

**Lucent Technologies**  
Bell Labs Innovations



# **DDM-2000 FiberReach Multiplexer**

Applications, Planning, and Ordering  
Guide

363-206-300  
Issue 6  
March 2000

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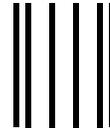
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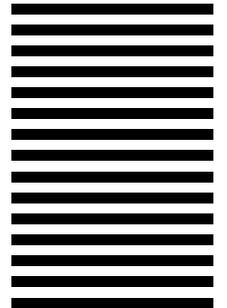
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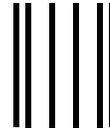
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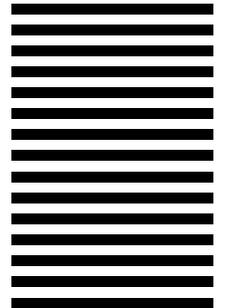
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## About This Document

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### **Purpose**

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This applications, planning, and ordering guide provides specific information about the features, applications, operation, engineering, and ordering of the DDM-2000 FiberReach Multiplexer. The following sections cover feature highlights and network applications, plus product information on transmission and control. The system-level operations philosophy and features are described in the section on operations, administration, maintenance, and provisioning (OAM&P). Other sections provide guidelines for system planning and ordering and summarize Lucent Technologies' extensive product support program.

### **Intended Audiences**

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This applications, planning, and ordering guide is primarily for network planners, engineers, and sales teams. It may be used by anyone desiring specific information about the features, applications, operation, engineering, and ordering of the DDM-2000 FiberReach Multiplexer.

### **Reason for Reissue**

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This document, Issue 6, replaces the *DDM-2000 FiberReach Multiplexer Applications, Planning, and Ordering Guide*, Issue 5. Description, application, and engineering information has been updated to include Software Releases 2.2, 3.0, 3.1, and 4.0 information. Ordering sections have been updated to reflect changes.

Major changes in this issue are noted by bars (|) in the outermost margins. Major changes include adding information for the following:

- STS-3c 0X1 when shelf is equipped with 29G-U/29H-U OLIUs in Main slots and 22-Type OLIUs in Function Unit slots
- DCC provisioning on Main slots for FiberReach to allow a remote shelf to interconnect through its Main ring interfaces with a 1+1 linear extension on a host OC-3, OC-12, or OC-48 shelf
- Provisioning of asynchronous CIT port to run TL1
- Remote alarm status using AGNE and Alarm Group concept
- 29G-U OLIU 1310 nm long reach OC-12 circuit packs
- 29H-U OLIU 1550 nm long reach OC-12 circuit packs
- 22G4-U OLIU 1310 nm long reach OC-3 circuit packs



**NOTE:**

This applications guide covers software releases up to and including TARP release 3.0 and higher. The impact of introducing TARP affects many areas of the document. Be aware that both TARP and the Lucent Directory Services (LDS) protocol operations are discussed and that some operations and features available in pre-TARP releases will no longer be applicable in Release 3.0 and higher.

## **Multi-Vendor OI**

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To support multi-vendor OI, DDM-2000 FiberReach Release 3.0 or later supports Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 OC-3 R13.0, OC-12 R7.0, and FT-2000 OC-48 R8.0, or later DDM-2000 releases) also support TARP; thus Lucent 2000 Product Family OI compatibility is still supported but not OI compatibility with previous releases of DDM-2000 and FT-2000. TARP is the established multi-vendor standard for SONET NEs that support TL1 OS interfaces.

DDM-2000 FiberReach Release 3.0 and later is developed to be compatible with any other-vendor NEs that also support TARP, OSI, and TL1/X.25 as specified in Telcordia Technologies GR-253. In addition, DDM-2000's TARP Manual Adjacency feature enables DDM-2000 to operate in networks that include CMISE-based NEs which may not support TARP propagation.

DDM-2000's compatibility with Tellabs *TITAN*\* 5500/S R5.0 DCS, including TL1/X.25 OS access with TITAN 5500/S DCS serving as the TL1/X.25 GNE, has been confirmed through cooperative joint testing. DDM-2000's compatibility with some other-vendor NEs has also been tested by independent third parties such as Telcordia Technologies.

Because DDM-2000 FiberReach Release 3.0/3.1 is intended to facilitate OS-based centralized operations, and because TL1/X.25 OS access is the key standardized multi-vendor OI application, the following Remote NE Status features are not supported in DDM-2000 FiberReach Release 3.0/3.1:

- Remote office alarms
- Remote CIT alarm reports
- Remote user panel indications
- TBOS
- Parallel telemetry

All of the above features depend on the proprietary exchange of information among Lucent NEs in a subnetwork, specifically the communication of each remote NE's alarm status to other NEs. Although the Remote NE Status features were supported in previous releases of DDM-2000, such Lucent-only operations features in multi-vendor subnetworks would not include other-vendor NEs, due to the lack of applicable standards, and thus would be incomplete.

DDM-2000 FiberReach Release 4.0 supports the following Remote NE Status features:

- Remote office alarms
- Remote CIT alarm reports

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\* *TITAN* is a trademark of Tellabs, Inc.

## Related Documentation

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The following documents provide additional information about the DDM-2000 Multiplexers:

- Number: 363-206-200  
Title: *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide*  
Audience: Network planners, equipment engineers, and sales teams  
Content: Features, applications, high-level description, operations, administration, maintenance, planning, ordering, product support, reliability information, technical specifications, and a synchronous optical network (SONET) overview
- Number: 363-206-201  
Title: *DDM-2000 OC-3 Multiplexer, System Commands Quick Reference*  
Audience: Maintenance personnel  
Content: Abbreviated list of system commands and parameters
- Number: 363-206-202  
Title: *DDM-2000 OC-3 Multiplexer User/Service Manual, Volumes I and II*  
Audience: Maintenance personnel  
Content: Detailed description, technical specifications, commands and reports (Volume I); operations and maintenance procedures (Volume II). This manual covers information on Software Releases 2 through 7.2.
- Number: 363-206-204  
Title: *DDM-2000 OC-3 Multiplexer Installation Manual*  
Audience: Customers planning to install the equipment  
Content: Customer installation instructions
- Number: 363-206-206  
Title: *DDM-2000 OC-12 Multiplexer — System Commands Quick Reference*  
Audience: Maintenance personnel  
Content: Abbreviated list of system commands and parameters
- Number: 363-206-207  
Title: *DDM-2000 OC-12 Multiplexer User/Service Manual*  
Audience: Maintenance personnel  
Content: Detailed description, technical specifications, commands and reports, and operations and maintenance procedures. This manual covers information pertaining to OC-12 Software Releases 1.0 through 3.2.

- Number: 363-206-208  
Title: *DDM-2000 OC-12 Multiplexer Installation Manual*  
Audience: Customers planning to install the equipment  
Content: Customer installation instructions
- Number: 363-206-220  
Title: *DDM-2000 OC-3/OC-12 Multiplexer Circuit Pack Options Job Aid*  
Audience: Maintenance personnel  
Content: List of circuit pack options
- Number: 363-206-222  
Title: *DDM-2000 OC-3/OC-12 Multiplexer Acceptance Task List Job Aid*  
Audience: Maintenance personnel  
Content: Check list of acceptance and turnup procedures
- Number: 363-206-280  
Title: *DDM-2000 OC-3 Multiplexer User/Service Manual, Volumes I and II*  
Audience: Maintenance personnel  
Content: Detailed description, technical specifications, commands and reports (Volume I); operations and maintenance procedures (Volume II). This manual covers information pertaining to OC-3 Software Releases 9.0 and later.
- Number: 363-206-290  
Title: *DDM-2000 OC-12 Multiplexer User/Service Manual, Volumes I and II*  
Audience: Maintenance personnel  
Content: Detailed description, technical specifications, commands and reports (Volume I); operations and maintenance procedures (Volume II). This manual covers information pertaining to OC-12 Software Releases 5.0 and later.
- Number: 363-206-301  
Title: *DDM-2000 FiberReach Multiplexer User/Service Manual*  
Audience: Maintenance personnel  
Content: System overview, system description, introduction to each system interface, administration and provisioning, operations and maintenance procedures (in TOP format), and maintenance support information (alarm tables, etc.)

- Number: 363-206-310  
Title: *DDM-2000 FiberReach Multiplexer Installation Manual*  
Audience: Installation and maintenance personnel  
Content: Customer installation instructions
- Number: 824-102-151  
Title: *DDM-2000 Multiplexers Operations Systems Engineering Guide*  
Audience: Engineers  
Content: Operations systems engineering information for the DDM-2000 OC-3, OC-12, and FiberReach Multiplexers
- Number: 363-208-400  
Title: *SLC LineReach Access System Applications, Planning, and Ordering Guide*  
Audience: Network planners, equipment engineers, and sales teams  
Content: Features, applications, high-level description, operations, administration, maintenance, planning, ordering, product support, reliability information, and technical specifications
- Number: 363-208-401  
Title: *SLC LineReach Access System User/Service Manual*  
Audience: Maintenance personnel  
Content: Detailed description, technical specifications, commands and reports, and operations and maintenance procedures.
- Number: 363-208-402  
Title: *SLC LineReach Access System Installation Manual*  
Audience: Installation and maintenance personnel  
Content: Customer installation instructions
- Number: 107-564-270  
Title: *ITM SNC Users Guide*  
Audience: Operations personnel  
Content: Integrated Transport Management Subnetwork Controller information (Release 6.0 and earlier)

- Number: 190-223-100  
Title: *ITM SNC Users Guide*  
Audience: Operations personnel  
Content: Integrated Transport Management Subnetwork Controller information (Release 8.0 and later)
- Number: 365-523-110 (Manual only)  
Number: 365-523-111 (Manual and Software)  
Title: *CPro-2000 User Manual*, Release 5.0  
Audience: Customers, engineers, maintenance personnel  
Content: Operations information for CPro-2000 software tool to provision and maintain networks
- Number: 365-523-120 (Manual only)  
Number: 365-523-121 (Manual and Software)  
Title: *CPro-2000 User Manual*, Release 6.0  
Audience: Customers, engineers, maintenance personnel  
Content: Operations information for the CPro-2000 software tool to provision and maintain networks
- Number: 365-576-140 (User Manual only) Release 8.0  
Number: 365-576-141 (User Manual and Software) Release 8.0  
Title: *CPro-2000 User Manual*  
Audience: Maintenance personnel  
Content: Using the tool to provision and maintain ring networks
- Number: 365-576-150 (User Manual only) Release 9.0  
Number: 365-576-151 (User Manual and Software) Release 9.0  
Title: *CPro-2000 User Manual*  
Audience: Maintenance personnel  
Content: Using the tool to provision and maintain ring networks
- Number: 365-576-160 (User Manual only) Release 10.0  
Number: 365-576-161 (User Manual and Software) Release 10.0  
Title: *CPro-2000 User Manual*  
Audience: Maintenance personnel  
Content: Using the tool to provision and maintain ring networks

- Number: 824-102-144  
Title: *Lucent Technologies 2000 Product Family Multi-Vendor Operations Interworking Guide*  
Audience: System planners and engineers  
Content: Operations interworking information for the Lucent Technologies Product Family 2000 systems, including DDM-2000 Multiplexers and FT-2000 OC-48 Lightwave Systems in multi-vendor subnetworks.
- Number: 824-102-147  
Title: *Lucent Technologies 2000 Product Family Operations Interworking Guide*  
Audience: System planners and engineers  
Content: Operations interworking information for the Lucent Technologies Product Family 2000 systems, including DDM-2000 Multiplexers and FT-2000 OC-48 Lightwave Systems

The following documents provide additional information about the SLC<sup>®</sup>-2000 Access System:

- Number: 363-205-004  
Title: *SLC-2000 Multi-Services Distant Terminal (MSDT) Feature, User/Service and Ordering Manual*  
Audience: Engineers, installers, administrators, operation and maintenance personnel, and technical support  
Content: Applications, physical and functional description, administration, powering, technical specifications, construction and installation, and operation and maintenance [in task-oriented practice (TOP format)]. This document also contains ordering information for the MSDT.
- Number: 363-208-000  
Title: *SLC-2000 Access System, Applications, Planning, and Ordering Guide*  
Audience: Network planners, equipment engineers, and sales teams  
Content: Features, applications, high-level description, operations, administration, maintenance, planning, ordering, product support, reliability information, technical specifications, and a synchronous optical network (SONET) overview

- Number: 363-208-001  
Title: *SLC-2000 Access System, User/Service Manual*  
Audience: Installers, technicians, engineers, and troubleshooters  
Content: System overview, system description, introduction to system interface, administration and provisioning, operations and maintenance, and maintenance support procedures (in TOP format), and maintenance support information (alarm tables, etc.).
- Number: 363-208-003  
Title: *SLC-2000 Access System, Command and Message/Service Manual*  
Audience: Installers, technicians, engineers, and troubleshooters  
Content: A tutorial on system commands and messages, as well as detailed information about system commands in manual-page format. The document pages are organized by user interface panel (UIP) commands and craft interface terminal (CIT) commands.
- Number: 363-208-010  
Title: *SLC-2000 Access System, Customer Assembly Manual for RT Frames*  
Audience: Customers planning to install the equipment  
Content: Configuration drawings and detailed instructions for ordering, installing, assembling, and connecting the equipment in a remote terminal (RT) frame arrangement. This document also includes installation procedures, cabling and wiring diagrams, application schematic diagrams (SDs), parts lists, and supporting information. Shelf assembly, cable routing, and frame installation are provided.
- Number: 363-208-011  
Title: *SLC-2000 Access System, Customer Assembly Manual for COT Frames*  
Audience: Customers planning to install the equipment  
Content: Configuration drawings and detailed instructions for ordering, installing, assembling, and connecting the equipment in a Central Office Terminal (COT) frame arrangement. This document also includes installation procedures, cabling and wiring diagrams, the application schematic diagrams (SDs), a parts list, and supporting information. Shelf assembly, cable routing, and frame installation are provided.

- Number: 363-208-029

Title: *SLC-2000 Access System, Software Release Description - Release 4.07.00: Issue 1*

Audience: Installers, technicians, engineers, and troubleshooters

Content: Provides information about the software release and procedures for implementation. Describes the features and capabilities provided in the release. Lists operating issues from the previous release that have been resolved, the operating issues in this release, and any work-arounds.

DDM-2000 FiberReach Drawings follow:

ED-8C762-20	DDM-2000 FiberReach Cable Assemblies
ED-8C762-30	DDM-2000 FiberReach Wideband Shelf
ED-8C843-30	DDM-2000 FiberReach Shelf Carrier Assembly
ED-8C785-20	DDM-2000 FiberReach Cable Assemblies
ED-8C785-30	DDM-2000 FiberReach Narrowband Shelf
ED-8C843-31	DDM-2000 FiberReach Wall DT Unit
ED-8C843-32	DDM-2000 FiberReach LGX Panel
ED-8C843-34	DDM-2000 FiberReach Release 2.0 Software
ED-8C843-35	DDM-2000 FiberReach Release 3.0 Software
108680224	DDM-2000 FiberReach Release 4.0 Software
ED-8C852-30	DDM-2000 DS1 Interconnect Panel
SD-7C516-01	Application Schematic

DDM-2000 OC-3 Drawings follow:

ED-8C724-10	OC-3 and OC-3/OC-12 Combined Bay Arrangements
ED-8C724-15	Cabling Plan (Rear Access)
ED-8C724-16	Cabling Plan (Front Access)
ED-8C724-20	Cable Assemblies
ED-8C724-21	Cable Assemblies
ED-8C724-22	Cable Assemblies
ED-8C724-30	DDM-2000 Shelf Assembly
ED-8C724-31	User Panel Assembly
ED-8C724-34	OC-3 Releases 2 and 3 Software Ordering
ED-8C724-36	OC-3 Release 5 Software Ordering
ED-8C724-37	OC-3 Release 6 Software Ordering
ED-8C724-38	OC-3 Release 7 Software Ordering
ED-8C724-39	OC-3 Release 8 Software Ordering
ED-8C724-41	OC-3 Release 11 Software Ordering
ED-8C724-42	OC-3 Release 13 Software Ordering
108680133	OC-3 Release 15 Initial Diskette plus SWRD
ED-8C733-30	Fan, Filter, and Baffle Assemblies
SD-7C510-01	Application Schematic
T7C510-31	Interconnect Wiring (Rear Access)
T7C510-32	Interconnect Wiring (Front Access)
801-525-168	Floor Plan Data Sheets

DDM-2000 equipment is also available in traditional loop enclosure arrangements, descriptions of which may be found in the following Lucent Technologies practices:

- Number: 363-205-000  
Title: *SLC Series 5 Carrier System Ordering Guide — Loop Transmission Systems* (to be replaced by 363-205-010)
- Number: 363-205-010  
Title: *SLC Series 5 System Applications and Planning Guide*
- Number: 626-500-128  
Title: *51A-type Cabinets Ordering Information and Lettering Guide — for DDM-2000 FiberReach Wideband Shelves and SLC Series 5 Carrier Systems*
- Number: 640-250-289  
Title: *51A-type Cabinets Ordering Information and Lettering Guide — for DDM-2000 FiberReach Wideband Shelves and DDM Plus*
- Number: 640-030-205  
Title: *61B-type Cabinets Ordering Information and Lettering Guide — for DDM-2000 FiberReach Wideband and Narrowband Shelves*
- Number: 626-500-105  
Title: *80-type Cabinets Ordering Information and Lettering Guide*
- Number: 626-500-115  
Title: *90-type Cabinets Coding and Ordering Information*

The following document provides additional information about related equipment:

- Number: 636-299-120  
Title: *LGX<sup>®</sup> Distribution System, Planning, Engineering, Installation, and Operation System Reference Guide*

## How to Order Documents

To order additional copies of this document and/or request placement on the standing order list, send or call in an order as follows:

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One-time orders include a binder (if applicable) and the document contents for the current issue in effect at the time of order. Also, you may request placement on the standing order list for all later reissues of the document. The standing order list for each document provides automatic distribution for all reissues of the document. RBOC/BOC customers should process document orders or standing order requests through their Company Documentation Coordinator. For questions regarding standing orders or to be placed on a standing order list, call the applicable Lucent Technologies Customer Information Center number listed previously.

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## **Electronic Documentation**

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Documentation for the DDM-2000 Multiplexer is now available in electronic form, on compact disk, read-only memory (CD-ROM). CD-ROM has many advantages over traditional paper documentation, including cost savings, search and retrieve capability, and the assurance of the most current documentation.

CD-ROM is available by annual subscription (on standing order).

- To order, call your Technical Information Resource Manager, your Lucent Technologies Account Executive, or the Lucent Technologies Customer Information Center at **1-888-LUCENT8 (1-888-582-3688)**.
- For pricing information, contact your Lucent Technologies Network Systems Account Executive or the Lucent Technologies Customer Information Center **1-888-LUCENT8 (1-888-582-3688)**
- For technical information, call Lucent Technologies Documentation Support at **1-800-645-6759**.



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# Introduction

# 1

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# Contents

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## **Introduction**

# **1**

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### **Overview**

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This section introduces the Lucent Technologies' 2000 Product Family and briefly describes the DDM-2000 FiberReach product.

### **Lucent Technologies' 2000 Product Family**

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Lucent Technologies is focused on a carefully planned and growing product family designed to provide total network solutions. The 2000 Product Family complies with the synchronous optical network (SONET) standard and builds on features and capabilities that customers have found to be useful and successful in networks such as single-ended maintenance features and product upgrade capabilities. These upgrade capabilities allow a graceful evolution from today's asynchronous networks to the world-class intelligent networks of the future. The 2000 Product Family provides the significant elements of the Lucent Service Net-2000 Architecture.

Lucent's Service Net-2000 Architecture starts with the network as it exists today and provides real-world solutions to build upon your existing base. It also allows a graceful evolution from rigid wire centers to a network of flexible nodes. This network distributes intelligence to where it functions best.

The Service Net-2000 Architecture offers access bandwidth, service on demand, and self-healing network applications. Access bandwidth offers increased capacity, giving end users the ability to access any desired service. This

increased access bandwidth, provided over fiber, offers superior network reliability while opening up new revenue opportunities.

Service on demand offers high-capacity services implemented in short intervals. This application gives local exchange carriers the opportunity to generate new revenue faster by provisioning new services at a competitive "fast start" pace. At the same time, they help maintain the existing revenue base by increasing customer satisfaction. Service on demand also reduces start-up costs, thereby improving capital management.

The self-healing network application involves careful planning and provisioning of cross-product capabilities with the 2000 Product Family. At the core of this network is DACS III-2000 and DACS IV-2000 Cross-Connect Systems, the nerve center of interoffice transmission. The intelligent DACS III-2000 and DACS IV-2000 Cross-Connect Systems, working with the *ITM XM* controller, can identify failed connections and reroute signals according to a preestablished recovery plan.

The Lucent 2000 Product Family includes the:

- DDM-2000 OC-3 Multiplexer
- DDM-2000 OC-12 Multiplexer
- DDM-2000 FiberReach Multiplexer
- FT-2000 OC-48 Lightwave System
- DACS III-2000 Cross-Connect System
- DACS IV-2000 Cross-Connect System
- *ITM XM* Controller
- *SLC*<sup>®</sup>-2000 Access System
- Business Remote Terminal-2000 (BRT-2000)
- ITM SNC Subnetwork Controller
- CPro-2000 System

## **DDM-2000 Product Family**

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The DDM-2000 Product Family includes the DDM-2000 OC-3 Multiplexer, the DDM-2000 OC-12 Multiplexer, and the DDM-2000 FiberReach Multiplexer, and DDM-Plus. The DDM-2000 Multiplexers are designed for loop (access), interoffice (transport), and customer location applications. They start with many of the proven features of Lucent's DDM-1000 Multiplexer and extend into the future with the flexibility of the SONET standard.

The DDM-2000 FiberReach OC-1 Multiplexer (WBS) operates at 51 Mb/s, the DDM-2000 OC-3 Multiplexer operates at 155 Mb/s, and the DDM-2000 OC-12 Multiplexer operates at 622 Mb/s. All three multiplexers provide flexible and evolvable network solutions. With common operations practices and circuit pack reuse, your investment (for example, technician training, circuit pack inventory) is preserved as the network evolves to higher capacities and advanced topologies.

The DDM-2000 FiberReach Multiplexer (NBS) provides a 48-line (48 voice-frequency line) optical network unit (ONU) with a complete DS1 interface product. The DDM-2000 FiberReach Multiplexer consists of two shelves, the wideband shelf and the narrowband shelf, that can be used in various combinations. It also integrates into the SONET access product network by being hosted by either a DDM-2000 OC-3 or the ARM shelf of a *SLC-2000* System (for the wideband shelf) or a *SLC-2000* Access System (for the narrowband shelf). The extension from the host node is an OC-1/OC-3/OC-12 signal on a dual fiber path-switched ring topology.

The DDM-2000 OC-3 Multiplexer supports many network topologies such as point-to-point, OC-3 fiber hubbing, and linear and ring DS1/DS3/EC-1 add/drop and OC-1 rings with time slot interchange (TSI) in a single 8.5 inch high shelf. The DDM-2000 OC-3 shelf, in addition, now offers ring capacity upgrade to OC-12 for higher bandwidth applications. This is achieved by replacing the OC-3 optics with OC-12 optics in the same DDM-2000 OC-3 shelf. Each topology is supported with efficiency and a full complement of operations features.

The DDM-2000 OC-12 Multiplexer supports several stand alone topologies including point-to-point, hubbing, and ring configurations. In addition, the DDM-2000 OC-12 multiplexer is an efficient OC-12 upgrade to all the OC-3 network configurations. Installed together, the DDM-2000 OC-3 and OC-12 Multiplexers provide integrated DS1 to OC-12 multiplexing.

The DDM-2000 Multiplexers are designed for easy installation and operation. Centralized operations are supported by a full set of single-ended control and maintenance features. Integrated test capabilities and default provisioning simplify installation. Most tasks can be performed using faceplate LEDs, displays and controls, while a craft interface terminal (CIT) gives access to sophisticated provisioning, maintenance and reporting features. A personal computer (PC) is needed to download software and to run CPro-2000 graphical user interface tool software.

## The Year 2000

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DDM-2000 Multiplexers store dates relative to a non-zero default of January 1, 1970. The last year that can be provisioned using the `set-date` command is 2069. Therefore, DDM-2000 Multiplexers will not be affected by the arrival of the year 2000.

## Introduction to the DDM-2000 FiberReach Multiplexer

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The DDM-2000 FiberReach Multiplexer is a full-service access product designed to support business carrier access, fiber-in-the-loop, and private network applications. DDM-2000 FiberReach has been designed to serve a multitude of services through a very modular architecture based on extensive reuse. The architecture consists of:

- Wideband Shelf
  - Provides the optics for the narrowband shelf, as well as a complete DS1 to OC-1/OC-3/OC-12 solution. Eight low-speed slots are available, optionally provisioned for up to sixteen 1x1 protected or unprotected DS1s, or up to twenty-eight 1x7 protected or unprotected DS1s. These low-speed slots may also be used to house T1 extension or HDSL circuit packs. Two function slots are also available, offering shelf space for 1x1 protected DS3, or DS3/OC-3c data interfaces.
  - As part of the 2000 Family of Products, the DDM-2000 FiberReach Multiplexer supplies complete operations, administration, maintenance, and provisioning (OAM&P) features with a look and feel that matches the DDM-2000 OC-3 and OC-12 Multiplexers. The DDM-2000 FiberReach Multiplexer fits into the already existing SONET networks and interworks with the existing operations support systems. Remote operations are via the International Standards Organization (ISO) standard seven-layer open systems interconnection (OSI) protocol, while a user panel and craft interface terminal (CIT) port support local operations needs. Complete performance-monitoring features, including DS1 path performance monitoring, permit the service provider to verify the quality of service based on key tariffs.
- Narrowband Shelf
  - Which can be used together or separately in a variety of configurations. The narrowband shelf supports all of the services that are currently supported by Lucent's *SLC-2000* Multi-Services Distant Terminal (MSDT) product but has two times the capacity to serve customers by requiring a concentration of special services at a single site. The channel units housed in the narrowband module are the *SLC-2000* channel units.

- Which can be used for telephony applications, complete remote operations, such as channel unit provisioning and integrated testing, are available through the *SLC-2000* host. The *SLC-2000* host also creates the link into the *5ESS*<sup>®</sup> electronic switch for TR08 or TR303 communications.

Together, the wideband and narrowband shelves can be deployed in outside plant or customer premises enclosures (including wall mounted) or can be rack-mounted.

The DDM-2000 FiberReach Multiplexer has a phased release plan. This manual covers Releases \* 2.2, 3.0, 3.1, and 4.0 of the DDM-2000 FiberReach Multiplexer. The manual will be updated to cover additional releases as they become available.

- *SLC LineReach* Access System

- The *SLC LineReach* Access System is a small digital loop carrier (DLC) remote terminal (RT) that provides up to 48 lines of POTS-type services, special services, or other DS0 services. Feature package 1.1 (FP1.1) supports up to two DS1-type interfaces and can be deployed in either a universal or integrated DLC configuration. Some of the basic features that make the *SLC LineReach* system an attractive, cost-effective DLC system include:

- **Small Size.** The small system size means that you can easily mount it to meet your customer's specifications. The system is approximately the same size as the narrowband shelf.
- **TR-08, INA, and TR-303 Interfaces.** FP1.1 provides for a TR-08 interface to the switch, *SLC2000*, or *SLC96* COT. If interfacing with a *SLC* Series 5 COT, it provides an "FPC-type" interface that uses extended SuperFrame (ESF) framing format. In addition, FP1.1 provides for an INA interface. Future economical upgrades will also allow for a TR-303 interface to a switch.
- **Full Range of Services.** The system offers a full range of services including POTS (plain old telephone service), locally switched special services, integrated services digital network (ISDN), and non-locally switched special services.
- **High Bit Rate Digital Subscriber Line (HDSL) and Other Interface Capability.** In addition to providing a T1 carrier interface and a DSX-1 feeder interface, the *SLC LineReach* system can also provide HDSL feeder interface. HDSL feeders allow the system to operate without repeaters over existing copper facilities that meet carrier serving area (CSA) guidelines.

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\* This manual also covers releases that are DAed (that is, Releases 1.0, 2.0, 2.1).

- **Central Office Terminal (COT) Compatibility.** For universal applications, the *SLC LineReach* system can interface with the switch through standard *SLC 96*, *SLC Series 5*, or *SLC-2000* COTs, D4, and DACS.
- **Drop Testing** (non-INA systems only). The system supports a standard drop testing operations system allowing you to test and maintain the customer's drop.

These features allow you to deploy and maintain the *SLC LineReach* system easily, quickly and flexibly. The system consists of a shelf assembly with 10 inch by 11 inch dimensions. It is populated with common circuit packs and channel units.

The *SLC LineReach* Access System now supports an integrated configuration with DDM-2000 FiberReach WideBand Shelf which provides new interface applications. For more information on these applications, refer to Chapter 3, "Applications."

For more information regarding the *SLC LineReach* Access System, as well as these new applications, refer to the *SLC LineReach Access System Applications, Planning, and Ordering Guide*, 363-208-400.

## **DDM-2000 FiberReach Releases**

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### **Release Descriptions**

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The following paragraphs provide brief descriptions of the available DDM-2000 FiberReach Multiplexer releases.

**Release 2.2** provides the following:

- New OC-3 OLIU (28G-U) for OC-1 Shelf. The new 28G-U OLIU provides OC-3 optics directly from the DDM-2000 OC-1 Shelf. This allows the FiberReach shelf to support an OC-3 ring, with the low-speed input capacity of the 28 VT1.5 shelf. The 28G-U OLIU provides visibility to the full STS-3 bandwidth and allows for selection of any 28 VT1.5s within the 3 STS-1s on the OC-3 ring for drop at the FiberReach shelf. Remaining traffic can be passed-through on the OC-3 ring.
- New Secured-Area Telecommunications Applications Cabinet (STAC) System — FRC 2000. This small, integrated modular indoor cabinet offering enables the provisioning of electronic controls, terminals, and instruments quickly at the point of need with minimal investment and real estate. The enclosure optimizes equipment density, heat transfer, environmental protection, and ease of installation and maintenance. It is designed to maximize public and installation safety.
- The HDSL circuit pack (BBF8) provides for HDSL interface capability on the DDM-2000 FiberReach shelf. It allows the transport of DS1 rate payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Data is transported over each pair bidirectionally using echo cancellation techniques.

**Release 3.0 (TARP Release)** supports the following new features:

- Pointer Justification Count (PJC). This performance monitoring parameter indicates a frequency error in the network or other potential synchronization problems. It provides a threshold crossing alert (TCA) when the STS-1 pointer justification count in a performance bin exceeds a user provisioned threshold value.
- The BBF3B DS1 PM Circuit Pack low-speed interface can be provisioned for the following DS1 formats: clear channel (default), superframe (SF) as specified in *ANSI/T1.403-1989*, or extended superframe (ESF) as specified in *ANSI/T1.403-1989*. In the case of SF or ESF format selections, DS1 performance information is collected by monitoring the associated DS1 framing format.
- Single DS1 facility loopback using the BBF3B circuit pack.
- Multi-Vendor Operations Interworking (OI) compatibility.

- DDM-2000 FiberReach is compatible with any other-vendor NEs that support Target ID Address Resolution (TARP) protocol, OSI, and TL1/X.25 as specified in Telcordia Technologies GR-253.
- Compatible with Tellabs *TITAN* 5500/S Release 5.0 Digital Cross-Connect System, including TL1 OS access with TITAN 5500/s DCS serving as the TL1/X.25 GNE.
- Lucent 2000 Product Family OI compatibility.
  - Compatible with DDM-2000 OC-3 Release 13.0 and OC-12 Release 7.0 and FT-2000 R8.0 (but not with earlier releases due to multi-vendor OI support).
- Large subnetworks.
  - Supports large subnetworks of up to 256 NEs by partitioning the subnetwork into multiple areas connected via Level 2 Intermediate Systems (IS).
- CPro-2000, ITM SNC support. Release 3.0 is supported by:
  - CPro-2000 Release 7.0; ITM SNC Release 5.0
  - ITM SNC Release 5.0 enhancements for FiberReach Release 3.0:
  - ITM SNC software download to FiberReach \*
  - ITM SNC as the TL1/X.25 GNE
  - ITN SNC backup and restore enhancements

**Release 3.1 (TARP Release)** supports the following new features:

- Supports the OC-3 optics through the 28G-U OLIU circuit packs in the Main Unit slots and therefore supports all the related features that were added to Release 2.2. The related OC-3 features are as follows:
  - STS-1 pass-through cross-connections on the 28G-U equipped FiberReach shelves.
  - Full OC-3 VT cross-connections to Main slots equipped with the 28G-U OLIU
  - Provisionable S1 byte option, if the FiberReach shelf is equipped with the OC-3 interfaces in both Main Unit slots.
  - Provisionable *Synch Autoconfiguration*
  - Supports the STS-3c 0X1 application using the OC-3 interface (22-type) in the Function Unit slots of the FiberReach NEs

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\* This feature will be useful when upgrading from FiberReach Release 3.0 to later releases.

- Supports the DS3 (BBG4B Circuit Pack) in the Function Unit slots of the FiberReach shelf. This provides the ability of transporting STS-1 services using the DS-3 circuit packs in the Function Unit slots.
- Multi-media Data Services: A new DS3 (BBG19) interface provides the flexibility to offer a full range of multi-media data services via embedded and new DDM-2000 networks. This full-solution offering is made possible by interfacing DDM-2000 to any of the numerous commercially available data edge devices which provide the various data services interfaces.
- The HDSL circuit pack (BBF8) provides for HDSL interface capability on the DDM-2000 FiberReach shelf. It allows the transport of DS1 rate payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Data is transported over each pair bidirectionally using echo cancellation techniques.

**Release 4.0** supports the following applications and features:

- Support the OC-12 optics through the 29G-U/29H-U OLIU circuit packs in the Main Unit slots. The related features are as follows.
  - STS-1/STS-3c/VT1.5 pass-through cross-connections on the 29G-U/29H-U OC-3 equipped shelves
  - STS-3c cross-connections to Function Unit
  - In-service upgrades only from 28G-Types to the new 29-Type OLIUs
- Support DCC provisioning on Main (identical/distinct) for OC-3/OC-12 ring interface. Identical DCC mode allows a remote shelf to interconnect through its Main ring interfaces with a 1+1 linear extension on a host OC-3, OC-12, or OC-48 shelf using ring software.
- Support the provisioning of asynchronous CIT port to run TL1.
- Remote alarm status (using the AGNE and the Alarm Group concept)
- CPro-2000, ITM SNC support: Release 4.0 is supported by:
  - CPro-2000 Release 10.0; ITM SNC Release 10.0
- DS3 using BBG4/BBG4B while using the OC-1 optics in the Main
- Multimedia Data Services using DS3 BBG19 for Lucent DDM-2000 FiberReach NE (used for DS3 locked cross-connects, to support data services), while using the OC-1 (26-Type) OLIUs in Main. (The BBG19 in the Function Unit slots is currently supported with the 28-Type OLIUs in Main to provide this type of service).



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## Features

# 2

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### Overview

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This section lists and briefly describes the feature highlights of the DDM-2000 FiberReach Multiplexer. The features are described in Chapter 3, "Applications," Chapter 4, "Product Description," and Chapter 5, "Operations, Administration, Maintenance, and Provisioning," as applicable.

### Basic Description of the DDM-2000 FiberReach Multiplexer

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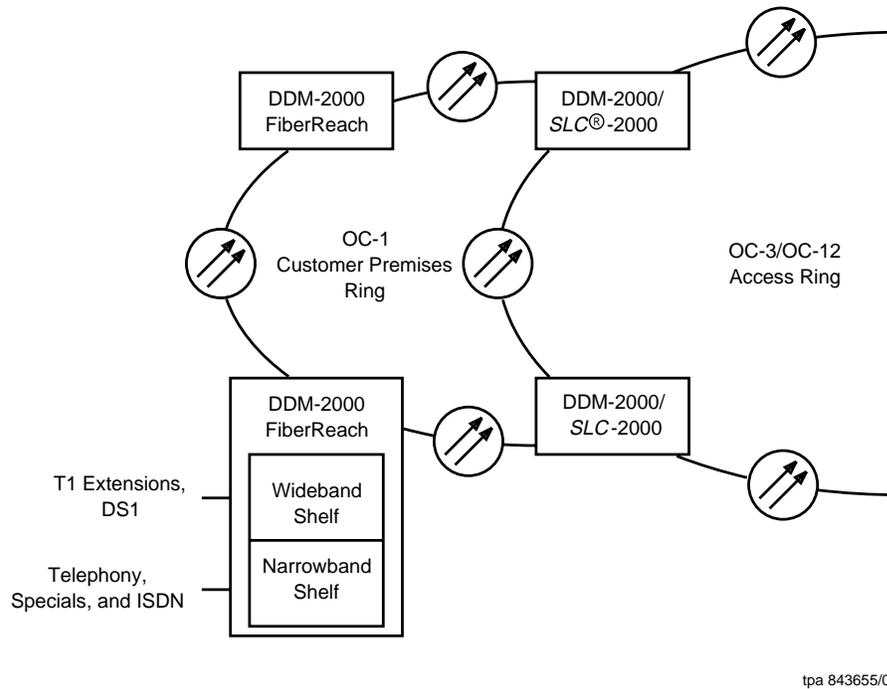
The DDM-2000 FiberReach Multiplexer is a full-service access product, combining a 48-line optical network unit with a complete DS1 interface product. DDM-2000 FiberReach is a synchronous optical network (SONET) product that is "hosted" by a DDM-2000 OC-3 or a *SLC*<sup>®</sup>-2000 Access System. The extension from the host node is an OC-1/OC-3 signal in a ring topology.

The DDM-2000 FiberReach Multiplexer architecture consists of two types of shelves: a narrowband and a wideband shelf, which can be used together or separately in a variety of configurations.

- Wideband Shelf:
  - The wideband shelf provides the DS1 to STS-1 multiplexing function and the optics for the fiber connection to the host DDM-2000 system, as well as broadband service slots [DS3, OC-3c, and future EC-1, local area networks (LANs)]. The wideband shelf has been designed to be similar in physical design with the DDM-2000 OC-3 and OC-12 Multiplexers. This includes the design of the user panel and reuse of circuit packs, as well as the operations, administration, maintenance, and provisioning (OAM&P) functions of the system.
- Narrowband Shelf:
  - The narrowband shelf provides POTS, POTS-like special, or integrated services digital network (ISDN) basic rate interface (BRI) services and is used in conjunction with the wideband shelf. All of the services that are currently supported by the *SLC-2000* Multi-Services Distant Terminal (MSDT) product are now supported with the narrowband shelf and at up to four times the capacity of the *SLC-2000* MSDT, depending upon the configuration selected. The channel units housed in the narrowband shelf are mostly the same as those used in the *SLC-2000* MSDT.

The wideband and narrowband shelves interface via a standard DS1 signal. The electrical interface is compatible with DSX-1 requirements. The DS1 transmission interface can be protected or unprotected through the use of a circuit pack in the low-speed slot of the wideband shelf. The narrowband shelf has no equipment protection options.

Figure 2-1 shows one example of how the DDM-2000 FiberReach Multiplexer fits into existing networks.



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**Figure 2-1. DDM-2000 FiberReach Multiplexer in the Network**

## **DDM-2000 FiberReach Multiplexer Features**

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### **OC-1 Ring Extensions**

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The OC-1 ring capability of the DDM-2000 FiberReach Multiplexer allows multiple DDM-2000 FiberReach systems to be connected to the backbone network of DDM-2000 or SLC-2000 via a single facility. Network growth is as easy as adding another DDM-2000 FiberReach node on the ring, since no additional fiber or host circuit packs need to be added.

### **Carrier Extension with Line Powering**

---

Many of the T1 lines being deployed in fiber-to-the-curb and longer range fiber-to-the-business applications require line powering. A T1 EXT circuit pack that merges the capabilities of a T1 repeater with the DS1 PM circuit pack of the DDM-2000 Multiplexer is supported in DDM-2000 FiberReach. Each circuit pack supports two T1 interfaces. This new pack supports typical T-carrier span lengths (6,000 feet of 22-gauge cable), supplying 60 milliamperes of line power current and performance monitoring for tariff verification. The line power can support one span of a T1 line.

### **OC-3 Ring Extensions**

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When equipped with the 28G-U OC-3 OLIU, the FiberReach Multiplexer can be hosted from low-speed OC-3 interfaces on an DDM-2000 OC-12 shelf or an FT-2000 OC-48 shelf.

### **OC-12 Ring Capacity Expansion**

---

OC-12 OLIU circuit packs (29-Type) are available to install into the FiberReach shelf. This allows the FiberReach shelf to have the high speed characteristics of an OC-12 shelf. This is accomplished by installing a pair of 29-Type OLIU circuit packs into the Main slots of the FiberReach shelf and connecting the two OC-12 OLIUs with a faceplate cable.

This feature provides a lower cost solution in many OC-12 applications. This requires placing 29-Type OLIUs in Main slots at every node in the ring. Once upgraded, each node receives all 12 STS-1s contained in the fiber and can select up to any 4 STS-1s (3 STS1s to drop, and 1 STS1 worth of VT1.5s to drop). The remaining STS-1s are passed through the node and continue on the OC-12 ring.

An alternative application is to have the OC-3 shelf (with OC-12 optics) serve as a low capacity node in an OC-12 ring with existing OC-12 shelf nodes. This allows DS1 service and FiberReach connections from the OC-3 shelf directly out of an

OC-12 ring. Also, when supporting the OC-12 optics, the OC-3 shelf can support STS-3c pass-through circuits as well as STS-1s. An OC-12 ring can consist of any combination of OC-12, OC-3, and FiberReach shelves. This allows customers to install only the drop capacity needed at a given node.

### **OC-12 Optics**

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The DDM-2000 FiberReach Multiplexer supports optional OC-12 1310 nm (29G-U) and 1550 nm optics (29H-U) for ring applications. The OC-12 interface can be used in any application supported by the FiberReach interface.

### **Multiservice Offering**

---

DDM-2000 FiberReach is a multiservice offering for current and future business, as well as residential applications. The product supports DS1/T1 service for business carrier access applications, as well as fiber-in-the loop telephony with DS1 service applications. DDM-FiberReach 4.0 can support DS3 with OC-1 optics. DDM-2000 FiberReach also supports DS3, OC-3c, and HDSL low-speed interfaces where Main slots are equipped with OC-3 or OC-12 circuit packs.

The narrowband shelf supports telephony services that include traditional voice services in addition to special services, ISDN, and data. Up to 48 POTS lines or 40 ISDN lines are available. Also, one-way MPEG 2 for video-on-demand and two-way video for teleconferencing and distance learning will be via a new low-speed interface option for the DDM-2000 FiberReach narrowband shelf. Another service that is growing in the business carrier access market is a native mode LAN service.

### **Host Flexibility**

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The DDM-2000 FiberReach Multiplexer can be hosted from a DDM-2000 OC-3 shelf or the ARM shelf of the *SLC-2000* Access System with a direct OC-1 fiber extension. This flexibility integrates the DDM-2000 FiberReach Multiplexer into the embedded base and extends the Lucent Technologies' end-to-end SONET survivable network closer to the customer. It also allows the DDM-2000 and *SLC-2000* systems to support a broader array of services. In addition, the direct OC-1 connection to a DDM-2000 OC-3 shelf or *SLC-2000* System ARM shelf with OC-12 optics provides a lower cost solution to deliver smaller numbers of DS1 services from an OC-12 backbone ring, without requiring an intermediate DDM-2000 OC-3 system. The OC-12 host is provided via OC-12 optics in the DDM-2000 OC-3 shelf, which is available in Release 11.0 and later.

## Reuse

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The DDM-2000 FiberReach Multiplexer has been designed with extensive circuit pack, device, and software reuse from the DDM-2000 and *SLC-2000* Access System. This reuse reduces inventory-carrying costs and enhances the look-and-feel commonality between DDM-2000 FiberReach and the other Lucent embedded equipment. The channel units housed in the narrowband shelf are reused from the *SLC-2000* System and Series 5 system. The DS1 packs and controller pack in the wideband shelf are reused from the DDM-2000 OC-3 Multiplexer. (In addition, *SLC-2000* ARM and the DDM Multiplexer share many circuit packs.) DS3 circuit packs from the DDM-2000 OC-3 Multiplexer can be reused in the DDM-2000 FiberReach shelf.

## Time Slot Interchange

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Complete bandwidth management features in the WBS complement DDM-2000's flexible network and host flexibility capabilities. VT1.5 time slot interchange (TSI) allows individual DS1 services to be added, dropped, and groomed anywhere in the network. The grooming flexibility of TSI, not possible with time slot assignment (TSA), is especially useful in administering complex networks. For example, pass-through tributaries at a hub site may be groomed to shed unused bandwidth, thus increasing facility utilization and preserving spare capacity for unforeseen demand.

In the DDM-2000 FiberReach Multiplexer, TSI is provided by the optical line interface unit (OLIU) and operates on individual VT1.5 tributaries across the entire OC-1/OC-3/OC-12 bandwidth.

For the NBS, the *SLC-2000* host digital terminal (HDT) TSI provides bandwidth management of DS0 services.

## **High Quality Network Synchronization and Timing**

---

DDM-2000 FiberReach Wideband Shelf Multiplexers are always configured for line timing from the incoming host signal. If the OC-1/OC-3/OC-12 timing reference becomes corrupted or unavailable, the DDM-2000 FiberReach Multiplexer will automatically switch to another timing reference in order to maintain the highest quality timing available. This is done through a synchronization messaging feature to ensure the integrity of network synchronization during both normal and abnormal conditions. Through the use of synchronization messaging, the current quality of the timing source can be conveyed from one DDM-2000 FiberReach Multiplexer to another. The synchronization messaging feature is based on the scheme developed in the *ANSI* T1X1 standards committee.

The narrowband shelf derives synchronization and timing from the PSIs connected back to the HDT and the LDS.

## **Performance Monitoring for Proactive Maintenance and Tariff Verification**

---

Performance monitoring is necessary for proactive maintenance procedures that correct network problems before they become service affecting. The DDM-2000 FiberReach Multiplexers offer full performance monitoring and reporting of SONET section, line, path, and DS1/DS3 parameters. Thresholds for each parameter can be provisioned on a per shelf basis to satisfy specific installation requirements.

The DDM-2000 FiberReach Multiplexer takes advantage of the embedded performance reporting capabilities found in end user DS1 service termination equipment to provide complete end-to-end performance monitoring of DS1 tariffed service offerings. This allows service providers to verify that the error performance experienced by an end customer is operating within the contractually guaranteed limits of their specific service tariff. Since this capability is directly integrated into the DDM-2000 FiberReach Multiplexer, the service provider can eliminate the cost and extra operation complexities associated with external monitoring equipment.

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\* Registered trademark of American National Standards Institute, Inc.

## **On-Board Power Modules**

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The DDM-2000 FiberReach wideband shelf eliminates the need for external power circuit packs by providing on-board power modules in the wideband shelf circuit packs to convert central office voltages. This distributed power configuration allows for a more uniform heat dissipation, aids in keeping system first-costs low, minimizes overall shelf size, and improves system reliability.

The DDM-2000 FiberReach narrowband shelf uses the power conversion unit (PCU) to convert incoming –48 volts to all the voltages required for powering.

## **Other Power Options**

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The DDM-2000 FiberReach Multiplexer provides two independent –48 volt office power feeders that enter the shelf through cables and are fused at the user panel. If a power source other than –48 volts is being supplied, a miscellaneous mounted power converter is available in the following options:

- 60 V AC
- Commercial power (120 V AC) with battery backup

DDM-2000 FiberReach also has a provision for replacing the User Panel without causing a service interruption. (Refer to Chapter 4, “Power Description” for more details.)

## **Suitable for Any Environment**

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The DDM-2000 FiberReach Multiplexers operate in the environmentally uncontrolled outside plant, as well as in standard central office environments or customer premises. They also meet Federal Communications Commission (FCC) Class A electromagnetic compatibility (EMC), lightning protection, and *UL*<sup>\*</sup> and Canadian Standards Association (CSA) requirements for all applications, including customer premises.

## **Convenient Cabling Access**

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Front and rear access cabling options are available on DDM-2000 FiberReach Multiplexers. The same cables are used for both front and rear access. The user may choose front or rear access, depending upon the routing of the cables.

