office, Washington D.C., telephone number (202) 783–3328

BELLCORE TECHNICAL PUBLICATIONS*

PUB 41005	Data Communications Using the Switched Telecommunications Network. May 1971.
PUB 47102	Miniature Plugs and Jacks. December 1982.
PUB 61100	Description of Analog Voiceband interface Between the Bell System Local Exchange Lines and Terminal Equipment. January 1983.
PUB 62310	Digital Data System Channel Interface Specification. September 1983.

BELLCORE TECHNICAL ADVISORIES

TA−TSY−000055	Basic Testing Functions for Digital Networks and Services. Issue 3, April 1987.
TA−TSY−000077	Digital Channel Banks − Requirements for Dataport Channel Unit Functions. Issue 3, April 1986.
TA−TSY−000083	Generic Requirements for the Digital Data System (DDS) Network Office Channel Unit. Issue 2, April 1986.
TA−NPL−000458	Digital Signal Zero, "A" (DS−0A 64 kb/s) Systems Interconnection. February 1988.
TA−NPL−000912	Compatibility Information for Telephone Exchange Service. February 1989.

BELLCORE TECHNICAL REFERENCES

TR−TSY−000393	ISDN Basic Access Digital Subscriber Lines. Issue 1, May 1988.
TR−TSY−000505	Call Processing − LATA Switching Generic Requirements (LSSGR), Section 5. Issue 2, July 1987.
TR−TSY−000506	Signaling − LATA Switching Systems Generic Requirements (LSSGR), Section 6. Issue 2, July 1987.
TR−TSY−000507	Transmission − LATA Switching Systems Generic Requirements (LSSGR), Section 7. Issue 3, March 1989.

*Bellcore Documents may be obtained from:

Bell Communications Research
Customer Service
60 New England Avenue
Piscataway, NJ 08854−4196
(201)699−5800

DERIVED CHANNEL ACCESS SERVICE DIGITAL DATA OVER VOICE NETWORK INTERFACE SPECIFICATION

CONTENTS

DERIVED CHANNEL ACCESS SERVICE DIGITAL DATA OVER VOICE NETWORK INTERFACE SPECIFICATION

1. GENERAL

1.1 This Addendum supplements BellSouth Services TR 73548, "Derived Channel Access Service Digital Data Over Voice Network Interface Specification", June 1990.

1.2 This Addendum and TR 73548 describe the network interface specifications associated with BellSouth's Derived Data Channel Service (DDCS).

1.3 The purpose of this Addendum is to specify a new Derived Data Channel Service access to a multiplexed DDCS signal in the network. This multiplexed network signal contains multiple DDCS DDOV customer channels, and conforms to the DS∅B format used within the BellSouth DDS and SynchroNet-® service architectures. Access to this DS∅B formatted signal was previously only available as a BellSouth SynchroNet service access. The network interface specifications of the new DDCS DS∅B access service are identical to those of the aforementioned SynchroNet service access, and are described in Section 7 of BellSouth TR 73545, Issue B, "SynchroNet® Service Network Interface Specifications", October, 1990.

2. OVERVIEW

2.1 Figure 1 is a simplified diagram of the DDCS architecture. The data from as many as twenty 2.4 kilobits per second (kbit/s) DDCS Digital Data Over Voice (DDOV) customers can be multiplexed into one "DS∅B" signal. This DS∅B signal is an internal BellSouth network signal, and does not appear at a network interface. However, access to this signal is available through 64 kbit/s SynchroNet service, as described in Section 7 of BellSouth TR 73545, Issue B. Although the network interface specifications for the new DDCS DS∅B access is identical to those for the SynchroNet service access, no performance objectives are associated with the DDCS DS∅B access.

2.2 The new 64 kbit/s DDCS access can only be used in conjunction with DDCS DDOV circuits.

3. MECHANICAL AND ELECTRICAL INTERFACE SPECIFICATIONS

The mechanical and electrical interface specifications for the DDCS DS∅B service access are identical to those for 64 kbit/s SychroNet service, and are contained in Section 3 and 4 of BellSouth TR 73545, Issue B.

4. DS∅B SIGNAL FORMAT

4.1 The DS∅B signal is a standard DDS signal used within the BellSouth network. It is a 64 kbit/s signal comprised of several multiplexed subrate circuits. The DS∅B signal can contain one of the following:

Up to twenty 2.4 kbit/s circuits
Up to ten 4.8 kbit/s circuits
Up to five 9.6 kbit/s circuits

The mixing of different types of subrates within an individual DS∅B is not permitted. Currently, only the multiplexing of 2.4 kbit/s DCAS service is offered.