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\* Registered trademark of Underwriters Laboratories, Inc.

## **Universal Optical Connector**

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The DDM-2000 FiberReach Multiplexers provide Lucent's universal optical connector on the OC-1/OC-3/OC-12 OLIUs. The universal optical connectors are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*<sup>®</sup>, FC-PC, or SC connectors as needed. Both 0 dB and attenuating buildouts are supported.

## **Multiple Mounting Arrangements and Enclosures**

---

The DDM-2000 FiberReach Multiplexers can be installed in the outside plant in enclosures such as a controlled environment vault (CEV), hut, or 51A or 61B enclosures. It can also be installed at the customer premises in customer location cabinets or wall-mounted enclosures.

## **Three-Tiered Operations\***

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The DDM-2000 FiberReach Multiplexer wideband shelf operations interface procedures are built on three levels of system information and control, spanning a user's operations needs from summary-level status to detailed reporting.

## **Wideband Shelf Operations**

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### **User Panel and Faceplate LEDs (Operations Tier 1)**

The first operations tier consists of the user panel displays, pushbuttons, and the circuit pack faceplate light-emitting diodes (LEDs). The first tier allows routine installation and maintenance activities to be performed without a craft interface terminal (CIT) or any test equipment. The circuit pack faceplate FAULT LEDs allow fast and easy fault isolation to a particular circuit pack. The user panel provides system-level alarm and status information for both the local and remote terminals.

---

\* The introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI) in DDM-2000 FiberReach Release 3.0 and later will affect the operations of some features in the three tiers. Refer to Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

## **Craft Interface Terminal (Operations Tier 2)**

The second operations tier provides access to DDM-2000 operations from a CIT over an EIA-232-D interface. System details that cannot be obtained from the first operations tier alone can be obtained over the CIT interface. A VT-100 compatible terminal or terminal emulator software running on a PC can be used as a CIT. Command and prompt modes are available with extensive on-line help features. The CIT interface supports OAM&P activities such as PM on any and all DDM-2000 NEs in the SONET maintenance subnetwork from a single DDM-2000. An optional software tool (CPro-2000) used with a PC is also available.

- CPro-2000 is a Windows-based application that provides access to Lucent's SONET NEs with a command-based AUI (ASCII user interface) and a GUI (graphical user interface). Using this tool, a user can take advantage of the graphics to do many provisioning related activities.

## **Operations System (OS) Interfaces (Operations Tier 3)**

The third operations tier provides access to DDM-2000 FiberReach Multiplexer wideband shelf operations from a remote operations system (OS). The FiberReach Multiplexer offers parallel telemetry, telemetry byte-oriented serial (TBOS), and TL1/X.25 OS via a host (that is, TL1/X.25 GNE in a CO) interfaces. These interfaces provide support for automated service provisioning, remote recovery and control, installation provisioning, alarm status, fault isolation, and fault location. An optional element management system (ITM SNC) is also available.

- Lucent's Integrated Transport Management SubNetwork Controller (ITM SNC) is an element management system (EMS) that supports SONET NEs. ITM SNC provides fault, provisioning, configuration, and security management functions via a GUI.

Lucent's DDM-2000 FiberReach Multiplexers offer a wide range of OS interfaces to meet the needs of an evolving OS network. Installations can optionally use TBOS\* protocol, and optional parallel telemetry. In loop feeder applications, the DDM-2000 FiberReach Multiplexers transmit up to 15—depending on the release and OS type—user-definable environmental input points to the OS: 9 parallel, 15 TBOS, 15 TL1. These miscellaneous discrete points can be used to monitor collocated equipment at a remote site. In addition, four miscellaneous control points are available to control external functions (for example, generators or pumps).

---

\* TBOS is not available in Release 3.0/3.1 or later, and other releases that support TARP. See Section 5 for more information.

A TL1/X.25 interface to a DDM-2000 FiberReach Multiplexer is provided through a host system (for example, a DDM-2000 OC-3 Multiplexer). The DDM-2000 FiberReach Multiplexer host supports a TL1/X.25 interface for communication between local and remote DDM-2000s, and alarm surveillance and provisioning operations systems such as Telcordia Technologies' Network Monitoring and Analysis (NMA) and Operations Systems/Intelligent Network Element (OPS/INE) operations systems. FiberReach 4.0 is supported by TEMS. The DDM-2000 OC-3 Multiplexer TL1/X.25 interface is based on Telcordia Technologies' TR-TSY-000833, Issue 5.



**NOTE:**

There is no X.25 port for FiberReach 4.0.

### **Narrowband Shelf Operations**

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The DDM-2000 FiberReach Multiplexer narrowband shelf features three levels of system information and control, similar to those features on the wideband shelf. The first tier allows fast and easy fault isolation via LEDs on the DSXBIU faceplate. Five LEDs convey the following: fault on the DSXBIU circuit pack, carrier line failure (CLF) on one of up to four incoming DS1s, configuration alarm, and near-end and far-end indications. An LED test button is used to test the LEDs on all of the circuit packs in the narrowband shelf. The ringing generator unit (RGU), power converter unit (PCU), and channel and drop test unit (CDTU) circuit packs, each have a failure indication LED.

The second operation tier offers detailed information and system control, which can be obtained by using a PC via the CIT interface at the *SLC-2000* ARM shelf. The CIT supports provisioning, maintenance, configuration, administration, and performance monitoring activities from the *SLC-2000* ARM location or remotely via a modem to an operations center.

The third operation tier provides the telephone company centralized operations systems access via the *SLC-2000* ARM directly through the TL-1 message interface or through the switch. Functions include provisioning, maintenance, line and channel testing, configuration, administration, and performance monitoring activities.

## **Lucent Product Family 2000 OI\***

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**Note:** The term single-ended operations (SEO) has traditionally been used to refer to such operations among DDM-2000 systems. Now that SEO is supported among the 2000 Product Family NEs as well as multi-vendor operations, the term operations interworking (OI) is more commonly used.

The OI capability of the DDM-2000 Multiplexers provides remote access to all DDM-2000 systems in a subnetwork from a single location. This allows most maintenance, provisioning, and administration to be performed on a centralized basis, minimizing technician travel. CITs, user panel functions, and OS interfaces all give access to remote systems. Upgrades are simplified because OI is integrated into the DDM-2000 Multiplexers through the SONET section DCC. If desired, the DCC can be disabled between any two DDM-2000 shelves to create maintenance boundaries.

The FT-2000 OC-48 Lightwave System OI has been expanded to include DDM-2000 Multiplexers. This means that in subnetworks consisting of both DDM-2000 Multiplexers, and FT-2000 OC-48 Release 6.0 and later Lightwave System shelves, DDM-2000 Multiplexer alarms appear in FT-2000 OC-48 Lightwave System alarm reports, and FT-2000 OC-48 Lightwave System alarms are included in DDM-2000 alarm reports. In addition, users at FT-2000 OC-48 Lightwave System shelves are able to log into any DDM-2000 shelf in the subnetwork using the FT-2000 OC-48 Lightwave System CIT. The FT-2000 OC-48 Lightwave System connectivity reports also list the DDM-2000 shelves in the subnetwork and vice-versa. This is in keeping with the Lucent 2000 Product Family philosophy of OI.

## **Multi-Vendor OI**

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To support multi-vendor OI, DDM-2000 FiberReach Release 3.0 and later supports Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 OC-3 Release 13.0 and Release 15.0, OC-12 Release 7.0, and FT-2000 OC-48 Release 9.0, also support TARP, thus Lucent 2000 Product Family OI compatibility is still supported but not OI compatibility with previous releases of DDM-2000 and FT-2000. TARP is the established multi-vendor standard for SONET NEs that support TL1 OS interfaces.

DDM-2000 FiberReach Release 3.0 and later has been developed to be compatible with any other-vendor NEs that also support TARP, OSI, and TL1/X.25

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\* The introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI) in DDM-2000 FiberReach Release 3.0 and later will affect the operations of some OI features. Refer to Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

as specified in Telcordia Technologies GR-253. In addition, DDM-2000's TARP Manual Adjacency feature enables DDM-2000 to operate in networks that include CMISE-based NEs which may not support TARP propagation.

DDM-2000's compatibility with Tellabs *TITAN 4x 5500/S* Release 5.0 DCS, including TL1/X.25 OS access with TITAN 5500/S DCS serving as the TL1/X.25 GNE, has been confirmed through cooperative joint testing. DDM-2000's compatibility with some other-vendor NEs has also been tested by independent third-parties such as Telcordia Technologies.

Because DDM-2000 FiberReach 3.0 or later is intended to facilitate OS-based centralized operations, and because TL1/X.25 OS access is the key standardized multi-vendor OI application, the following Remote NE Status features are not supported in DDM-2000 FiberReach Release 3.0 or later:

- Remote office alarms
- Remote CIT alarm reports
- Remote user panel indications
- TBOS
- Parallel telemetry

All of the above features depend on the proprietary exchange of information among Lucent NEs in a subnetwork, specifically the communication of each remote NE's alarm status to other NEs. Although the Remote NE Status features were supported in previous releases of DDM-2000, such Lucent-only operations features in multi-vendor subnetworks would not include other-vendor NEs, due to the lack of applicable standards, and thus would be incomplete.

## **Easy Provisioning**

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The DDM-2000 FiberReach Multiplexers minimize time and trouble with their simplified installation procedures. DDM-2000 FiberReach Multiplexers offer intelligent provisioning defaults for those parameters which are typically constant across many installations (for example, optical line switching threshold). Customers' needs are carefully considered in determining these defaults to simplify system installation. If the provisioning parameters (for example, performance-monitoring thresholds, alarm levels, etc.) need to be altered to meet a specific need, they can be easily changed on the wideband shelf using the CIT. The DDM-2000 FiberReach Multiplexers offer switch selectable settings for those parameters which are fixed at installation (for example, DS1 line buildouts).

## **Remote Software Upgrades**

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### **Wideband Shelf Remote Software Upgrades**

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The DDM-2000 FiberReach Multiplexers provide the capability to upgrade the system software in service without requiring any control circuit pack changes. The DDM-2000 FiberReach Multiplexers use flash erasable programmable read-only memory (flash EPROM) chips to provide this capability. Software can be downloaded from a PC to a remote network element even when the local shelf is a different member of the DDM-2000 product family or a *SLC-2000* Access System. This remote software download capability eliminates the need for a technician to travel to the remote site. These software upgrades are the primary mechanism to add new feature enhancements to the in-service DDM-2000 network.

DDM-2000 FiberReach Multiplexers can also accept software downloads from Lucent's ITM SNC Release 5.0 when upgrading from FiberReach Release 3.0/3.1 or later to a subsequent release.

### **Narrowband Shelf Remote Software Upgrades**

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The *SLC-2000* Access System provides an in-service software installation capability to update the generic program in local and remote systems. Upgrades will be distributed on *MS-DOS* formatted diskettes containing the new software and an installation program. The PC is connected to the CIT port on the *SLC-2000* Access System. The installation program installs the software on to the SMU, which then installs the software to the *SLC-2000* DLC subsystem. The software also includes the latest version for downloading on to the DSXBIU in the narrowband shelf.

## **Remote Inventorying Capabilities**

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The DDM-2000 FiberReach Multiplexer wideband and narrowband shelves provide automatic version recognition of all hardware and software installed in the system. All circuit pack *CLEI*\* codes and serial numbers are accessible by the system controller. This greatly simplifies inventorying, provides recognition of the current version of hardware and software being used, and allows easy identification of circuit packs by their manufacturing dates.

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\* COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Telcordia Technologies.

## **Security**

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The DDM-2000 FiberReach Multiplexer offers security against unauthorized access via its CIT port or through a remote operations port. The use of security is provisionable for the CIT port and through the DCC. In addition to this, the DCC can be totally disabled to ensure isolation of a DDM-2000 system from possible remote intrusion. A provisionable time-out is available for each access port that enables automatic termination of inactive or unattended sessions. The DDM-2000 FiberReach Multiplexer supports four user levels: privileged user, with full read/write access to all information on the system, including passwords; general user, with read/write access to system provisioning and maintenance information; reports-only user, with read access to system information but no ability to modify provisioning and maintenance parameters; and maintenance-only user, with access to maintenance functions only. Each user has an individual login and password, and each user selects and maintains his/her own password.

## **Standards Compliance**

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The DDM-2000 FiberReach Multiplexers comply with American National Standards Institute (ANSI) and Telcordia Technologies standards on SONET, asynchronous interface standards, and technical advisories/technical requirements (GRs) on OAM&P. Environmental standards include Telcordia Technologies NEBS requirements, FCC electromagnetic compatibility (EMC) requirements, and *UL* 1459.

The DDM-2000 FiberReach Multiplexers also meet CSA Certification Standard C22.2 No.225-M90.

All *SLC*-2000 apparatus and equipment complies with the Telcordia Technologies standards or their predecessor issues, as reflected in LTP 363-208-000, *SLC-2000 Access System Applications, Planning, and Ordering Guide*, Issue 6, in effect when the apparatus and equipment were first deployed.

## **TR08/TR303 Compliance**

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The DDM-2000 FiberReach narrowband shelf and host terminal are compliant with Telcordia Technologies requirements TR08 and TR303. These requirements specify a communications protocol that allows a remote terminal to interface and integrate directly with a switch at the central office, without going through a central office (CO) terminal, thereby reducing the amount equipment needed at a CO.

## **Data Base Backup and Restoral**

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The CPro-2000 Graphical User Interface and Provisioning Tool includes a backup and restoral feature to protect provisioning information in the DDM-2000 FiberReach Multiplexer network. This feature saves a copy of each node's provisionable parameters so they can be restored at a later date, if necessary. This feature provides backup and restoral for information, such as cross-connections and DS1 port options. See the *CPro-2000 User Manual* for more information on this feature.

## **The Lucent Technologies' 2000 Product Family Advantage**

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Lucent's 2000 Product Family is unique in the industry by providing a full-range product line. The *SLC-2000* Access System, DDM-2000 Multiplexers, and FT-2000 Lightwave System offer complete feature coverage, working together to build a coordinated network solution for present and future services. Capacity and configuration can be optimized for each situation, knowing that the future network can evolve through the modular flexibility of the Lucent's 2000 Product Family.

The FT-2000 Lightwave System offers features to complement the DDM-2000 FiberReach Multiplexer to provide OI. This means customers can deploy these Lucent's 2000 Product Family systems in a single subnetwork resulting in increased profitability. See Section 5, "Operations, Administration, Maintenance, and Provisioning", for more information on OI with Lucent's 2000 Product Family.

Common modules and circuit packs simplify maintenance and provisioning and reduce inventory costs. Coordinated operations features and a consistent "look-and-feel" mean that technicians will be quicker and more accurate at their daily OAM&P tasks. Lucent's 2000 Product Family will continue to offer these benefits with a coordinated product evolution strategy to support a changing network.

The *SLC-2000* Access System, part of the Lucent Technologies' 2000 Product Family, integrates the DDM-2000 OC-3 Multiplexer hardware and software. Most of the features offered by the DDM-2000 system are also offered in the *SLC-2000* system, providing flexible access solutions. See LTP 363-208-000, *SLC-2000 Access System Applications, Planning, and Ordering Guide*, for more information.

## **Easy to Order**

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The DDM-2000 FiberReach Multiplexer ordering is simplified through planning tools, technical support services, common equipment, and ample inventories. Standard configuration customer location cabinets and remote cabinet packages are available to simplify system ordering and planning.



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## Overview

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The DDM-2000 FiberReach Multiplexer can support a range of applications with maximum economy and efficiency. This section highlights the ways the DDM-2000 FiberReach Multiplexer, along with other members of the 2000 Product Family, meets these diverse network needs.

## DDM-2000 FiberReach Applications Summary

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Lucent Technologies' 2000 Product Family has set the standard for networking flexibility. The newest member of this family, the DDM-2000 FiberReach Multiplexer, extends the benefits of the DDM-2000 Multiplexer and *SLC*<sup>®</sup>-2000 Access System to end users whose capacity needs may be small but still demand the cutting edge services and support of the larger customers. Targeting the diverse needs of business carrier access, residential fiber-in-the-loop, and private network applications, DDM-2000 FiberReach will deliver a full range of services using the narrowband and wideband shelf as follows:

- Narrowband Shelf
  - Telephony
  - DS0 specials
  - Integrated Services Digital Network (ISDN)

- Wideband Shelf
  - DS1 services (via DSX-1 or T1 carrier access)
  - Video transport

DDM-2000 FiberReach interworks with DDM-2000 OC-3/OC-12 and *SLC-2000* Access System hosts via an exceptional variety of networking options, including single-homed OC-1 path-switched ring extensions and fully survivable dual-homing topologies. In every application, DDM-2000 FiberReach offers a thorough set of operations features with a look and feel that matches the other acclaimed DDM-2000 Multiplexer systems. Remote operation is via the data communications channel (DCC), while a user panel and craft interface terminal port support local operations needs. Complete performance-monitoring (PM) features, including DS1 path PM, permit the service provider to verify the quality-of-service terms of key tariffs.

Three types of DDM-2000 FiberReach applications are offered:

- **Business Carrier Access:** Premium-tariffed telecommunications services (via DS1 or T1 carrier extensions) supplied by public network providers to business customers
- **Fiber in the Loop:** Cost-effective basic telephony, as well as emerging video and data services
- **Private Networks:** Privately held networks that supply the internal communication needs of large corporations, organizations, and institutions

While DDM-2000 FiberReach applications are quite flexible and easy to use, aspects like bandwidth, facility management, and operations subnetwork design require some more detailed consideration. Where appropriate, this section will provide a high level overview and refer you to Section 6, "System Planning and Engineering," for further details.

## Ring Topologies

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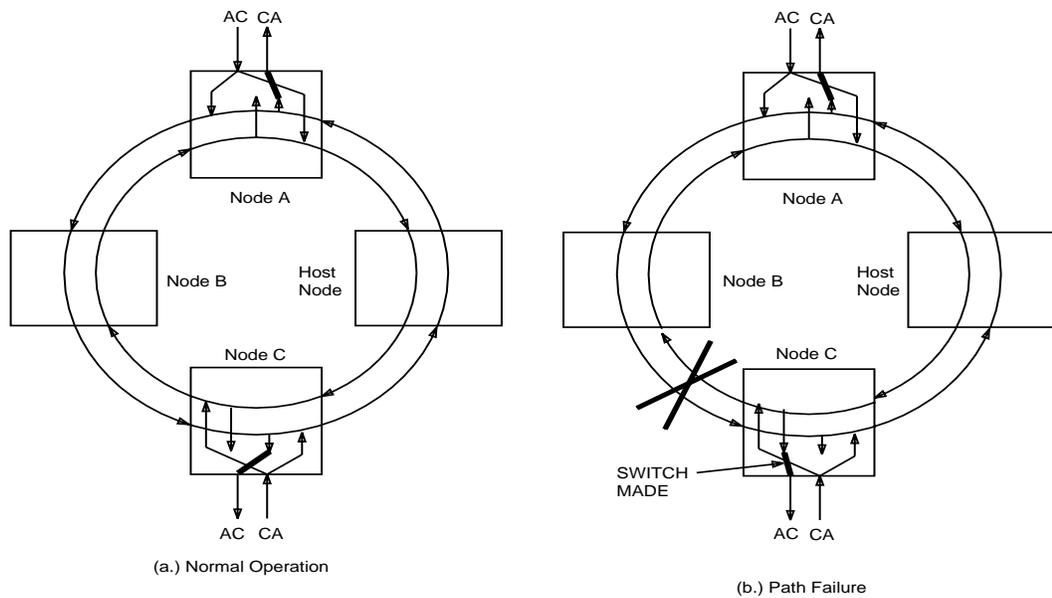
The need to prevent service outages caused by network failure has created a new class of applications. The 2000 Product Family offers a wide range of self-healing network features that automatically protect against service outages caused by cable cuts and equipment failures, which in turn protect customers and generate increased revenue. These self-healing features include flexible DACS-based restoration with the *DACScan-2000* controller, FT-2000 2- and 4-fiber rings, DDM-2000 OC-3 and OC-12 virtual tributary 1.5 (VT1.5) and STS-1 path switched rings, *SLC-2000* Access System path switched rings, and DDM-2000 FiberReach VT1.5 path-switched rings.

DDM-2000 FiberReach, DDM-2000 OC-3, DDM-2000 OC-12, *SLC-2000* Access System, and self-healing rings offer the performance and administrative benefits demonstrated by the successful Lucent FT Series G Ring Diversity Switch. Since the DDM-2000 FiberReach, OC-3, and OC-12 path switched rings operate in an integrated, single-ended fashion, complex network-level coordination is not

necessary to restore traffic. This means restoration is faster and more reliable. Furthermore, bandwidth administration and network reconfigurations (for example, adding or deleting nodes) can be easier.

The DDM-2000 FiberReach, OC-3, and OC-12 path-switched rings operate as shown in Figure 3-1(a). Traffic entering a path switched ring node is sent on to both rotations of the ring. At the receiving node, the signal having the highest integrity (based on SONET path information) is selected and dropped as outgoing traffic. At intermediate nodes, the traffic is "passed-through" without changing the SONET path information. The DDM-2000 time slot interchange (TSI) capabilities make the provisioning of add/drop and pass-through traffic quick and easy.

The self-healing nature of the path switched ring is shown in Figure 3-1(b). In this case, the fiber failure between nodes B and C causes node C to switch from the counterclockwise ring to the clockwise ring, thus maintaining service between node A and C.



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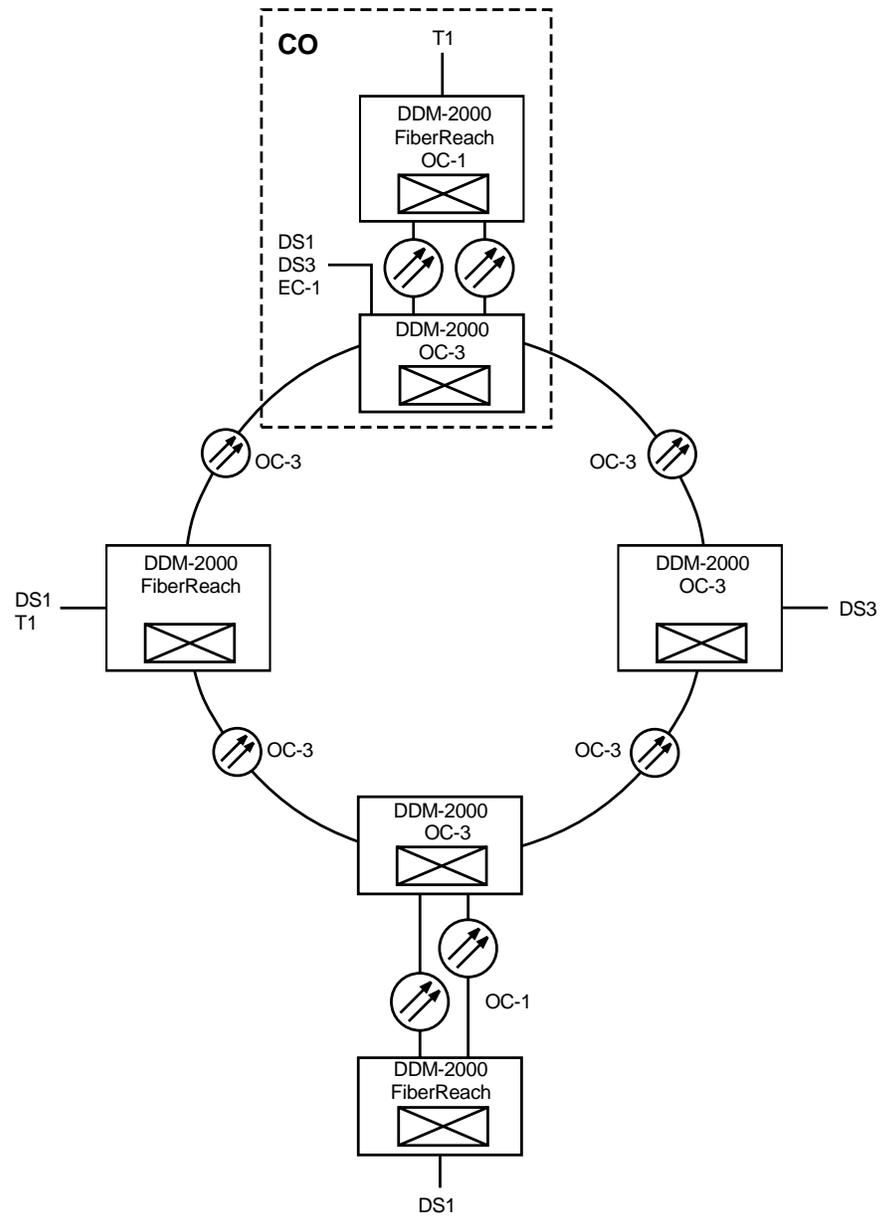
**Figure 3-1. Path Switched Ring**

A network which requires the bulk of its traffic to be dropped at a single node is an ideal application for path switched rings. A typical loop feeder network, where most traffic is between the subscriber loop to a central office, fits this mold. Such an application calls for the delivery of protected DS1 and DS3 service to customer locations. In many cases, where the network serves only voice traffic and DS1s, a DDM-2000 FiberReach/OC-3/SLC-2000 path switched ring is a perfect fit. If DS3 service or a mixture of DS1 and DS3 service is needed, multiple OC-3 rings or an OC-12 ring may be necessary. Cost, fiber availability, and bandwidth flexibility all play a part in determining whether a single OC-1 or OC-3 ring, multiple OC-1 or OC-3 rings, or an OC-12 ring will be the best network solution.

### **OC-3 Path Switched Ring**

A DDM-2000 FiberReach can be equipped with OC-3 optics. This option offers a cost effective solution at locations where the dropped traffic is primarily VT1.5 based and is accessed from any one of the 3 STS-1s. DDM-2000 OC-3 multiplexers can be mixed in the same OC-3 ring. The OC-3 multiplexers can be used at sites requiring DS3 and other higher bandwidth STS path-switched traffic, while the FiberReach multiplexer is used at sites requiring VT path access for DS1, T1, etc. Figure 3-2 shows an OC-3 ring that includes both OC-3 and FiberReach multiplexers.

Starting with FiberReach Release 3.1, FiberReach shelves can be used at sites requiring DS3 services (STS-1 path access for DS3).

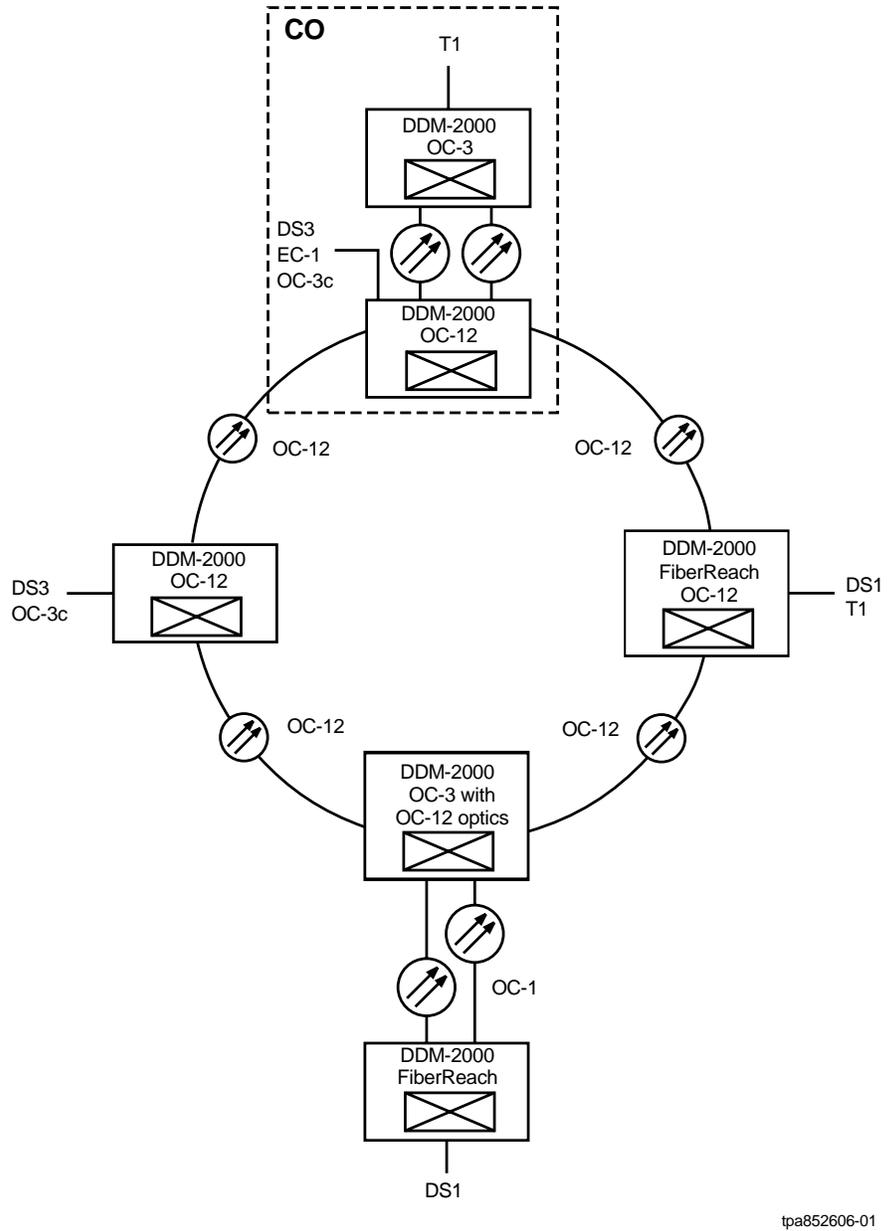


tpa853761/01

**Figure 3-2. OC-3 Path Switched Ring Using OC-3 Multiplexer and FiberReach Multiplexer With OC-3 Optics**

### **OC-12 Path Switched Ring**

A DDM-2000 FiberReach can be equipped with OC-12 optics. This option offers a cost effective solution at locations where the dropped traffic is primarily VT1.5 based and is accessed from any one of the 12 STS-1s. FiberReach multiplexers equipped with OC-12 optics in Release 4.0 and later can be mixed in the same OC-12 ring. The OC-12 multiplexers can be used at sites requiring DS3 and other higher bandwidth STS path-switched traffic, while the FiberReach multiplexer is used at sites requiring VT path access for DS1, T1, etc. Figure 3-3 shows an OC-12 ring that includes both OC-3, OC-12, and FiberReach multiplexers.



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**Figure 3-3. OC-12 Path Switched Ring Using DDM-2000 OC-12, OC-3, and FiberReach Multiplexers With OC-12 Optics**

## **DDM-2000 FiberReach Network Topologies (OC-1)**

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Business Carrier Access is one of today's fastest growing network applications. To supply the advanced communications services demanded by many business customers, local exchange carriers and competitive access providers are dedicating access networks between these customers and their wire centers. Long-distance voice and data services (for example, 1-800 reservations and customer support lines) are delivered from interexchange carrier (IXC) points of presence (POP) to the access networks along with any intra-LATA services needed by the customer. Network survivability, leading edge services, and quick response to changing end user demands are cornerstones of this market.

Small businesses and branch offices are increasingly sophisticated telecommunications users, demanding the advanced services, survivability, and network performance traditionally afforded only the large business locations. While many locations may get by today with a DS1 and a few voice lines, fast emerging LAN interworking, video conferencing, and other data and image applications require an access network of great flexibility. With the DDM-2000 FiberReach system, network providers have an unsurpassed opportunity to expand and compete in this critical market.

Where services are at the DS1 rate and above, DDM-2000 networks supply all the host functions a DDM-2000 FiberReach needs. However, switched service network providers require a forward-looking access network that handles DS0, specials, ISDN, and telephony with DS1 high capacity services in an integrated offering. Where telephony, DS0, and ISDN services are needed, the SLC-2000 Access System host supplies powerful bandwidth management and operations for DS0 level channel units, testing, and TR08/TR303 integrated switch interfaces.

DDM-2000 FiberReach is typically placed at customer locations, in telecommunications equipment rooms and closets, and often connects to an OC-3 or OC-12 backbone feeder ring at a nearby cabinet, controlled environment vault (CEV), or other remote terminal location. Alternatively, customer sites near a wire center can be served by OC-1 facilities directly from the wire center, bypassing the backbone feeder ring.

## **Basic Wideband Shelf Configurations**

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### **DS1 and T1 Services**

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The examples in this section provide DS1/T1 services only. If the NBS and DS0 level services are needed, a FiberReach Wideband Shelf must be co-located with SLC-2000 systems on the OC-3/OC-12 rings to provide DS1 connections from the SLC-2000 MDS shelves to the FiberReach OC-1 ring.

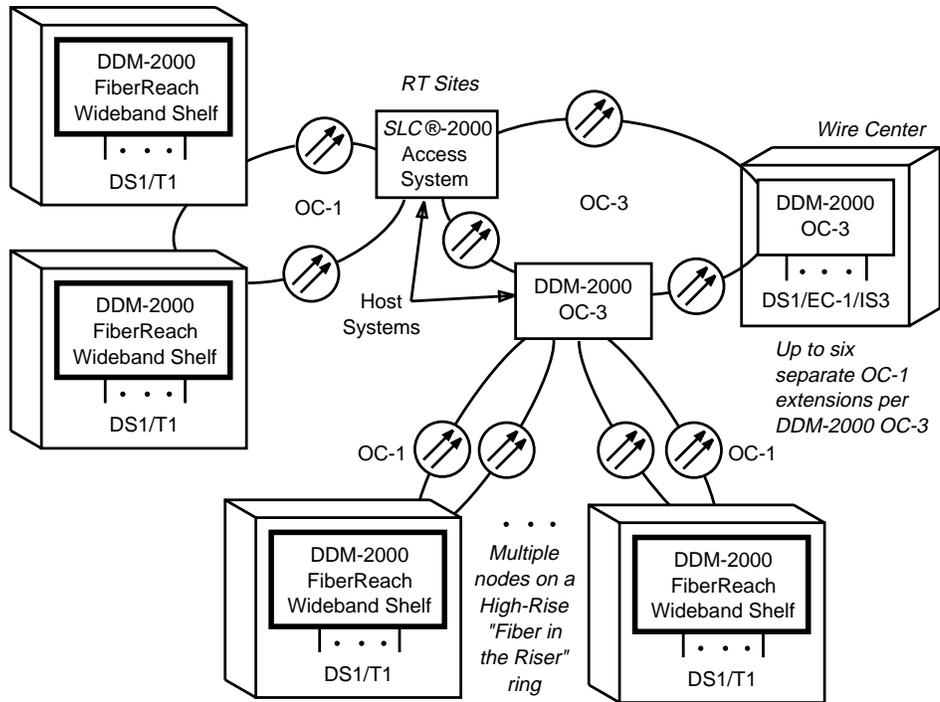
## Single-Homed Access via Backbone Ring

Figure 3-4 and Figure 3-5 illustrate how single-homed OC-1 extensions can satisfy a growing access network. Single-homing applications connect both rotations of the OC-1 extension to a single DDM-2000 OC-3 Multiplexer or *SLC-2000* Access System host. The DDM-2000 FiberReach is placed at the customer's location, such as in a telecommunications equipment closet on each floor of a high-rise office complex, and delivers protected DS1 channels to the business customer.

The OC-1 ring capability allows multiple DDM-2000 FiberReach systems to be connected to the backbone network via a single facility. Compared to other optical extension products that are limited to a single remote node per extension, the ring-based DDM-2000 FiberReach solution uses far less fiber and host optics for typical serving areas with multiple business locations. Network growth is as easy as adding another DDM-2000 FiberReach node on the ring; no additional fiber or host circuit packs are required.

With the dual OC-1 capability of the 27G-U optical line interface unit (OLIU), a DDM-2000 OC-3 ring node supports up to six single-homed OC-1 extensions; a *SLC-2000* Access System access resource module (ARM) shelf can supply up to two single-homed OC-1 extensions. Thus, competing businesses in the same serving area can receive a dedicated access facility into the backbone ring, alleviating any privacy concerns.

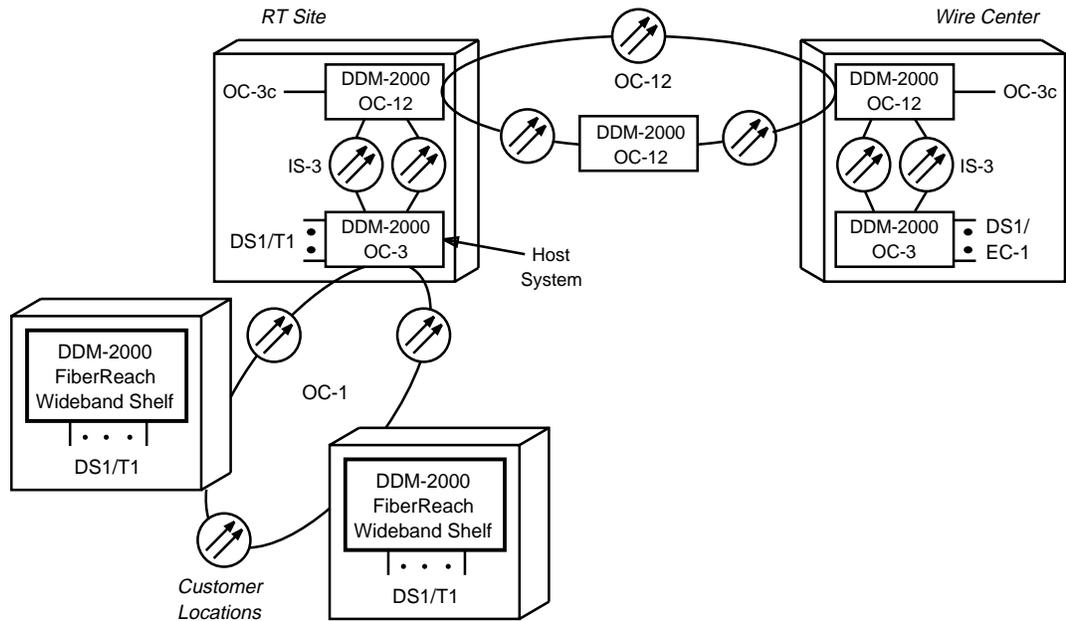
The DDM-2000 FiberReach remote system employs standard path protection switching for a highly reliable network that guarantees 60 millisecond recovery from any single facility or equipment failure. Path protection switching occurs at a node in which the channel is dropped from the ring to a low-speed interface. For example, in Figure 3-4 the remote DDM-2000 FiberReach nodes and the DDM-2000 OC-3 in the wire center supply the path switching function for a survivable end-to-end transport between the customer and wire center. Channels pass between the OC-1 and OC-3 rings at the host DDM-2000 OC-3 and *SLC-2000* systems with a ring (0x1) low-speed interface. This arrangement supports full TSI assignment between low-speed and high-speed time slots while preserving independent service and protection paths between the host and extension rings. Refer to Section 6, "System Planning and Engineering," for details on network size considerations.



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**Figure 3-4. DDM-2000 FiberReach Rings Single Homing to a DDM-2000 OC-3 Ring**

DDM-2000 FiberReach can also be extended from an OC-12/virtual tributary (VT) path-switched ring as shown in Figure 3-5. The DDM-2000 OC-3 system at the host node grooms and packs VT1.5 channels from the OC-1 extension rings for maximum utilization of the OC-12 backbone ring. Both the host OC-3 and OC-12 systems use the ring (0x1) low-speed interfaces, with 60 millisecond path protection switching performed, at the remote DDM-2000 FiberReach and wire center DDM-2000 OC-3 endpoints.

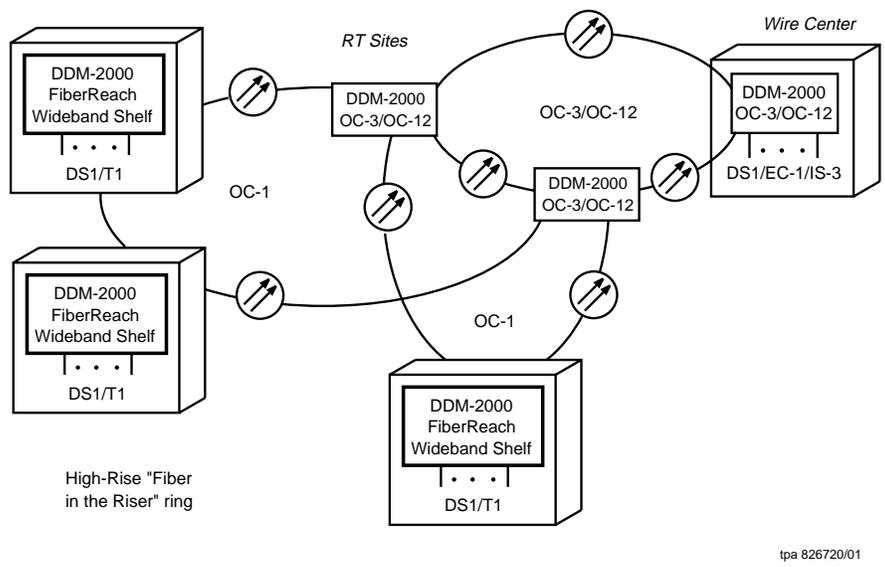


**Figure 3-5. DDM-2000 FiberReach Rings Single Homing to a DDM-2000 OC-12 Ring**

### Dual-Homed Access via a Backbone Ring

Dual homing offers even more survivability than a single-homed network. Even the catastrophic failure of a host node can be protected. Figure 3-6 illustrates dual-homed OC-1 extensions from four remote nodes to an OC-3 access ring. The host nodes can be two DDM-2000 OC-3 Multiplexers, two *SLC-2000* Access Systems, or one DDM-2000 OC-3 Multiplexer and one *SLC-2000* Access System.

Path protection switching is employed for dual-homed applications, just like in single-homed applications. That is, 60 millisecond path switching is supplied by the remote DDM-2000 FiberReach nodes and the DDM-2000 OC-3 or OC-12 systems in the wire center. The OC-3 host node configuration differs from that used for single-homing because each host node terminates only one leg of the OC-1 extension. At each host node, a connection is made from the single OC-1 extension to just one rotation of the OC-3/OC-12 host ring. Dual- and single-homed extensions can also be mixed at a host node, allowing the access network to be tailored efficiently to different groups of customers.

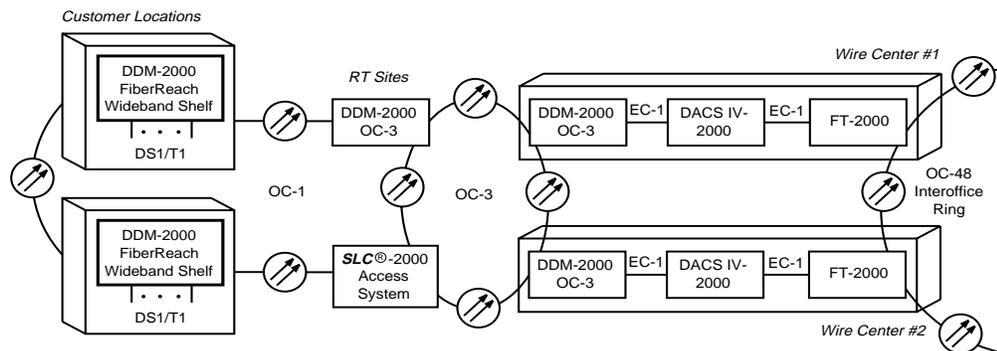


**Figure 3-6. DDM-2000 FiberReach Dual Homing to a DDM-2000 OC-3/OC-12 Ring**

## Integration with Dual Wire Center Applications

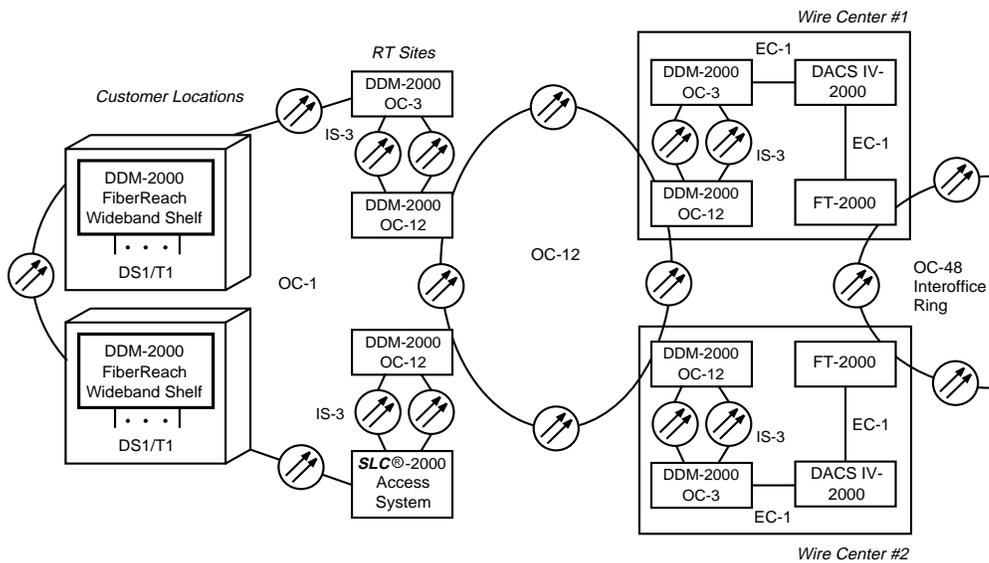
The survivability and networking benefits of Lucent's dual ring interworking solution are cost-effectively extended to smaller locations via DDM-2000 FiberReach dual-homing capabilities. Figure 3-7 shows an OC-3 feeder ring from duplicated wire centers, with dual-homed DDM-2000 FiberReach extensions from selected feeder ring remote sites.

The host nodes and remote DDM-2000 FiberReach systems are configured just like the previously described dual-homing configuration with single 0x1 cross-connections (ring 0x1 low-speed interface) employed by the host. In the dual wire center architecture, the access network is also protected from a catastrophic failure of one wire center, because the access and interoffice networks have duplicate points of interworking. The DDM-2000 OC-3 systems in the two wire centers employ the drop and continue cross-connection. (For more details on the dual wire center application, see LTP 363-206-200, *DDM-2000 Multiplexer Application, Planning, and Ordering Guide*.)



**Figure 3-7. DDM-2000 FiberReach Ring Dual Homing to a DDM-2000 OC-3 Ring in a Dual Wire Center Application**

Dual-homing applications can also be upgraded to an OC-12 backbone ring as shown in Figure 3-8. As with the single-homing application, the DDM-2000 OC-3 host system supplies the VT1.5 grooming necessary for optimum backbone utilization.

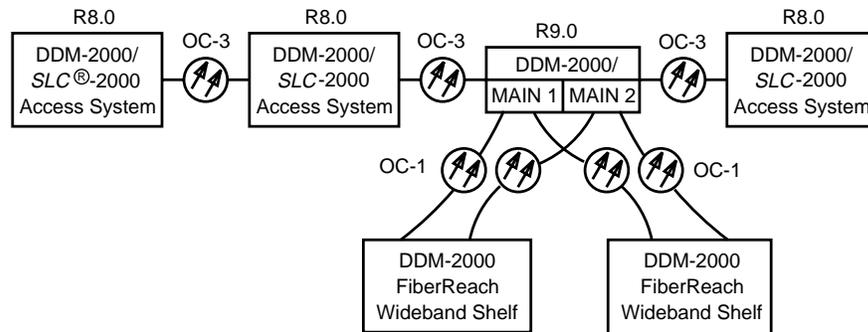


**Figure 3-8. DDM-2000 FiberReach Ring Dual Homing to a DDM-2000 OC-12 Ring in a Dual Wire Center Application**

### Single Homing to Linear DDM-2000 OC-3 Networks

In business applications where the DDM-2000 OC-3 host is a node on a linear topology, two single-homed OC-1 ring extensions can be provided to multiple DDM-2000 FiberReach Multiplexers (see Figure 3-9). In this tapered linear application configuration, function slot "C" of the DDM-2000 OC-3 host is used for incoming traffic, and the "A" and "B" slots are used for downstream traffic or local terminations. The host DDM-2000 OC-3 Multiplexer must be using software Release 9.0 or later. The other DDM-2000 OC-3 Multiplexers in the linear application must be using Release 8.0 software.

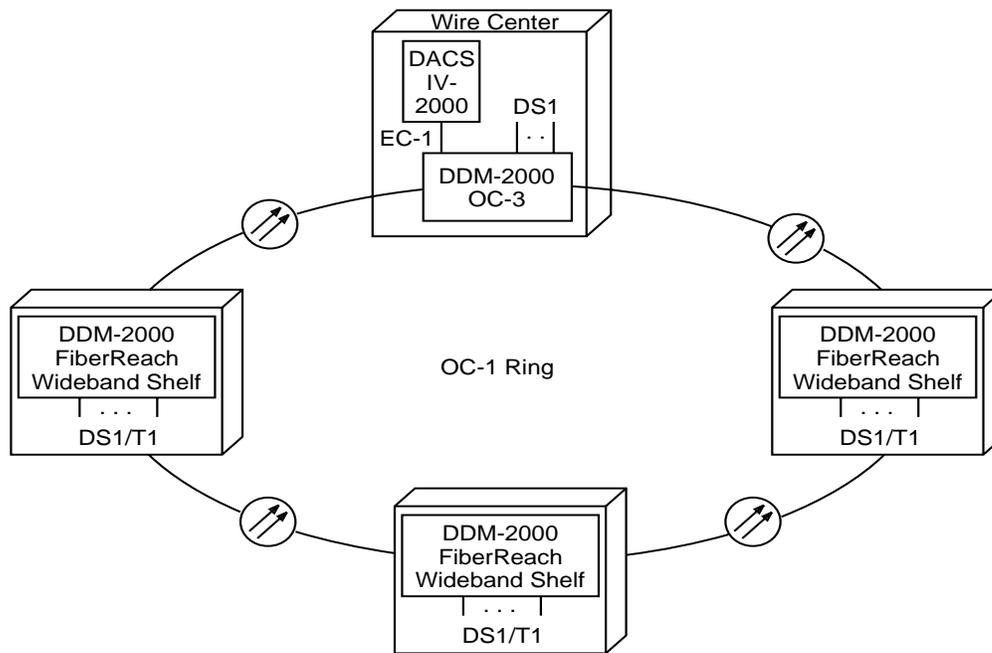
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**Figure 3-9. Single-Homed OC-1 Ring to a DDM-2000 OC-3 Linear Application**

### Stand-Alone OC-1 Ring/Hub Networks

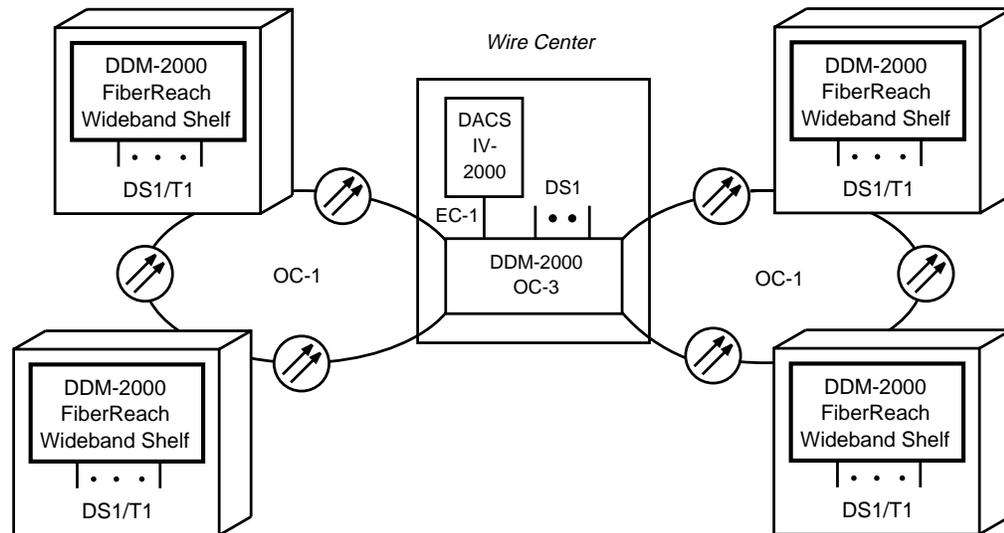
In applications such as campus or other self-contained environments where an OC-3 or OC-12 backbone ring is not needed or practical, DDM-2000 FiberReach can be deployed in a stand-alone OC-1 ring. This OC-1 ring extension can be configured directly from a DDM-2000/SLC-2000 shelf with 27-type circuit packs in the Main slots. A mix of DS1 and T1 carrier traffic from remote DDM-2000 FiberReach nodes can be flexibly groomed and dropped at the host to a mix of DS1, EC-1, and OC-3 interfaces, as shown in Figure 3-10. Channels can be established directly between two DDM-2000 FiberReach remotes on the same OC-1 ring. This configuration would be very effective for customers within a short radius of the wire center or for isolated demand at a distant location where there is no appropriate access network yet in place.



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Figure 3-10. DDM-2000 FiberReach Stand-Alone OC-1 Ring

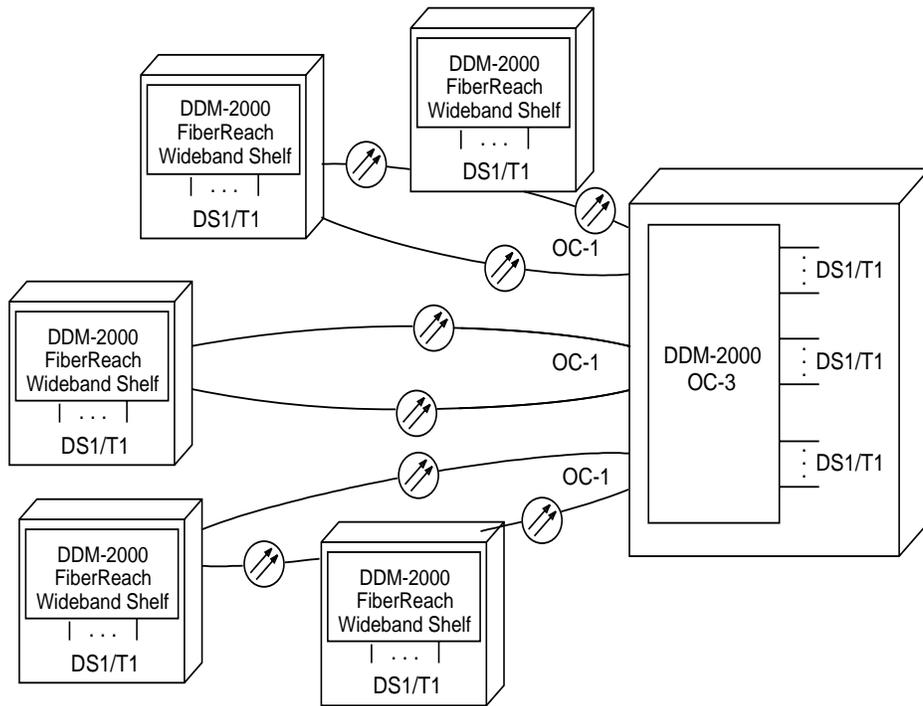
This application can be further expanded to hub up to two OC-1 rings from a stand-alone DDM-2000/SLC-2000 host system, as shown in Figure 3-11. In a future release, up to six OC-1 rings can be supported by equipping the function slots of the DDM-2000/SLC-2000 shelf with 27G2-U OLIU circuit packs.



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**Figure 3-11. DDM-2000 FiberReach Single Homing to a Stand-Alone OC-1 Hub Host**

Another configuration of the OC-1 hub network uses the full capacity of the OC-3 shelf by dropping up to 28 VT1.5 channels to the low-speed DS1 slots for each of the 3 OC-1 ring extensions. The total capacity is 84 DS1 signals. This triple OC-1 Multiplexer configuration, shown in Figure 3-12, supports three independent OC-1/DS1 ring networks with a consolidated host node for operations access, network synchronization, and efficient physical packaging.



**Figure 3-12. Triple OC-1 Multiplexer Application**

## Enhanced Routing

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The DDM-2000 hosts can support a collection of enhanced routing features, as shown in Figure 3-13, Figure 3-14, Figure 3-15, and Figure 3-16. These features support cross-connections within and across Function Units without using bandwidth on the main OC-3 or OC-12 rings. This allows even greater networking flexibility and efficiency. While the high-speed OC-3 interface can carry up to 84 VT1.5 channels, each of the 3 Function Units has a 2-OC1 capacity, or up to an additional 168 VT1.5 channels. For example, a DDM-2000 OC-3 system with 22-type OLIUs in the Main slots and 27G2-U dual OC-1 OLIUs in each Function Unit supports up to 168 VT1.5 channels: 84 between high-speed OC-3 and low-speed OC-1, and another 84 channels that pass directly between this host's remote FiberReach system.



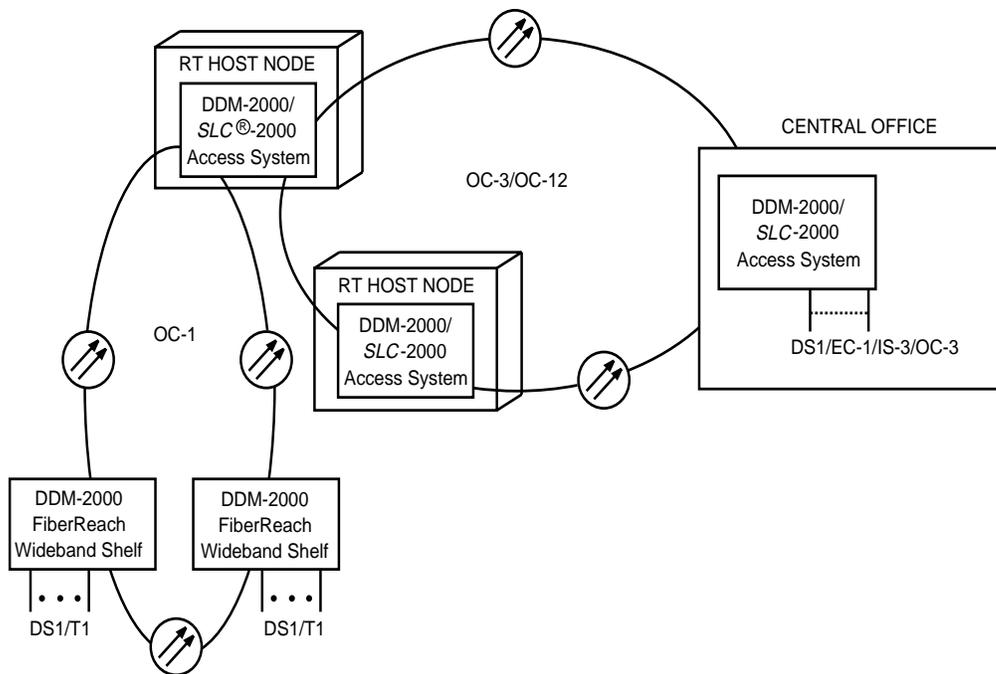
**NOTE:**

*SLC-2000* has only two function groups (A and C) rather than three in DDM-2000.

The OC-1 ring interconnection enhanced routing options utilize 0x1 or pass-through cross-connections at the DDM-2000 host. Path protection switching is performed at the DDM-2000 FiberReach system at the path midpoints. The local drop enhanced routing option employs path protection switching in the OC-3 host's Function Unit in order to drop to local EC-1, DS1, or OC-3 ports. This local drop option requires the use of Release 11.0 software at the DDM-2000 host.

### OC-1 Ring Pass-Through

This enhanced routing option establishes pass-through cross-connections for channels on an OC-1 ring terminating on a pair of 27G2-U OLIUs in the Function Units of a DDM OC-3. This application must use a pair of 27G2-U OLIUs in the function units slots. (See Figure 3-13.) These cross-connections are just like the pass-through cross-connections that can be provisioned for rings terminating on Main slots. This allows traffic to be routed from one FiberReach node to another FiberReach node on the same OC-1 ring without using bandwidth on the OC-3/OC-12 ring.

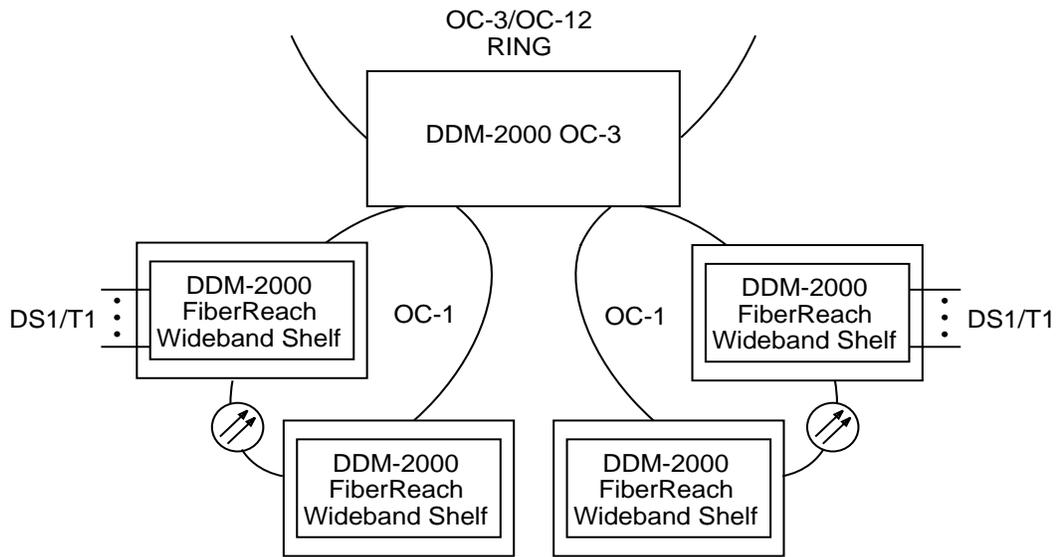


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**Figure 3-13. OC-1 Ring Pass-Through in a Function Unit**

### OC-1 Ring Hairpin Routing, Single-Homed

This routing option establishes cross-connections between channels on two separate OC-1 facilities that terminate on 27G2-U OLIU circuit packs in either the same or different Function Units (see Figure 3-14). In the single-homed configuration, both rotations of each of the two OC-1 rings terminate on a pair of 27G2-U OLIUs. There may be a pair of 27G2-U OLIUs that terminates both rings, or one pair of 27G2-U OLIUs in each of two Function Units that terminate the rings. Each rotation of one ring is cross-connected to the corresponding rotation of the other ring. This allows traffic to be routed from one FiberReach node on one OC-1 ring to any other FiberReach node on another OC-1 ring without using bandwidth on the OC-3/OC-12 ring.



**Figure 3-14. Single-Homed Hairpin Routing**

### OC-1 Ring Hairpin Routing, Dual-Homed

This routing option establishes cross-connections between channels on two separate OC-1 facilities that terminate on 27G2-U OLIU circuit packs in either the same or different Function Units. (See Figure 3-15.) In the dual-homed arrangement, only one rotation of each of the two OC-1 rings terminates on a single OC-3 shelf. At the OC-3 shelf, there may be a single 27G2-U OLIU that terminates both rings or a 27G2-U OLIU in each of two Function Units that terminate the rings. The other rotation of each ring terminates on a different OC-3 shelf. This allows traffic to be routed from one FiberReach node on one OC-1 ring to any other FiberReach node on another OC-1 ring without using bandwidth on the OC-3/OC-12 ring.

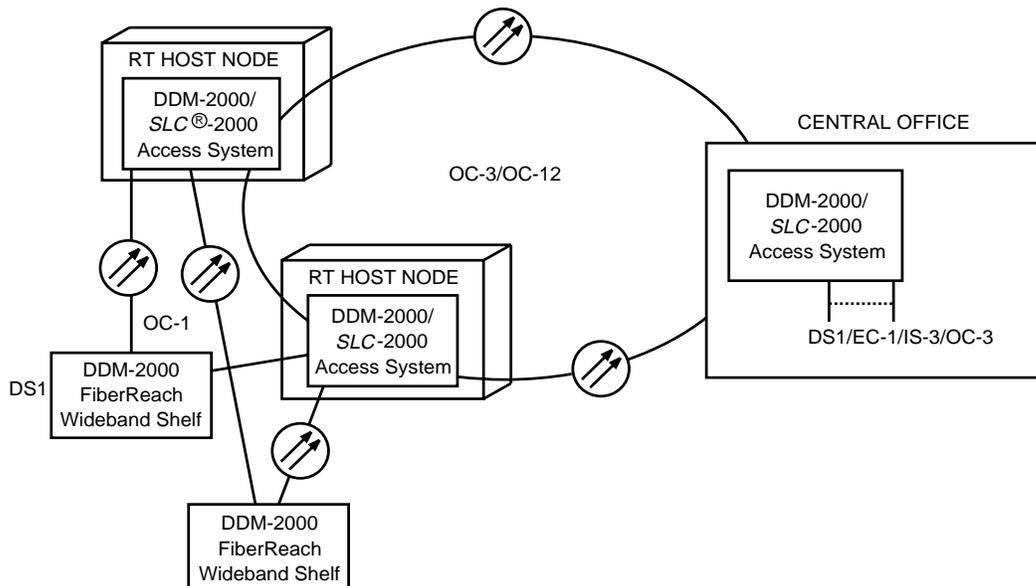
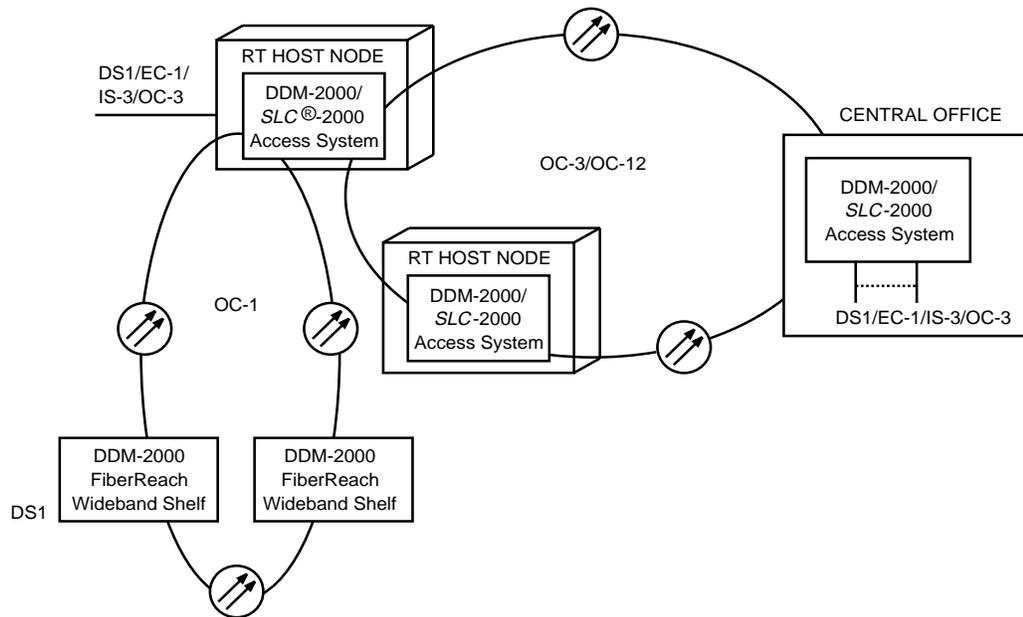


Figure 3-15. Dual-Homed Hairpin Routing

### Hairpin Local Drop Routing

Figure 3-16 shows a hairpin local drop routing. This routing option establishes path-protection switched drop cross-connections between channels on an OC-1 ring and ports/channels on DS1/EC1/OC-3 circuit packs. (See Figure 3-16.) The OC-1 facility terminates on a pair of 27G2-U OLIU circuit packs in the Function Unit slots. These connections are just like the drop cross-connections that can be established between channels on a ring terminating on the Main slots and port or channels in a Function Unit. This allows traffic to be routed from a FiberReach node on an OC-1 ring to a local drop without using bandwidth on the OC-3/OC-12 ring.



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**Figure 3-16. Hairpin Local Drop Routing**

A mix of the enhanced routing services shown in Figure 3-14, Figure 3-15, and Figure 3-16 can be created in a single DDM-2000 FiberReach host. OC-3 Release 9.1 software and 27G2-U OLIUs are needed for these services.

## **DDM-2000 FiberReach Network Topologies (OC-3 and OC-12)**

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### **28-Type Optical Line Interface (28G-U)**

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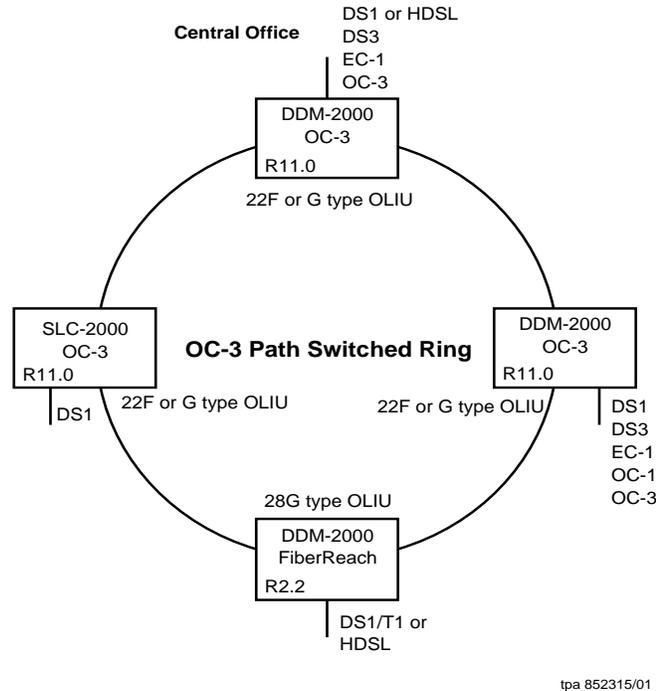
This section describes applications in which the FiberReach multiplexer is equipped with the 28G-U OC-3 OLIUs in the Main slots.

#### **Circuit Pack Overview**

The 28G-U is used in the Main slots of the DDM-2000 FiberReach shelf in a unidirectional path protection switched OC-3 ring configurations.

The primary functions of the 28G-U OLIU are to multiplex up to 7 VT-G signals and 3 STS-1 signals, or 3 STS-1 signals into a single OC-3 optical signal in the transmit direction; to demultiplex an OC-3 signal into 3 STS-1 signals or 2 STS-1 signals and up to 7 VT-G signals in the receive direction; to provide for cross-connections among the 3 STS-1s and all VT1.5 signals that may be embedded within any of the STS-1s and provide system clock and frame.

The 28G-U provides timing for the entire wideband shelf. Two modes will be provided, line-timed, and holdover. Figure 3-17 displays OC-3 Ring Mixed Application with DDM-2000 FiberReach. DDM-2000 OC-3 and SLC-2000 ARM shelves on the same OC-3 ring.



**Figure 3-17. OC-3 Ring Mixed Application**

### **29-Type Optical Line Interface (29G-U/29H-U)**

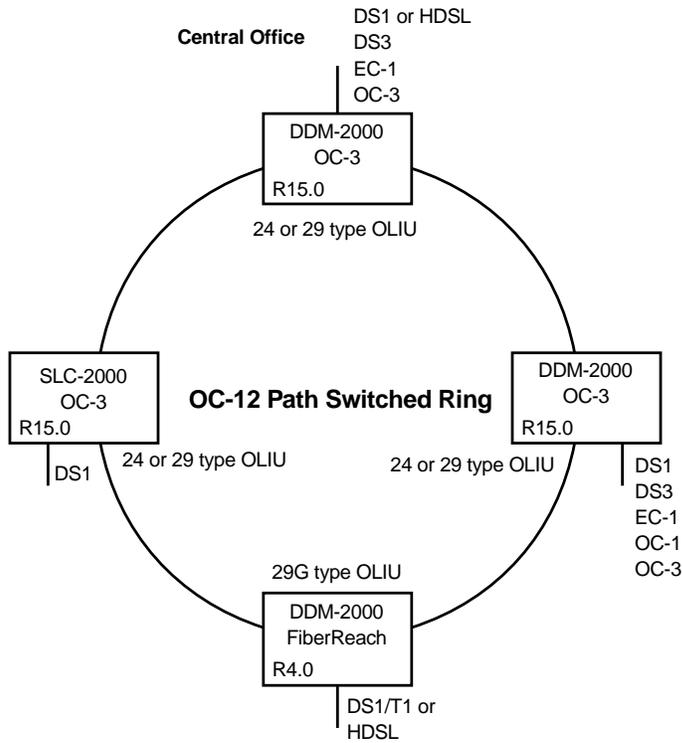
This section describes applications in which the FiberReach multiplexer is equipped with the 29-Type OC-12 OLIUs in the Main slots.

#### **Circuit Pack Overview**

The 29-Type OLIU is used in the Main slots of the DDM-2000 FiberReach Shelf in a unidirectional path protection switched OC-12 ring configurations.

The primary functions of the 29-Type OLIU are to multiplex up to 7 VT-G signals and 3 STS-1 signals in the transmit direction; to demultiplex an OC-12 signal into 3 STS-1 signals and up to 7 VT-G signals in the receive direction; to provide for cross-connections among the 3 STS-1s and all VT1.5 signals that may be embedded within any of the STS-1s and provide system clock and frame.

The 29-Type provides timing for the entire wideband shelf. Two modes will be provided, line-timed, and holdover. Figure 3-18 displays OC-12 Ring Mixed Application with DDM-2000 FiberReach. DDM-2000 OC-12 and SLC-2000 ARM shelves are on the same ring.



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Figure 3-18. OC-12 Ring Mixed Application

## **DDM-2000 FiberReach Service Applications**

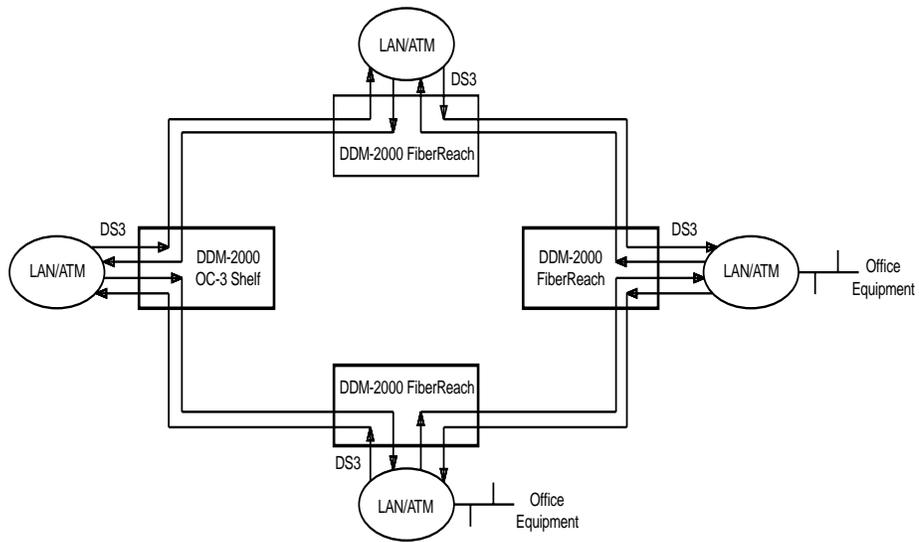
This section describes specific service applications. In addition to traditional telephony, DS1, and T1 extension services, the following are examples of specific service applications utilizing DDM-2000 FiberReach Multiplexers.

### **LAN/WAN Data Networking: DS3 Data Services**

Release 3.1 introduced a new DS3 Data Services Interface circuit pack (BBG19) for use with data edge devices.

Increasing demands for data and multimedia applications have led to a significant growth in LAN service needs among business customers. These service needs have been focused on providing interconnection of business customer LANs over a wide area network (WAN). To transport these LAN interconnect data services over the public network LAN routers and concentrators collect the data at a LAN location and map it into traditional telephone network transmission signals (for example, DS1 or DS3). These telephony signals can then be transmitted to wide area locations where the data can be mapped onto the LAN at that location.

DDM-2000 FiberReach Multiplexers are ideally suited to serving the growing demands for such WAN services. DDM-2000 FiberReach multiplexers can interface to an external LAN/ATM switch via DS3 interfaces (see Figure 3-19 and Figure 3-22). Using such an external LAN/ATM switch approach, DDM-2000 FiberReach Multiplexers can provide the necessary transport capabilities to meet the business customer LAN interconnect service needs. Delivering LAN interconnect services using DDM-2000 provides the same high level of reliability and availability for these services as is supported for all other premium business services — this includes full STS-1 path-switching in ring configurations.

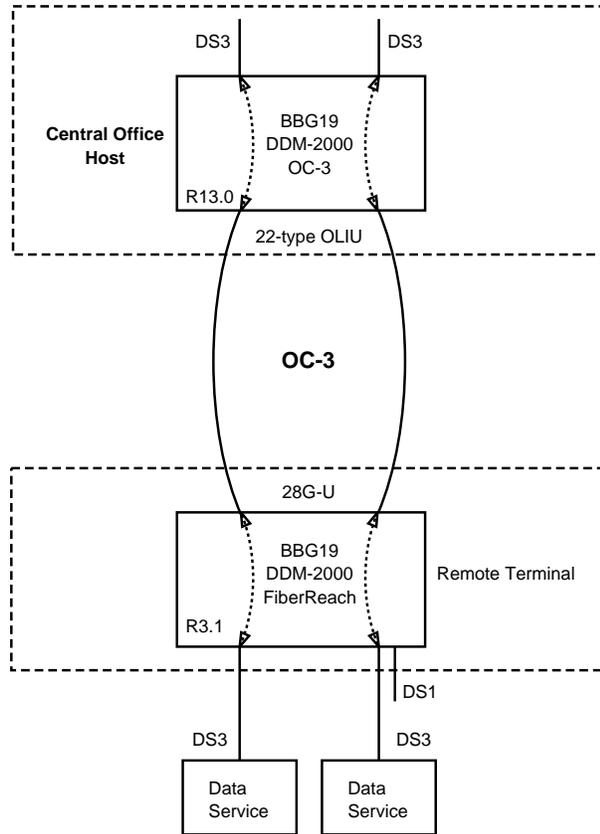


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**Figure 3-19. LAN/WAN Data Networking Using Locked DS3 Cross-Connections**

Figure 3-20 shows an application in which access for two unprotected DS3 data service channels is provided using BBG19 front access DS3 data services circuit packs. In the unprotected mode a single FiberReach shelf equipped with BBG19s provides drop capacity for two DS3s and up to 28 DS1s.

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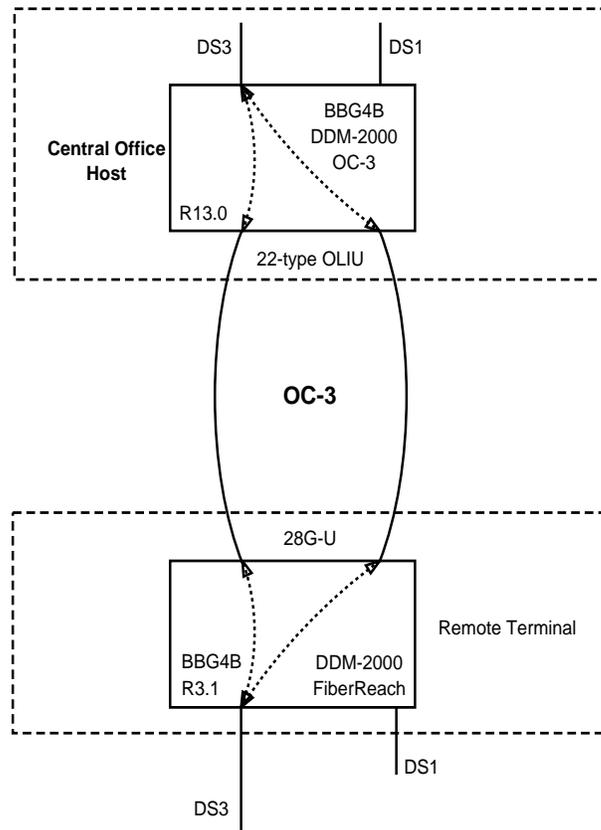


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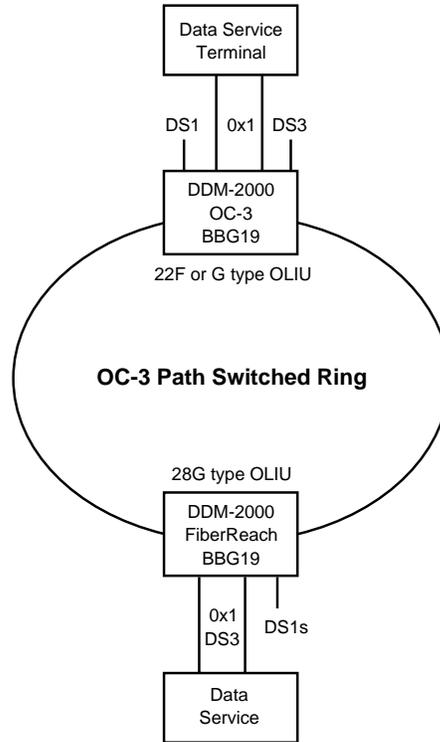
**Figure 3-20. Unprotected DS3 Data Services using BBG19 Circuit Packs**

Figure 3-21 shows an application which provides access for a single DS3 using BBG4B DS3 circuit packs. In the protected mode a single FiberReach shelf equipped with BBG4Bs provides drop capacity for a single DS3 and up to 28 DS1s.



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**Figure 3-21. Protected DS3 Data Services using BBG4B Circuit Packs**



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**Figure 3-22. LAN/WAN Data Networking**

### **High Data-rate Subscriber Line (HDSL) Application**

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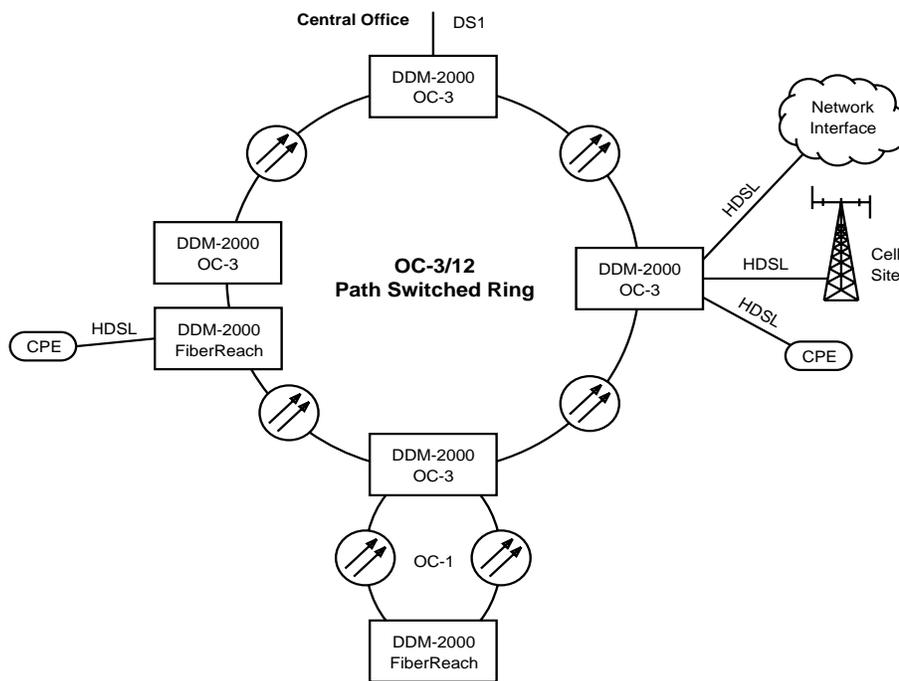
The HDSL circuit pack (BBF8) provides HDSL interface capability on the DDM-2000 OC-3 shelf to compatible *PairGain*\* equipment at the customer premises. It allows the transport of DS1 rate payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Figure 3-23 shows examples of HDSL circuit packs providing this capability in both the DDM-2000 OC-3 and the DDM-2000

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\* *PairGain* is a registered trademark of PairGain Technologies, Inc.

FiberReach shelves. Application for business customers, the private network, cell sites, PBXs, customer premises equipment (CPE), and other applications are supported.

The BBF8 circuit pack fits into the low-speed slots and provides two, four-wire HDSL interfaces. Each interface provides a full DS1 rate payload capacity mapped to a SONET VT1.5 and then VT cross-connected into an STS-1. Once in SONET, DS1 rate payload is treated as a normal DS1.



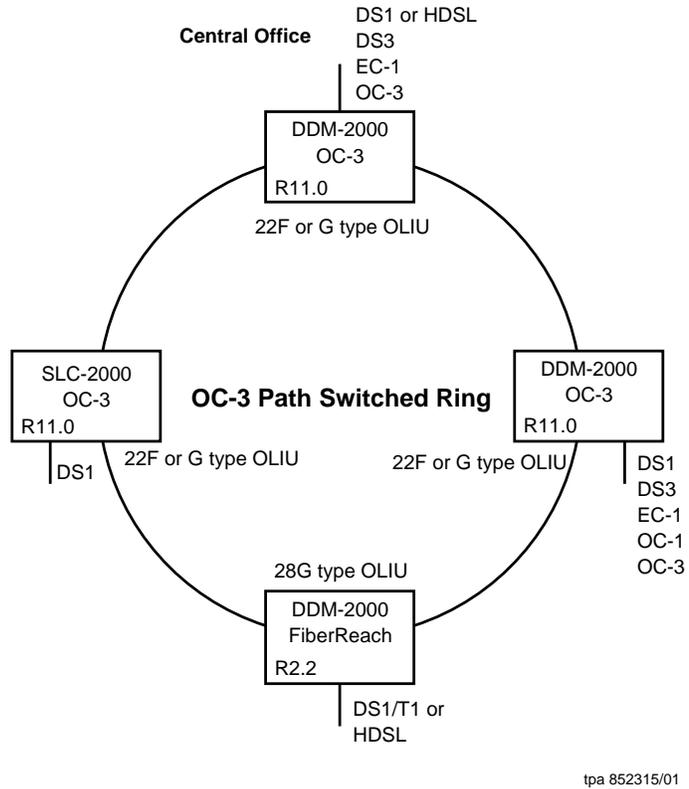
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**Figure 3-23. HDSL Application**

### DDM-2000 FiberReach Service Applications Using the 28G-Type OLIU (Release 2.2 — Non-TARP Release)

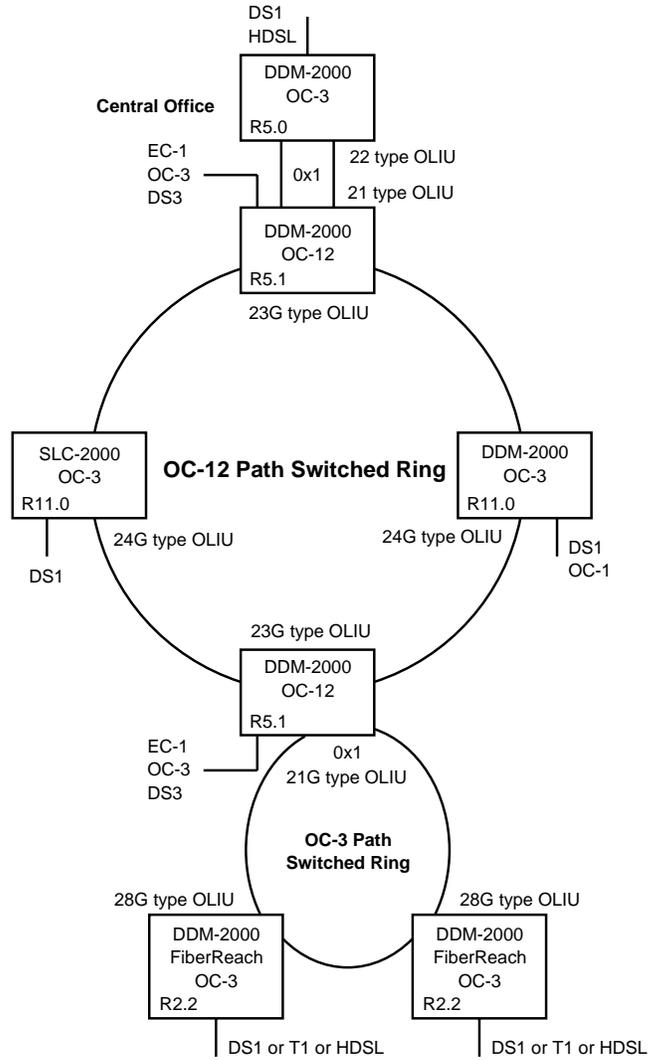
The following figures show service applications of the DDM-2000 FiberReach Multiplexer using the 28G-type OLIU.

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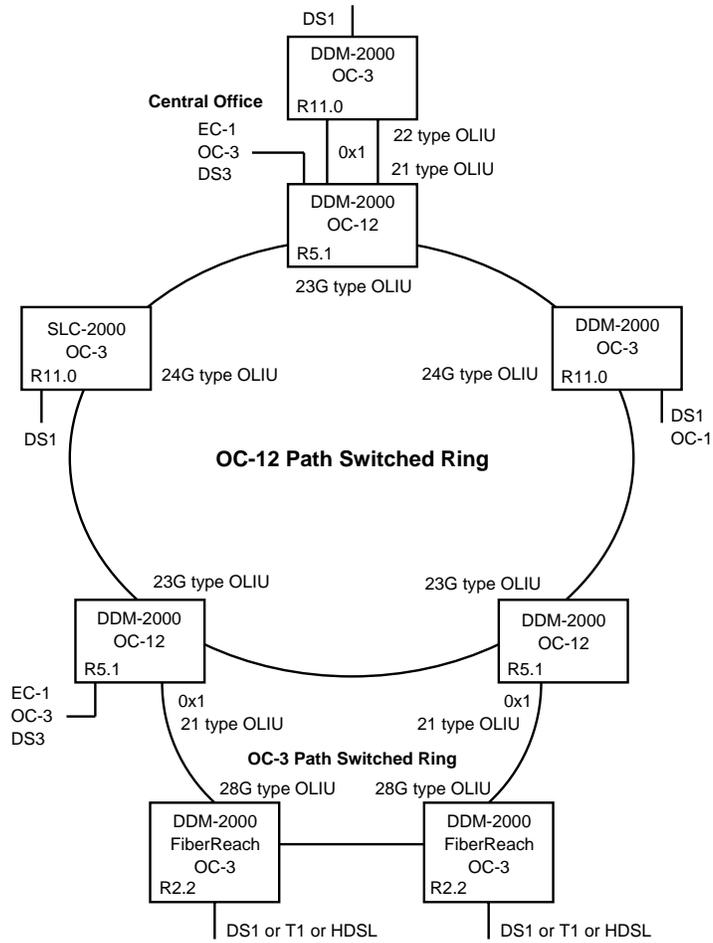
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**Figure 3-24. OC-3 Ring Mixed Application**



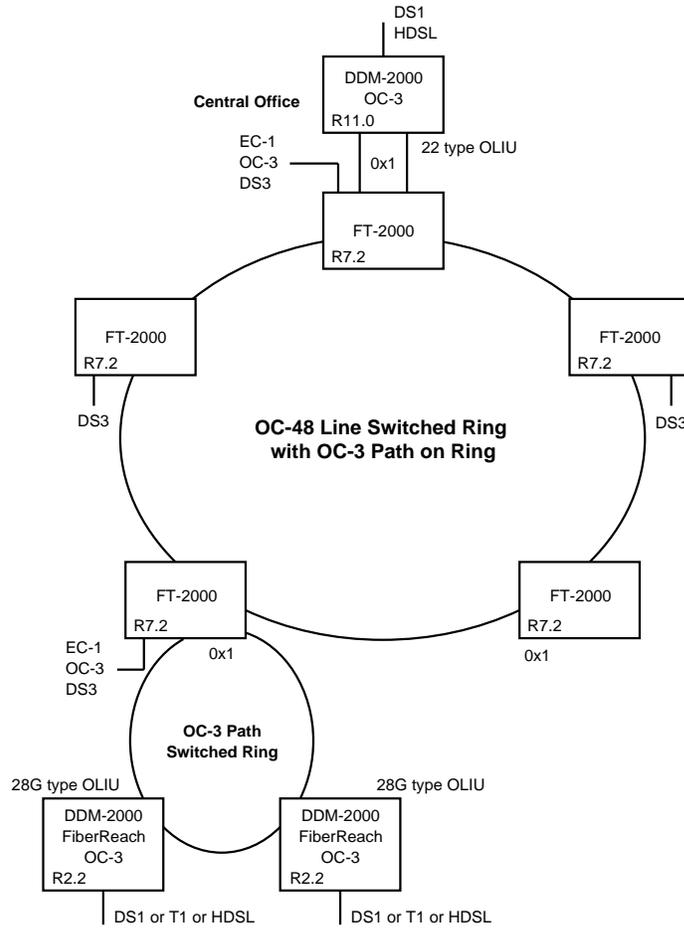
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**Figure 3-25. OC-3 FiberReach Extension (Single-Homed) on OC-12 Ring Application**



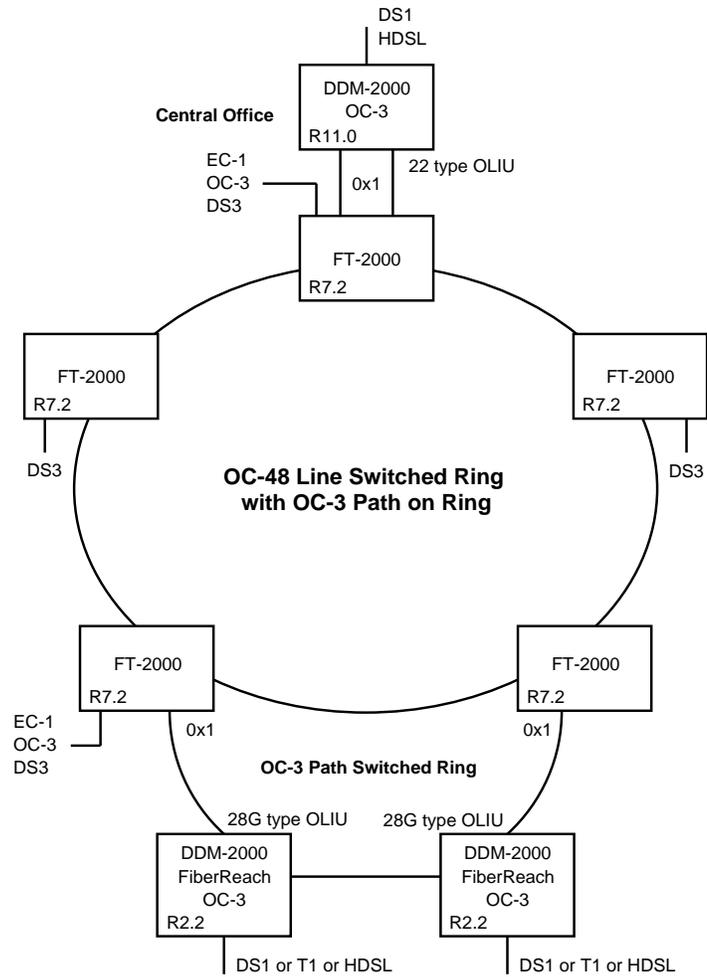
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**Figure 3-26. FiberReach Extension (Dual Homed) on OC-12 Ring Application**



tpa 852377/01

**Figure 3-27. OC-3 FiberReach Extension (Single-Homed) on OC-48 Ring Application**

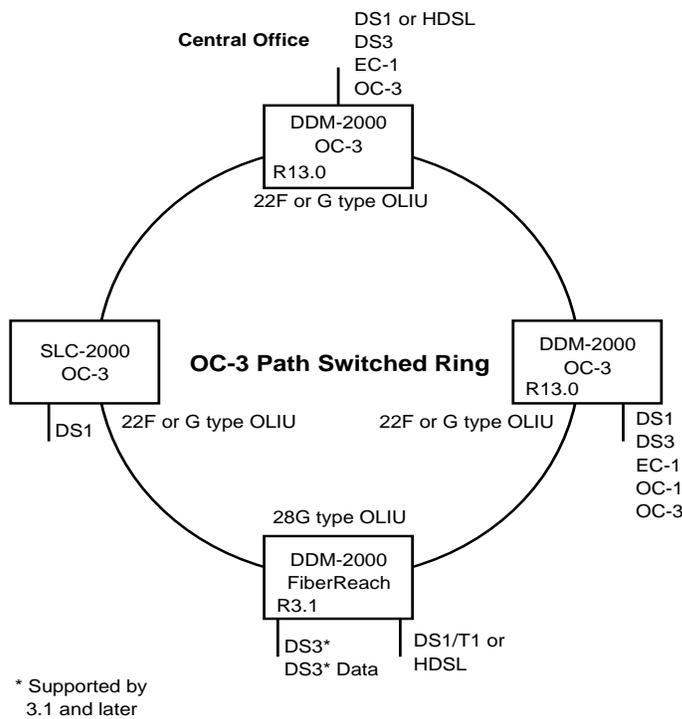


tpa 852376/01

**Figure 3-28. OC-3 FiberReach Extension (Dual-Homed) on OC-12 Ring Application**

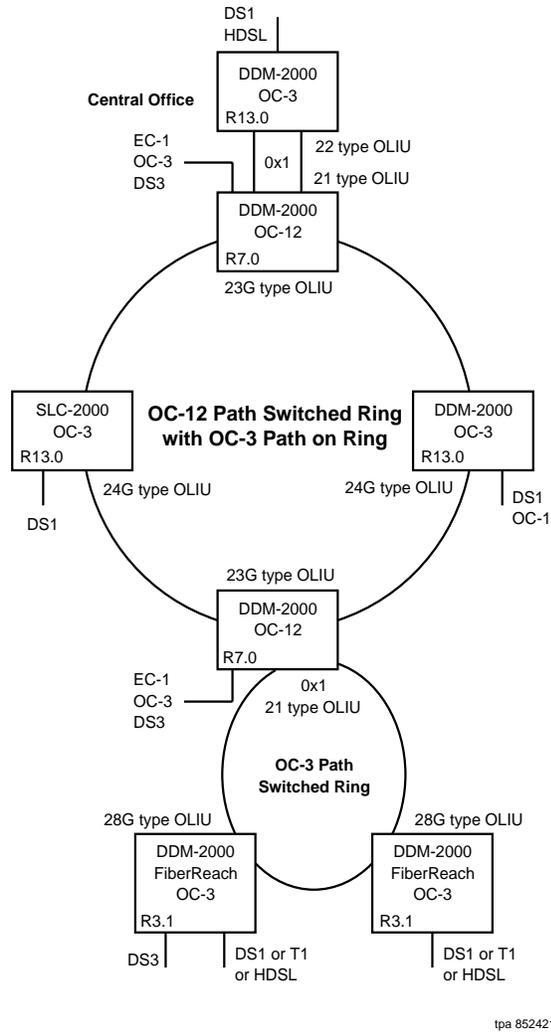
### DDM-2000 FiberReach Service Applications Using the 28G-Type OLIU (Release 3.1, TARP)

The following figures show service applications of the DDM-2000 FiberReach Multiplexer using the 28G-type OLIU. In Figure 3-29, the FiberReach multiplexer is a network element on an OC-3 path switched ring with a DDM-2000 OC-3 host shelf in the Central Office. The host shelf provides timing to other NEs on the ring and serves as a gateway NE to a TL1 based operation support system. Fiber connections are between main OLIUs. The FiberReach shelf provides a DS3 interface and up to 28 DS1 service interface, or a mix of DS1, T1 and HDSL. Figure 3-30, Figure 3-31 and Figure 3-32 are example applications in which the FiberReach multiplexer is a node in an OC-3 ring carried on an OC-12 or OC-48 ring.