The specifications for a standard DS∅B signal is contained in Bellcore Technical Advisory TA−TSY−000280, "Digital Cross−Connect System (DCS) Requirements and Objectives for the Sub−Rate Data Cross−Connect (SRDC) Feature."

4.2 DS∅B STRUCTURE

The DS∅B signal is comprised of eight−bit bytes transmitted at 8000 times per second. The frame format is as follows:

```
 S D D D D D D C S D D D D D D C ..... S D D D D D D C
└──── byte 1 ────┘└──── byte 2 ────┘    └──── byte n ────┘
```

Where: D = Customer data bit
S = DS∅B subrate framing pattern bit
n = 5 for 9.6 kbit/s
10 for 4.8 kbit/s
20 for 2.4 kbit/s
C = 1 for customer data
= 0 for network codes and idle code (S1111110)

The subrate framing bit (S−bit) patterns for 2.4, 4.8 and 9.6 kbit/s are:

SUBRATE	S−BIT PATTERN
2.4 kbit/s	01100
4.8	0110010100
9.6	01100101001110000100

5. NETWORK INTERFACE SPECIFICATIONS

The signal passed across the Network Interface must have a format and structure such that it conforms to DS∅B specifications at the DS0−level crossconnect point in the network. In order to do this, the customer installation must conform to the mechanical, electrical, signal format, and maintenance requirements for 64 kbit/s SynchroNet service contained in BellSouth TR 73545, Issue B. The signal format is summarized below.

The local loop signal consists of nine−bit byte, comprised of eight customer data bits and one F−bit. Because of the insertion of the F−bit in the local loop, the actual local loop line rate is 72 kbit/s. The F−bit is only used in the local loop. The frame format of the customer data bits in the local loop (and across the network interface) is as follows:

```
 S D D D D D D F C S D D D D D D F C ......S D D D D D D F C
└──── byte 1 ──────┘└──── byte 2 ──────┘    └──── byte n ──────┘
```

Where D = Customer data bits, except when network codes described in BellSouth TR 73545, Issue B are being transmitted

S = DS∅B subrate framing pattern bits (see Section 4.2)

C = 1 for customer data
0 for network codes

F = Local loop framing pattern bit. The F−bit framing pattern is the repeated sequence of:

101100...

n = 20 for 2.4 kbit/s DDCS customer facilities
10 for 4.8 kbit/s DDCS customer facilities*
5 for 9.6 kbit/s DDCS customer facilities*

* These DDCS access rates are not currently offered.

F−bits transmitted by the Customer Premises Equipment across the network interface must be byte aligned with the eight−bit subrate bytes within the local loop signal. Specifically, the signal towards the network must be transmitted such that an F−bit is contained in bit position 8 of each 9−bit subrate byte within the 64 kbit/s local loop signal.

Each byte (1 through n) contains one DDCS DDOV customer channel data byte, with each byte position in the frame associated with a unique DDCS DDOV data channel. Byte 1 position contains DDOV channel 1 data bytes, byte 2 position contains DDOV channel 2 data bytes, etc. There may be as many as 20 2.4 kbit/s DDOV customer data channels multiplexed within the 72 kHz signal across the network interface.

The assigment of individual DDOV channels to particular byte positions in the 72 kbit/s local loop frame must be coordinated through a bilateral agreement at subscription time.

The format specifications for this service are above and beyond those for basic 64 kbit/s SynchroNet service access (but is consistent with the special requirements in Section 7 of BellSouth TR 73545, Issue B regarding DS∅B access). This places additional requirements on CPE, as compared to basic SynchroNet service.

6. RELATED DOCUMENTS

The following document is referenced in this addendum:

TR 73545, Issue B	“SynchroNet® Service Network Interface Specifications”, BellSouth Services.[1]
TA−TSY−000280	“Digital Cross−Connect System (DCS) Requirements and Objectives for the Sub−Rate Data Cross−Connect (SRDC) Feature”, Bellcore.[2]

FOOTNOTES

1. This document can be obtained by sending check or money order (payable to Craftsman Printing, Inc.) to:

   BellSouth Services Incorporated
   Documentation Operations
   3535 Colonnade Parkway
   Room N5A1
   Birmingham, AL 35243

   Current price: $13.00

2. This document can be ordered through Bell Communications Research (Bellcore), Customer Service, 60 New England Avenue, Piscataway, NJ, 08854−4196. Telephone orders can be made by calling 1−800−521−CORE, or (201) 669−5800. Pricing and availability information is also available at this number.