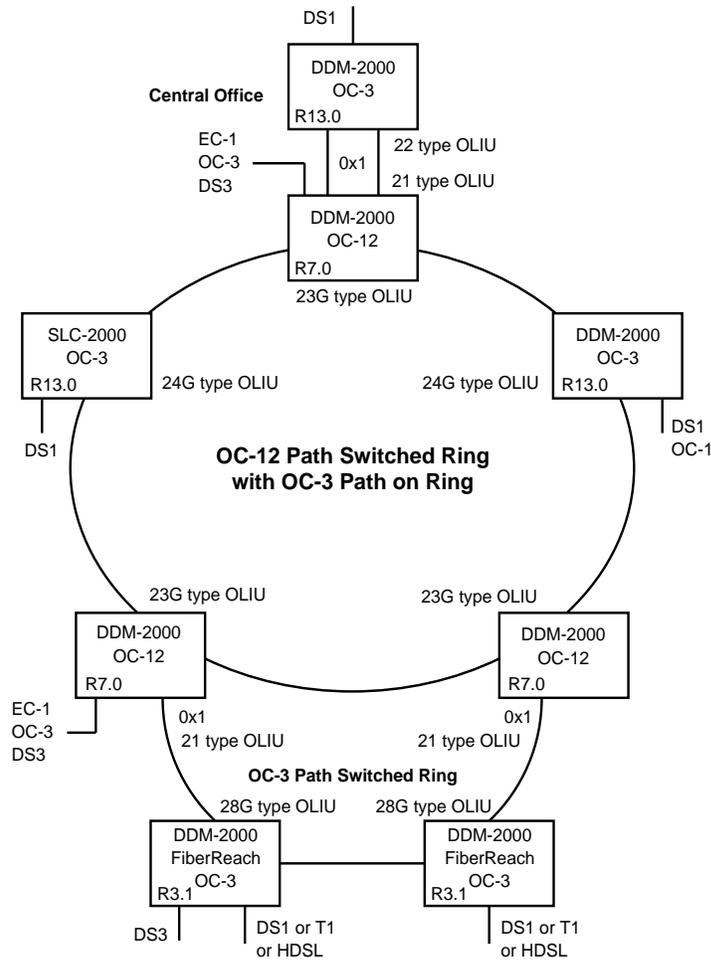


tpa 852419/01

Figure 3-29. OC-3 Ring Mixed Application (Release 3.1 or Later)

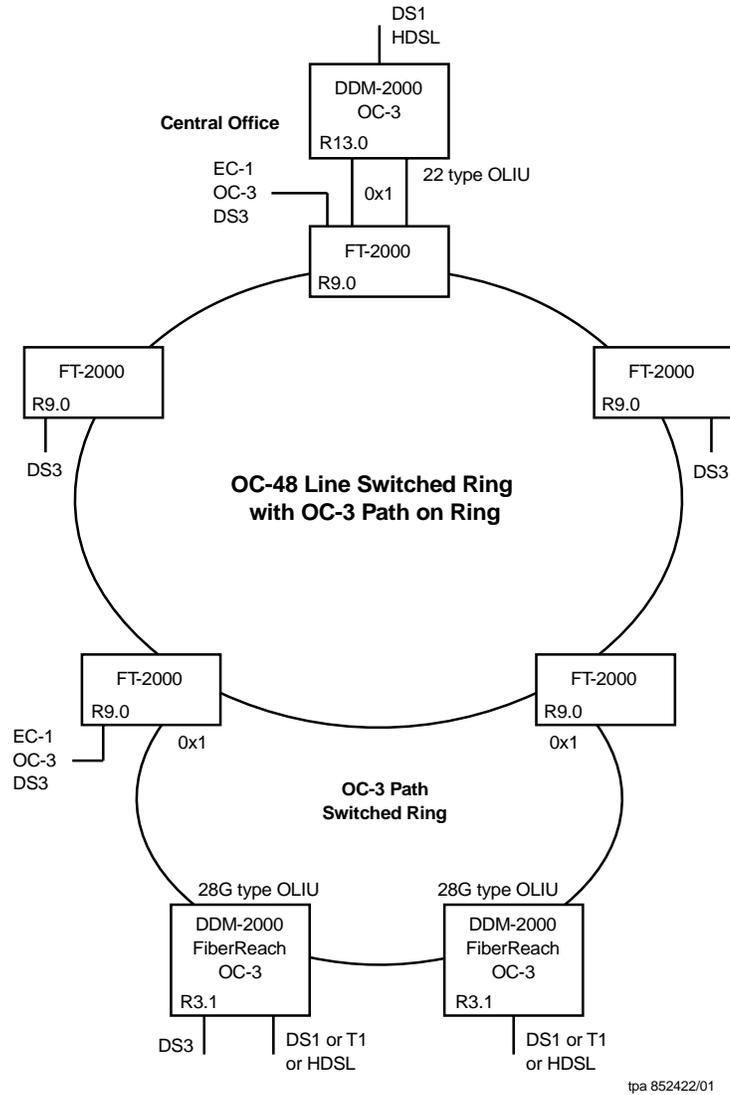


**Figure 3-30. OC-3 FiberReach Extension (Single-Homed) on OC-12 Ring Application (Release 3.1 or Later)**



tpa 852420/01

**Figure 3-31. FiberReach Extension (Dual Homed) on OC-12 Ring Application (Release 3.1 or Later)**

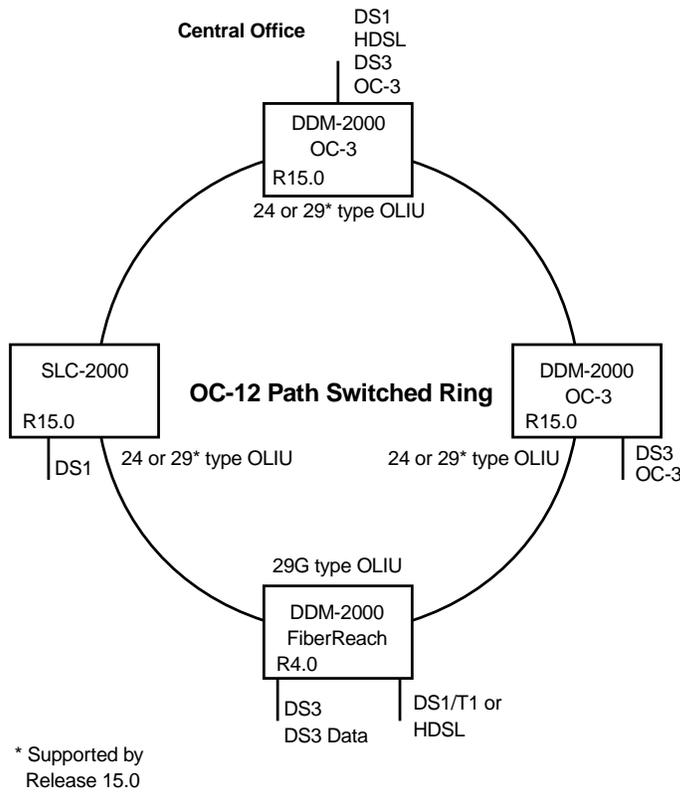


tpa 852422/01

**Figure 3-32. OC-3 FiberReach Extension (Dual - Homed) on OC-48 Ring Application (Release 3.1 or Later)**

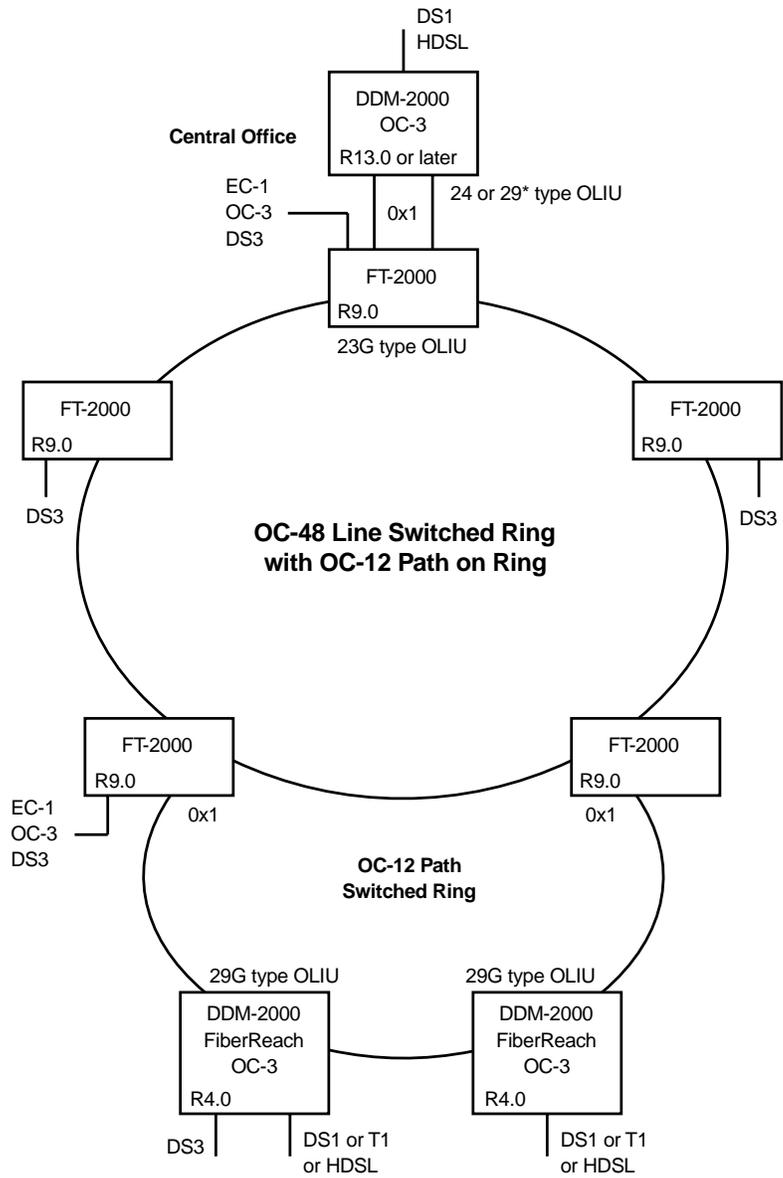
### DDM-2000 FiberReach Service Applications Using the 29-Type OLIU (Release 4.0, TARP)

The following figures show service applications of the DDM-2000 FiberReach Multiplexer using the 29-Type OLIU. In Figure 3-33, the FiberReach multiplexer is a network element on an OC-12 path switched ring with a DDM-2000 OC-3 host shelf in the Central Office. The host shelf provides timing to other NEs on the ring and serves as a gateway NE to a TL1 based operation support system. Fiber connections are between main OLIUs. The FiberReach shelf provides a DS3 interface and up to 28 DS1 service interface, or a mix of DS1, T1 and HDSL. Figure 3-34 is an example application in which the FiberReach multiplexer is a node in an OC-3 ring carried on an OC-12 or OC-48 ring.



tpa 853761/06

Figure 3-33. OC-12 Ring Mixed Application



\* Supported by Release 15.0

tpa 853761/05

**Figure 3-34. OC-3 FiberReach Extension (Dual - Homed) on OC-48 Ring Application (Release 4.0)**

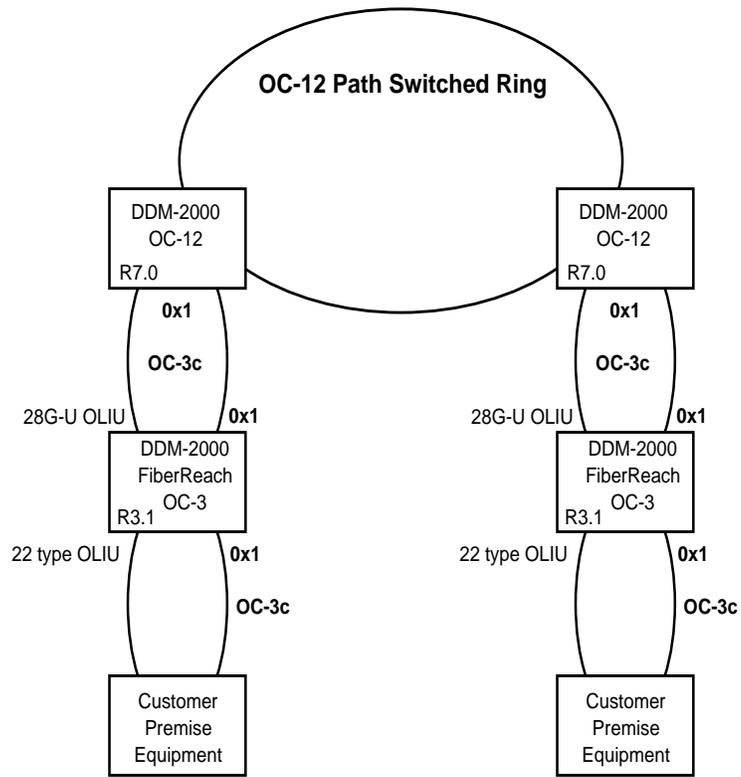
### **STS-3c 0X1 Optical Interface**

This new interface provides the ability of transporting STS-3c services on an OC-3c low-speed Function Unit optical interfaces that have been provisioned for 0X1 applications.

Ring path switching is not done on the DDM-2000 FiberReach ring; rather STS-3c level path switching is done elsewhere in the network (for instance, when the FiberReach ring is used to transport ATM STS-3c traffic, path switching (rerouting) is normally executed through the external ATM switch/routers).

With 0X1 application, the FiberReach ring passes the content of the STS-3c time slots between the low-speed OC-3 lines and the OC-3 high-speed lines without terminating them or performing any path protection switching on them.

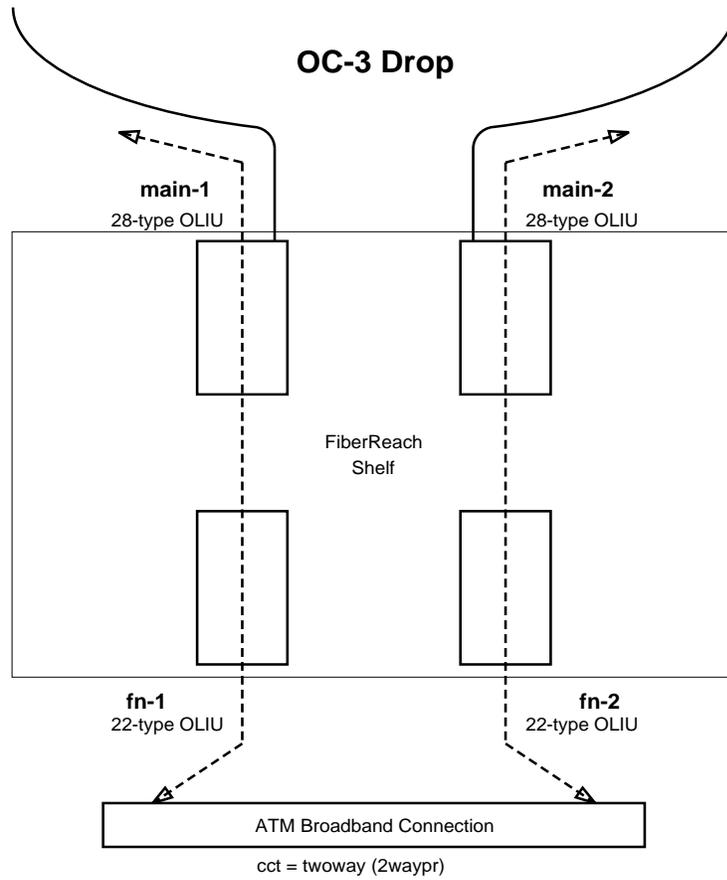
Figure 3-35 and Figure 3-36 are example applications in which the FiberReach multiplexer is equipped with 22-type OLIUs in the function unit slots provides OC-3c access.



tpa 852423/01

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**Figure 3-35. FiberReach OC-3c Extension on OC-12 Ring Application (Release 3.1 or Later)**



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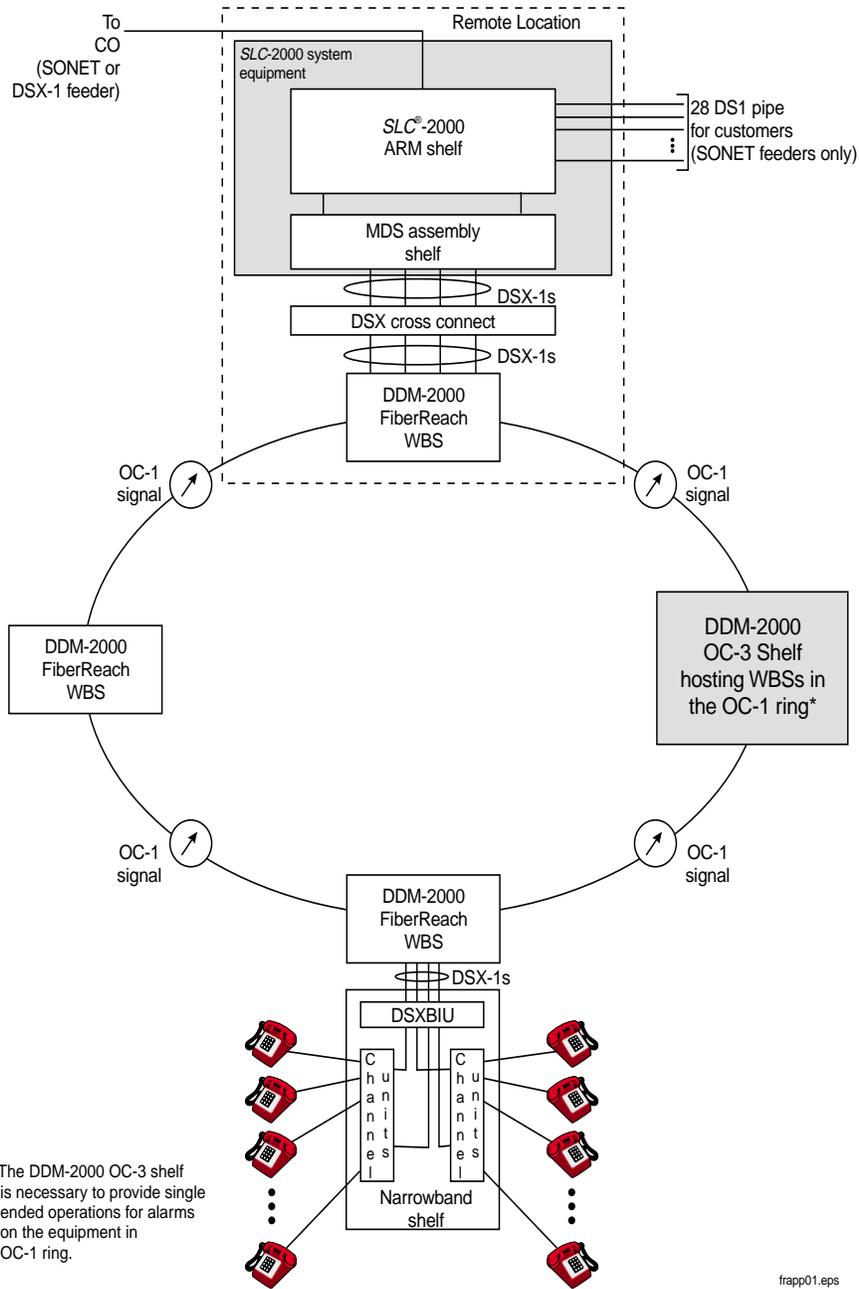
**Figure 3-36. STS-3c Dual 0X1 Application (Release 3.1 or Later)**

## Basic Narrowband Shelf Configurations

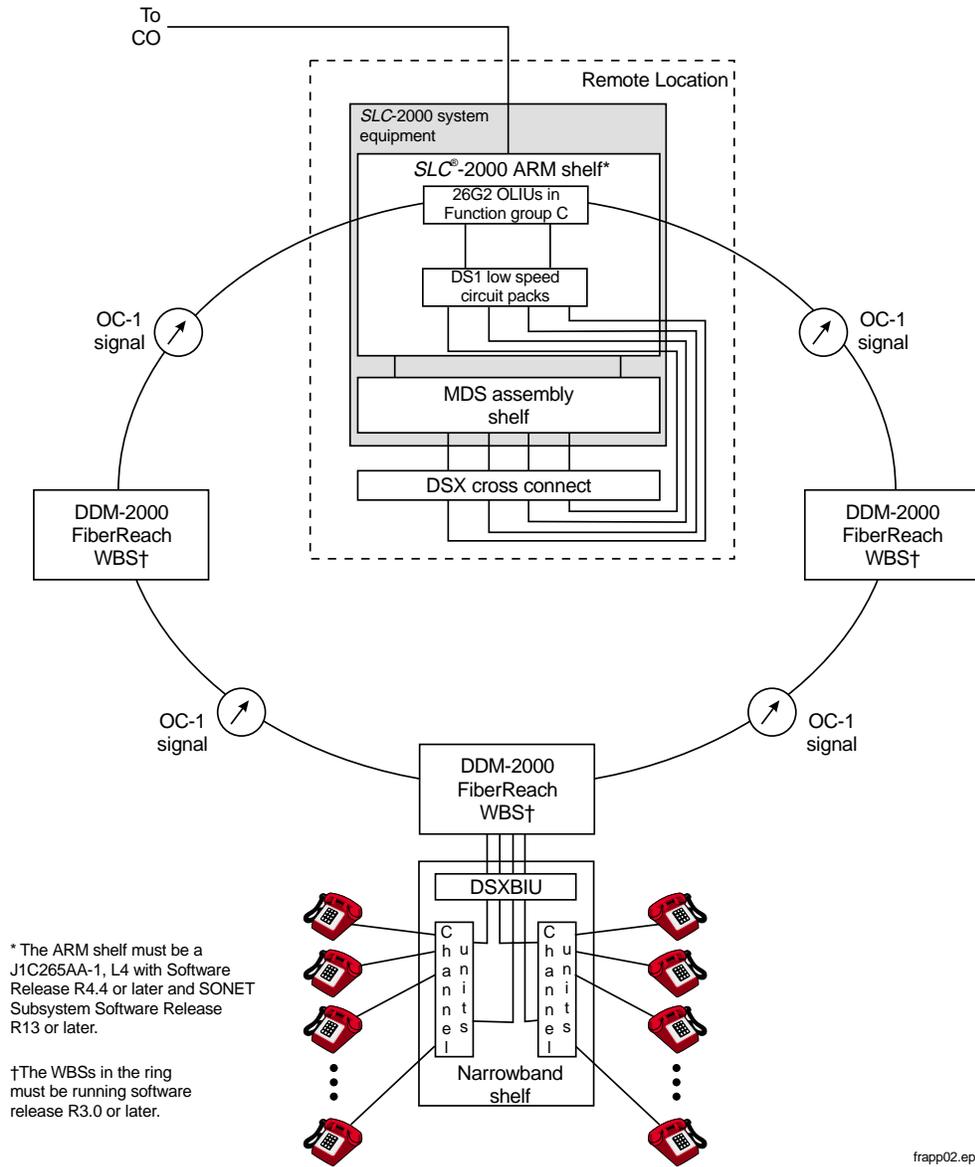
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The *SLC-2000* system can host a DDM-2000 FiberReach Narrowband shelf (NBS) optical network unit (ONU) through an OC-1 ring using DDM-2000 FiberReach Wideband shelves (WBSs). Figure 3-37 and Figure 3-38 show the following typical applications:

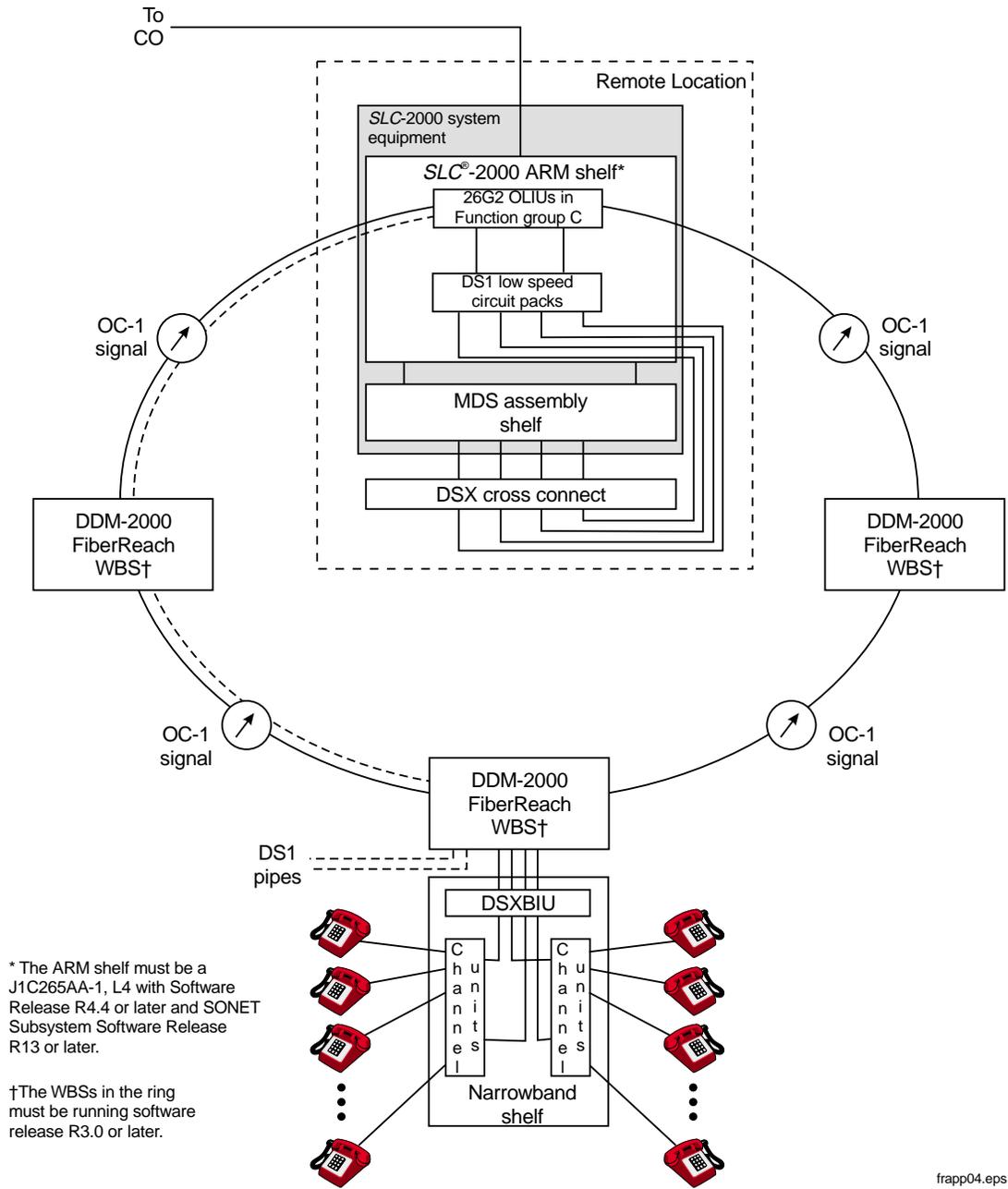
- **WBS Collocated with the SLC-2000 system (Figure 3-37):** In this configuration, the collocated WBS is part of an OC-1 ring. This configuration requires a DDM-2000 OC-3 shelf or a *SLC-2000* ARM shelf to be part of the ring and host the WBSs. I.
- **SLC-2000 J1C265AA-1, L4 ARM Shelf with 26G2-U OLIUs (Figure 3-38):** In this configuration, the J1C265AA-1, L4 ARM shelf contains 26G2-U OLIUs in Function Group C as part of the OC-1 ring. The *SLC-2000* system must contain SONET subsystem Software Release R13 or later and the WBSs in the ring must contain FiberReach software R3.0 or later. This configuration eliminates the need for a collocated WBS and a DDM-2000 OC-3 shelf to host the WBSs in the OC-1 ring. In this configuration, the 28 DS1 pipes are not accessible from the DS1 low-speed slots in Function Group C of the ARM shelf. However, as shown in Figure 3-39, DS1 pipes are accessible from any of the WBSs on the ring if the bandwidth to support them is available on the OC-1 ring.



**Figure 3-37. SLC-2000 System Hosting a FiberReach NBS Through a Collocated WBS**



**Figure 3-38. SLC-2000 System Hosting a FiberReach NBS using 26G2-U OLIUs and a J1C265AA-1, L4 ARM Shelf**



**Figure 3-39. SLC-2000 System Hosting a FiberReach NBS using 26G2-U OLIUs and a J1C265AA-1, L4 ARM Shelf Provisioning DS1 Pipes Through a WBS**

As stated earlier, the WBSs on the OC-1 ring must be hosted by either a DDM-2000 OC-3 shelf or the ARM shelf of a *SLC-2000* system. Figure 3-40 shows the configuration of a collocated WBS hosted by a *SLC-2000* ARM shelf. This configuration eliminates the need for a separate DDM-2000 OC-3 shelf. However, the 28 DS1 pipes are not accessible from the DS1 low-speed slots in Function Group C of the ARM shelf.

For detailed applications connecting the *SLC-2000* Access System to the DDM-2000 FiberReach NBS ONU, see 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*.

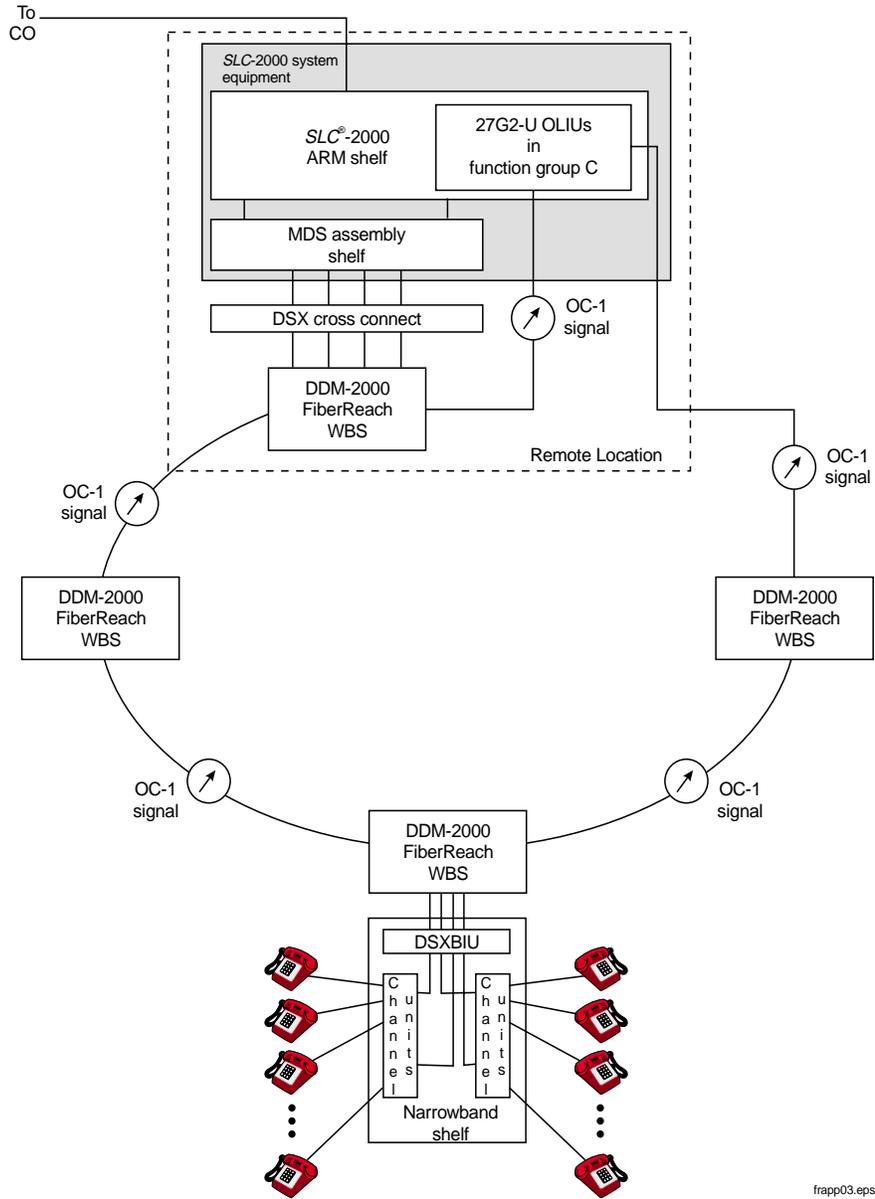


Figure 3-40. SLC-2000 ARM Shelf Hosting DDM-2000 FiberReach WBSs

## **Integrated DS1, T1, and DS0 Services**

### **Integrated Narrowband Business Carrier Access**

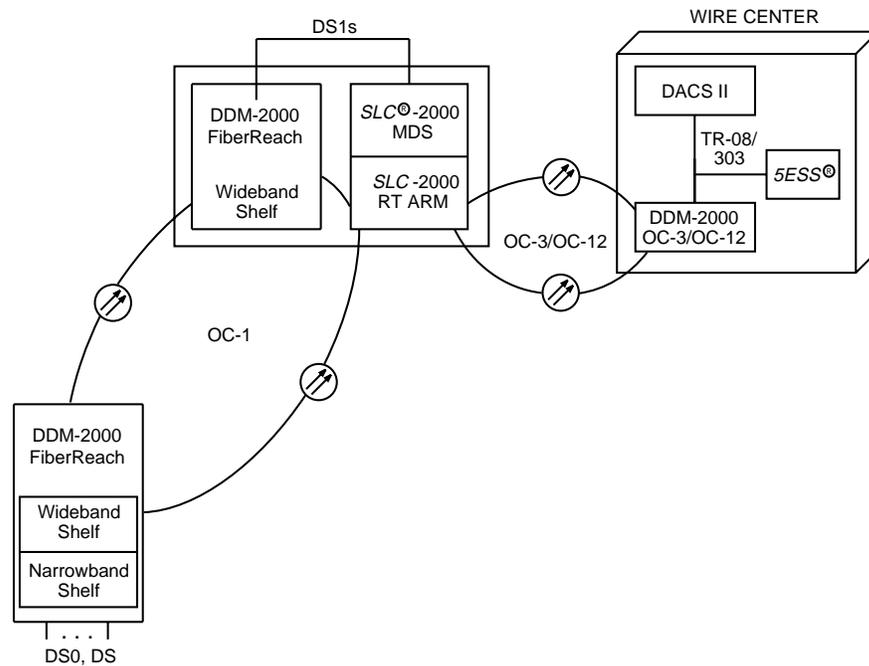
Figure 3-41 shows a business narrowband application using the DDM-2000 FiberReach Multiplexer on an OC-1 path-switched ring. This application provides protected POTS, ISDN, and special services, as well as DS1 services on a protected OC-1 fiber. This ring host is an OC-3/OC-12 path-switched ring via a *SLC-2000* ARM or a DDM-2000 Multiplexer. The FiberReach product in this application contains both the wideband and narrowband shelves. The narrowband shelf has the capacity to provide telephony services such as POTS and POTS-like special services or basic rate ISDN service, while the wideband shelf provides DS1 rate services. The narrowband shelf contains 12 slots for service cards that provide up to 48 lines of POTS service.

At the wire center, the DS0 services are groomed by the *SLC-2000* remote terminal and sent either to the *5ESS*<sup>®</sup> switch for locally switched traffic or to the *DACS II* Cross-Connect System for non-locally switched traffic. The DS1 traffic goes directly to a *DACS-IV* 2000 Cross-Connect System.



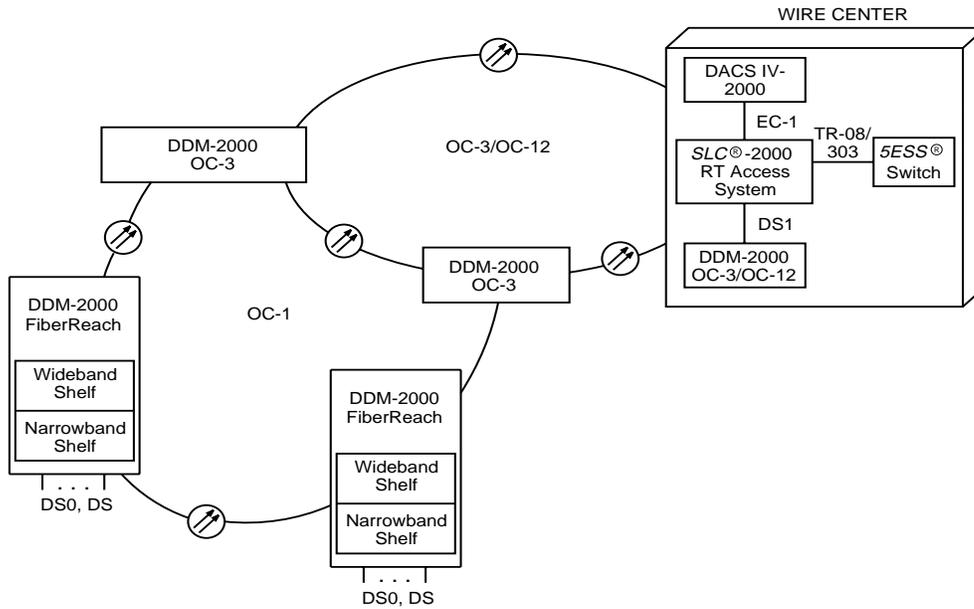
Figure 3-42 shows a configuration similar to Figure 3-41, however the *SLC-2000* RT host is at a remote site, not in the wire center. TR08/TR303 grooming is done by the *SLC-2000* at the remote location.

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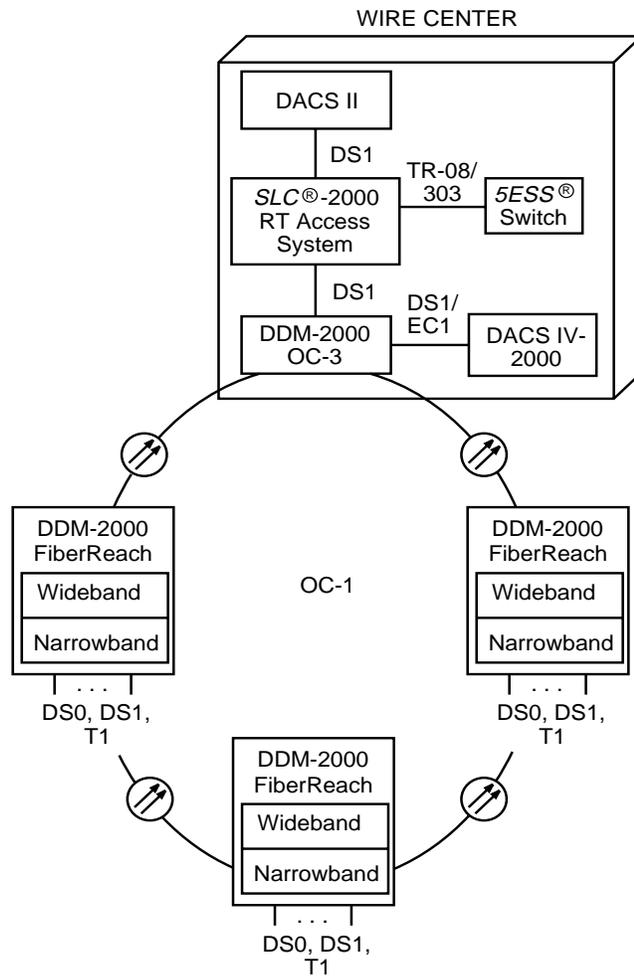
**Figure 3-42. DDM-2000 FiberReach Multiplexer Business Narrowband Application with a Remote SLC-2000**

Figure 3-43 shows a dual-homed integrated application. Figure 3-44 shows three types of stand-alone applications.



tpa 850272/01

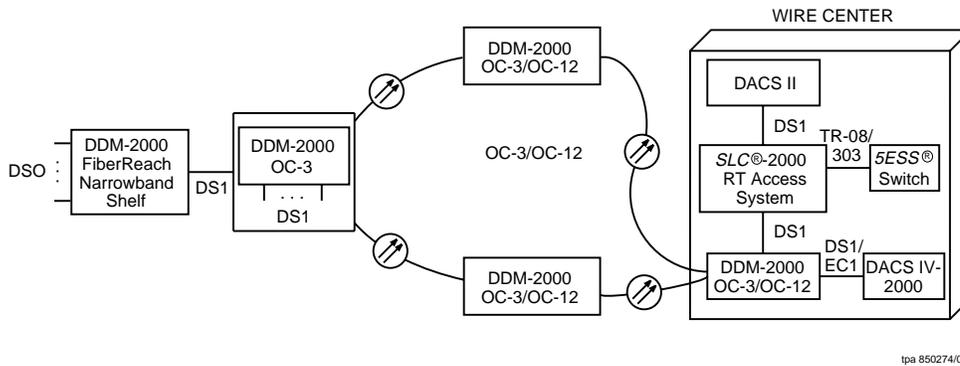
**Figure 3-43. DDM-2000 FiberReach Multiplexer Dual-Homed Integrated Application**



tpa 850273/01

**Figure 3-44. DDM-2000 FiberReach Multiplexer Stand-Alone Integrated Application**

Another integrated narrowband business carrier access application option for the DDM-2000 FiberReach narrowband shelf is to collocate it with the DDM-2000 OC-3/OC-12 shelf. Since the narrowband shelf's high-speed interface is a DS1, a DDM-2000 OC-3/OC-12 multiplexer can serve as the ring vehicle for carrying the DS0 traffic. This application is shown in Figure 3-45.



**Figure 3-45. DDM-2000 FiberReach Multiplexer Low-Speed Traffic Application**

## **Integrated DS1 Transport Configuration with *SLC LineReach* Access System**

---

The *SLC LineReach* Access System supports DSX-1 electrical interface options by using the AUA61E LIU. The DSX-1 LIU meets all requirements in the digital cross-connect specification. The LIU has equalizer switches that provide equalization to the DSX cross-connect. The maximum separation between the *SLC LineReach* system and DSX cross-connect is 655 feet of 22 gauge cable (see 915-710-115, Series 5 Applications Engineering).

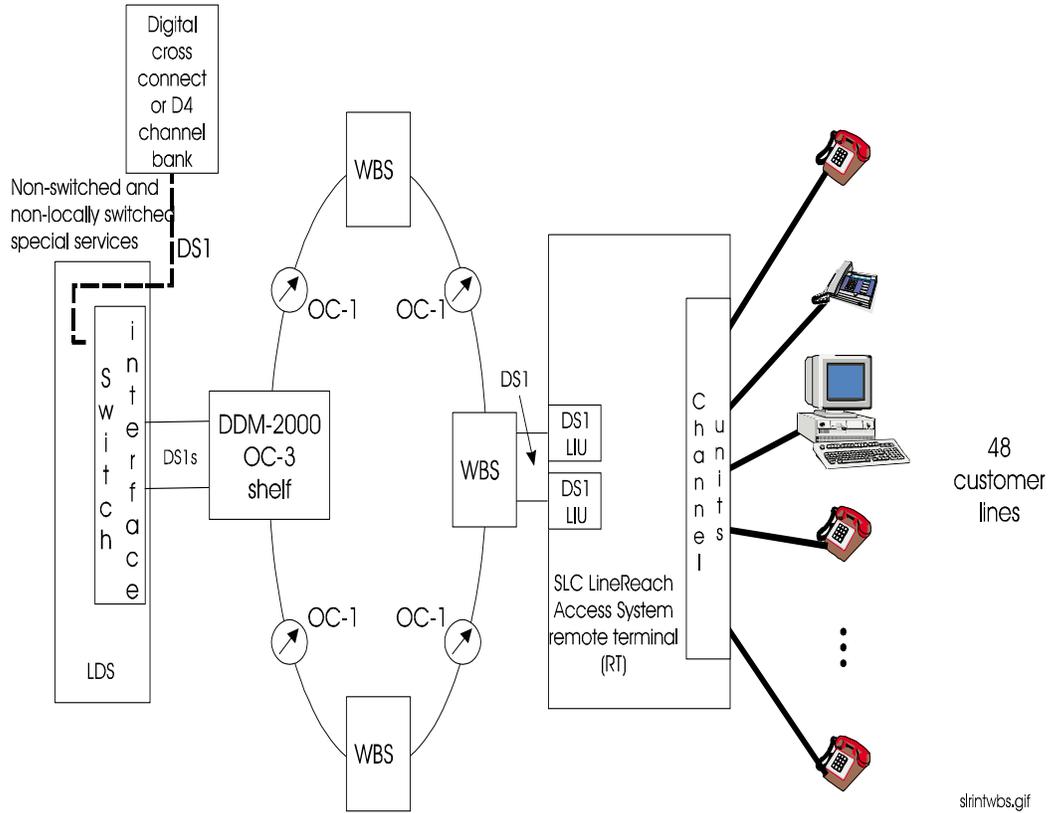
### **SONET Transport**

An OC-1 optical ring can serve as a DS1 transport between the switch, INA, or COT interface and the *SLC LineReach* system. An example of this type of transport uses the DDM-2000 FiberReach Multiplexer wideband shelves. The wideband shelves must be hosted by either a DDM-2000 Multiplexer OC-3 shelf or the SONET subsystem of a *SLC-2000* Access System to provide single-end operation of the SONET system (allows for an interface to provide OAM&P functions).

In this application, an optical multiplexer (either a DDM-2000 OC-3 shelf or a wideband shelf) accepts DS1 feeders from an integrated LDS or a COT and multiplexes them onto an OC-1 ring. If using a *SLC-2000* COT, the COT can multiplex the analog lines directly onto an OC-1 ring. At the *SLC LineReach* remote terminal location, the wideband shelf demultiplexes the DS1 feeders from the OC-1 ring and sends them to the *SLC LineReach* system. For this application, the *SLC LineReach* system must contain AUA61E LIUs.

A single OC-1 ring can support up to 14 Mode 1 (48 lines, 2 DS1s), 28 Mode 1 (24 lines, 1 DS1), or 28 Mode 2 (48 lines, 1DS1) *SLC LineReach* systems. If you need to support more *SLC LineReach* systems, you can upgrade the OC-1 ring to an OC-3 ring by changing hardware and, if necessary, software in the SONET equipment. A single OC-3 ring can support up to 42 Mode1 or 84 Mode 2 *SLC LineReach* systems.

Figure 3-46 shows an integrated application using a SONET OC-1 ring. In this example, a DDM-2000 Multiplexer OC-3 shelf is collocated with the LDS. The OC-3 shelf not only multiplexes the DS1 signals (from the DS1 feeders) onto an OC-1 ring, but also hosts the wideband shelves in the ring.



**Figure 3-46. DSX-1 Electrical Interface — SONET Transport (Integrated Configuration)**

## **Intelligent Vehicle Highway System (IVHS)**

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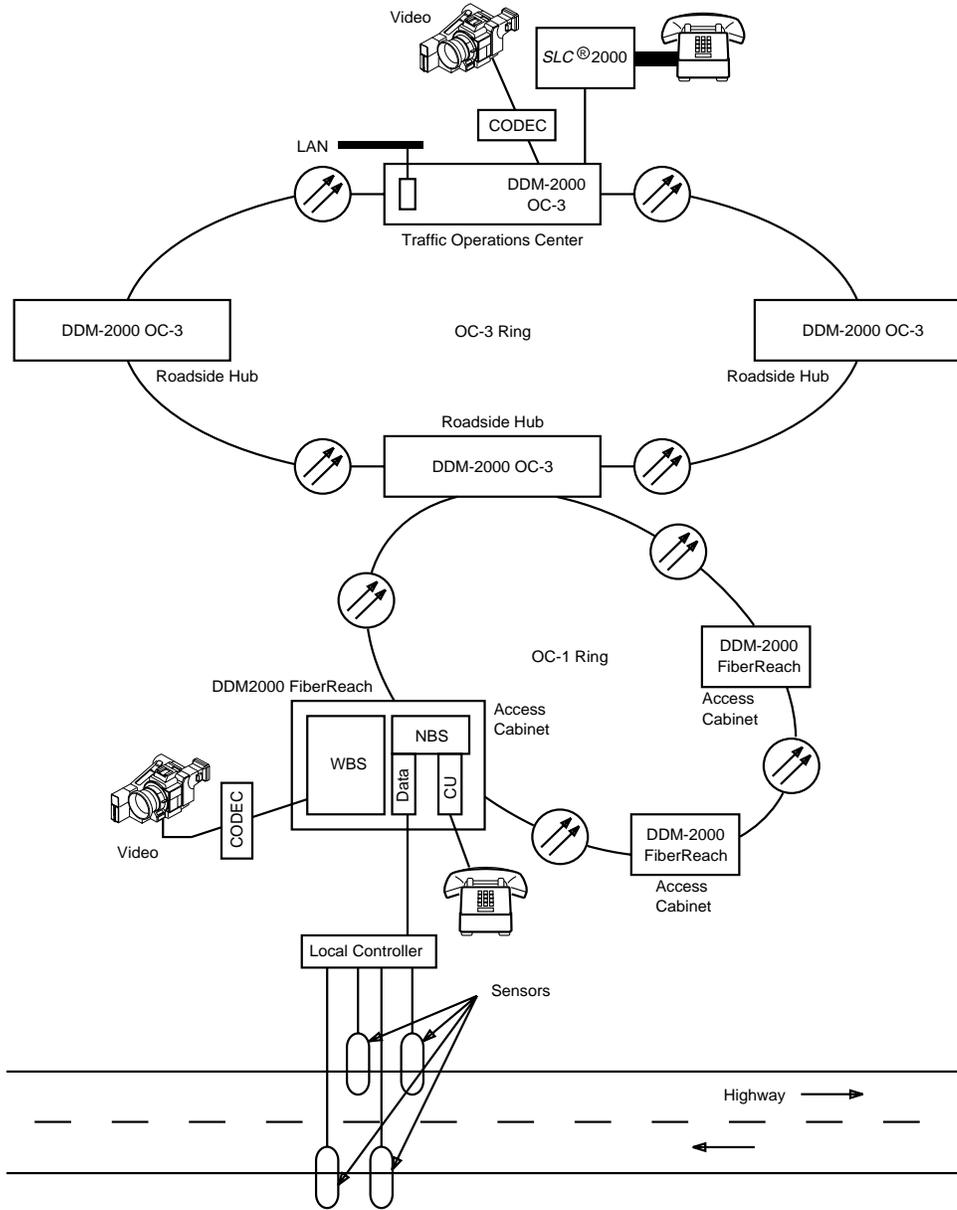
The IVHS is beginning and will grow to play a major role in the roadway systems of the future. The primary use in the near-term is to reduce congestion. This is done in several ways:

- The IVHS provides more efficient and optimal traffic management, which attempts to avoid congestion in the first place.
- The IVHS provides better management of congestion caused by random occurrences, such as accidents or breakdowns.
- The IVHS eliminates many of the foreseeable causes of congestion, such as toll-taking, by automating these functions.

In the future, the INVS system will also help travelers plan their routes by providing up-to-the-minute traffic and highway information. The DDM-2000 FiberReach, OC-3, and OC-12 Multiplexers are a perfect match for the networking needs of these systems.

Figure 3-47 shows a typical IVHS application. An IVHS network carries data between roadside equipment, such as traffic counters, speed sensors, variable messaging signs, video cameras, toll-gathering equipment, pay phones and call boxes, and a traffic operations center, where incoming data is processed and responses are generated. The DDM-2000 FiberReach, OC-3, and OC-12 Multiplexers provide a perfect backbone for carrying this information. The DDM-2000 SONET ring capability, when coupled with diverse fiber routing on opposite sides of the roadway, makes the backbone completely self-healing in the face of failures. Such reliability is absolutely essential, especially as travelers come to depend more and more on IVHS networks.

DDM-2000 FiberReach supplies a single system solution for the small access cabinets, each of which requires a few voice-frequency (VF) and DS0 data channels, as well as DS1-based services. The bandwidth management capabilities of the DDM-2000 FiberReach, OC-3, and OC-12 Multiplexers allow flexible allocation of bandwidth to match the dynamics of a roadway system which is undergoing unpredictable changes in traffic patterns, breakdowns, accidents, and repairs. Such bandwidth management provides a system which meets the IVHS network needs in a cost-effective manner.



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**Figure 3-47. Intelligent Vehicle Highway System (IVHS) Application**

## **Teleprotection and Supervisory Control and Data Acquisition (SCADA) Communications for Electric Utilities**

---

Electric utilities are facing an unprecedented demand for increased communications bandwidth to support modern operations and business applications such as substation automation, computer networking, and video teleconferencing. Many electric utilities are installing SONET fiber optic backbones to meet these needs. SONET fiber optic backbones are a valuable communications resource that can also be used for real time protective relay and SCADA applications.

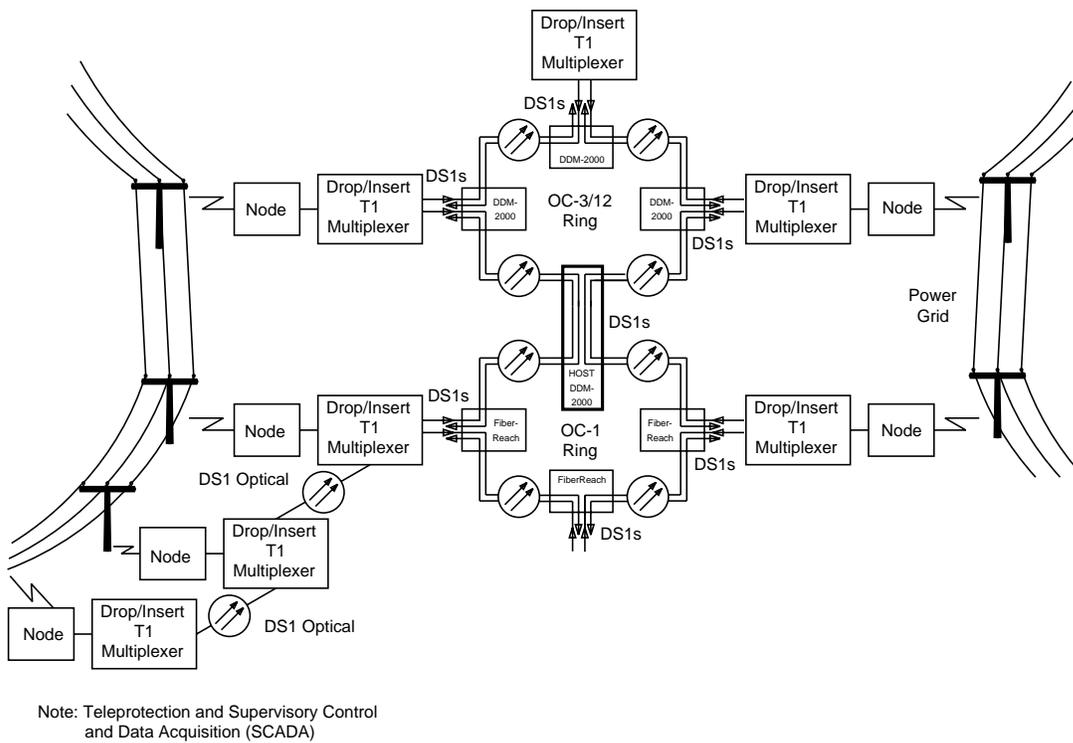
DDM-2000 OC-3, OC-12, and DDM-2000 FiberReach systems can be used in a flexible backbone network among electrical substations and other important sites. These systems provide an innovative locked cross-connection feature that enhances the ability of SONET rings to transport protective relay and SCADA communications. The locked cross-connection feature meets the teleprotection requirements for minimum and stable transmission delay, minimum system outage during a protection switch, and DS0 level bandwidth management at all ring nodes.

The locked cross-connection feature allows a DS1 to be removed from the TR-496 compliant virtual tributary (VT) path protection switching algorithm and is provisioned as an unswitched path between any two nodes on the ring. Figure 3-48 shows that locked DS1s can be used to interconnect adjacent nodes all the way around SONET rings, thereby permitting access to the DS1 at each SONET node.

Figure 3-48 shows a single DS1 locked between ring nodes, but this can be extended to an arbitrary number of DS1s within the available SONET bandwidth. This locked cross-connection feature fixes the ring rotation (and delay) of the DS1 paths on the ring and also permits DS0 grooming of the DS1s at each DDM-2000 or FiberReach node using an external drop/insert multiplexer, such as the RFL 9001 Intelligent Multiplexer. Figure 3-48 also shows the DDM-2000 interconnecting at the DS1 level with an adjacent RFL 9001 Intelligent Multiplexer, which in turn connects on the low-speed side to protective relay and SCADA equipment. Specially designed channel units in the RFL 9001 Intelligent Multiplexer detect when a fault occurs on the power line or substation and communicates at the DS0 level with other substation nodes to isolate the power grid fault.

In addition to the efficient DS0 grooming capability, the RFL 9001 Intelligent Multiplexer implements its own protection algorithm that can restore the DS0 level circuits within the locked cross-connection should the ring be cut. This algorithm operates much faster than the SONET TR-496 algorithm, thereby minimizing system outage during a protection switch.

Figure 3-48 also shows an optical drop/insert DS1 extension from the SONET rings implemented with RFL 9001 Intelligent Multiplexers. This extension is useful for serving low bandwidth sites remote from the SONET backbone. The figure shows a single host DDM-2000 interconnecting the rings, but a dual ring interworking (DRI) could be used to provide node survivability.



**Figure 3-48. DDM-2000 FiberReach Teleprotection and SCADA Communications**

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# Contents

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## Product Description

# 4

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### Overview

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This section provides a more detailed view of the architecture and features of the DDM-2000 FiberReach Multiplexer. The DDM-2000 FiberReach Multiplexer can support a wide range of applications. A modular architecture is employed to satisfy diverse applications in a cost-effective manner. The system is partitioned into two physical shelves which can be mixed or matched to create a configuration that meets the customer requirements. The two shelves offered are the wideband and the narrowband shelves.

A description of each shelf is provided as follows:

- Physical design
- Power architecture
- The transmission
- Synchronization
- Control features of the DDM-2000 FiberReach Multiplexer which are described at the circuit pack level

## Wideband Shelf Features

### Physical Design

#### Wideband Shelf Architecture

The DDM-2000 FiberReach Multiplexer wideband shelf is shown in Figures 4-1 through Figure 4-9. Figures 4-1 through 4-7 show various shelf configurations. The shelf measures approximately 9.65 inches high by 9.17 inches wide by 13.11 inches deep. Each wideband shelf is a stand-alone entity with its own fiber cabling and interfaces to the DSX-1, office power, and operations interfaces. The default configuration provides rear access cabling. Front access is also an option. Front-access optical connectors interconnect to optical fiber facilities and facilitate shelf loopback. The optical connectors are mounted on the optical line interface unit (OLIU) circuit pack faceplate. A DDM-2000 FiberReach Multiplexer wideband shelf consists of the following:

- Fourteen circuit pack slots
  - Eight 4-inch slots
  - Six 8-inch slots, including a user panel
- Fully connectorized backplane
- Front cover

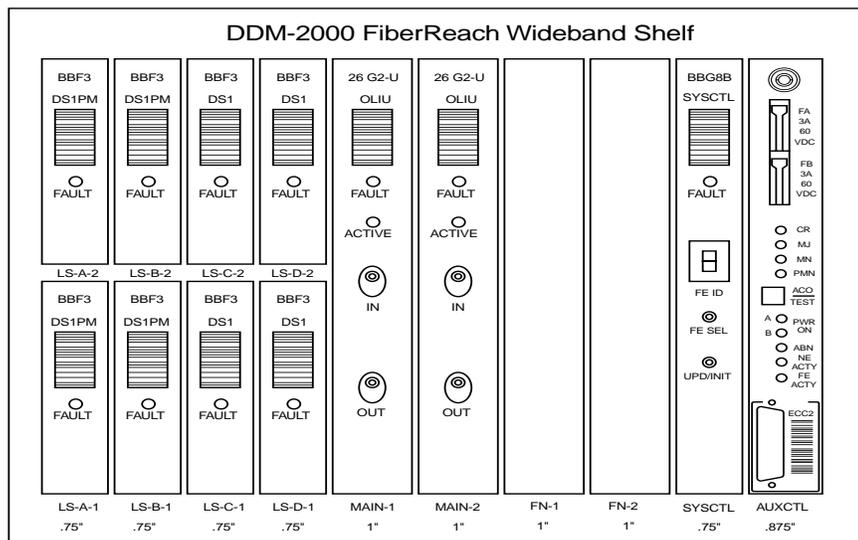
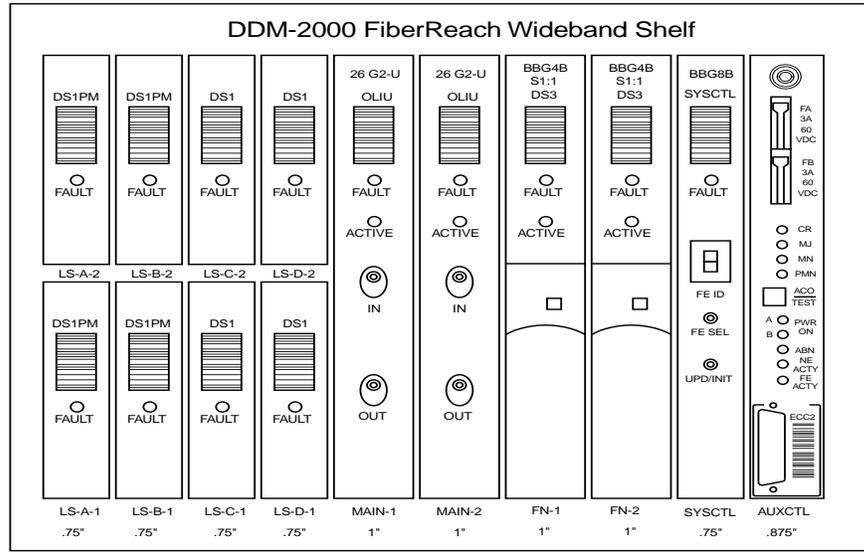
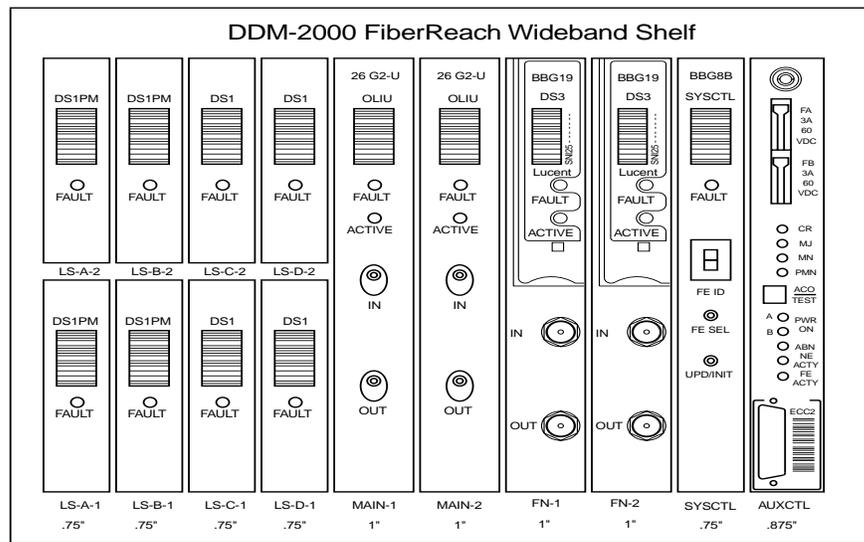


Figure 4-1. DDM-2000 FiberReach Multiplexer Wideband Shelf — Front View



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Figure 4-2. OC-1 Optics with BBG4B



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Figure 4-3. OC-1 Optics with BBG19

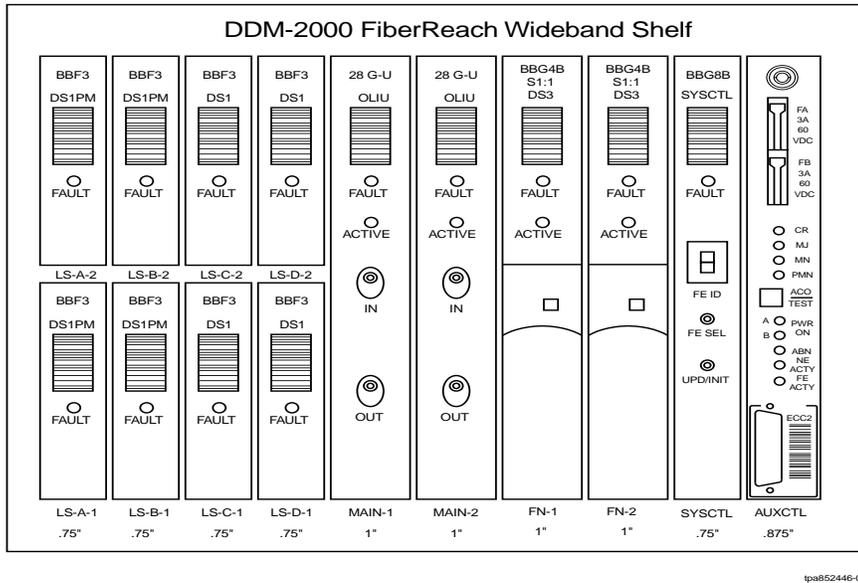


Figure 4-4. DDM-2000 FiberReach Multiplexer Wideband Shelf — with BBG4B

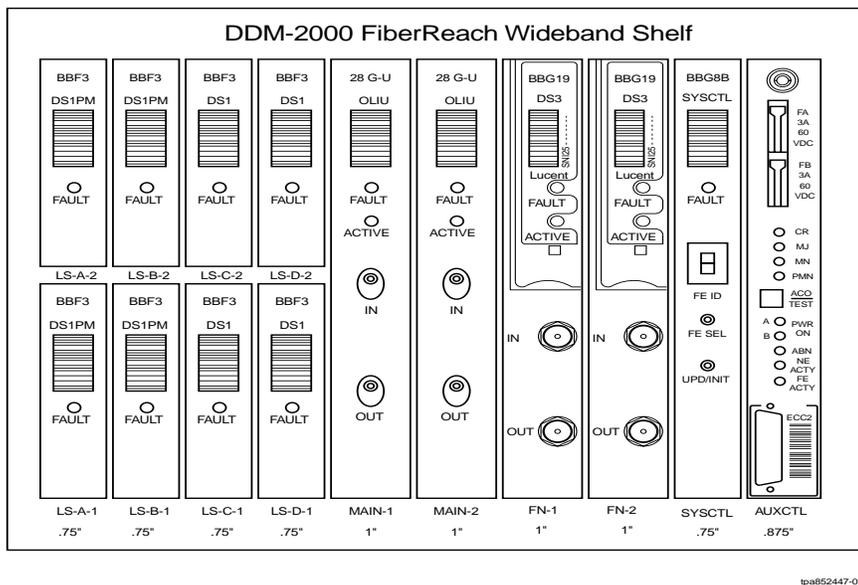
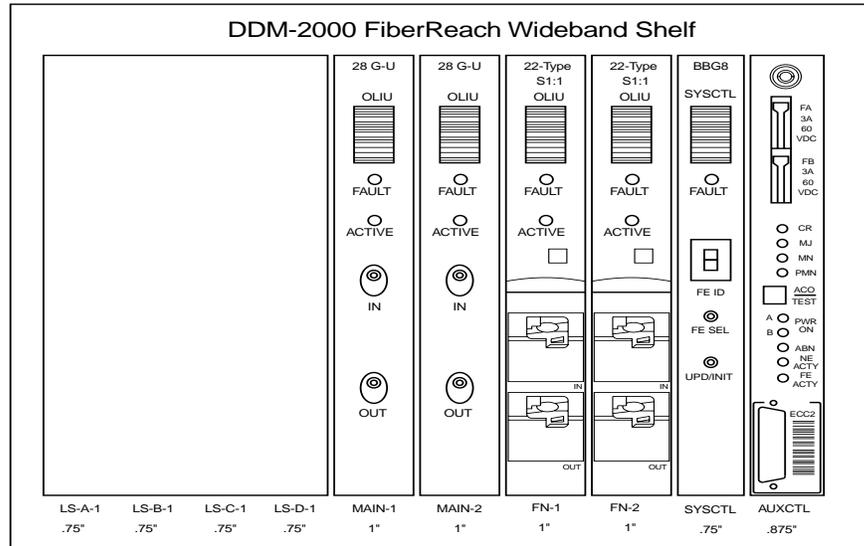
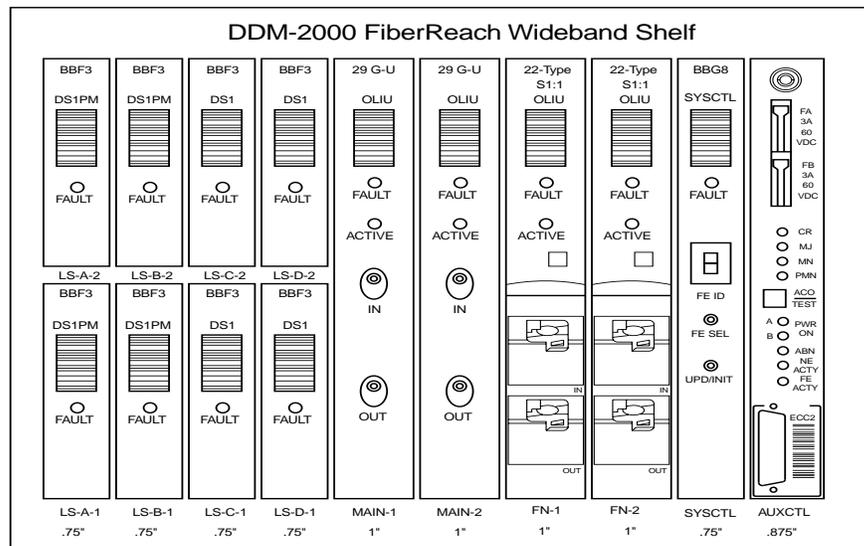


Figure 4-5. DDM-2000 FiberReach Multiplexer Wideband Shelf — with BBG19



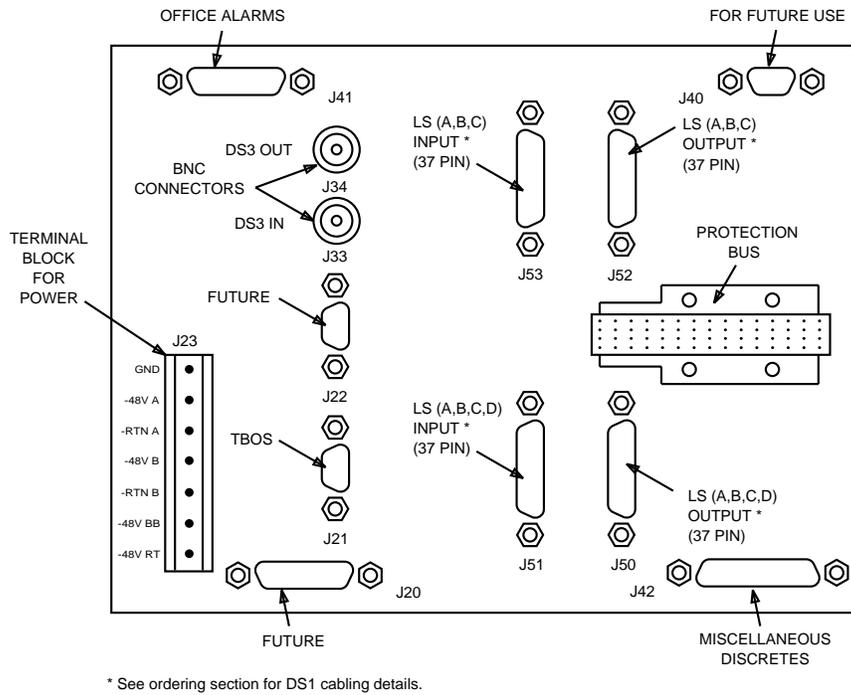
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Figure 4-6. DDM-2000 FiberReach Multiplexer Wideband Shelf —with 22-Type



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Figure 4-7. DDM-2000 FiberReach Multiplexer Wideband Shelf — with OC-12 Optics



**Figure 4-8. DDM-2000 FiberReach Multiplexer Wideband Shelf — Rear View**

## Wideband Shelf Plug-Ins

Table 4-1 lists the DDM-2000 FiberReach Multiplexer wideband shelf plug-ins.

**Table 4-1. DDM-2000 FiberReach Wideband Shelf Plug-Ins**

Product Code	Functional Name	Functional Designation
BBF1B	DS1 Low-Speed Interface	DS1
BBF3/BBF3B	DS1 Performance Monitoring	DS1PM
BBF6	T1 Extensions	T1EXT
BBF8 (See Note)	HDSL Interface	HDSL
BBG4	DS3 low-speed interface	DS3
BBG4B	DS3 low-speed interface	DS3
BBG8/BBG8B	System Controller	SYSCTL
BBG19	DS3 Interface	DS3
22D-U	OC-3 IS-3 OLIU w/TSI	OLIU
22F2-U	OC-3 OLIU w/TSI	OLIU
22G2-U	OC-3 OLIU w/TSI	OLIU
22G3-U	OC-3 OLIU w/TSI	OLIU
22G4-U	OC-3 OLIU w/TSI	OLIU
26G2-U OLIU	OC-1 OLIU with TSI	OLIU
28G-U*	OC-3 OLIU with TSI	OLIU
29G-U*	OC-12 OLIU with TSI	OLIU
29H-U*	OC-12 OLIU with TSI	OLIU
177A	Retainer	
ECC2†	User Panel	USPNL

\* Requires Interconnect Cable Assembly (847721271)

† The user panel is part of the wideband shelf assembly but may also be ordered separately.

**⇒ NOTE:**  
28G-U or 29-Type is required. A maximum of 3 HDSL cards per shelf is allowed and cannot be mixed with other low-speed packs.



**CAUTION:**

*In addition to primary lightning protection, an external Lighting and Surge Secondary Protection Assembly (ED-8C783-30 or equivalent) is required for circuit packs used in outside plant applications.*

As shown in Figure 4-1, starting at the far left, eight 4-inch slots are reserved for service and protection low-speed interfaces. The DS1, DS1 PM, T1EXT, and low speed interface circuit packs can be configured as 1x1, 1x7, and unprotected. HDSL circuit packs can be configured as 1X2 or unprotected. Each circuit pack is equipped with a fault Light Emitting Diode (LED) indicator.

The next two 8-inch slots are reserved for service and protection main OC-1, OC-3, or OC-12 OLIU circuit packs. Each OLIU is equipped with both a fault and active LED indicator. The OLIUs are located in the slots labeled Main-1 and Main-2.

The next two 8-inch slots are for the Function Unit. The Function Unit became active with FiberReach Release 3.1 using the 28G-Type OLIUs. With FiberReach Release 4.0, the Function Unit slots will be active with any valid optics in the Main. The Function Unit slots can be equipped as 0x1 or 1x1 protected. These slots are reserved for broadband services such as OC-3, or for DS3 Services.

The next section of the shelf consists of two 8-inch slot reserved for control circuit packs. The system controller (SYSCTL) slot is reserved for the SYSCTL circuit pack. The auxiliary controller (AUXCTL) slot is reserved for the user panel (USPNL) circuit packs.

The user panel (USPNL) is located at the far right side of the wideband shelf and is equipped with the following:

- Two –48 volt fuses (labeled FA and FB)
- Four alarm LEDs
- ACO/TEST pushbutton control
- Five status LEDs
- Craft interface terminal (CIT) port



**NOTE:**

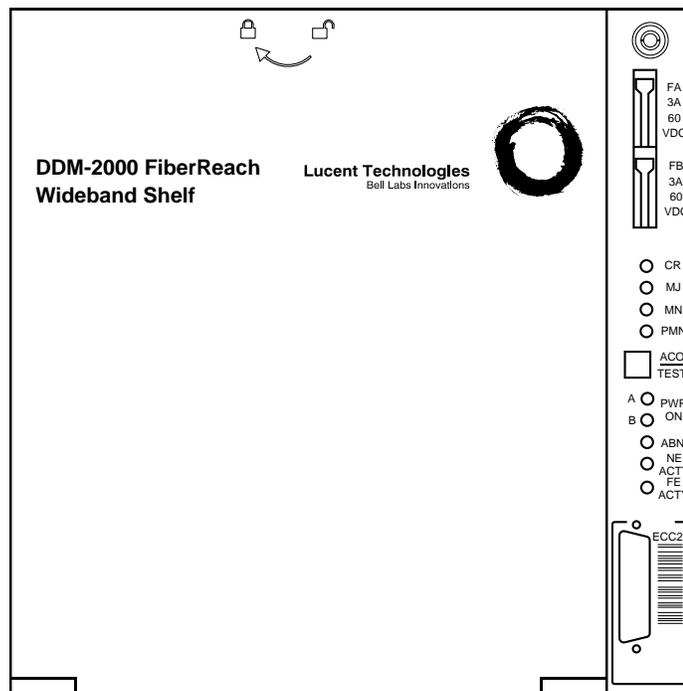
Damage that may occur to the shelf due to accidental insertion of same-size circuit packs in incorrect slots is prevented through circuit pack keying. Three keying combinations are provided. The key mechanism is located on the faceplate latch with an interference mechanism on the shelf.

The front of the wideband shelf is covered with an electromagnetic compatibility (EMC) cover, as shown in Figure 4-9. If the shelf needs to be accessed for maintenance activities, the cover is hinged to drop down 180 degrees. The cover can also be removed by tapping the door in when it is open and held horizontally

outward, until the hinge pops out of the hinge plate. The hinge pin can then be lifted up and the door removed.

The back of the wideband shelf is covered by an cover over the circuit pack slots on the backplane and a cover over the protection bus. All covers are necessary to meet the EMC guidelines set by the Federal Communications Commission (FCC).

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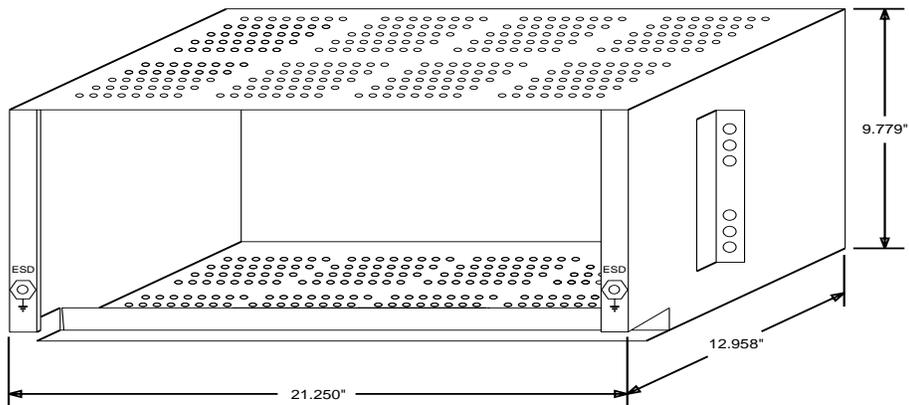
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**Figure 4-9. DDM-2000 FiberReach Multiplexer Wideband Shelf Front Panel**

## Wideband Shelf Carrier Assembly

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The wideband shelf must be mounted in a carrier for a cabinet or bay arrangements. For rack-mounted applications, the DDM-2000 FiberReach Multiplexer carrier assembly is available, as shown in Figure 4-10. This carrier assembly provides space for up to two wideband shelves or one wideband and one narrowband shelf, or two narrowband shelves. Two electrostatic discharge (ESD) jacks are mounted on the carrier frame.



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**Figure 4-10. DDM-2000 FiberReach Multiplexer Carrier Assembly**

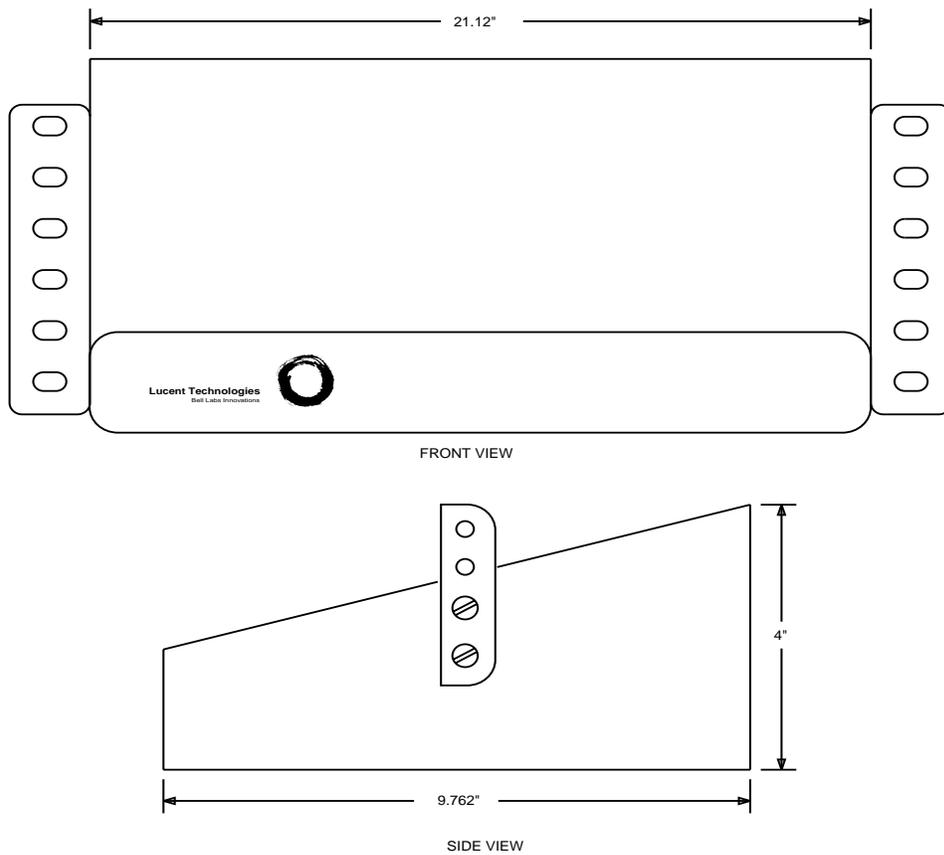
## Wideband Shelf Heat Baffle Assembly

A heat baffle assembly should be installed above and below each DDM-2000 FiberReach shelf for cooling. The heat baffle assembly, shown in Figure 4-11, is required for all applications in a bay frame. For cabinet configurations, use of the heat baffle is dependent on the specific thermal environment.



**NOTE:**

The heat baffle should be installed above the shelf. However, if the shelf is mounted above heat producing equipment that does not provide its own heat baffle, a second heat baffle is required under the shelf.



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**Figure 4-11. DDM-2000 FiberReach Multiplexer Heat Baffle Assembly**

## **Transmission**

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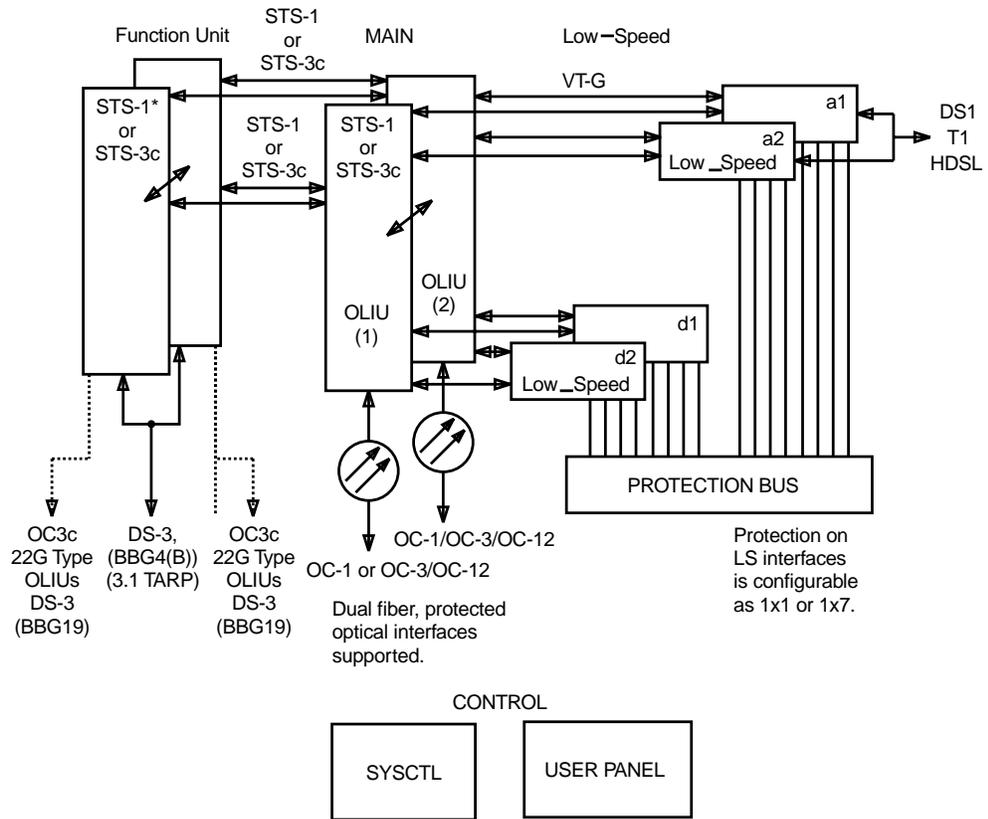
### **Wideband Shelf Interfaces and Multiplexing**

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The DDM-2000 FiberReach wideband shelf supports DS1, HDSL (with 28G-U [Release 3.1] and 29-Type [Release 4.0] OLIUs) and T1 carrier extension interfaces. The DS1 interface accepts any DSX-1 compatible signal (clear channel interfaces). When equipped with 28G-U or 29-Type OLIUs, the shelf supports 1 protected or 2 unprotected DS3 interfaces, or a single OC-3c interface. When equipped with 26G2-U OLIUs and with Release 4.0, the shelf supports 1 protected or 2 unprotected DS3 interfaces.

Figure 4-12 is an overall block diagram of the DDM-2000 FiberReach Multiplexer. Internally, the Multiplexer uses synchronous optical network (SONET) standard multiplexing. (Refer to Appendix A.) On the low-speed side, asynchronous DS1 signals map into floating mode VT1.5 signals. The VT1.5 signals are combined into virtual tributary groups (VTGs) and then multiplexed to one STS-1 signal. This VT structured STS-1 signal can be combined with an STS-1 signal from the function unit slots along with a pass through STS-1 to form an OC-3 signal.

In the opposite direction, a received OC-N signal is converted back to "N" electrical STS-1 signals. A DS1-formatted STS-1 signal is demultiplexed to VT groups and then to VT1.5 signals. The VT1.5 signals are then converted to DS-1 signals prior to connecting to the DS1 interface.



Function unit usage requires Release 3.0 and OC-3 mains, or Release 4.0 and OC-1/OC-3/OC-12 mains.

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**Figure 4-12. DDM-2000 FiberReach Wideband Shelf Block Diagram**

## **Wideband Shelf Protection Architectures**

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The eight low-speed interface slots of the DDM-2000 FiberReach wideband shelf can be configured in two protection architectures: 1x1 protected or 1x7 protected. (See Note.) In a 1x1 protection configuration, the eight slots are divided into four low-speed groups — A, B, C, and D. The bottom four slots are the service A, B, C, and D slots and the top four slots are the associated protection A, B, C, and D slots. This configuration is most appropriate for applications with a mixture of low-speed service needs (for example, DS1 and T1 carrier extensions).



**NOTE:**

A wideband shelf comes with a 1x1 and a 1x7 protection bus module that goes on the backplane. However to change the protection scheme, it must be done out of service.

In a 1x7 protection configuration, the eight slots are provisioned as a single low-speed group with seven service slots and one protection slot. This arrangement is intended for applications where only one type of low-speed service is needed. Multiple types of low-speed services (T1 or DS1 only) can be supported at one time; however only one type will be protected, determined by the type of circuit pack in the protection slot. In both 1x1 and 1x7 protection architectures, the protection slot(s) can be left unequipped, leaving the low-speed service unprotected. The protection architecture can be changed between 1x1 and 1x7 but must be done out of service by installing the appropriate protection module bus on the rear of the shelf as shown in Figure 4-8.

## **Wideband and Narrowband Shelf Integration**

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The wideband and narrowband shelves communicate with each other via a standard DS1 transmission interface. The electrical interface is compatible with DSX-1 requirements. No control communication is necessary between the wideband and narrowband shelves.

## **Wideband Shelf Transmission Circuit Packs**

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### **DS1 Low-Speed Interface (BBF1B DS1 and BBF3/BBF3B DS1PM)**

The DS1 circuit pack provides an interface between four DS1 signals and a DDM-2000 FiberReach Multiplexer.

In the transmit direction, the DS1 circuit pack accepts four DS1 signals from a DSX-1 panel (or equivalent). The DS1 signals can have alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) coding. DS1 signal coding is assigned on a per-DS1 basis. The four incoming DS1 signals are mapped into a standard

floating mode, asynchronous VT1.5 signal with VT path overhead. The four VT1.5 signals are then multiplexed into one VT-G signal that is sent to the OLIU circuit pack.

In the receive direction, a VT-G signal is received from the OLIU circuit pack and demultiplexed into four VT1.5 signals. Each VT1.5 signal is passed through circuitry to interpret VT pointers and access path overhead. The DS1 payload is then extracted from each VT1.5 signal and transmitted to the DSX-1 panel.

The DS1PM circuit pack performs all of the same transmission functions as the DS1 circuit pack and, in addition, performs DS1 path performance monitoring (PM). Near-end PM data is collected from incoming DS1 signals (arriving from the DSX-1) in either extended superframe (ESF) or superframe (SF) formats. For ESF-formatted DS1s, the DS1PM circuit pack also reads the embedded ESF data link to collect far-end performance information. Any combination of DS1 and DS1PM circuit packs can be equipped in the low-speed slots of the DDM-2000 FiberReach Multiplexer. These low speed circuit packs are configured (using a protection bus module) for either 1x1 protection or 1x7 protection. A protection module is always required. Unprotected service is accomplished by not equipping the protection slot.

Single DS1 facility loopback is provided with the BBF3B circuit pack.

### **T1 Extension (BBF6 T1EXT)**

The T1 Carrier Extension (T1EXT) circuit pack provides an interface to two T1 carrier signals. In the transmit direction, the T1EXT circuit pack accepts two T1 signals from a patch panel (or equivalent). The T1 signals can have AMI or B8ZS line coding. The line coding is assigned on a per-T1 basis. The two incoming T1 signals are mapped into a standard, floating mode, asynchronous VT1.5 signal with VT path overhead. The two VT1.5 signals are then multiplexed into one VT-G signal that is sent to the OLIU circuit pack.

In the receive direction, a VT-G signal is received from the OLIU circuit pack and demultiplexed into two VT1.5 signals. Each VT1.5 signal is passed through circuitry to interpret VT pointers and access path overhead. The DS1 payload is then extracted from VT1.5 signal and transmitted to T1 carrier.

Each T1 carrier loop is also supplied with simplex power with a 60 mA constant current. The T1EXT circuit pack performs DS1 path performance monitoring on each T1. Near-end performance data is collected from incoming T1 signals (arriving from T1 loop) in either extended super frame (ESF) or superframe (SF) formats. For ESF-formatted T1s, the circuit pack also reads the embedded ESF data link to collect far-end performance information. A T1EXT circuit pack can be configured for either 1X1 or 1X7 protection, provided that the protection slot is equipped with an identical circuit pack. An external lightning and surge protection assembly is required with the T1 configuration for outside plant applications. For each BBF6 circuit pack used in an outside plan application, two LPROT lightning protection cards should be used in the lightning and surge protection assembly.

Refer to Chapter 6, "System Planning and Engineering," for specific engineering rules regarding T1 extensions.

### **BBG4/BBG4B DS3 Circuit Pack Description**

The BBG4/BBG4B DS3 circuit pack provides a low-speed interface between asynchronous DS3-rate signals and SONET STS-1 signals. The BBG4B DS3 provides the same functions as the BBG4 DS3 and can be used in place of the BBG4 DS3 in all applications. In addition, the BBG4B DS3 has enhanced DS3 PM capabilities.

The BBG4/BBG4B DS3 circuit pack provides bidirectional transport of one DS3 signal through DDM-2000 OC-3 in either clear channel (CC) mode, violation monitor and removal (VMR) mode, or violation monitor (VM) mode, by mapping the DS3 into an STS-1 signal. The BBG4/BBG4B DS3 performs maintenance and provisioning functions associated with the STS-1 and DS3 signals and provides access to the STS-1 path overhead. It interfaces to the OLIU at the STS-1 rate, to the DSX-3, and to the SYSCTL, and receives timing signals traceable to the TG circuit pack. When provisioned for the CC mode, the DS3 can transport any DS3 rate signal that meets specified electrical interface requirements. When provisioned for the VMR or VM mode, the DS3 signal must meet both electrical and DS3 frame format requirements.

The transmit direction is the direction towards the STS-1 signal, and receive direction refers to the direction towards the DSX-3. In the transmit direction, the BBG4/BBG4B DS3 receives an incoming B3ZS encoded DS3 signal from the DSX-3. A closed protection relay contact routes the DS3 to a circuit that splits the signal and sends one output to the companion (standby) circuit pack and the other to its own receiver. The BBG4/BBG4B DS3 receiver performs equalization and clock recovery. The MUX circuitry performs B3ZS decoding, optional automatic DS3 AIS insertion, and a provisionable VMR function, then synchronizes and maps the DS3 to the STS-1 rate. The DS3 signal is then synchronized to the STS-1 payload rate, STS-1 path overhead is inserted, and an STS-1 rate signal is transmitted to an OLIU pair.

| The BBG4/BBG4B DS3 receives STS-1 data from both OLIUs, selects one STS-1, performs pointer interpretation, processes and removes the path overhead, desynchronizes the embedded DS3, provides a provisionable VMR function, and then B3ZS encodes the signal for transmission to the DSX-3. A jumper allows the user to insert or remove an LBO network (225 ft. of 734A-type cable equivalent) to provide the required signal level and shape at the DSX-3.