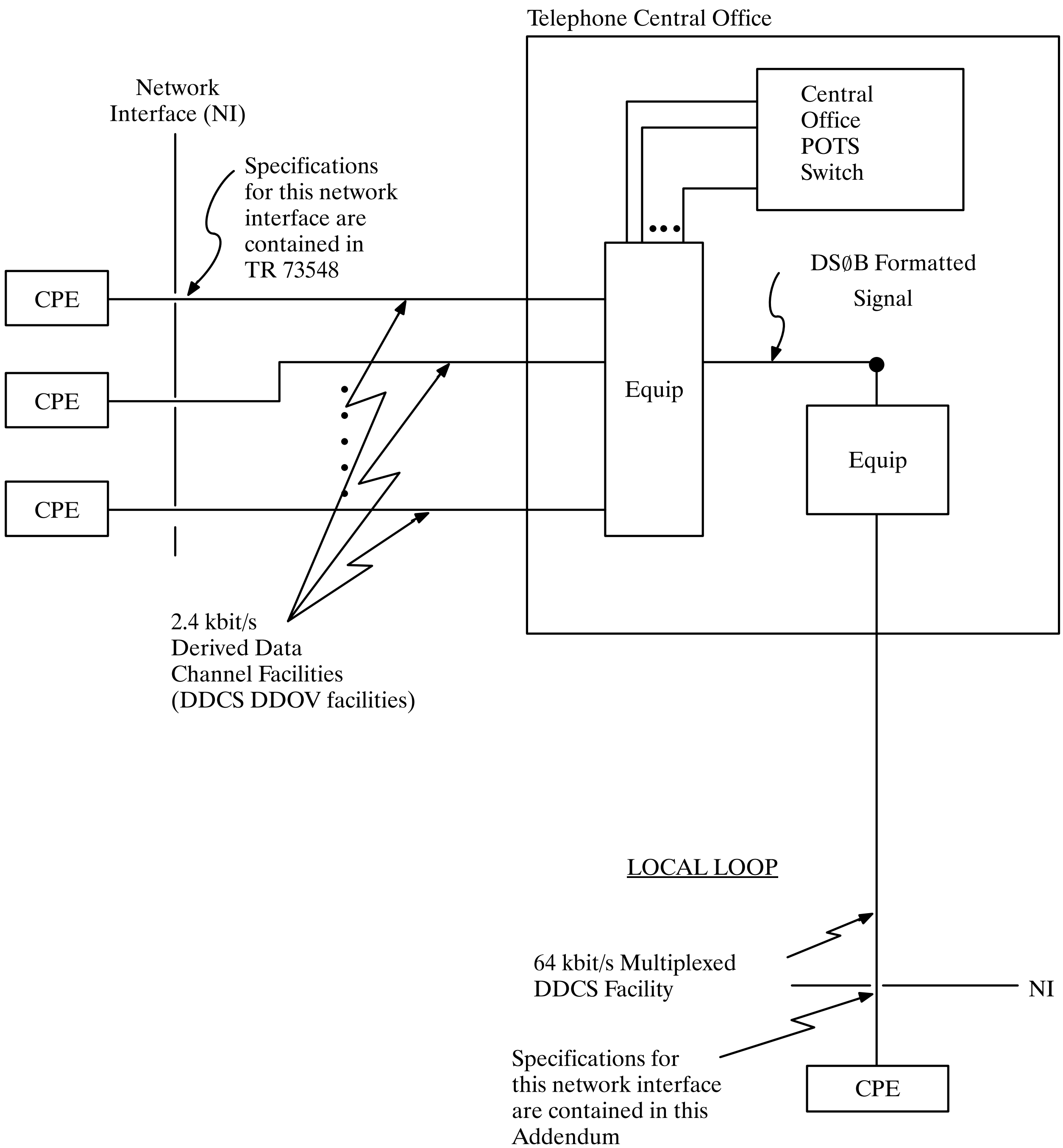


FIGURE 1 – SIMPLIFIED DDCS ARCHITECTURE