## High Data Rate Digital Subscriber Line (HDSL) Circuit Pack (BBF8)



**NOTE:**

An external lightning and surge protection assembly is required with the HDSL configuration for outside plant applications. For each BBF8 circuit pack used in an outside plant application, two LPROT lightning protection cards should be used in the lightning and surge protection assembly. Refer to Chapter 6, "System Planning and Engineering," for specific engineering rules regarding HDSL extensions.

The HDSL circuit pack (BBF8) provides for HDSL capability on the DDM-2000 FiberReach shelf. It allows the transport of DS1 rate payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Data is transported over each pair bidirectionally using echo cancellation techniques.

In the transmit direction, the HDSL circuit pack performs an inverse multiplexing function which splits the DS1 rate payload into two 784 kb/s data streams. These signals are then transmitted over two twisted-pair line using a 2B1Q line code. At the receiving end an interface compatible with *PairGain*<sup>\*</sup> HDSL equipment<sup>†</sup> will combine the two data streams to reconstruct the original DS1 rate payload.

In the receive direction, the HDSL circuit pack combines the two 784 Kb/s data streams back into the original DS1. The signal is then sent through normal multiplexing operations to the SONET level.

The BBF8 fits into the low-speed slot and provides two, four-wire HDSL interfaces. Each interface provides a full DS1 rate payload capacity mapped to a SONET VT1.5. Once in SONET, the DS1 rate payload is treated as a normal DS1.



**NOTE:**

The BBF8 requires the 28G-U or 29-Type OLIU. Only three HDSLs circuit packs are allowed and cannot be mixed with other low-speed packs.

The HDSL circuit pack supports both the HDSL and DDM-2000 management domain. DDM-2000 management can perform DS1 loopback functions, tests and alarm reporting through the SONET DCC or DDM-2000 CIT access. The HDSL management domain, available only through a BBF8 faceplate RS-232 port, can

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\* PairGain is a registered trademark of PairGain Technologies, Inc.

† For more information, contact:  
Pair Gain Technologies  
14402 Franklin Avenue  
Tustin, CA 92780-7013  
Customer Service # 1-800-638-0031

perform all these functions plus provide performance monitoring and history reporting. Two LPROT cards are required for each HDSL (BBF8).

### **Lightning and Surge Secondary Protection Assembly for T1 Extensions and HDSL**



**CAUTION:**

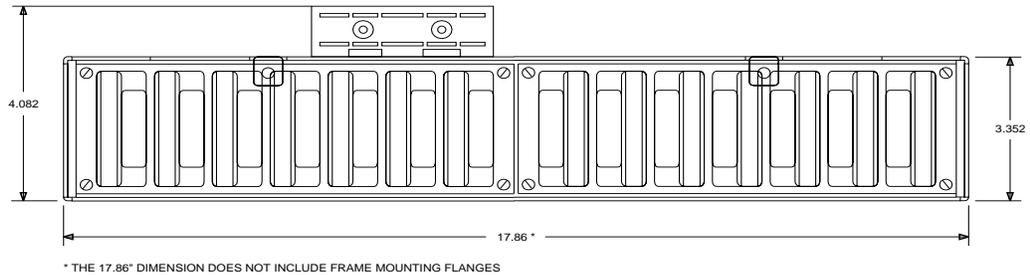
*In addition to primary lightning protection, an external Lightning and Surge Secondary Protection Assembly (ED-8C783-30 or equivalent) is required for circuit packs used in outside plant applications.*

T1/HDSL digital lines in the outside plant environments may be exposed to high voltages due to lightning surges and power crosses due to fallen power lines. In order to protect a DDM-2000 shelf with T1EXT/HDSL circuit packs from such occurrences, an external assembly that houses a secondary surge protection is required.

The lightning and surge protection assembly, shown in Figure 4-13, is approximately 17.5 inches wide, 3.45 inches high, and 5.65 inches deep and can be installed in 23-inch racks. The shelf has enough capacity to support 14 T1 extension or 6 HDSL extensions channels in a FiberReach shelf (the maximum capacity). A small circuit board with fuses, current limiting resistors, and thermal cutoff devices for both the tip and ring conductors is installed in the edge connector whenever the DDM-2000 FiberReach shelf is equipped with a T1EXT circuit pack. The small circuit board provides for secondary surge and power cross protection.

The lightning and surge protection assembly does not include any primary surge protectors. The tip and ring conductors must have gas tubes (Lucent protector unit 4B3EW or equivalent) installed at the point of entry into a cabinet or building.

The lightning and surge protection assembly meets the requirements specified in Section 4 of the Telcordia Technologies GR-1089-CORE, Issue 1, November 94, as well as *UL* 1459.



**Figure 4-13. T1 Lightning and Surge Protection Assembly**

### **DS3 Data Services Interface (BBG19) Circuit Pack**

**⇒ NOTE:**  
DS3 access is through a BNC connector on the faceplate.

The DS3 Data Services Interface circuit pack (BBG19) provides a mapping between a DS3 low-speed signal from a DS3 Data Services Device and an internal STS-1 signal. The BBG19 provides the same functions as the BBG4B, but provides DS3 access through two BNC connectors on the faceplate. DS3 access to the BBG4B is through BNC connectors on the rear of the shelf.

In the transmit direction, the incoming DS3 signal can be either formatted or unformatted (clear channel). The BBG19 DS3 circuit pack accepts one 44.736 Mb/s bipolar 3-zero substitution (B3ZS) coded DS3 signal. The incoming DS3 signal is mapped into an STS-1 payload envelope using SONET asynchronous mapping. The STS-1 path overhead and pointer bytes are added and the resulting signal is sent to the high-speed OLIU circuit pack.

In the receive direction, the STS-1 signal from the OLIU circuit pack goes through STS-1 pointer interpretation, and path overhead is removed and processed.

After the DS3 signal is recovered from the STS-1 payload envelope, the DS3 performance bits (P-bits) may be monitored and corrected through a provisionable violation, monitor, and removal (VMR) function.

**⇒ NOTE:**  
Protection switching must be done externally to the FiberReach multiplexer.

The BBG19 DS3 circuit pack provides enhanced DS3 performance monitoring capabilities with software releases 3.1 and later.

## 26G2-U Optical Line Interface Unit

The 26G2-U OLIU circuit pack interfaces with a 1310 nm OC-1 optical line in the transmit and receive directions and support DDM-2000 FiberReach self-healing ring configurations through its VT1.5/STS-1 time slot interchange (TSI) capabilities. The 26G2-U OLIU circuit packs photonics exceed the SONET span lengths specified for the intermediate reach requirements. Fiber access is via a pair of universal optical connectors on the 26G2-U OLIU faceplate that supports ST®, SC- and FC-type optical connectors. While a single mode fiber is suggested for optimum performance, multimode facilities are also supported.

The 26G2-U OLIU is installed in the Main slots of the DDM-2000 FiberReach. It provides an interface between an OC-1 optical line and electrical VT-G signals. For the FiberReach system in the transmit direction, it multiplexes up to seven VT-G signals from the low-speed into an STS-1 signal. VT1.5 signals can be cross-connected and switched as needed. The SONET path overhead, as well as transport overhead bytes, are added on this circuit pack. The STS-1 signal is then scrambled and converted to an OC-1 optical signal.

In the receive direction, the 26G2-U OLIU terminates an OC-1 signal, converts it into an electrical signal, recovers timing, unscrambles the signal, synchronizes with the incoming SONET STS-1 frame, and processes the overhead. Then the signal goes through STS-1 pointer interpretation, and the path overhead is removed and processed. The VT-G signals are removed from the STS-1 payload and transmitted via backplane to the low speed.

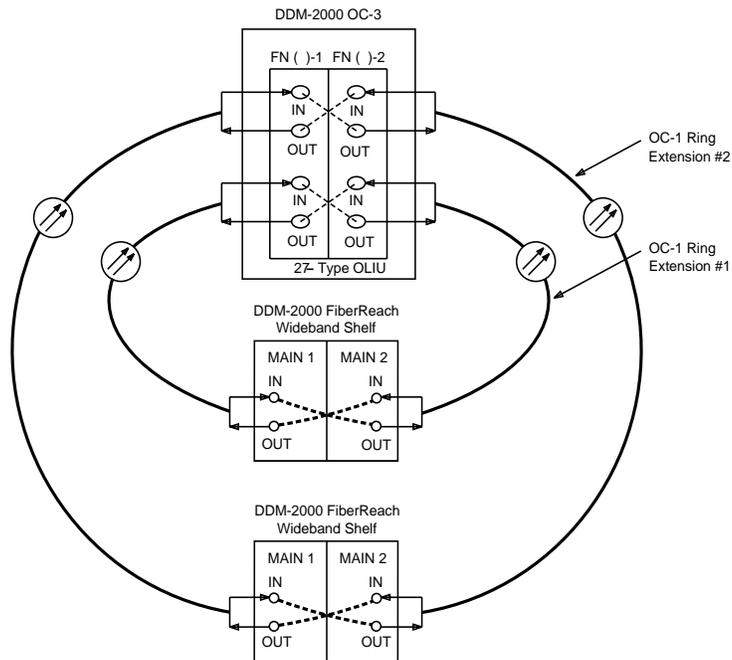
The 26G2-U OLIU is installed in the Main slots of the DDM-2000 FiberReach. In Release 4.0, it provides an interface between an OC-1 optical line and an electrical STS-1 signal. For the FiberReach system in the transmit direction, it inserts a DS3 from the Function Unit into an STS-1 signal. The STS-1 signal can be cross-connected and switched as needed. The SONET path overhead, as well as transport overhead bytes, are added on this circuit pack. The STS-1 signal is then scrambled and converted to an OC-1 optical signal.

In the receive direction, with Release 4.0 the 26G2-U OLIU terminates an OC-1 signal, converts it into an electrical signal, recovers timing, unscrambles the signal, synchronizes with the incoming SONET STS-1 frame, and processes the overhead. Then the signal goes through STS-1 pointer interpretation, and the path overhead is removed and processed. The DS3 signal is removed from the STS-1 payload and transmitted via backplane to the Function Unit.

The companion circuit packs to the 26-type are the 26G2-U and the 27-type OLIU circuit packs, located on the host OC-3 (refer to the OC-3 User/Service Manual for system requirements) or *SLC-2000* ARM shelf (see Figure 4-14). The 27-type is a

dual OC-1 circuit pack that interfaces with the 26G2-U on the FiberReach shelf. It is installed in the Function Unit or Main slots of the host DDM-2000 shelf on which two OC-1 rings are terminated and interfaces with two 1310 nm OC-1 optical lines in the transmit and receive direction. The 27-type OLIU supports two self-healing ring configurations through VT1.5 TSI capabilities. The OLIU photonics exceed the SONET span lengths specified for intermediate reach requirements. The 27G2-U OLIU is required in the DDM-2000 OC-3 host shelf when using the expanded topology configurations in Release 9.1 and later releases.

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**Figure 4-14. 27G-U/27G2-U Dual OC-1 OLIU**

## 28G-U/28G2-U Optical Line Interface

With Release 2.2, the 28-Type OLIU circuit pack used in the FiberReach shelf interfaces with a 1310nm OC-3 optical line in the transmit and receive directions. The functionality of the 28-Type is similar to the 26G2-type OLIU circuit packs, with add/drop and ring configurations with its VT1.5 and STS-1 TSI capabilities, but supports OC-3 long reach applications.

With Release 3.1 or later, the 28-Type OLIU provides an OC-3 SONET compliant long reach MLM interface for the DDM-2000 FiberReach shelf, providing an OC-3 VT on STS-1 path switched ring interface. The 28-Type combines the OC-3 section, line termination, VT/STS-1/STS-3c cross-connection and ring switching functions provided by the 22G-U OLIU with the VT multiplexing and timing functions provided by the 26-type OLIU. Up to 28 VT1.5s on the OC-3 interface can be selected for VT cross-connection to low speed units. Up to 84 VT channel can be VT cross-connected as pass-through on the OC-3 ring. Up to three STS-1 channels can be STS-1 cross-connected on the OC-3 ring.

The distributed feedback laser supplies an NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

The 28-Type provides timing for the entire wideband shelf. Two modes will be provided: line-timed, and holdover. A faceplate connector is required to allow each 28-Type access to the recovered input clock of its companion OLIU. This recovered clock signal is fed to the "on-board" phase lock loop to be used for timing reference switching.



### NOTE:

The 28-Type provides the powering required for up to 3 BBF8 (HDSL) circuit packs and cannot be mixed with other low-speed circuit packs.

All of the same options for dropping the traffic at low-speed ports that were supported on a DDM-2000 FiberReach system equipped with the 26-type OLIUs and running Release 2.1 continue to be supported when 28-Type OLIUs are used in the Main slots. A DDM-2000 FiberReach shelf equipped with the 28-Type OLIU can be linked with other similarly equipped FiberReach shelves as well as with non-FiberReach DDM-2000 OC-3 shelves. In addition, the Ring-on-Ring configuration between an OC-12 ring and a FiberReach shelf equipped with the 28-Type (OC-3 interface) can be supported. Also a Fiber Reach shelf equipped with the OC-3 interface can be interconnected with FT-2000 OC-48 rings via the OC-3 0X1 interface. Finally, a FiberReach Release 3.1 or later equipped with 28-Type OLIU circuit packs in the Main slots and OC-3 (22-type) OLIUs in Function Units can support the STS-3c 0X1 application interface for Broadband applications (ATM) . See STS-3c 0X1 Optical Interface for more information on this application.

## **22G-U/22G2-U/22G3-U/22G4-U Optical Line Interface Unit**

The 22-Type OLIU circuit pack interfaces with a 1310 nm OC-3 optical line in the transmit and receive directions and supports an STS-3c 0x1 configuration through its STS-1 TSI capabilities. The 22-Type OLIU circuit pack photonics support long reach applications.



### **NOTE:**

The 22-Type optical line interface unit is only supported in the FN slots of the FiberReach shelf if the 28-Type or the 29-Type is in the Main slots.

The multilongitudinal laser transmitter supplies an NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of *ST*, *SC*, or *FC-PC* lightguide connectors on the 22-Type OLIU faceplate. While single-mode fiber is suggested for optimum performance, multimode facilities are also supported.

## **29G-U/29H-U Optical Line Interface Unit**

The 29G-U OLIU circuit pack used in the FiberReach shelf interfaces with a 1310 nm OC-12 optical line in the transmit and receive directions. The 29H-U OLIU circuit pack used in the FiberReach shelf interfaces with a 1550 nm OC-12 optical line in the transmit and receive directions.

The distributed feedback laser supplies an NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of *SC*, *ST*, or *FC-PC* lightguide connectors on the 29-Type OLIU faceplate. Single-mode fiber only is required to achieve the maximum reach.

The 29-Type OLIU's TSI performs VT1.5, STS-1, and STS-3c cross-connections from the Main shelf position and it has access to the entire VT1.5 capacity of the OC-12 signal. All 12 STS-1s and 336 VT1.5s in the OC-12 payload are presented to the TSI. A faceplate connector allows passage of pass-through signals between Main OLIUs for ring functionality.

In the receive direction, the incoming OC-12 optical signal is converted to an electrical STS-12 signal and demultiplexed to 12 STS-1 signals, and the transport overhead bytes are extracted. After pointers are realigned to the local system

clock, all 12 STS-1s are selected for input to the TSI and all 12 STS-1s are passed through the faceplate connector to the companion 29-Type OLIU in the other Main slot. The TSI cross-connects STS-1 or VT1.5 time slots from the fiber to Function Unit time slots.

The 29-Type provides timing for the entire wideband shelf. Two modes will be provided: line-timed, and holdover. A faceplate connector is required to allow each 29-Type access to the recovered input clock of its companion OLIU. This recovered clock signal is fed to the "on-board" phase lock loop to be used for timing reference switching.



**NOTE:**

The 29-Type provides the powering required for up to 3 BBF8 (HDSL) circuit packs and cannot be mixed with other low-speed circuit packs.

## **Power**

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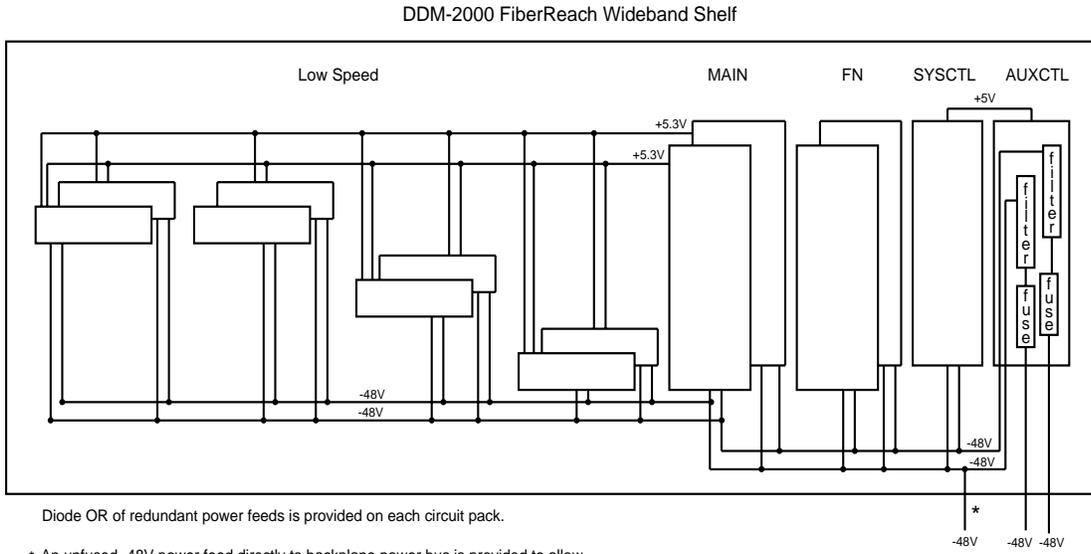
The DDM-2000 FiberReach Multiplexer can be powered from a variety of power sources. The most common powering method is the –48 V DC power available in telecommunication facilities.

Using commercially available 60 V AC or 120 V AC power converters, –48 V DC for FiberReach can be provided.

### **Wideband Shelf –48 V Battery Powering**

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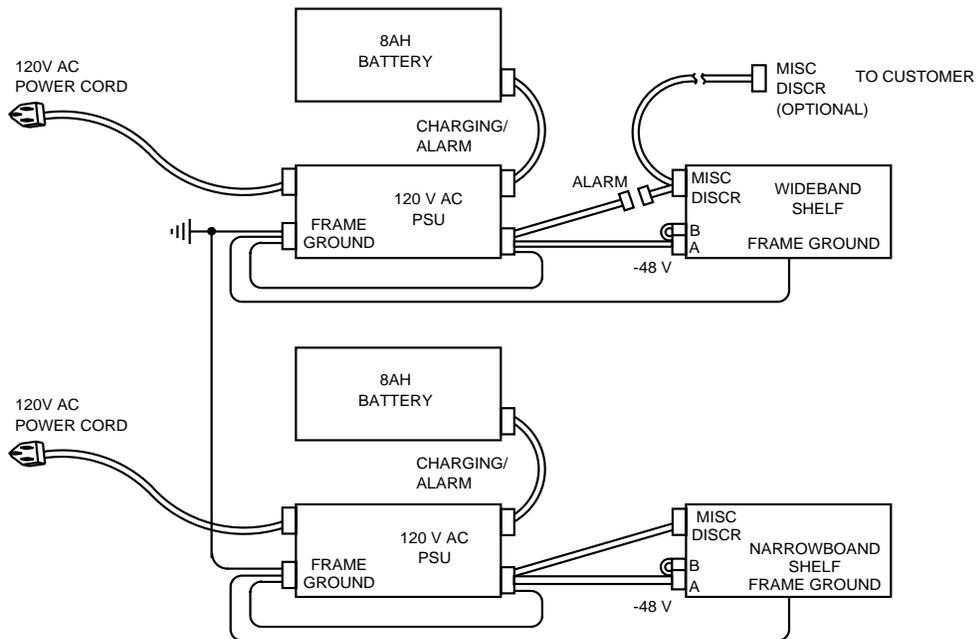
The DDM-2000 FiberReach Multiplexer wideband shelf uses on-board power conversion, eliminating the need for slots for bulk power converters. Two independent –48 volt office power feeders (A and B) enter the shelf through dangler cables (cables that come from the rear of the cabinet and "dangle" to provide front access to rear connectors), fused at the user panel, and distributed to the circuit packs. Power conversion is performed through modular power converters located on the circuit packs. In each circuit pack, the two feeders are diode ORed, fused, filtered, and regulated by the board-mounted power modules. This provides the required redundancy in case of the loss of one feeder or one fuse. Figure 4-15 shows the distribution schematic. The power converter located on the OLIU circuit pack provides power to the DS1 and HDSL circuit packs. T1EXT circuit packs use –48 volts from the backplane to provide line powering with 60mA constant current source.



**Figure 4-15. DDM-2000 FiberReach Multiplexer Wideband Shelf Power Architecture**

## Wall Distant Terminal Powering -- WBS/NBS

The DDM-2000 FiberReach Multiplexer wall distant terminal (DT) uses bulk power converters to support powering from 120 V AC (see Figure 4-16). This converter supplies -48 V to the FiberReach shelf. Customer premises locations usually have 60 V AC or 120 V AC commercial power from utilities. These powering options provide battery backup for up to 8 hours.

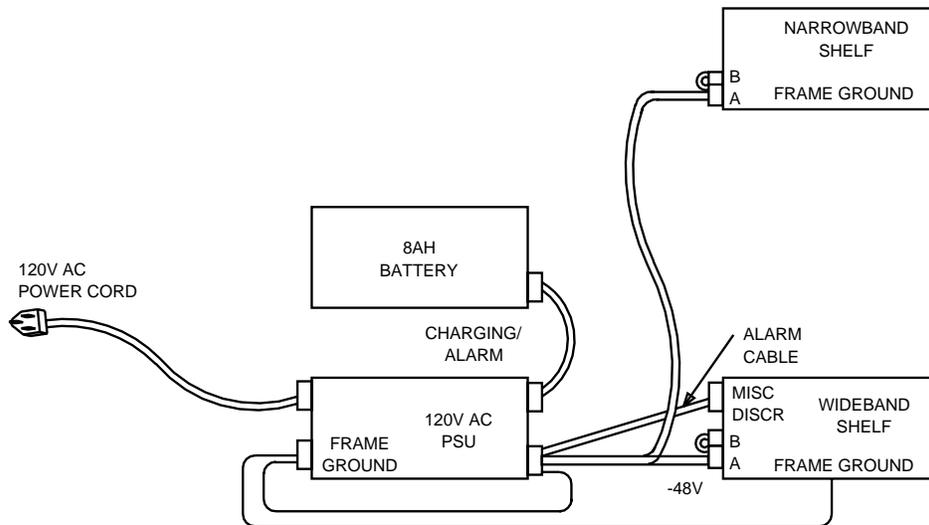


\* ALARM CABLE CAN DIRECTLY ATTACH TO THE MISC DISCRETE CONNECTOR ON WBS. OPTIONALLY IT CAN BE CONNECTED TO A "Y" CABLE THAT INTERFACES WITH THE MISC DISCR CONNECTOR ON THE WBS AND HAS A BRANCH THAT FACILITATES PICK-UP OF ADDITIONAL DISCRETE ALARM INPUTS.

Figure 4-16. Wall DT Powering — WBS/NBS

## Alternative Wall Distant Terminal Powering

Figure 4-17 shows an alternative power option. Both the wideband and narrowband shelves are powered from a single source.



NOTE: Alarming for this arrangement can be from the wideband shelf (cable ED8C852-20 G7) or from the narrowband shelf (cable ED8C785-20 G9). Optionally it can be connected to a "Y" cable (ED8C852-20 G12) that interfaces with the MISC DISCR connector on the wideband shelf only and has a branch that facilitates pick-up of additional discrete alarm inputs.

tpa 850271/02

Figure 4-17. Alternative Wall DT Powering

## **DDM-2000 FiberReach Control -- Wideband Shelf**

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### **Wideband Shelf Control Features**

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The DDM-2000 FiberReach wideband shelf provides extensive control features, accessible through a number of technician and operations system (OS) interfaces. In addition to accessing local systems through direct interfaces, technicians and OS can use the single-ended operations features provided by the data communications channel in the OC-1 signal to reach remote shelves. Control functions are provided by the SYSCTL circuit pack in the wideband shelf.

Reflecting the numerous common modules shared by the DDM-2000 Multiplexers and the integrated nature of DDM-2000 Multiplexer applications, the following discussion of control features applies to both systems unless noted otherwise.

### **User Panel**

The DDM-2000 Multiplexers employ a common user panel design. The user panel provides system-level information and control functions. The condition of the individual circuit packs can be determined using faceplate LEDs. These features enable operations tasks (for example, system installation or circuit pack replacement) to be performed without a CIT or external test equipment.

The system controller faceplate and user panel for the wideband shelf are shown in Figure 4-18.

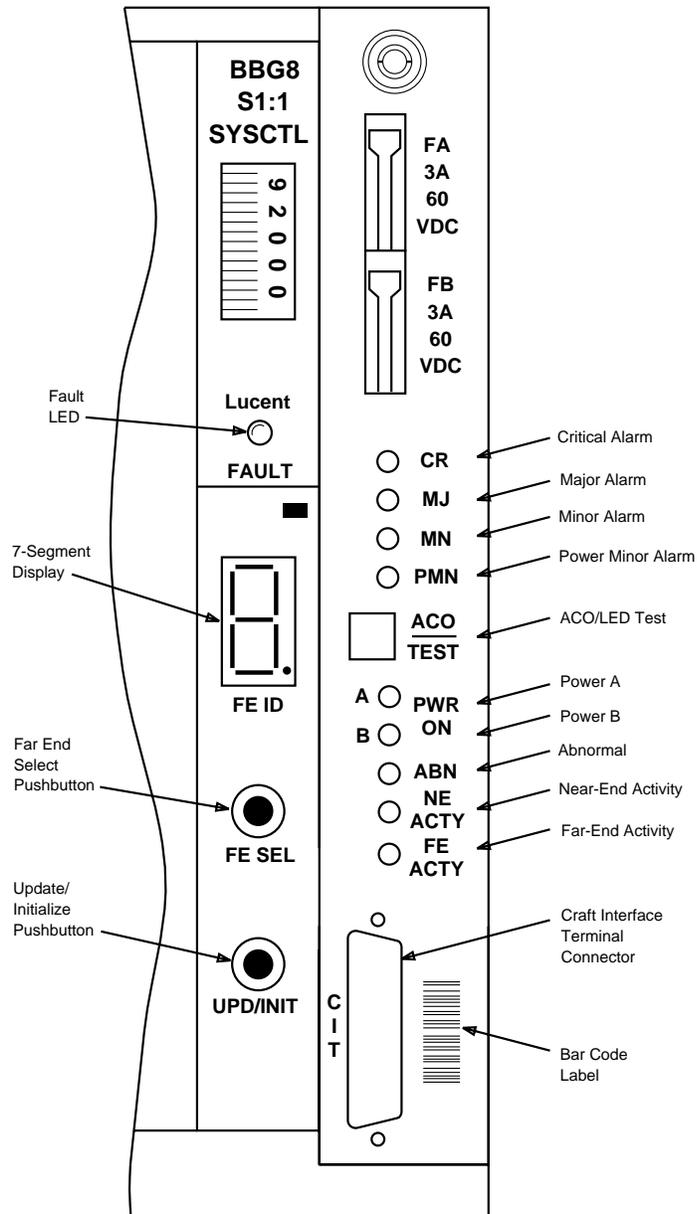


Figure 4-18. DDM-2000 FiberReach Multiplexer Wideband Shelf User Panel

## Control Circuit Packs

### System Controller (BBG8/BBG8B SYCTL)

The SYCTL circuit pack provides all functions required for basic operation of the DDM-2000 FiberReach Multiplexer. This includes a microprocessor, nonvolatile memory to store the generic program software and provisioning database, and additional memory for system operation. The BBG8 SYCTL circuit pack also has interfaces across the backplane to monitor and control every circuit pack in the shelf.

The user interfaces to DDM-2000 FiberReach wideband shelf are provided by the BBG8 SYCTL circuit pack. Technician interfaces include user panel functions (seven-segment numeric LED display, far end select\*, and update/initialize), plus a red FAULT LED. Operations interfaces are office alarm, remote terminal (RT) miscellaneous discretes, TBOS telemetry\*, and monitors for the two –48 V power feeder.

### User Panel (ECC1/ECC2 USPNL)

The user panel provides alarm and status LEDs, ACO pushbutton, CIT connector, and replaceable indicating fuses for the –48 V power feeders.

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\* This is not applicable for users of Release 3.0 or later due to the introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI). Refer to Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

## **Synchronization**

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Synchronization is an important part of all SONET products. The DDM-2000 FiberReach Multiplexer is designed for high performance and reliable synchronization.

## **Wideband Shelf Timing**

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The DDM-2000 FiberReach Multiplexer wideband shelf supports two synchronization reference configurations. Initially, the FiberReach Multiplexer derives its synchronization from the incoming OC-1/OC-3/OC-12 optical signal (line timing). These timing modes are supported by the 26-type, 28-type, and 29-type OLIU circuit packs. The OLIU circuit packs distribute clock and frame signals, derived from the selected reference source, to the transmission packs. Internal timing functions—reference interfaces, the on-board clock elements, and timing distribution—are located in the OLIU circuit pack. In line-timing mode, the OLIU derives local shelf timing from the received OC-1/OC-3/OC-12 optical signals. In holdover mode, the OLIU derives timing from a high stability temperature-compensated, voltage-controlled crystal oscillator.

SONET synchronization messaging is used to communicate the quality of subnetwork timing, internal timing status, and timing states throughout a subnetwork. Switch selection is based on synchronization messages received over the optical line from which the DDM-2000 FiberReach system is extracting timing. In case of unprotected synchronization reference failure, the OLIU will switch to "holdover mode" and continue to provide system timing, using the internal oscillator to maintain the last known good reference frequency. See Section 6, "System Planning and Engineering," for more information on synchronization.

## Shelf Carrier Assembly -- WBS/NBS/ LineReach

The wideband shelf must be mounted in a carrier for cabinet or bay arrangements. For rack-mounted applications, the DDM-2000 FiberReach Multiplexer carrier assembly is available, as shown in Figure 4-19. This carrier assembly provides space for up to two wideband shelves, or one wideband and one narrowband shelf, or two narrowband shelves, or one wideband shelf and one LineReach. Two electrostatic discharge (ESD) jacks are mounted on the carrier frame.

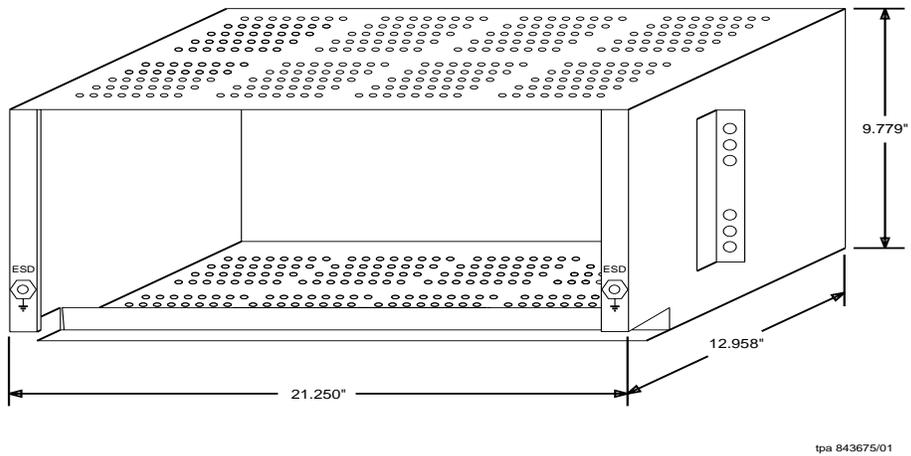


Figure 4-19. DDM-2000 FiberReach Multiplexer Carrier Assembly

## **Narrowband Shelf Features**

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### **Physical Design**

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The DDM-2000 FiberReach Multiplexer can support a wide range of applications. A modular architecture is employed to satisfy diverse applications in a cost-effective manner. The system is partitioned into two physical shelves which can be mixed or matched to create a configuration that meets the customer requirements. The two shelves offered are the wideband and the narrowband shelves.

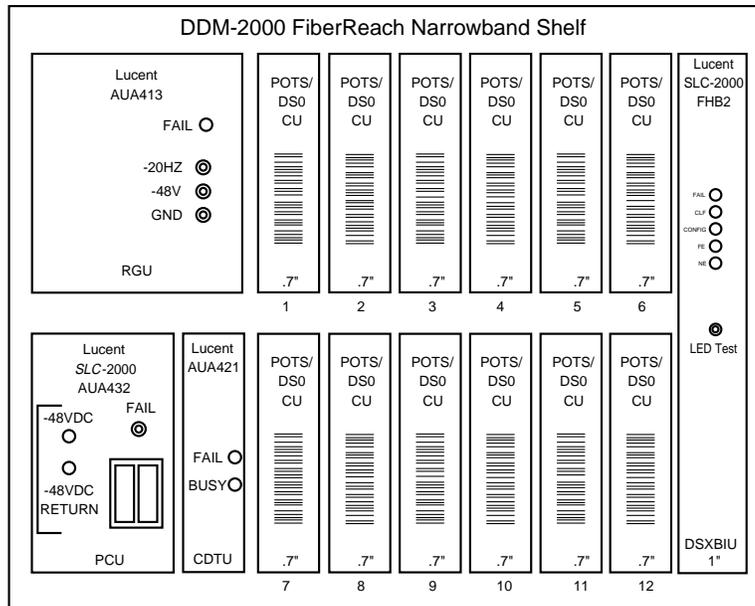
### **Narrowband Shelf Architecture**

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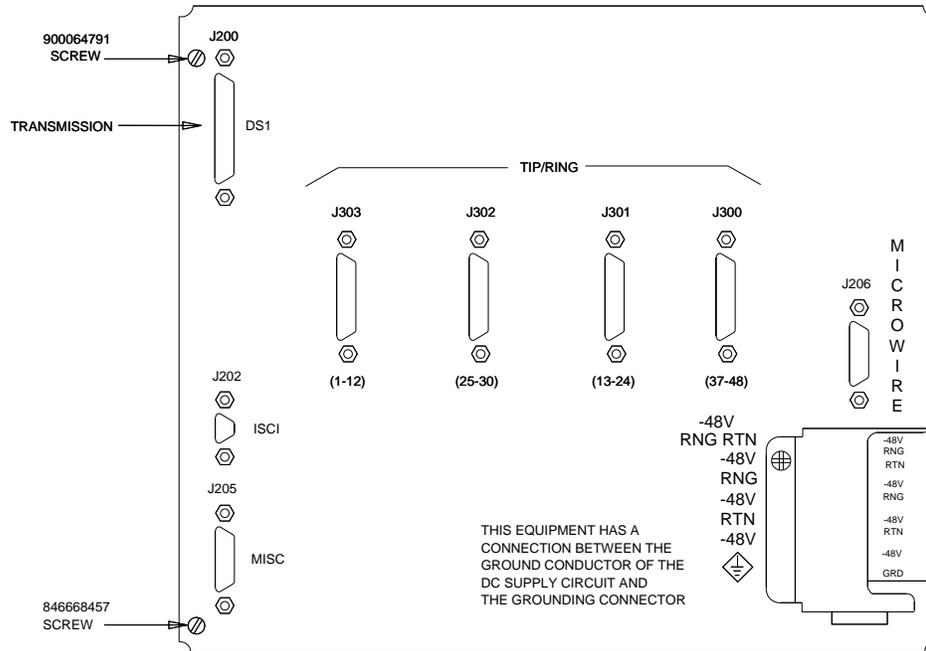
The DDM-2000 FiberReach Multiplexer narrowband shelf is shown in Figure 4-20 and Figure 4-21. The narrowband shelf can be used in conjunction with the wideband shelf or as a stand-alone entity to provide sub-DS1 rate services with protected or unprotected DS1. The narrowband shelf has its own power conversion. The shelf measures approximately 9.65 inches high by 8.03 inches wide by 11.93 inches deep.

A DDM-2000 FiberReach Multiplexer narrowband shelf consists of the following:

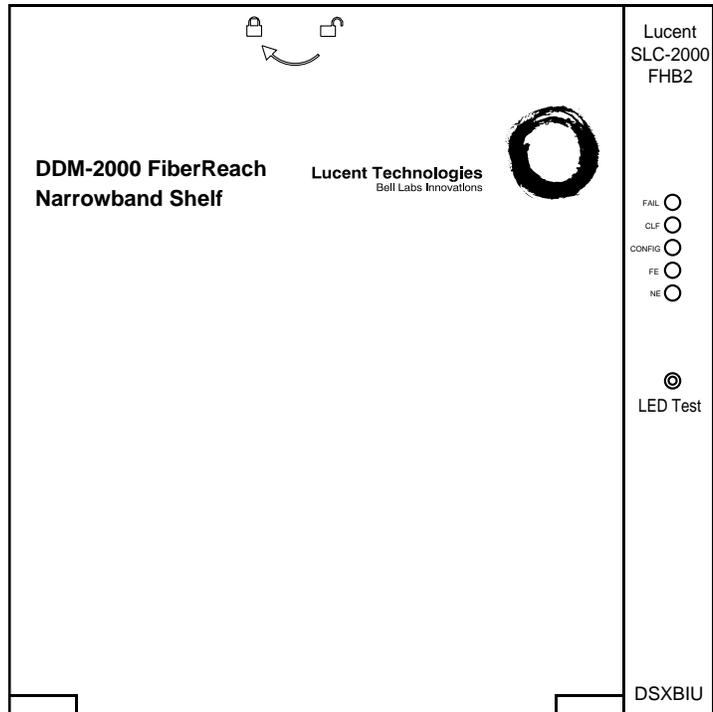
- One 2.1-inch by 4-inch ringing generator unit (RGU) slot
- One 1.4-inch by 4-inch power conversion unit (PCU) slot
- One 0.7-inch by 4-inch channel and drop test unit (CDTU) slot
- Twelve 0.7-inch by 4-inch channel unit slots
- One 1-inch by 8-inch digital signal cross-connect backplane interface unit (DSXBIU) slot



**Figure 4-20. DDM-2000 FiberReach Multiplexer Narrowband Shelf — Front View**



**Figure 4-21. DDM-2000 FiberReach Multiplexer Narrowband Shelf — Rear View**



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**Figure 4-22. DDM-2000 FiberReach Multiplexer Narrowband Shelf Front Panel**

### **Narrowband Shelf Channel Unit Plug-Ins**

Table 4-2 lists the circuit packs that can be housed in the 12-channel unit slots of the narrowband shelf. All circuit packs within the DDM-2000 FiberReach narrowband shelf are unprotected. These channel units are mostly the same as those used in the *SLC*<sup>®</sup>-2000 Access System Multi-Services Distant Terminal (MSDT). Table 4-2 also indicates which circuit packs are available with each *SLC*-2000 software release.

**Table 4-2. DDM-2000 FiberReach Narrowband Shelf Channel Unit Plug-Ins**

<b>Product Code</b>	<b>Functional Name</b>	<b>Available With SLC-2000 Release</b>
AUA25B*	POTS/M SPOTS CU CF (Discontinued Availability)	4.4
AUA27*	POTS CF + OHT (Versus feature not available)	4.4
AUA39	POTS/SPOTS CU CS + OHT/CLASS (Discontinued Availability)	4.4
AUA41	4W VF CF (Discontinued Availability)	4.4
AUA41B	4-Wire CF, (FXS/ETO/DX)	4.4
AUA42*	E SPOTS CU at COT (Discontinued Availability)	4.4
AUA42B	E SPOTS CU at COT	4.4
AUA43B	E SPOTS CU CF	4.4
AUA44*	4-Wire VF CS (Includes TDM Signaling) (Discontinued Availability)	4.4
AUA44B	4W VF CS I (Includes TDM Signaling)	4.4
AUA45B	Dual Ringing Repeater (Manual Ring)	4.4
AUA52	OCU Dataport (Discontinued Availability)	4.4
AUA52B	OCU Dataport, All-rate	4.4
AUA53	Coin CF	
AUA53B	Single Coin CF	4.4
AUA54	4W VF Types I and II E&M (Discontinued Availability)	4.4
AUA54B	4W VF Types I and II E+M/PLR	4.4
AUA55	Multiparty CF	4.4
AUA55B	Multiparty CF (Discontinued Availability)	4.4
AUA56	DID/DPT (Discontinued Availability)	4.4
AUA56B	Dual DID/DPT	4.4
AUA57	FSR CF	4.4
AUA59	SPOTS CU CF + OHT/CLASS (Discontinued Availability)	4.4
AUA75*	Private Line Automatic Ring (PLAR)	4.4
AUA93	ISDN BRITE II, ANSI-U <sup>†</sup>	4.4
AUA94	ISDN Dual ANSI-U	4.4
AUA150*	POTS/SPOTS CU CF + OHT/CLASS	4.4
AUA150C	Dual POTS/SPOTS CF + OHT/CLASS + ALC	4.4
AUA152 <sup>‡</sup>	OCU dataport (TR-08/INA VRTs) (Discontinued Availability)	4.4
AUA158B	ALC POTS CF + OHT/ CLASS (Discontinued Availability)	4.4
AUA158C	ALC POTS CF + OHT/CLASS (Discontinued Availability)	4.4

**Table 4-2. DDM-2000 FiberReach Narrowband Shelf Channel Unit Plug-Ins**

<b>Product Code</b>	<b>Functional Name</b>	<b>Available With SLC-2000 Release</b>
AUA158D	Dual POTS (ALC+ CF + OHT/CLASS + Adaptive Balance)	4.4
AUA159B	ALC POTS/SPOTS CF + OHT/CLASS (modified OHT loss)	4.4
AUA159C	ALC POTS/SPOTS CU + OHT/CLASS	4.4
AUA178	ALC C-POTS CF OHT/CLASS (Discontinued Availability)	4.4
AUA178B	C-POTS (ALC + Adaptive Balance + Extended Range to 1400 OHMS + OHT + CLASS)	4.4
AUA179	ALC POTS/SPOTS CU + ALIC5 + OHT/CLASS	4.4
AUA200	2-wire switched 56-kb/s DPX	4.4
AUA232	RS-232 DSU Dataport	4.4
AUA252	OCU Dataport with SW56 (Discontinued Availability)	4.4
AUA252B	OCU Dataport with SW56 (2.4, 4.8, 9.6, 19.2, 38.4, 56, and 64 kilobits data rates)	4.4
AUA293	ISDN BRITE III, ANSI-U	4.4
MCU <sup>5</sup> 205	Metallic Channel Unit (Tollgate)	4.4
SPQ <sup>®</sup> 300	POTS CS + OHT/CLASS + LSAS	4.4
SPQ340	SLC-2000 ALC POTS/SPOTS <sup>®</sup> CU CS + OHT/CLASS + LSAS	4.4
SPQ400*	SLC-2000 ALC POTS CF + OHT/CLASS (Discontinued Availability)	4.4
xSPQ400*	SLC-2000 ALC POTS CF + OHT/CLASS	4.4
SPQ400*B	ALC POTS CF + OHT/CLASS (Discontinued Availability)	4.4
SPQ400C	Quad POTS (CF + OHT/CLASS)	4.4
SPQ401*	SLC-2000 ALC POTS CF + OHT/CLASS (Discontinued Availability)	4.4
SPQ401B	SLC-2000 POTS/SPOTS CU CS + DHT/CLSS + LSAS VFDE (Discontinued Availability)	4.6
SPQ402	Quad POTS (CF + OHT/CLASS + ALC + VFDE + Adaptive Balance, 1400 OHMS)	4.4
SPQ419	Quad Coin CF	4.4
SPQ429	Quad EBS P-Phone (Discontinued Availability)	4.4
SPQ440	Quad SLC-2000 ALC POTS/SPOTS CU CF + OHT + CLASS + CLSS (Discontinued Availability)	4.4
SPQ440B	Quad POTS/SPOTS ALC CF + OHT + CLASS + CLSS (Discontinued Availability)	4.4
SPQ440C*	Quad Extended Range SPOTS (Discontinued Availability)	4.4
SPQ440D*	Extended Range SPOTS; VFDE	4.6
SPQ442	SLC-2000 E SPOTS CU CS	4.4

**Table 4-2. DDM-2000 FiberReach Narrowband Shelf Channel Unit Plug-Ins**

<b>Product Code</b>	<b>Functional Name</b>	<b>Available With SLC-2000 Release</b>
SPQ443*	SLC-2000 E SPOTS CU CF	4.4
SPQ450	ALC POTS/SPOTS CU CF + OHT/CLASS ALIC5 + LSAS	4.4
SPQ452	SLC-2000 OCU Dataport	4.4
SPQ453	Dual Coin CF	4.4
SPQ456	Quad DID	4.4
SPQ460	Quad POTS/SPOTS (ALC, CF + Extended Range + VFDE)	4.4
SPQ478	SLC-2000 ALC C- POTS CF OHT/CLASS	4.4
SPQ494	Quad ISDN ANSI-U	4.4
SPQ909	Lower-power POTS CF + OHT/CLASS	4.4

\* Some engineering restrictions (for example, power limitations) must be considered when using this channel unit. Refer to Section 6, "System Planning and Engineering," for more information.

† Registered trademark of American National Standards Institute, Inc.

‡ GTE only.

§ Trademark of Tollgate Communications, Inc.

### **Narrowband Shelf Interfaces and Multiplexing**

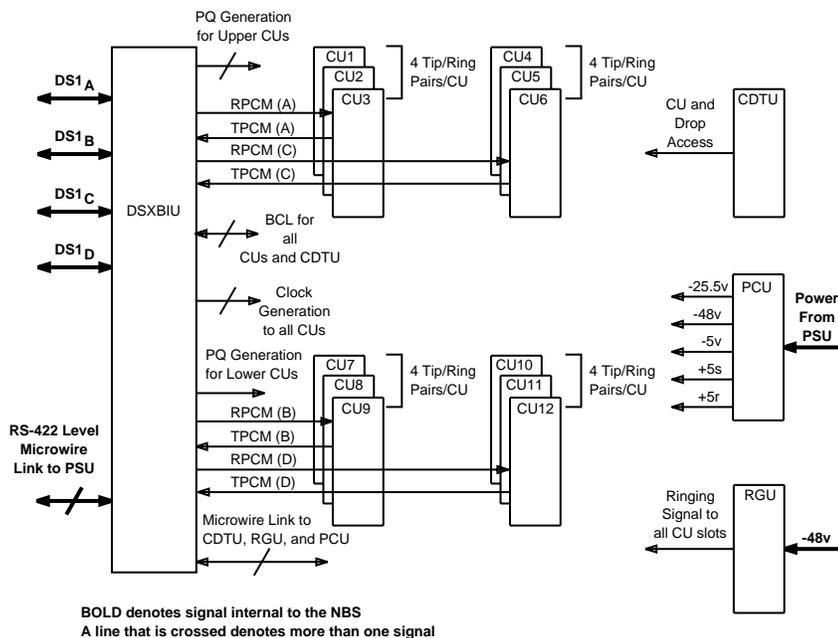
The DDM-2000 FiberReach narrowband shelf supports the same channel units as the *SLC-2000* MSDT. However, the narrowband shelf can offer an increased number of narrowband services. This provides more flexibility for special services, such as integrated services digital network (ISDN).

The main controller and interface for the narrowband shelf is the digital signal cross-connect backplane interface unit (DSXBUI), which interfaces to the 12 channel units via TCPM and RCPM lines for pulse code modulation and the bank control link (BCL) for provisioning and inventory. See Figure 4-23. Clock generation and synchronization are controlled by the DSXBUI. A ringing generator unit (RGU) sends the ringing signal to all of the channel unit slots. A channel and drop test unit (CDTU) provides the channel and drop testing capability for the narrowband shelf. The power converter unit (PCU) delivers power to the narrowband shelf. The DSXBUI communicates with the common units via a serial protocol link called the microwire link. This link is a serial three-wire clock, transmit, and receive protocol. For the PSU, the DSXBUI has an additional microwire interface operating at RS-422 levels.

The backplane for the narrowband shelf can be configured in either quad or octet modes. In the quad mode, the 6 channel units in the upper subshelf and the 6 channel units in the lower subshelf provide up to 24 DS0s of service each on a 1-DS1 capacity per subshelf (2 DS1s total). Four DS0 time slots are provided to each physical channel unit slot.

In the octet mode, two DS1 links are provided to the 6 channel unit slots in the upper subshelf and two DS1 links are provided to the 6 channel unit slots in the lower subshelf for a total capacity of 96 DS0 or 4 DS1 lines. Eight DS0 time slots are provided to each physical channel unit slot. One DS1 link is provided for each group of three channel unit slots.

Narrowband shelf services are supported by *SLC-2000* Releases 4.3 and 4.4, or later. For Release 4.4, the *SLC-2000* host must be equipped with the SPQ810 DT server to support both quad and octet mode services. See LTP 363-208-000, *SLC-2000 Access System Application, Planning, and Ordering Guide* for additional information.



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**Figure 4-23. DDM-2000 FiberReach Multiplexer Narrowband Architecture (Octet Mode Shown)**

## **Narrowband Shelf Transmission**

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The NBS operates in conjunction with the WBS or as a stand-alone entity. In both cases, it must be hosted by a *SLC-2000* host digital terminal (HDT) containing the correct software release. At the *SLC-2000* HDT, you must provision the MDS assembly shelves hosting the NBS to the Fiber-in-the-Loop (FITL) mode of operations using the user interface panel or the CIT logged into the DLC subsystem.



**NOTE:**

For detailed information on *SLC-2000* software releases that support the NBS and provisioning in the *SLC-2000* system, see 363-208-000, *SLC-2000* APOG.

An MDS assembly shelf provisioned for FITL contains DT servers to interface with the NBS. The DT servers “extend” the backplane of the MDS assembly to the NBS through DSX-1 signals. This allows the channel units that provide the customer services to be closer to the customer. By using the NBS in this ONU configuration, you realize a cost savings by replacing many copper loops with a fiber.

The following material explains how the *SLC-2000* HDT interfaces with the NBS:

- Virtual — Distant Terminal Concept
- 48-Line NS fed through a T1 facility (no WBS)
- Basic 48-Line NBS Fed through a WBS
- Modes of operation with *SLC-2000* Software Release R4.4 or later
- Signal Path Using a *SLC-2000* HDT with a Collocated WBS
- Signal Path Using a *SLC-2000* HDT containing a J1C265AA-1, L4 ARM Shelf and SONET Subsystem Release R13 or later
- NBS Services



**NOTE:**

ONUs are usually hosted by HDTs using optical feeders. But for the purposes of this document, an ONU can occasionally be hosted by an HDT connected to the ONU over a metallic feeder such as a T1 facility.

### **Virtual-DT (V-DT) Concept**

The *SLC-2000* system can host a DDM-2000 NBS as the ONU. By using the *virtual DT* (V-DT) concept, the user notices very few changes when the HDT is hosting an NBS instead of a *SLC-2000* MSDT of earlier software releases.

Figure 4-24 and Figure 4-25 show the V-DT concept. The 48-line NBS is actually divided into two 24-line shelves (Shelf #1 and Shelf #2 in the figure). Each 24-line shelf has its own dedicated DT server at the HDT just as each *SLC-2000* MSDT has its own dedicated Server. In the figure, Server A hosts V-DT A and Server B hosts V-DT B. Thus, the *SLC-2000* HDT thinks it is actually hosting two 24-line MSDTs. All alarms and reports sent to the HDT actually show information about the 24-line V-DT.

**⇒ NOTE:**  
The V-DT concept also supports 12-line V-DTs if you have its DT server configured for 12-line service.

### **48-Line ONU Fed Through a T1 Facility**

**⇒ NOTE:**  
The following examples explain the basic signal paths starting at the *SLC-2000* HDT and ending at the channel unit slots in the NBS.

Occasionally, a customer requests that the NBS be fed using metallic facilities such as an existing metallic cable pair. Figure 4-24 shows an HDT hosting a 48-line DDM-2000 FiberReach NBS ONU using a T1 facility to transmit the signal between the HDT and the ONU. As stated earlier, the NBS can contain two V-DTs. Therefore, to configure a complete 48-line system, the HDT MDS assemblies must contain at least two DT servers to support this NBS.

Each server sends a DSX-1 signal to a DSX cross-connect collocated with the *SLC-2000* HDT. From the DSX cross-connect, the DSX-1 signals are sent to the NBS using a T1 facility. At the NBS, the DSX-1 signals leave the T1 facility and usually terminate on a DSX connector where they are connected to the DSXBUI. The DSXBUI then conditions the signals to be received by the six channel unit slots being fed by the specific DSX-1 signal. Using this method, V-DT A (the six slots in Shelf #1) is hosted by Server A at the HDT. V-DT B (the six slots in Shelf #2) is hosted by Server B at the HDT. Each of the two V-DTs will serve up to 24 lines for a total NBS capacity of 48 lines.

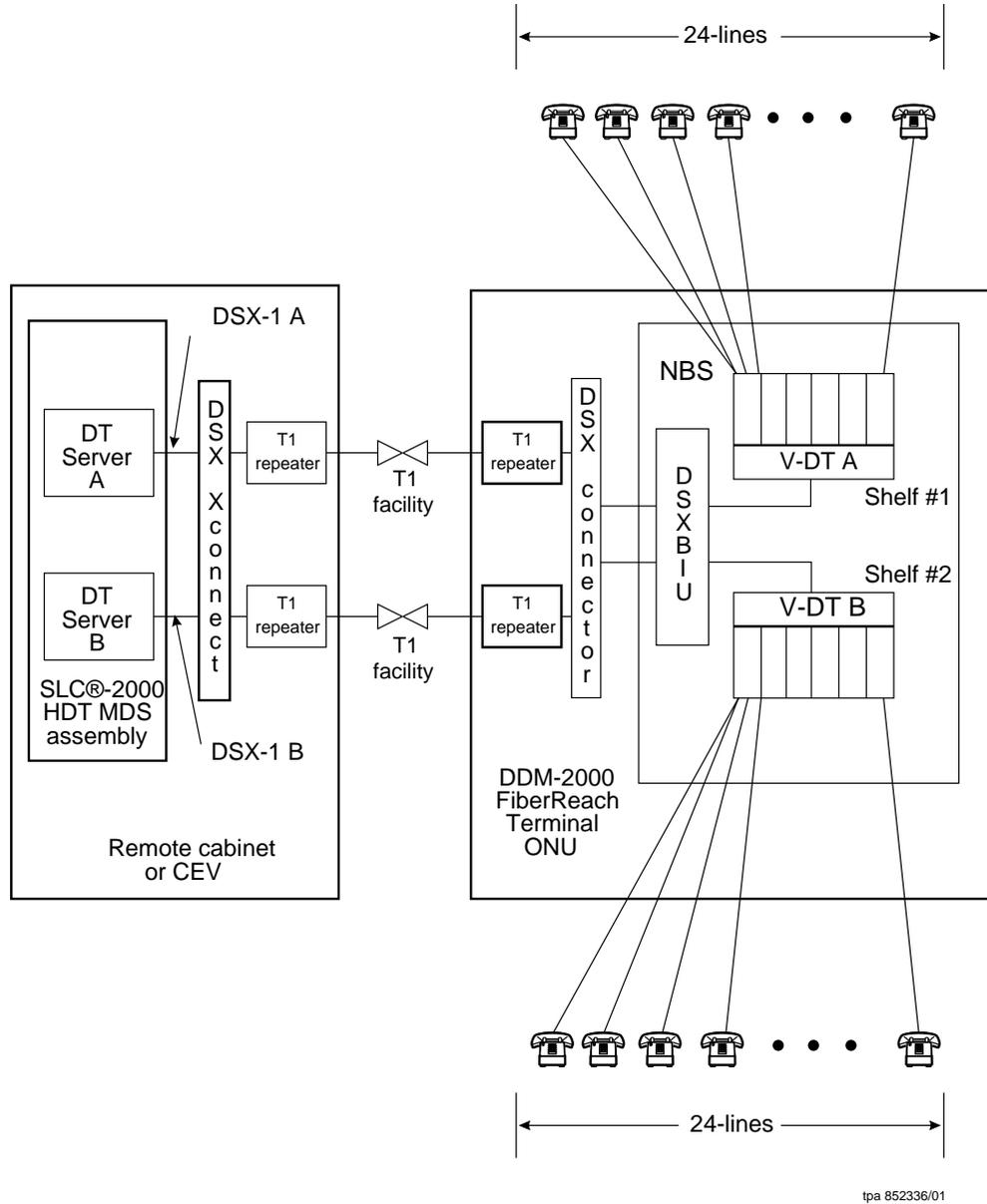


Figure 4-24. 48-Line ONU Fed Through a T1 Facility

## Basic 48-Line NBS Fed Through a DDM-2000 FiberReach Wideband Shelf



### NOTE:

The following examples explain the basic signal paths starting at the *SLC-2000* HDT and ending at the channel unit slots in the NBS.

Figure 4-25 shows an HDT hosting a 48-line DDM-2000 FiberReach NBS ONU. This configuration uses the DDM-2000 FiberReach Wideband Shelf (WBS) to transmit the signal between the HDT and the NBS. The NBS contains two V-DTs. Therefore, to configure a complete 48-line system, the HDT MDS assemblies must contain at least two servers to support this NBS.

In a typical configuration, each DT server sends a DSX-1 signal to the WBS collocated with the *SLC-2000* HDT. The WBS multiplexes the DSX-1 electrical signals onto an OC-1 on OC-3 optical ring and transmits it to the NBS. At the NBS, another WBS receives the OC-1 signal and demultiplexes it back into two DSX-1 signals and sends them to the DSXBIU in the NBS. The DSXBIU then conditions the signals to be received by the six channel unit slots being fed by the specific DSX-1 signal. Using this method, V-DT A (the six slots in Shelf #1) is hosted by Server A at the HDT. V-MDT B (the six slots in Shelf #2) is hosted by Server B at the HDT. Each of the two V-DTs will serve up to 24 lines for a total NBS capacity of 48 lines.

In a typical configuration, the WBSs are part of an OC-1 on OC-3 ring. At least one WBS in the OC-1 on OC-3 ring must be hosted by a DDM-2000 OC-3 multiplexer or the ARM shelf of a *SLC-2000* SONET subsystem.

## Modes of Operation With *SLC-2000*

*SLC-2000* software release 4.4 allows the *SLC-2000* HDT to support updated features at the DDM-2000 FiberReach NBS. Release 4.4 allows you to provision the DSX-1 signals terminating on the NBS to one of the following two modes:

- **Quad Mode:** This mode provides service where a single server can feed a six-slot V-DT for 24-line service. As shown in Figure 4-25, this configuration is optimized for supporting up to 24 POTS or special service lines per V-DT. However, as shown in Figure 4-25, the servers at the HDT are now DT servers and the shelves in the MBS are divided into two V-DTs. The HDT can host the NBS through either an optical feeder (Figure 4-25 or Figure 4-26) or a metallic feeder.
- **Octet Mode:** This mode allows you to further divide each shelf of the NBS in half to form four 3-slot quadrants. These three slots can support up to 24 DS0s. It is optimized for supporting up to 10 ISDN lines per V-DT. Figure 4-27 and Figure 4-28 show typical NBS configurations in the octet mode.

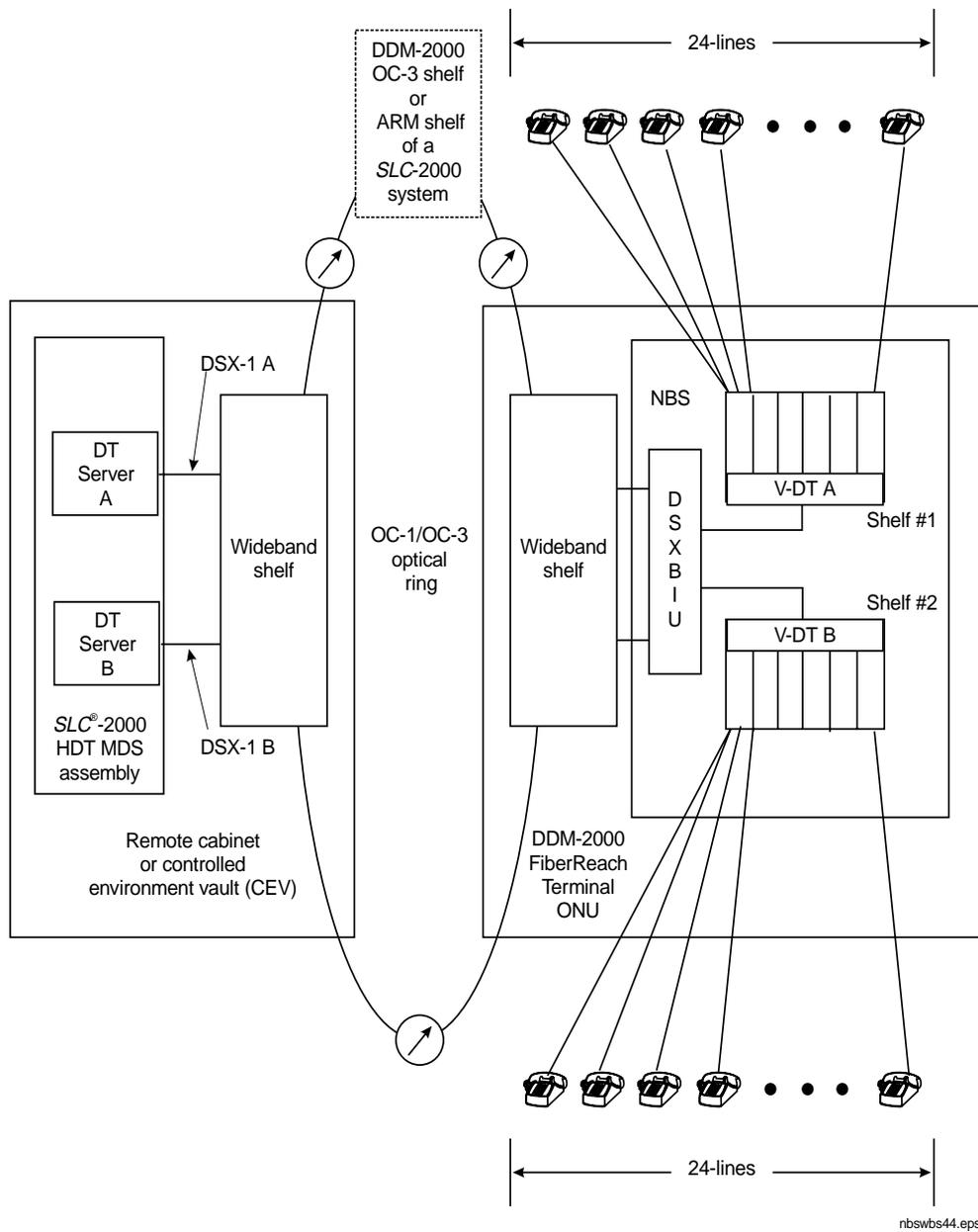


**NOTE:**

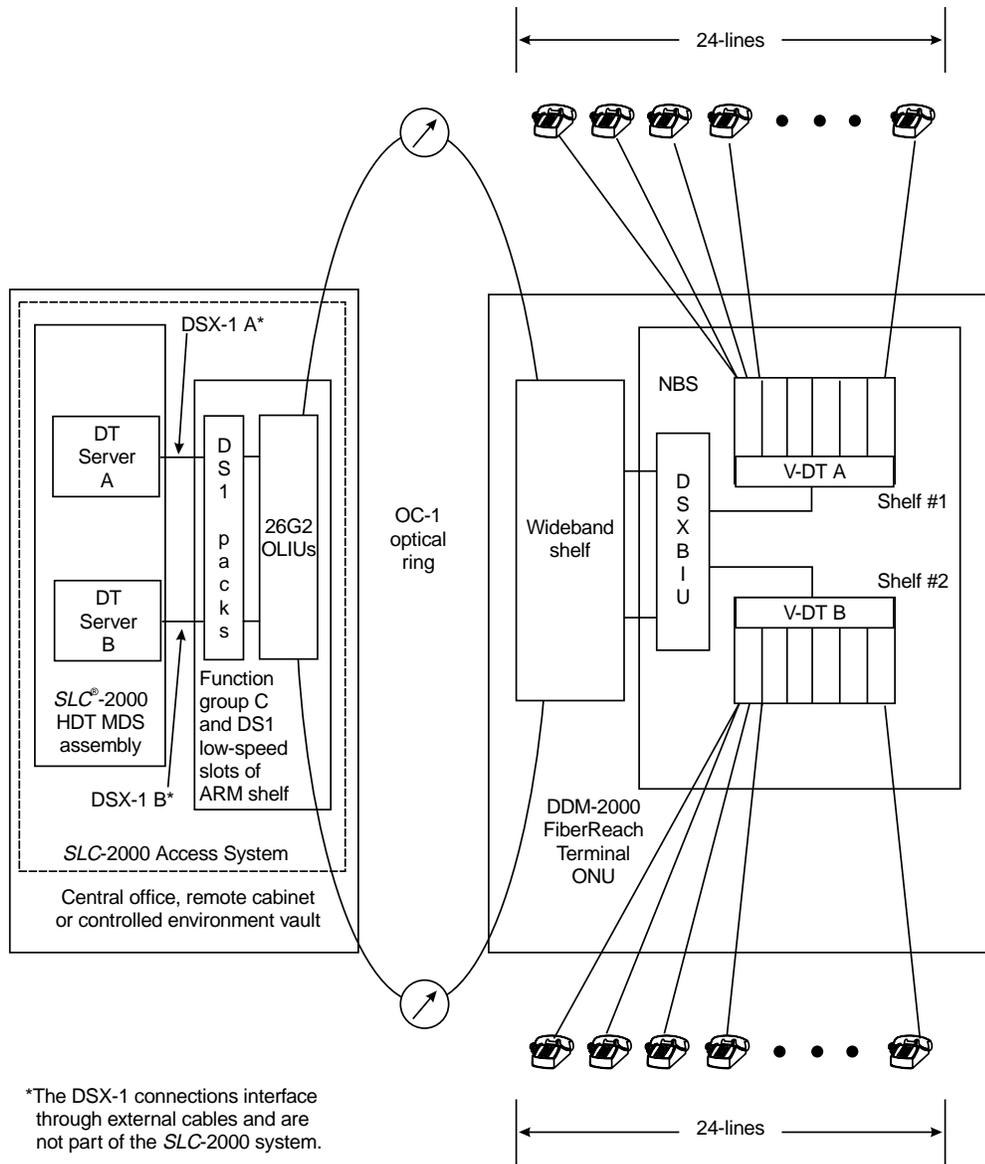
**Virtual-Distant Terminal (V-DT) Services.** A V-DT configured for the quad mode of operation will permit up to 24 POTS or special service lines, or up to 8 ISDN lines along with 6 POTS or special service lines for each of the two 6-slot V-DTs. A V-DT configured for the octet mode of operation will permit up to 12 POTS or special service lines or up to 10 ISDN lines for each of the four 3-slot V-DTs.

Whether using the quad mode or the octet mode, the *SLC-2000* system can interface the NBS by either of the following methods:

- **Metallic Method.** This method is shown in Figure 4-24.
- **Optical Method.** There are two basic optical interfaces depending on the *SLC-2000* ARM shelf type and the SONET subsystem software release:
  - **Any ARM Shelf and SONET SUBSystem Software Release.** Figure 4-25 and Figure 4-27 show a *SLC-2000* system using a collated WBS interfacing with a NBS through an OC-1 ring. The WBSs in the ring must be hosted by a DDM-2000 OC-3 shelf or the ARM shelf of a *SLC-2000* system to maintain the single ended operation capability of the SONET network.
  - **J1C265AA-1, L4 ARM Shelf with SONET Subsystem Software Release R13 or later:** As shown in Figure 4-26 and Figure 4-28, if the SONET Subsystem contains Software Release R13 or later and the *SLC-2000* ARM shelf is the J1C265AA-1, L4, you can replace the collocated WBS with 26G2-U OLIUs in function group C and DS1 low-speed circuit packs of the ARM shelf. This eliminates the expense of the collocated wideband shelf and also the need of a DDM-2000 OC-3 shelf to host the WBSs in the circuit.



**Figure 4-25. 48-Line NBS Fed Through a Collocated DDM-2000 FiberReach Wideband Shelf — Quad Mode (SLC-2000 Release 4.4 or Later)**



\*The DSX-1 connections interface through external cables and are not part of the SLC-2000 system.

nwr44r13.eps

**Figure 4-26. 48-Line NBS Fed Through Function Group C of a J1C265AA-1, L4 ARM Shelf (SONET Subsystem Release R13 or later) — Quad Mode (SLC-2000 Software Release 4.4 or Later)**

As the mode definitions show, *SLC-2000* Software Release 4.4 adds an octet mode of service. This allows the NBS ONU the capacity for 48 POTS-type lines or 40 ISDN lines with each line offering 2B+D service. However, the octet mode uses the V-DT concept. As shown in Figure 4-27 and Figure 4-28, each six-slot shelf in the NBS can be divided into two octet V-DTs to allow the NBS to contain four octet V-DTs. In the octet mode, each channel unit slot has access to eight DS0s instead of the four DS0s accessible in the quad mode. This allows the octet V-DT to contain an *SPQ494* Quad ISDN channel unit in each of the first two slots and an *AUA94* Dual ISDN unit in the third slot. A fully equipped NBS with four DSX-1 feeders provisioned for the octet mode can provide 40 ISDN lines with each line capable of 2B+D service. If the first two slots contain *SPQ494* channel units, the third slot can also contain any other channel unit compatible with the NBS.

Each three-slot 24 DS0 V-DT in the octet mode still has its own specific server at the *SLC-2000* HDT. Figure 4-27 and Figure 4-28 show the NBS provisioned for the octet mode.

### Signal Path Using ARM Shelf and Collocated WBS



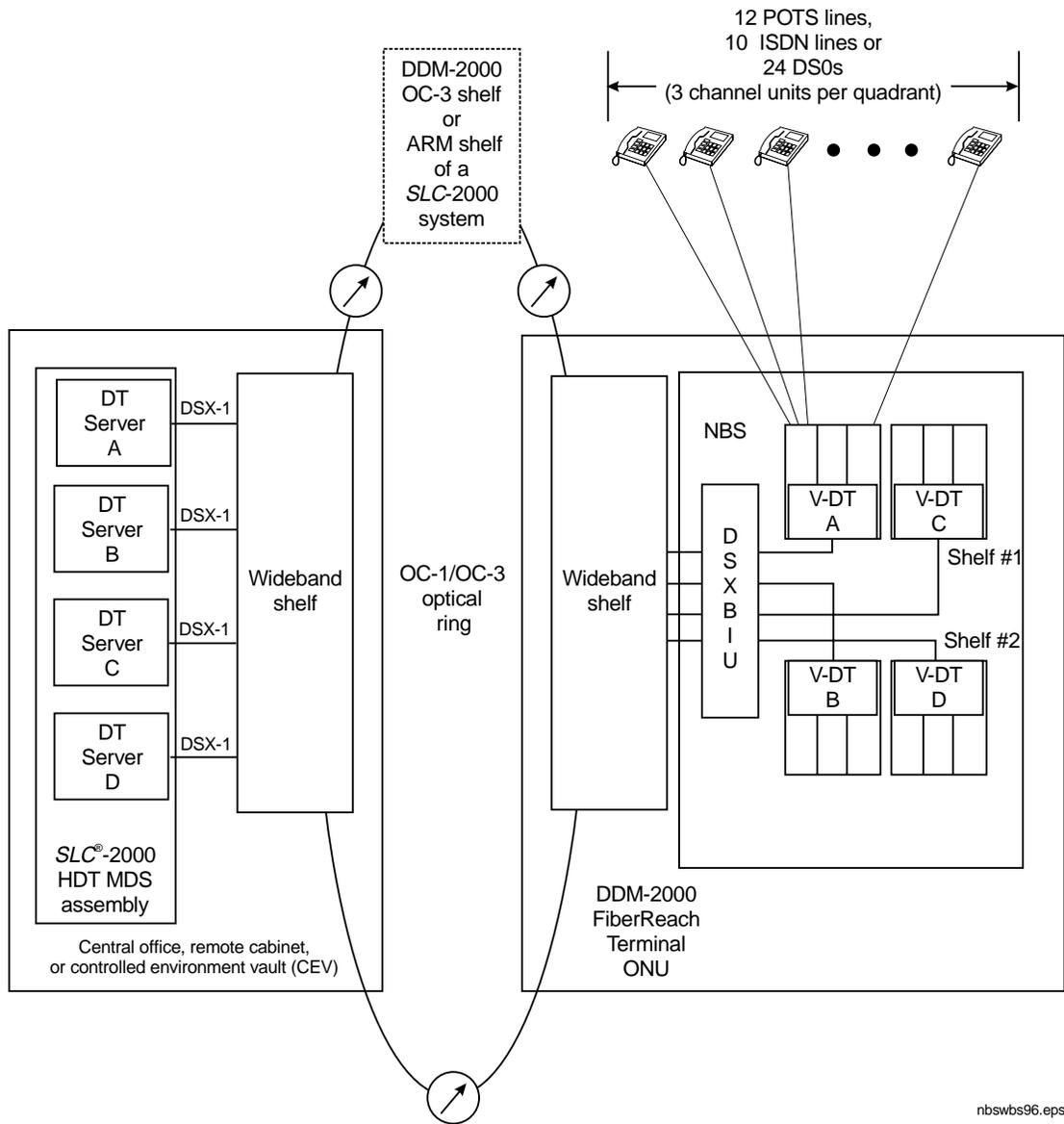
**NOTE:**

The following example explains the basic signal paths starting at the *SLC-2000* HDT and ending at the channel unit slots in the NBS.

Figure 4-27 shows an HDT hosting a DDM-2000 FiberReach NBS ONU with four DSX-1 feeders. This configuration uses a collocated DDM-2000 FiberReach WBS to transmit the signals on an OC-1/OC-3 ring between the HDT and the ONU. As stated earlier, the NBS operating in the octet mode can contain four V-DTs. Therefore, to configure a complete system with 40 ISDN lines, the HDT MDS assemblies must contain at least four servers to support this BS.

In a typical configuration, each server sends a DSX-1 signal to the WBS collocated with the *SLC-2000* HDT. The WBS multiplexes the DSX-1 electrical signals onto an OC-1 optical ring and transmits it to the NBS. At the NBS, another WBS receives the OC-1/OC-3 signal and demultiplexes it back into four DSX-1 signals and sends them to the DSXBUI. The DSXBUI then conditions the signals to be received by the three channel unit slots being hosted by the specific DSX-1 signal. Using this method, V-DT A (the first three slots in Shelf #1) is hosted by Server A at the HDT. V-DT B (the first three slots in Shelf #2) is hosted by Server B at the HDT. V-DT C (the last three slots in Shelf #1) is hosted by Server C at the HDT. V-DT D (the last three slots in Shelf #2) is hosted by Server D at the HDT.

As shown in Figure 4-27, the WBSs are part of an OC-1/OC-3 ring. At least one node in the OC-1/OC-3 ring must be a DDM-2000 OC-3 multiplexer or function group C of the ARM shelf in a *SLC-2000* SONET subsystem to maintain the single ended operation capability of the SONET network.



**Figure 4-27. Basic DDM-2000 FiberReach NBS ONU Configuration Operating in the Octet Mode — Collocated WBS**

## Signal Path Using Function Group C of a J1C265AA-1, L4 ARM Shelf and SONET Subsystem Software Release R13 and Later



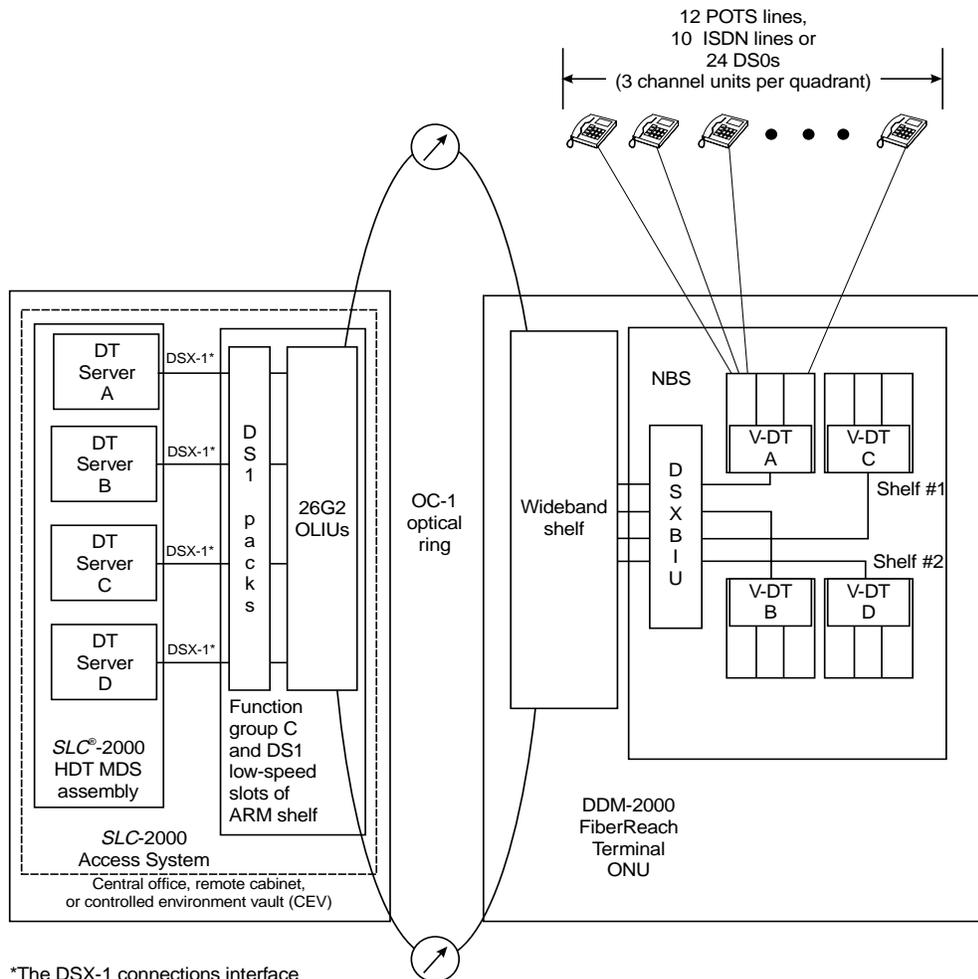
**NOTE:**

The following example explains the basic signal paths starting at the *SLC-2000* HDT and ending at the channel unit slots in the NBS.

Figure 4-28 shows an HDT hosting a DDM-2000 FiberReach NBS ONU with four DSX-1 feeders. This configuration uses the DS1 circuit packs and 26G2-U OLIUs in function group C of the SLC-2000 ARM shelf to transmit the signal between the HDT and the ONU. As stated earlier, the NBS operating in the octet mode can contain four V-DTs. Therefore, to configure a complete system with 40 ISDN lines, the HDT MDS assemblies must contain four servers to support this NBS.

In a typical configuration, each server sends a DSX-1 signal to the DS1 circuit packs in function group C of the ARM shelf in the HDT. The DS1 circuit packs multiplex the signals into a VT-G and pass them to the 26G2-U OLIUs in function group C. The OLIUs multiplexes the electrical signals into an OC-1 optical signal to interface with the OC-1 ring. The OC-1 ring carries the signal to the ONU. At the NBS, a WBS receives the OC-1 signal and demultiplexes it back into four DSX-1 signals and sends them to the DSXBUI. The DSXBUI then conditions the signals to be received by the three channel unit slots being hosted by the specific DSX-1 signal. Using this method, V-DT A (the first three slots in Shelf #1) is hosted by Server A at the HDT. V-DT B (the first three slots in Shelf #2) is hosted by Server B at the HDT. V-DT C (the last three slots in Shelf #1) is hosted by Server C at the HDT. V-DT D (the last three slots in Shelf #2) is hosted by Server D at the HDT.

As shown in Figure 4-28, the 26G2-U OLIUs in function group C and the WBS are part of an OC-1 ring. The ARM shelf serves as a host for the WBSs in the ring.



\*The DSX-1 connections interface through external cables and are not part of the SLC-2000 system.

nwoctr13.eps

**Figure 4-28. Basic DDM-2000 FiberReach NBS ONU Configuration Operating in the Octet Mode — J1C265AA-1, L4 ARM Shelf with SONET Subsystem Software Release R13 or Later**

### Narrowband Shelf Services

When the V-DT is operating in the quad mode, SLC-2000 Software Release 4.4 or later allows the DDM-2000 FiberReach NBS to contain any of the channel units listed in Table 4-2.

Table 4-3 shows the possible provisioning combinations for the DSX-1 signals A, B, C, and D feeding the V-DTs in the NBS. It also gives possible reasons for each provisioning combination. Refer to Figure 4-27 or Figure 4-28 for the physical location of the V-DT in the NBS.

**Table 4-3. Possible DSX-1 Provisioning Combinations for Each V-DT in the NBS (SLC-2000 Software Release 4.4 or Later)**

Provisioning Combination Number	Provisioned Mode of Each DSX-1 Feeding a V-DT in the NBS (Upper Shelf — Slots 1 - 6 Lower Shelf — Slots 7 - 12)	Comments
1	DSX-1 A — Quad DSX-1 B — Quad	Typically used for POTS or special services  <b>Upper and Lower Shelves</b> — Each channel unit slot can operate in the quad mode. Typically, the NBS can serve up to 48 customer lines.
2	DSX-1 A — Quad DSX-1 B — Octet; DSX-1 D — Octet	Typically used for a combination of POTS, special services, and ISDN services. You can also easily grow ISDN services in the future.  <b>Upper Shelf</b> — Each channel unit slot fed by DSX-1 A can typically offer up to 4 customer lines for a total of 24 lines (Quad mode).  <b>Lower Shelf</b> — A typical use for these slots fed by DSX-1 B and D is ISDN service (Octet mode). Each DSX-1 can serve up to 10 ISDN lines for a total of 20 ISDN lines (2B+D service).
3	DSX-1 A — Octet; DSX-1 C — Octet DSX-1 B — Quad	Typically used for a combination of POTS, special services, and ISDN services. You can also easily grow ISDN services in the future.  <b>Upper Shelf</b> — A typical use for these slots fed by DSX-1 A and C is ISDN service (Octet mode). Each DSX-1 can serve up to 10 ISDN lines for a total of 20 ISDN lines (2B+D service).  <b>Lower Shelf</b> — Each channel unit slot fed by DSX-1 B can typically offer up to 4 customer lines for a total of 24 lines (Quad mode).
4	DSX-1 A — Octet; DSX-1 C — Octet DSX-1 B — Octet; DSX-1 D — Octet	Typically used for ISDN service.  <b>Upper and Lower Shelves</b> — A typical use of this combination will allow the NBS to offer up to 40 ISDN lines (2B+D service).

The “Operations, Administration, Maintenance, and Provisioning” chapter gives the mode provisioning options and restrictions for each of the four DSX-1 signals feeding the NBS. It also gives the channel unit slot restrictions when operating in the octet mode.

## **Narrowband Shelf Transmission Circuit Packs**

### **FHB2 Digital Signal Cross-Connect Backplane Interface Unit (DSXBIU)**

The DSXBIU is a narrowband shelf circuit pack that operates as the local controller for the narrowband shelf and multiplexes the DS0 signals from the channel units to DS1 interfaces. The DS1 interface is fed from the DSXBIU to a DS1 circuit pack on the wideband shelf. Software for the DSXBIU is automatically downloaded from the *SLC-2000* host digital terminal.

The DSXBIU interfaces to the 12 channel slots on the narrowband shelf, providing provisioning and inventory information, as well as clock generation and synchronization. The DSXBIU communicates with the common units via a serial protocol microwire link. A separate microwire RS-422 interface connects with the power supply unit. A bank control link on the DSXBIU is used to communicate with the channel units.

### **AUA413 Ringing Generator (RGU)**

The RGU circuit pack is used in the *SLC-2000* MSDT as well as the DDM-2000 FiberReach narrowband shelf. This circuit pack provides 20 Hz negative-superimposed ringing voltage to satisfy loop applications up to 132 ohms. The RGU receives an input voltage from the power converter unit (PCU) and supplies ringing voltage to three lines simultaneously. Each line may have a maximum load of five ringer equivalent numbers (RENS). An output alarm monitor circuit on the RGU monitors the output ringing voltage for an over- or under-voltage condition and activates a red fail LED when either condition occurs. This circuit pack is protected from lighting and power surges by the output surge protection circuit.

### **AUA421 Channel and Drop Test Unit (CDTU)**

The CDTU circuit pack is used in the *SLC-2000* MSDT as well as the DDM-2000 FiberReach narrowband shelf. This circuit provides the remote end terminations and detectors required to support end-to-end channel testing of two-wire locally-switched services, such as POTS, coin, and multiparty services. When a channel test request is received on the narrowband shelf, the DSXBIU instructs the channel unit associated with the channel under test to operate its test relay. The DSXBIU then informs the CDTU that a test is occurring, and the CDTU then performs a drop test and reports the results back to the DSXBIU. The DSXBIU then returns an encoded test message to the test system. The CDTU provides channel test terminations in sequence based on requests from the DSXBIU. This circuit pack is optional.

The CDTU also contains a drop test circuit to determine the health of the metallic drop beyond the local DDM-2000 FiberReach shelf. The CDTU can detect the following:

- Hazardous voltage
- Foreign voltage
- Metallic leakage
- Receiver off-hook
- Lack of continuity to the station set

The circuit pack contains a red fail LED to indicate an internal failure in the CDTU circuit pack and a green busy LED to indicate that a test session is active.

### **AUA432 Power Converter Unit (PCU) Power**

The AUA432 PCU is located in the narrowband shelf and accepts  $-48$  V DC power. The PCU converts incoming  $-48$  V DC to  $+5$  and  $-5$  V DC, as well as  $-25.5$  V DC for use by various channel units that may be in the narrowband service card slots. The PCU provides power to all the circuit packs on the narrowband shelf by converting incoming  $-48$  V DC power to voltages required for the various circuit packs.

### **BGW1 Supply Unit (PSU)**

The BGW1 PSU, miscellaneously mounted with the DDM-2000 FiberReach narrowband shelf, terminates a 60 V AC from a network-provided source (for example, centralized power). The PSU converts incoming 60 V AC to  $-48$  V DC for use by the wideband and narrowband shelves. In applications where  $-48$  V DC is readily available, the PSU is not required. Other powering options will be available with future releases of the PSU.

## Synchronization

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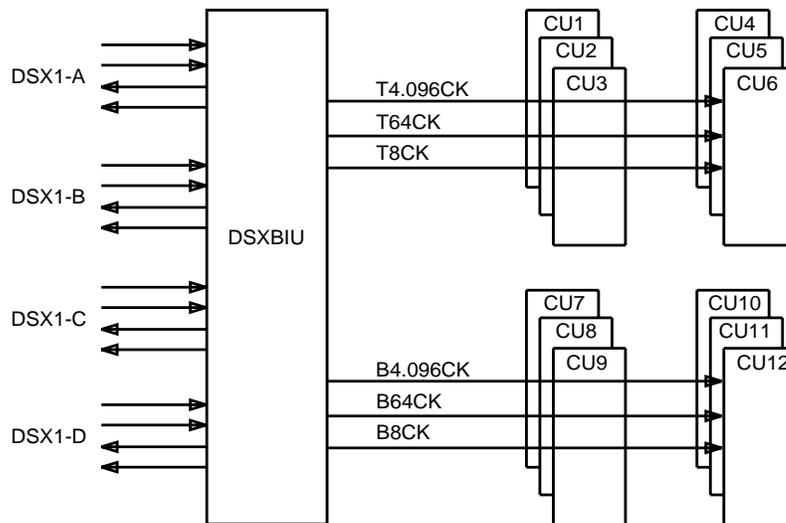
Synchronization is an important part of all SONET products. The DDM-2000 FiberReach Multiplexer is designed for high performance and reliable synchronization.

### Narrowband Shelf Timing

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The DSXBIU is responsible for generating all the clocks required for the narrowband shelf. Figure 4-29 shows the narrowband shelf timing architecture. The DSXBIU translates DSX-1 signals and generates clock and data leads for both directions. The DSXBIU must choose a single 1.544 MHz clock to phase lock to a 16.384 MHz voltage control oscillator (VCXO). The 6.176 MHz clock is divided by four to generate a 1.544 MHz transmit clock.

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**Figure 4-29. Narrowband Shelf Timing Architecture**

## DDM-2000 FiberReach Control -- Narrowband Shelf

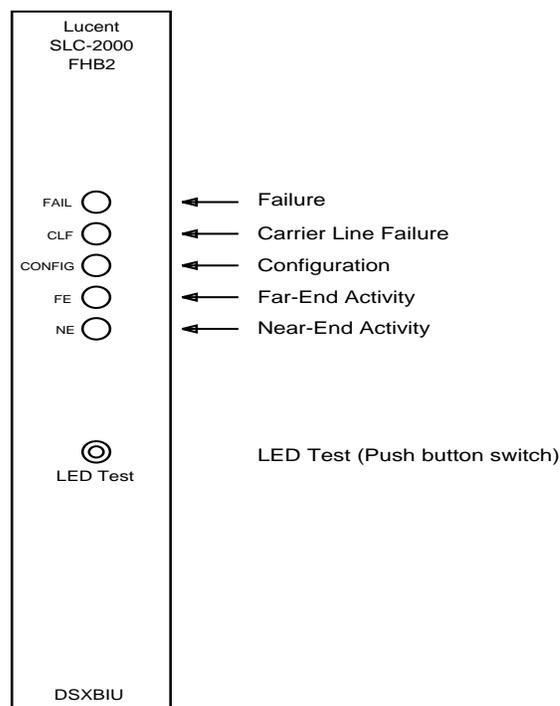
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### Narrowband Shelf Control Features

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Figure 4-30 shows the DSXBIU faceplate for the DDM-2000 FiberReach narrowband shelf. This contains all the local shelf indicators and includes the following:

- Fail LED
- Carrier line failure
- LED test button
- Near-end/far-end activity
- Configuration LED



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**Figure 4-30. DDM-2000 FiberReach DSXBIU Narrowband Shelf User Panel**

The user panel LEDs default to show local system information. The fail LED is a red indicator that shows the DSXBUI failure. The carrier line failure (CLF) LEDs indicate a failure in the carrier line. The configuration (CONFIG) LED indicates a configuration error (but not a hardware problem). The near end (NE) LED indicates when a near-end event has occurred. The far-end (FE) LED indicates when a far-end event has occurred. The LED test button tests all the LED indicators on the narrowband shelf.

The narrowband shelf reports inventory information for its common circuit packs (DSXBUI, RGU, CDTU, and PCU) and channel units to the *SLC-2000* host using the extended super frame (ESF) data links in the DS1s terminated in the DSXBUI. A user may enter commands at the *SLC-2000* host, specifying an appropriate address in the command to operate a circuit on the narrowband shelf. All alarms and events are treated as local events at the host *SLC-2000*.

### **Single-Ended Operations**

The narrowband shelf offers single-ended operations at the *SLC-2000* Access System host system. Operations for the narrowband shelf are handled by the *SLC-2000* host using the extended super frame (ESF) data links in the DS1s DSXBUI. A user may enter commands at the *SLC-2000* host, specifying an appropriate address in the command to operate a circuit on the narrowband shelf. All alarms and events are treated as local events at the host *SLC-2000*.

### **Remote Operations**

Remote operations for the narrowband shelf are handled through the operations of the *SLC-2000* Access System's gateway network element (GNE). Remote messages are passed between the GNE and the host via the data communications channel (DCC). Remote messages are also passed between the host and the DDM-2000 FiberReach narrowband shelf via the ESF data link on the DS1 terminated by the DSXBUI.

TL1 messages pass to and from the narrowband shelf using the host system's target identifier (TID). The address in the TL1 message determines which DDM-2000 FiberReach multiplexer, and the wideband or narrowband shelf within the FiberReach multiplexer, to which the message applies.

For TBOS reporting, the narrowband shelf shares the TBOS display with the host.

For parallel telemetry, all alarm and status indications at the DDM-2000 FiberReach shelf are reported as local alarms to the host.

## Power -- Narrowband Shelf

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The DDM-2000 FiberReach Multiplexer can be powered from a variety of power sources. The most common powering method is the  $-48$  V DC power available in telecommunication facilities. The system can be configured to operate with a  $+48$  V or  $-48$  V input without the use of bulk converters.

Depending upon the application, power sources other than  $-48$  V DC can be used with DDM-2000 FiberReach. These include 60 V AC and 120 V AC (commercially available) power converters, which are miscellaneous mounted.

### Narrowband Shelf $-48$ V Battery Powering

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The PCU in the DDM-2000 FiberReach narrowband shelf provides fusing and converts a  $-48$  V DC input power feed to voltages required for the other circuit packs in the narrowband shelf. Figure 4-31 shows the power distribution. The narrowband shelf can draw up to 84 watts of power and meets all performance requirements when the DC input voltage varies between  $-42.5$  V and  $-56.5$  V, as specified in TR-499.

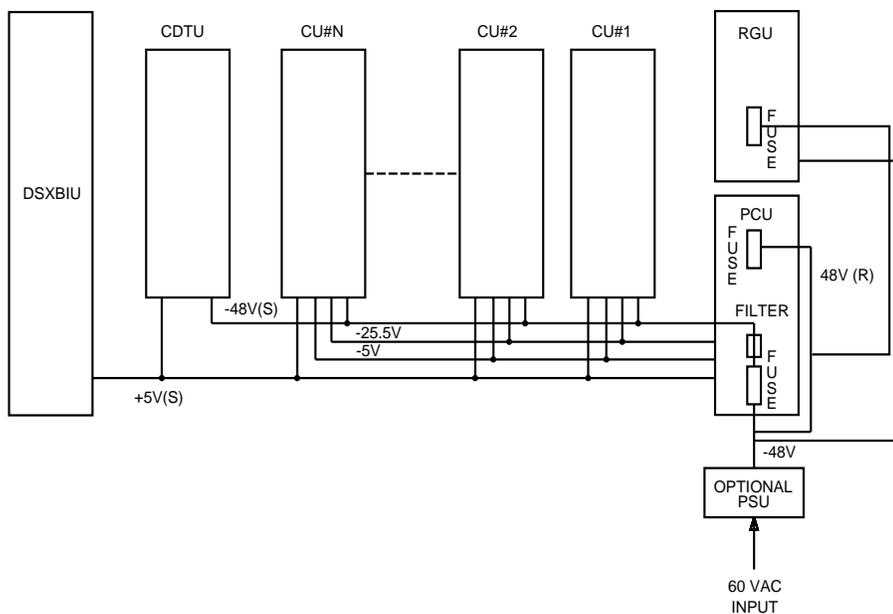
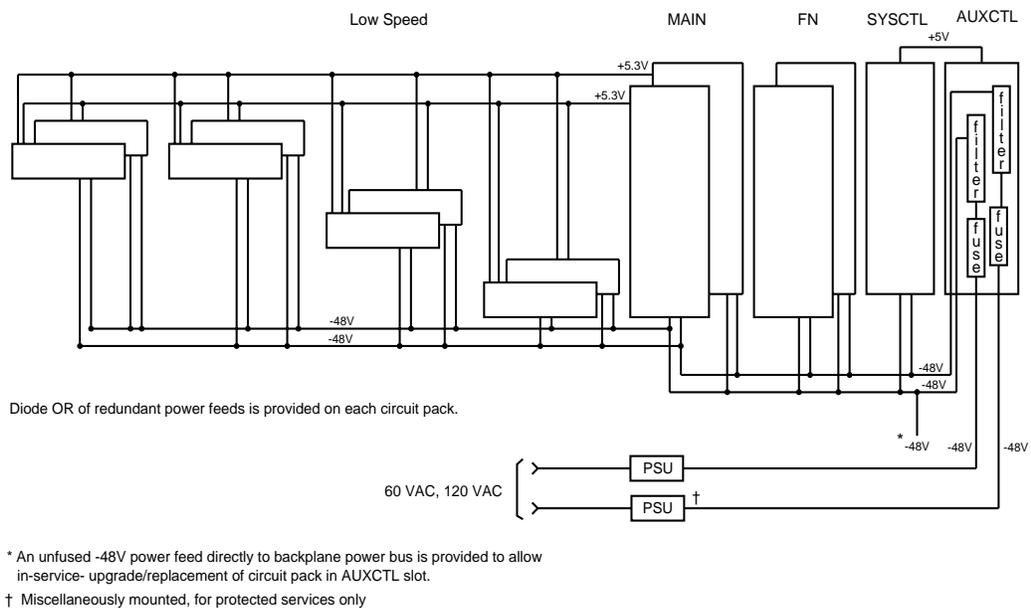


Figure 4-31. DDM-2000 FiberReach Multiplexer Narrowband Shelf Power Architecture

## Other Power Options

The DDM-2000 FiberReach Multiplexer uses miscellaneous mounted power converters to support powering from 60 V AC or 120 V AC sources. These converters supply -48 V to the FiberReach shelf (see Figure 4-32).

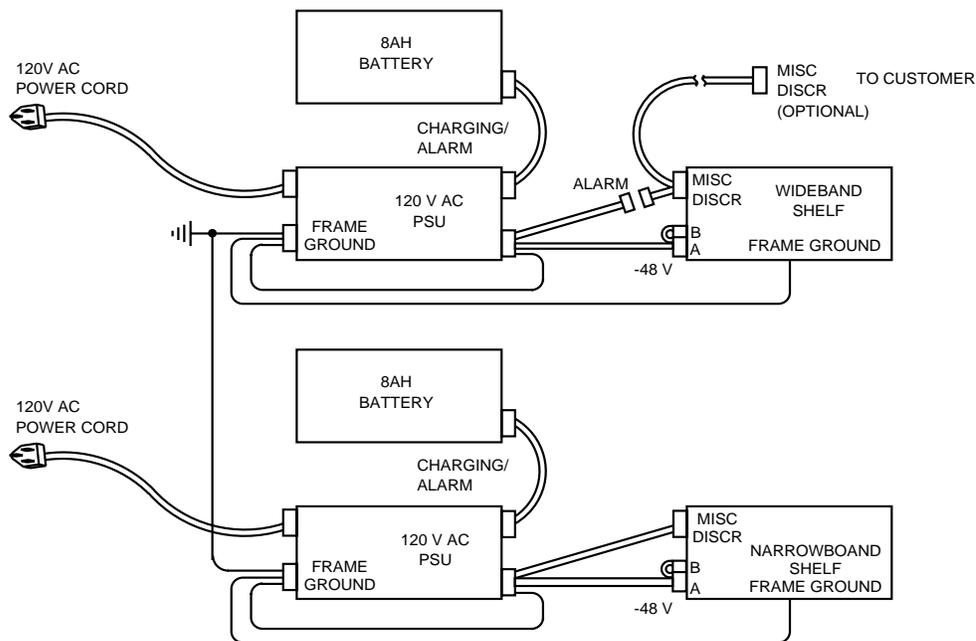
Customer premises locations usually have 120 V AC commercial power from utilities. The 60 V AC is widely used in cable TV applications. The converters are equipped with necessary lightning protection for outside plant applications.



**Figure 4-32. DDM-2000 FiberReach Multiplexer — Other Power Options**

## Wall Distant Terminal Powering

The DDM-2000 FiberReach Multiplexer wall distant terminal (DT) uses bulk power converters to support powering from 120 V AC (see Figure 4-33). This converter supplies -48 V to the FiberReach shelf. Customer premises locations usually have 60 V AC or 120 V AC commercial power from utilities. These powering options provide battery backup for up to 8 hours.

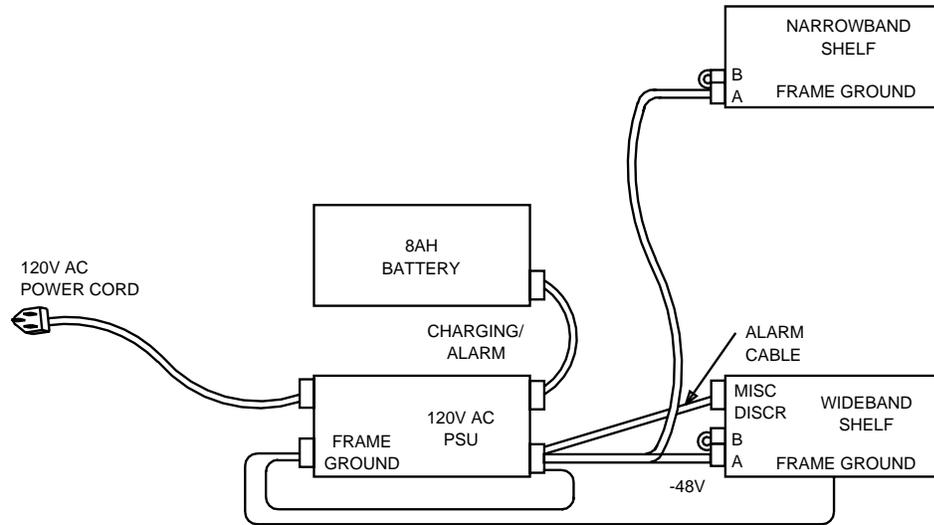


\* ALARM CABLE CAN DIRECTLY ATTACH TO THE MISC DISCRETE CONNECTOR ON WBS. OPTIONALLY IT CAN BE CONNECTED TO A "Y" CABLE THAT INTERFACES WITH THE MISC DISCR CONNECTOR ON THE WBS AND HAS A BRANCH THAT FACILITATES PICK-UP OF ADDITIONAL DISCRETE ALARM INPUTS.

Figure 4-33. Wall DT Powering

### Alternative Wall Distant Terminal Powering

Figure 4-34 shows an alternative power option. Both the wideband and narrowband shelves are powered from a single source.



NOTE: Alarming for this arrangement can be from the wideband shelf (cable ED8C852-20 G7) or from the narrowband shelf (cable ED8C785-20 G9). Optionally it can be connected to a "Y" cable (ED8C852-20 G12) that interfaces with the MISC DISCR connector on the wideband shelf only and has a branch that facilitates pick-up of additional discrete alarm inputs.

tpa 850271/02

**Figure 4-34. Alternative Wall DT Powering**



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# Contents

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# Operations, Administration, Maintenance, and Provisioning

# 5

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## Overview

This section describes the operations, administration, maintenance, and provisioning (OAM&P) functions for the DDM-2000 FiberReach Multiplexer. This includes information on the business carrier access application, as well as the fiber-in-the-loop application. Refer to LTP 824-102-151, *DDM-2000 Multiplexers Operations Systems Engineering Guide*, for operations system engineering information for the DDM-2000 Multiplexers and LTP 824-102-149, *SLC-2000 Access Systems Operations Systems Engineering Guide*, for information for operations system engineering information for the *SLC-2000* System.

DDM-2000's FiberReach Release 3 or later introduces multi-vendor operations interworking (OI) compatibility using TARP instead of the Lucent Directory Service (LDS) protocol. See "Multi-Vendor OI" in this chapter for further information.

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## Wideband Shelf Features

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### Wideband Shelf Maintenance

#### Single-Ended Maintenance Philosophy

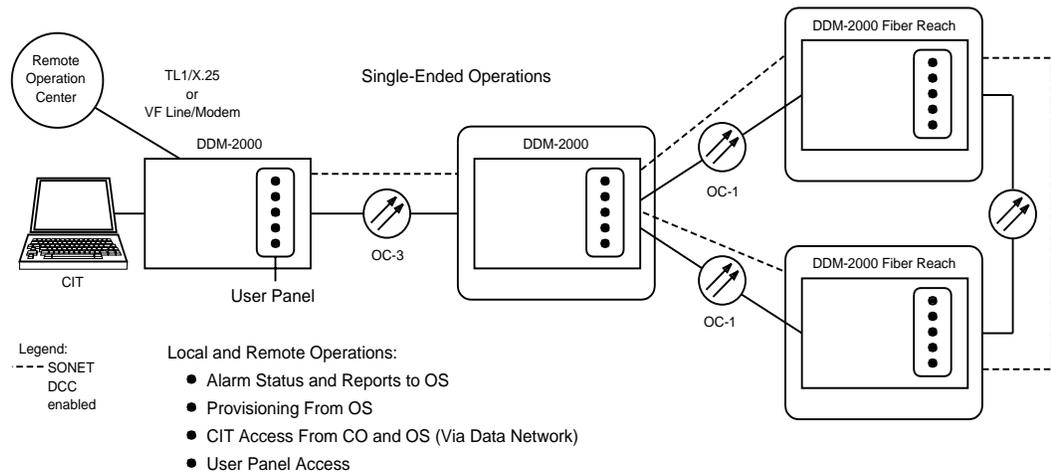
A single-ended maintenance philosophy was originally incorporated in the design of the DDM-2000 Multiplexers as part of their optimization for operation in the subscriber loop. The same philosophy is incorporated in the design of the DDM-2000 FiberReach Multiplexers. DDM-2000 FiberReach Multiplexers allow the

operation of all network elements (NEs) in a subnetwork from anywhere in that subnetwork. In addition, remote operations systems (OS) are available to allow operation of the DDM-2000 Multiplexers from a centralized operations center. The DDM-2000 FiberReach Multiplexers use the synchronous optical network (SONET) data communications channel (DCC) to provide craft interface terminal (CIT), remote CO access, remote alarm reports, user panel remote access, and telemetry remote access. In addition, OSs are available to allow operation of the DDM-2000 Multiplexers from a centralized operations center.

The terms single-ended maintenance and single-ended operations (SEO) are synonymous and have traditionally been used to refer to operations among DDM-2000 systems only. Now that SEO is supported among the 2000 Product Family NEs as well as in multi-vendor applications, the term operations interworking (OI) is more commonly used. OI among multi-vendor NEs is covered later in this chapter.

Figure 5-1 shows the single-ended operations (SEO) capability that provides remote access to all DDM-2000 FiberReach systems in a subnetwork from a single DDM-2000 location. This minimizes technician travel because most maintenance, provisioning, and administration can be performed on all DDM-2000 Multiplexers in a subnetwork by accessing any one DDM-2000. This capability is provided by the DDM-2000 Multiplexers in most subnetwork topologies. The SEO capability is supported for point-to-point, hubbing, rings, and rings with optical extensions topologies. The SEO capability can be disabled between DDM-2000 shelves to create subnetwork maintenance boundaries (for example, interoffice applications) or for security reasons.

All single-ended operations features are also available for *SLC<sup>®</sup>-2000 Access Systems*. See LTP 363-208-000, *SLC-2000 Access System, Applications, Planning, and Ordering Guide*, for more information.



**Figure 5-1. DDM-2000 FiberReach Wideband Shelf Single-Ended Operations Philosophy**

### Three-Tiered Operations

Figure 5-2 shows the three-tiered operation procedures for the DDM-2000 Multiplexers, including DDM-2000 FiberReach wideband shelves. The DDM-2000 FiberReach Multiplexer operation procedures are built on three levels of system information and control, spanning operations needs from summary-level status to detailed reporting.

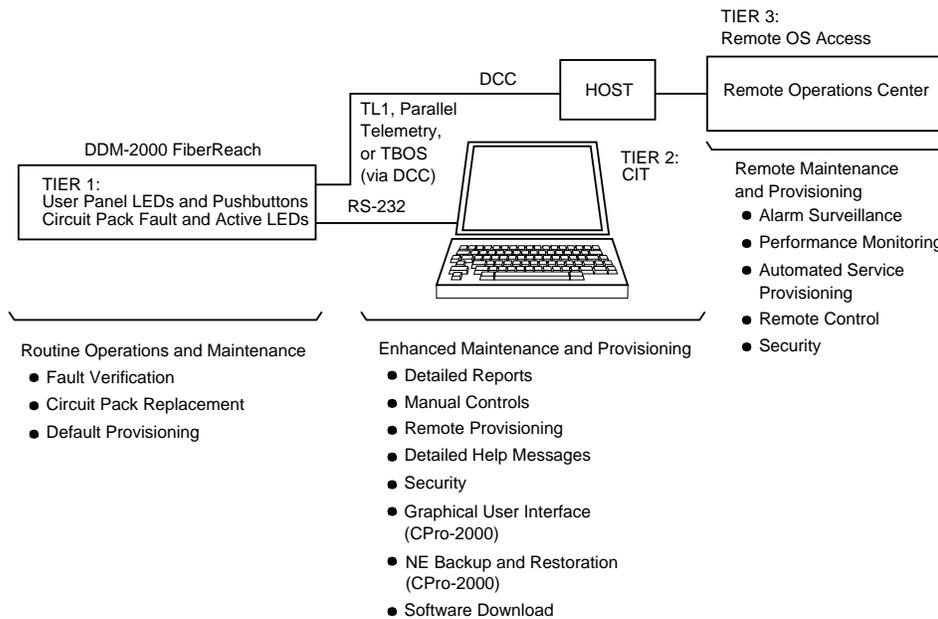


Figure 5-2. Three-Tiered Operations

## User Panel and Faceplate LEDs (Operations Tier 1)

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Office alarms are provided by a set of discrete relays that control office audible and visual alarms. Separate relays handle critical (CR), major (MJ), and minor (MN) alarms, although the CR and MJ alarms can be wire ORed to the office major, if desired. Prior to DDM-2000 FiberReach Release 3, office alarms can be remotely activated through the DCC among remote Lucent 2000 Product Family NEs.

The first operations tier consists of light-emitting diodes (LEDs) and pushbuttons on the user panel and circuit pack faceplates. These allow routine tasks to be performed without a craft interface terminal (CIT) or any test equipment. The user panel provides system-level alarm and status information for both the local and remote\* terminals. The circuit pack faceplate FAULT LEDs allow fast and easy fault isolation to a particular circuit pack.

The user panel LEDs default to show local system information. The highest active alarm level is shown by the red LEDs for CR and MJ alarms; yellow LEDs are shown for MN and power minor (PMN) alarms. A green ACO button/LED is used to activate the alarm cutoff function. When activated, the LED is on. The green ACO button also initiates an LED test when the button is depressed and held. A green PWR ON (PWR ON A and PWR ON B for G4 shelf user panels) LED shows that the power is on and the terminal is receiving a -48 V source. Three yellow status LEDs show abnormal (ABN) conditions, near-end activity, and far-end activity\*. The yellow ABN LED is lighted when a temporary condition, potentially affecting transmission, exists; for example, a manual protection switch or lockout, loopback, or system test in progress.

The UPDATE/INITIALIZE button addresses the local system and is located on the SYSCTL circuit pack. The recessed UPDATE/INITIALIZE button serves several functions during installation and circuit pack replacement. During the first 10 seconds after powering up the SYSCTL circuit pack, depressing this button initializes the nonvolatile memory with provisioning and state information. Secondly, after removing a circuit pack or low-speed input, depressing this button updates the system equipment list to show the slot or signal is now unequipped. Finally, a series of automatic turnup tests are initiated when the UPDATE/INITIALIZE and ACO buttons are depressed in a specific sequence.

The user panel's remote display functions\* serve the single-ended maintenance needs of loop applications. When any alarm or status condition exists at a remote DDM-2000 Multiplexer, the FAR-END ACTIVITY LED on the user panel is lighted. The other user panel alarm and status LEDs, normally set to display composite

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\* Remote and far-end user panel functions are not supported as of DDM-2000 FiberReach Release 3.0.

network conditions, can be manually cycled to display the user panel LEDs from each remote site when the FAR-END SELECT push-button is depressed. A 7-segment numeric display above the FAR-END SELECT push-button identifies the remote system presently displayed on the local user panel LEDs. The display shows a hyphen (-) when the remote system's Site ID is greater than 8. The FAR-END ACTIVITY LED and the FAR-END SELECT push-button are not operational as of FiberReach Release 3.0 or later.

To supplement the user panel's system-level view, each circuit pack provides a red FAULT LED on its faceplate. A lighted FAULT LED shows that the DDM-2000 FiberReach Multiplexer has isolated a failure to that circuit pack. On transmission and synchronization circuit packs, a flashing FAULT LED shows that an incoming signal to that circuit pack has failed. The green ACTIVE LED shows the current protection switching states of the 1x1 protected circuit packs.

## **Craft Interface Terminal (CIT) (Operations Tier 2)**

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The second operations tier provides access to DDM-2000 operations from a CIT over an EIA-232-D interface. System details that can not be obtained from the first operations tier alone can be obtained over the CIT interface. A VT-100 compatible terminal or terminal emulator software running on a PC can be used as a CIT. The dialog is settable to be either CCITT/ANSI MML-compliant, which provides both prompt and command modes with extensive on-line help features for assistance in command execution, or to an asynchronous TL1 interface.

The CIT interface supports OAM&P activities such as loopbacks and testing, protection switching, provisioning, PM, retrieving reports, and security on any and all DDM-2000 Multiplexers in a subnetwork from a single DDM-2000 or FT-2000. The local DDM-2000 or FT-2000 CIT alarm reports may include far-end summary alarm information about other Lucent NEs in the same subnetwork\*. Access to remote DDM-2000 Multiplexers is supported via CIT remote login.

The DDM-2000 FiberReach Multiplexer has a front access CIT port compatible with the EIA-232-D standard. The front access port is configured as a data circuit terminating equipment (DCE) for direct terminal access. The front CIT port provides data rates of 300, 1200, 2400, 4800, 9600, and 19200 baud.

An optional graphical user interface (CPro-2000) software tool used with a PC is also available.

- CPro-2000 is a Windows-based graphical user interface that allows a user to obtain common graphical look-and-feel for DDM-2000, SLC-2000, and FT-2000 products while continuing to have full access to the ASCII CIT and/or TL1 interfaces of those SONET products. CPro-2000 also mechanizes several tasks such as end-to-end path provisioning in path and line switched rings and provides an NE database backup and restoral feature. The CIT ports of the previously mentioned SONET products can be accessed remotely over data networks and/or dial up modems. Consequently, a user can access all Tier 2 operations using just a terminal or CPro-2000 locally or remotely. See Section 11, "Technical Specifications," for hardware and software needed to use CPro-2000. See 190-523-101 and/or 365-576-1xx, *CPro-2000 User Manual*, for more information.

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\* This does not apply to Release 3.0 or later users. Refer to "Multi-Vendor OI" in this chapter.

## **Operations System (OS) Interface (Operations Tier 3)**

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The third operations tier consists of the remote OS interfaces. These OS interfaces include parallel telemetry, telemetry byte-oriented serial (TBOS), miscellaneous discrete telemetry, and a TL1/X.25 interface.

### **Serial Telemetry**

For FiberReach 2.2 and earlier, serial telemetry is provided using the TBOS protocol. TBOS telemetry offers detailed alarm, status, and control (AS&C) information to and from a remote maintenance center, via a 2400-baud RS-422 port. The TBOS AS&C link can be shared among multiple DDM-2000 networks. Since a link has eight displays and each shelf requires one display (each display provides 63 information points [DDM-2000 FiberReach Release to OS] and 64 control points [OS to DDM-2000 FiberReach]), any combination of DDM-2000 FiberReach Multiplexer shelves, not exceeding eight, can be supported on one AS&C link.

### **Miscellaneous Discretes**

To allow monitoring and control of equipment collocated with a DDM-2000 FiberReach Multiplexer in a remote site, a set of user-definable miscellaneous discrete environmental alarms and controls is provided.

Fifteen miscellaneous discrete alarm/status points are provided to monitor environmental conditions at remote terminal sites (open door, high temperature, etc.). The first 14 points are activated by contact closures. The fifteenth point (External Minor) is for monitoring of remote structure power and fan apparatus (for example, DC power shelf failure): this point is activated by a -48 volt input.

Four control points are provided to control equipment (pumps, generators, etc.) at remote terminal sites. When activated, the control points provide a contact closure between the control point output and ground.

Miscellaneous discrete alarms/statuses and controls are transmitted between the remote DDM-2000 FiberReach Multiplexers and the DDM-2000 OC-3 Multiplexer host via the SONET section DCC. OS access to all miscellaneous discretes alarm/status points (1 through 15) is provided via TL1/X.25 and access to input point 1 through 15 is available through TBOS. OS access to inputs 1 through 9 and point 15 is provided through a parallel telemetry output interface at the DDM-2000 Multiplexer at the CO. Input point 15 is sent to parallel output point 10 to provide External Minor. Access to all miscellaneous discrete alarm/status points is also provided through the CIT. The state of the control points can be reported but not controlled through the CIT.

## TL1/X.25



**NOTE:**

The FiberReach wideband shelf does not provide a direct X.25 interface. Access to the X.25 port on a gateway NE is via the DCC.

DDM-2000's TL1 message-based OS interface provides more detailed reporting and control capabilities than the parallel and serial telemetry interfaces. The interface uses the standard X.25 protocol and needs no mediation device; that is, the interface can be connected directly to an X.25 network. The virtual channels in the X.25 link can be used to provide remote access between users and DDM-2000 via a packet data network. The remote user could be an OS or a user at a terminal. Lucent Technologies is involved in an active OSMINE process to ensure compatibility of DDM-2000 FiberReach Multiplexers with Telcordia Technologies OSs. The DDM-2000 supports TL1 alarm surveillance and performance monitoring with OSs such as Telcordia Technologies's Network Monitoring and Analysis (NMA). The DDM-2000 supports service provisioning with memory administration OSs such as Lucent's ITM SNC\* or Telcordia Technologies's OPS/INE. (FiberReach 4.0 will be supported by TEMS.) The DDM-2000 also supports remote recovery and control functions, installation provisioning, and security over the TL1/X.25 link. The TL1 message set used has been updated to offer full remote reporting and control capabilities. This functional equivalency between the CIT and TL1 allows the option of using either the CIT or TL1 for provisioning tasks, whichever is more convenient. See 824-102-151, *DDM-2000 Multiplexers Operations Systems Engineering Guide*, for more information about OS interfaces.

The OS can use more than one NE as a GNE to provide redundancy and/or to distribute TL1 message volume across multiple X.25 links. The TL1/X.25 GNE serves as a single interface to the OS for the NEs in the same subnetwork. The TL1/X.25 GNE receives operations information from all the NEs through the DCC and reports this information, as well as its own information, to the OS. The operations information is in the form of TL1 messages. Through the GNE, the OS can send TL1 commands to any NE in the subnetwork. FT-2000 OC-48 Lightwave Systems can serve as the TL1/X.25 GNE for DDM-2000 NEs, but not vice versa until DDM-2000 OC-3 Release 13.0 and later, and OC-12 Release 7.0. For DDM-2000 FiberReach 3.0 and higher, Tellabs TITAN 5500/S R5.0 DCS, or other-vendor NEs that adhere to Telcordia Technologies GR-253, can be the TL1/X.25 GNE. DDM-2000 FiberReach can not be a TL1/X.25 GNE itself.

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\* The Integrated Transport Management SubNetwork Controller (ITM SNC) is an element management system that supports SONET NEs. ITM SNC provides fault, provisioning, configuration, and security management functions via a GUI.

## Lucent 2000 Product Family OI

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OI provides the capability to access, operate, administer, maintain, and provision remote Lucent NEs from any Lucent NE in a subnetwork or from a centralized OS. OI among the Lucent 2000 Product Family uses Lucent Directory Services (LDS) and is applicable for DDM-2000 FiberReach Release 2.2.

Other Lucent NEs that support OI includes FT-2000 OC-48 Lightwave System Release 6.0 through 7.2, DDM-2000 OC-3 Releases 7.2 through 11.x and OC-12 Releases 5.x, and the SLC-2000 Access System. Refer to the OI Software Compatibility table, Table 5-1 in this chapter. More compatibility information is provided in 824-102-147, *Lucent Technologies 2000 Product Family Operations Interworking Guide*.

Lucent 2000 Product Family OI is available among Lucent NEs that are connected through the SONET DCC in Lucent-only subnetworks. With this feature, users can do OAM&P on a centralized basis, saving travel time and money.

Lucent 2000 Product Family OI features include the following:

- Remote OS access
  - Parallel telemetry
  - Serial telemetry
  - TL1/X.25
- Remote login (remote technician access)
- Remote office alarms, alarm CIT reports, and user panel
- Remote software download and copy

## Directory Services Network Element (DSNE)

Lucent's 2000 Product Family supports open systems interconnection (OSI) 7-layer protocol stack architecture over the SONET DCC. This architecture requires network layer 3 identifiers called network service access points (NSAPs) for addressing NEs, while users at remote OSs and at NE CITs use application layer 7 identifiers called target identifiers (TIDs). The NE in each Lucent 2000 Product Family subnetwork that translates between NSAPs and TIDs is called the directory services network element (DSNE) (with the exception of DDM-2000 OC-3 R13, OC-12 R7.0, and all other TARP releases). The maximum number of DSNEs per subnetwork is 1.

Any Lucent NE in a subnetwork except a FiberReach node can act as a DSNE. Lucent 2000 Product Family NEs added to a subnetwork are automatically registered by the DSNE and have access to all OI features.

## Alarm Groups

An alarm group is a set of NEs that share status information between themselves. This status information includes:

- Alarm/status level
- User panel status
- ACO status
- TBOS status
- Parallel telemetry status
- Miscellaneous discrete information

The set of remote NEs with which an NE can exchange status information is determined by the value of the local alarm group parameter. This parameter is provisioned at each local NE and specifies whether that local NE does or does not exchange remote NE status with other Lucent NEs in the same subnetwork. In DDM-2000 FiberReach Release 2.2, all NEs are defaulted into the same alarm group (number 255).

Alarm groups can be nodes in a ring, nodes of a linear extension, nodes of an OC-12 service, or any other logical grouping such as a maintenance group or geographical group. For example, 24 NEs could be provisioned into three alarm groups each with eight NEs that share a community of interest such as the same TBOS interface (TBOS not applicable to DDM-2000 OC-3 R13.0 or later, DDM-2000 OC-12 R7.0 or later, and FiberReach R3.0 or later).

All members of the same alarm group share NE status information but do not share information with other alarm groups.

Depending on provisioning, a member of an alarm group can:

- Know the alarm/status of all members of the same alarm group and, if the NE is at the CO, activate audible office alarms for the alarm group.
- List a report of the summary alarm or status condition of other NEs in the group.
- Display composites of other members' user panel information. If the site identification of a remote NE is from 1 to 8, display the user panel status at the site instead of a composite display. As a feature, the same site/NE identification can appear more than once in a subnetwork, as long as it is in different alarm groups. This supports creating large networks by interconnecting several small subnetworks without having to change the site/NE identification. This feature is not applicable to DDM-2000 OC-3 R13.0, FiberReach R3.0, and DDM-2000 OC-12 R7.0.

- Relay other members' parallel telemetry alarm/status closure states to the OS (not applicable to DDM-2000 OC-3 R13.0, FiberReach 3.0 and later, and DDM-2000 OC-12 R7.0).
- Send and receive miscellaneous discrete alarm/status closure states to and from alarm group members at a CO.
- Send and receive ACO requests to and from members of the same alarm group with the same site number. This supports the ability for a user to activate ACO for a group of NEs having the same site number and subnetwork connectivity to another member NE in the group (not applicable to DDM-2000 OC-3 R13.0 and DDM-2000 OC-12 R7.0). In DDM-2000 OC-3 R15.0 and in FiberReach R4.0, only local ACO is supported.

### **Alarm Gateway Network Element (AGNE)**

Members of an alarm group exchange information through one or more alarm gateway NEs (AGNEs) (with the exception of DDM-2000 OC-3 R13.0, OC-12 R7.0, and FiberReach R3.0 and R3.1) that are defined in the same alarm group. The AGNE(s) and remote NEs use the DCC to receive and report alarm and status information from and to all Lucent NEs in the same alarm group. The AGNE rebroadcasts all alarm and status information from one NE to all the other NEs in the same alarm group. This information is used to activate remote user panel LEDs, CIT far-end summary alarm reports, and remote office alarms for each NE in the alarm group. At least one NE in each alarm group must be provisioned as the AGNE; an additional AGNE can be provisioned for redundancy. Considerations for choosing an NE as an AGNE include being central to the group to minimize communications links and being easily accessible for maintenance purposes.

For subnetworks having more than 16 NEs, the AGNE, DSNE and TL1/X.25 GNE should be separate NEs. The AGNE is a "collection point" and does not have to be a NE in a CO, for example.

### **Multi-Vendor OI**

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To support multi-vendor OI, DDM-2000 FiberReach R3 or later supports Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 OC-3 R13.0 or later, OC-12 R7.0, and FT-2000 OC-48 R8.0 also support TARP, thus Lucent 2000 Product Family OI compatibility is still supported but not OI compatibility with previous releases of DDM-2000 and FT-2000. (Refer to the OI Software Compatibility Table.) Both LDS and TARP are directory services that provide NSAP-TID translations. LDS supports additional Lucent-only features, but TARP is the established multi-vendor standard for SONET NEs that

support TL1 OS interfaces. DDM-2000 supports the TARP Data Cache (TDC) function to reduce the frequency of TARP propagation throughout the subnetwork and to improve performance. No DSNE is required for TARP.

DDM-2000 FiberReach is developed to be compatible with any other-vendor NEs that also support TARP, OSI, and TL1/X.25 as specified in Telcordia Technologies GR-253. In addition, DDM-2000's TARP Manual Adjacency feature enables DDM-2000 to operate in networks that include CMISE-based NEs which may not support TARP propagation. DDM-2000 FiberReach supports user provisioning of several OSI parameters to allow users to adjust their operations subnetwork, if necessary. For example, to support subnetwork partitioning of large subnetworks, DDM-2000 FiberReach supports user provisioning of NSAP area addresses. DDM-2000 FiberReach does not support Level 2 Intermediate System (IS) functionality itself.

DDM-2000 FiberReach Release 3.0 and later offers compatibility with Tellabs *TITAN*\* 5500 DCS R5.0, including TL1/X.25 OS access with TITAN 5500 DCS serving as the TL1-GNE for DDM-2000 FiberReach TL1-RNEs, has been confirmed through cooperative joint testing between Lucent and Tellabs. DDM-2000's compatibility with some other-vendor NEs has also been tested by independent third-parties such as Telcordia Technologies on behalf of the SONET Interoperability Forum (SIF).

Because DDM-2000 FiberReach Release 3.0/3.1 is intended to facilitate OS-based centralized operations, and because TL1/X.25 OS access is the key standardized multi-vendor OI application, the following Remote NE Status features are not supported in DDM-2000 FiberReach 3.0/3.1:

- Remote office alarms
- Remote CIT alarm reports
- Remote user panel indications
- TBOS
- Parallel telemetry

DDM-2000 FiberReach Release 4.0 supports the following Remote NE Status features:

- Remote office alarms
- Remote CIT alarm reports

The following Remote NE Status features are not supported in DDM-2000 FiberReach Release 4.0:

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\* *TITAN* is a trademark of Tellabs, Inc.

- Remote user panel indications
- TBOS
- Parallel telemetry
- Remote ACO Requests

All of the above features depend on the proprietary exchange of information among Lucent NEs in a subnetwork, specifically the communication of each remote NE's alarm status to other NEs. Although the Remote NE Status features were supported in previous releases of DDM-2000, such Lucent-only operations features in multi-vendor subnetworks would not include other-vendor NEs, due to the lack of applicable standards, and thus would be incomplete.

DDM-2000 FiberReach 3 and later still supports the following Lucent proprietary OI applications between Lucent NEs in multi-vendor subnetworks:

- Remote Craft Interface Terminal (CIT) login
- Remote software download and copy
- Remote NE-to-NE automatic time/date synchronization at start-up

For more information about DDM-2000 FiberReach Release 3.0/3.1 OI, refer to 824-102-144, *Lucent Technologies 2000 Product Family Multi-Vendor Operations Interworking Guide*.

## Maintenance Signaling

Alarm indication signals (AIS) are maintenance signals that notify equipment (downstream from a failure) that the failure has been detected and alarmed by some upstream equipment. Yellow or far-end-receive failure (FERF) signals notify upstream equipment that downstream equipment has detected a failure in the transmit path of the upstream equipment.

Maintenance signaling is compliant with SONET (Telcordia Technologies TR-TSY-000253) and asynchronous (Telcordia Technologies TR-TSY-000191) network requirements. Alarm indication signals include SONET line AIS, STS-1 path AIS, virtual tributary (VT) path AIS, DS3 AIS, and DS1 AIS. Yellow signals include STS-1 path yellow and VT path yellow. Other maintenance signals include line (FERF), STS-1 path unequipped, and VT path unequipped.

## **Fault Detection, Isolation, and Reporting**

The DDM-2000 FiberReach wideband shelves continuously monitor incoming signals and internal system conditions. Incoming SONET signals are monitored for loss of frame (LOF), loss of pointer (LOP), line AIS, path AIS, bit error ratio (BER) thresholds, and maintenance signals. The loss of signal (LOS) and BER threshold crossings are detected for incoming DS1 signals.

When an internal fault is detected, automatic diagnostics isolate the faulty circuit pack. Faults are reported to local technician and operations systems so that technician dispatch and repair decisions can be made. If desired, the network maintenance personnel can retrieve more detailed information through the CIT or OS interface.

All fault conditions detected by the system are stored and made available to be reported, on demand, through the CIT and OS interfaces. In addition, a history of past alarm and status conditions and CIT events is maintained and available for on-demand reporting. Each event is real time and date stamped.

The system also automatically and autonomously reports all detected alarm and status conditions through the office alarm relays, user panel and equipment LEDs, parallel telemetry\*, serial telemetry scan points\*, and TL1 message-based OS interface.

## **Loopbacks and Testing**

The DDM-2000 FiberReach wideband shelves allow technicians to perform loopback tests on all low- and high-speed interfaces. Low-speed DS1 electronic loopbacks, directed toward the high-speed OC-1, are individually controllable from the CIT. Active electronic loopbacks are shown by the abnormal (ABN) LED on the user panel and in the alarm and status report.

Front access to the optical connectors on the optical line interface unit (OLIU) circuit pack allows easy manual optical loopback. This loopback is performed by connecting a fiber jumper from the OLIU circuit pack output to its input. The OLIU requires a lightguide buildout assembly when performing an OC-1 loopback and has universal optical connector receptacles like the 22G-U OLIU.

Technicians can use the internal testing capabilities for installation and manual troubleshooting. The DS1 test signal generators and detectors are integrated in the system, eliminating the need for external test equipment to perform transmission tests. Each test returns a good/fail result. The test results are also reported to the CIT or TL1 user at the end of the test.

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\* Not applicable for Release 3.0 or later.

The DDM-2000 FiberReach Multiplexers also allow technicians to test for specific signals and system components. For example, technicians can manually enable the integrated test signal generators and detectors for a DS1 low-speed interface. These signal tests can be run selectively in the end-to-end or demultiplex direction. In addition to the automatic diagnostics, the DDM-2000 Multiplexers also provide tests for LEDs, telemetry points\*, office alarms, and the system controller (SYSCTL) circuit pack.

## **Wideband Shelf Protection Switching**

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### **Path Protection Switching (Path-Switched Rings)**

The DDM-2000 FiberReach Multiplexer Wideband Shelf supports path-switched ring applications, using the path protection switching schemes described in Telcordia Technologies TR-TSY-000496. This scheme offers 60-millisecond restoration times and simple network administration for access applications. The ring facility consists of two fibers, with service and protection rotating in opposite directions. Each low-speed input is duplicated and transmitted in both directions around the ring. The receiving end terminal monitors the quality of both signals and selects the best signal to drop to its low-speed interface. Path selection occurs on the VT1.5 level for DS1 services.

Path protection switching is nonrevertive. A manual path protection switching command allows switching back to the original path for ease of ring maintenance. Path switching is triggered by incoming LOS, AIS, VT1.5, or STS-1 path BER exceeding  $10^{-3}$  or a user-settable signal degrade threshold. Technician control of path protection is provided manual switch commands.

### **Equipment Protection**

The DDM-2000 FiberReach Multiplexer Wideband Shelf provides very flexible low-speed equipment protection schemes to accommodate mixed services applications. The schemes include 1X1 protected or 1x7 protected configurations, provisionable by the user. Provisioning is done at installation using a low-speed protection assembly on the backplane. The protection scheme can be changed (for example, upgrading from 1x1 to 1x7) but must be done out-of-service by replacing the protection bus module on the rear shelf. See Section 6, "System Planning and Engineering," for more information.

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\* Not applicable for Release 3.0 or later.

## **SLC 96 Carrier Protection Switching Provisioning on the Wideband Shelf**

This feature translates an incoming DS1 bipolar violation alarm into an outgoing DS1 loss of signal (all zeros). The *SLC* carrier system central office terminal (COT) will detect this loss of signal and initiate protection switching of the DS1. This feature allows the standard *SLC* 96 carrier system protection scheme to work through the fiber transports provided by the DDM-2000 terminals without the use of subscriber loop interface module (SLIM) terminals.

## **Performance Monitoring Parameters**

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The DDM-2000 FiberReach Multiplexer uses performance monitoring (PM) to support proactive maintenance of the network and tariffed service performance verification. Proactive maintenance refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming but indicative of an impending hard or soft failure. Hard and soft failures result in reactive maintenance.

Operative maintenance consists of monitoring performance parameters associated with the SONET sections, lines, and paths within the SONET network. Refer to the "Performance Monitoring Parameters Provisionable via the CIT" table in Chapter 10 for a list of the SONET performance-parameters monitored by DDM-2000. These parameters are thresholded to indicate degraded performance. When a performance-monitoring threshold is crossed, it is reported to the message-based operations system where all threshold crossings associated with a particular path can be correlated, and the likely source of the degradation can be identified.

## **DS1/T1 Carrier Performance Monitoring**

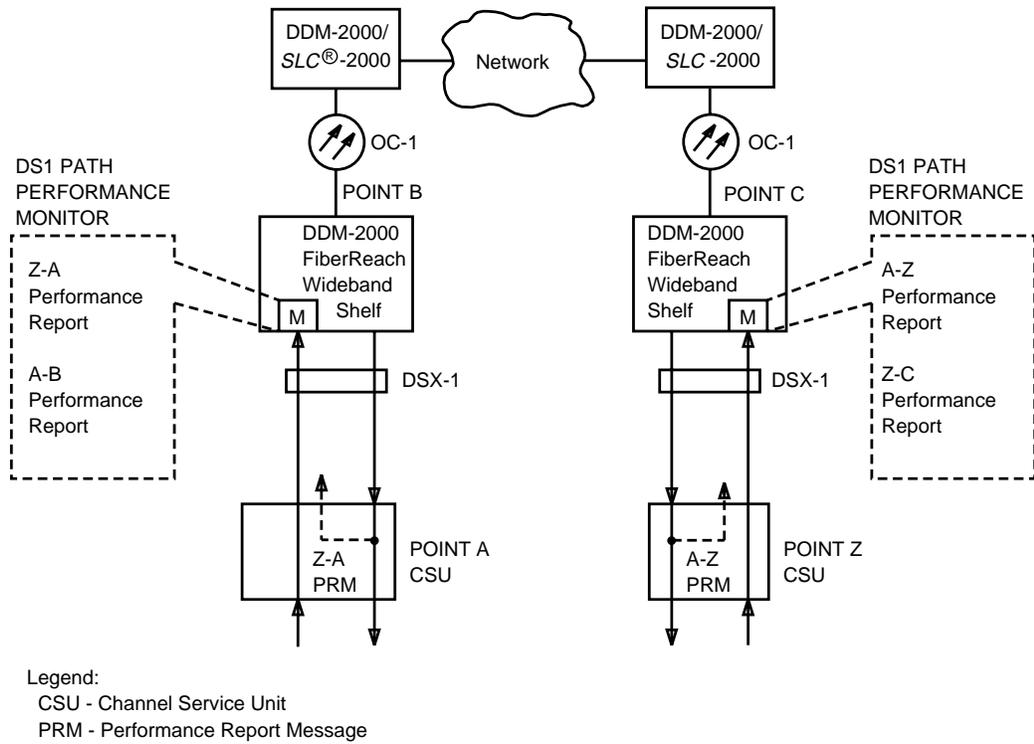
Tariffed service verification consists of monitoring performance parameters that can be associated with the customer's end-to-end service. The DDM-2000 Fiber Reach provides this capability for DS1 services with the DS1 performance-monitoring feature. Based on *ANSI*<sup>\*</sup> T1.403 extended superframe format (ESF), this capability retrieves performance report messages written into the ESF data link by the customer's terminal equipment. From these messages, the DDM-2000 FiberReach can determine and report the end-to-end error performance of the entire DS1 link as seen by the customer. These parameters, listed in "Performance Monitoring Parameters Provisionable via the CIT" table in Chapter 10, are thresholded and reported to indicate degraded performance, and the counts are retrieved by the message-based operations system to determine if the service is operating within tariffed limits.

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\* Registered trademark of American National Standards Institute.

Application of the DS1 performance-monitoring feature for tariffed service verification is shown in Figure 5-3. Figure 5-3 shows an ANSI/T1.403 ESF format DS1 service carried between points A and Z, using a DDM-2000 FiberReach wideband OC-1/OC-3 system and terminated at the customer's premises with channel service units (CSUs). At the "A" end, the received error performance (Z - A) is detected and written by the customer's CSU on to the outgoing (A - Z) ESF data link as a performance report message (PRM). The DS1PM circuit pack interfacing the "A" end reads the incoming DS1 signal's PRM (received from the customer's premises) and reports the Z - A performance. Likewise, the DDM-2000 FiberReach system interfacing the "Z" end reports the A - Z performance by reading the PRM from the customer's "Z" CSU. By reviewing the data from each DDM-2000 FiberReach, the service provider can determine the complete end-to-end performance (A - Z and Z - A) of the customer's service.

Additionally, each DS1PM circuit pack measures the near-end performance of the incoming DS1, allowing the service provider to determine if a good DS1 signal was received from the customer before transporting it through the network. This information can then aid in sectionalizing any reported performance problems. The DS1PM circuit pack can also provide this same near-end information for super frame (SF) formatted (also known as D4 framing) DS1 services, but complete end-to-end performance verification is limited due to the lack of the PRM in the SF format. The T1EXT circuit pack also supports DS1 performance monitoring for tariff verification.



tpa 843624/01

**Figure 5-3. DDM-2000 FiberReach DS1 Path Performance Monitoring**

## **Performance-Monitoring Data Storage**

The DDM-2000 FiberReach Multiplexers provide current quarter-hour and current day registers for all accumulated performance parameters. The previous 8 hours of quarter-hour and previous day registers also are provided. The DDM-2000 FiberReach Multiplexers can initialize these registers locally or remotely at any time, as well as retrieve and report their contents.

## **Performance Parameter Thresholds**

The current quarter-hour and current day thresholds for each parameter type are provisionable on a per shelf basis. If values other than the defaults are used, only one value for each parameter type needs to be set. Whenever the current quarter-hour or the current day threshold for a given parameter is exceeded, the DDM-2000 FiberReach Multiplexer generates a threshold-crossing alert (TCA) that is entered into the performance-monitoring exception report and reported to the OS.

## **Threshold-Crossing Alert (TCA) Reporting to OS**

The TCA information may be reported to the OS, using serial telemetry\* or the message-based operations system TL1 interface. A TCA can be used to trigger proactive maintenance activity at the OS.

Each alarm, status, and control (AS&C) TBOS display contains a summary performance-monitoring TCA point. This performance summary point shows a threshold crossing for any monitored parameter in the current quarter-hour or day.

The message-based OS interface should be used to derive full benefit from the DDM-2000 FiberReach Multiplexer's performance-monitoring capabilities. The full set of performance-monitoring data stored by the DDM-2000 Multiplexers (TCAs and the contents of PM registers) is provided through the Telcordia Technologies Network Monitoring and Analysis (NMA) compatible TL1 interface.

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\* Serial telemetry is supported by software Release 2.x and earlier only.

## **Wideband Shelf Provisioning**

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The DDM-2000 FiberReach Multiplexer allows the user to customize many system characteristics through provisioning features. Provisioning parameters are set by a combination of on-board switches and software control.

Only those system parameters fixed at installation time (for example, DS1 line buildouts) are set with on-board switches. Some parameters needed for typical installations, such as line coding, that may need to change later are settable by switches and overridable by software. This allows typical installations to be performed without a CIT. Other parameters that require a wide range of options or in-service changes must be set under software control. For example, PM thresholds and VT1.5 cross-connections can be customized for each installation using the CIT interface.

## **Default Provisioning**

Installation provisioning is minimized with thoughtfully chosen default values set in the factory. Every parameter has a factory default value. These factory defaults for software parameters are maintained in the SYSCTL circuit pack, and a single CIT command is provided to restore all default values. All provisioning data is stored in nonvolatile memory to prevent data loss during power failures and maintenance operations.

## **Remote Provisioning**

Software control allows remote provisioning of DDM-2000 FiberReach Multiplexers. This feature is provided especially for provisioning parameters likely to change in service in support of centralized operations practices.

## **Automatic Provisioning on Circuit Pack Replacement**

Replacement of a failed circuit pack is simplified by automatic provisioning of the original circuit pack values. The SYSCTL circuit pack maintains a provisioning map of the entire shelf so when a transmission or synchronization pack is replaced, the SYSCTL circuit pack automatically downloads the correct values to the new circuit pack. Likewise, if the SYSCTL circuit pack is ever replaced, the correct provisioning data from every other circuit pack in the shelf is automatically uploaded to the new SYSCTL circuit pack's nonvolatile memory.

## **Port State Provisioning**

Port state provisioning is a feature provided on DDM-2000 FiberReach Multiplexers that suppresses alarm reporting and PM by supporting multiple states [automatic (AUTO), in service (IS), and not monitored (NMON)] for DS1 ports.

Ports without signals (undriven) are in the automatic state until changed to the in-service state when a signal is present. Commands allow a user to retrieve and change the state of a port to the not monitored state or from the not monitored state to the automatic state.

## **Channel State Provisioning**

Automatic channel state provisioning is a capability provided on DDM-2000 FiberReach Multiplexers that suppresses reporting of transient alarms and events during provisioning by supporting multiple states (AUTO, IS, NMON) for VT1.5 and STS-1 channels.

While an end-to-end circuit is being set up, particularly during VT1.5 cross-connect provisioning, several transient maintenance signals result. Without automatic channel state provisioning, these are reported as alarms and events. The technicians are expected to ignore these transient alarms and initiate corrective action only if the alarms persist after the provisioning is completed. To avoid the confusion created by this, DDM-2000 FiberReach provides automatic channel state provisioning.

A VT1.5 or STS-1 channel is kept in the default AUTO state until the reception of a valid signal (a framed non-AIS or non-LOP signal) in that channel. While in AUTO state, no alarms or events are reported on the channel by the DDM-2000 FiberReach Multiplexer. On receiving a valid signal, which occurs when the end-to-end circuit is completely provisioned, the channel automatically changes to the IS state, where it resumes normal alarm and event reporting. An additional state, NMON, is also supported. NMON specifies that alarm and event reporting is suppressed, regardless of the validity of the signal being received on the channel. Like the port state provisioning capability already provided for DS1 ports, the user can use CIT commands to manually change a channel from IS or AUTO to NMON, and from NMON to AUTO. A direct change from NMON to IS is not allowed.

## **Wideband Shelf Reports**

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### **Alarms and Statuses**

The system provides an alarm report that lists all active alarm and status conditions. A description of the condition (for example, controller failure, incoming high-speed signal failure, synchronization reference failure, etc.) is included in the report along with a time stamp indicating when the condition was detected, its severity, and whether it is service affecting or not. The option to display specified subsets of alarm conditions is provided (for example, critical alarms only).

Status conditions include:

- Manually initiated abnormal conditions (for example, manual protection switching, manual lockouts, loopbacks, system testing)
- Automatic protection switching status (equipment and path switching)
- Incoming alarm indication signal (AIS) detected
- Incoming far-end-receive failure (FERF) detected
- Alarm cutoff (ACO) active

A description of the status condition (for example, DS1 loopback active, DS1 protection switch active, etc.) is included in the report along with a time stamp indicating when the condition began.

## **Performance Monitoring**

### **TCA Summary Report**

The system provides a report that lists the number of performance-monitoring parameters that have crossed their thresholds. This report provides a snapshot of the system performance level. If there is a signal degradation, it is quickly pinpointed so that corrective action may be taken before customers are affected, thus supporting proactive maintenance.

This report provides separate parameter summaries for each signal level in the system (optics, section, line, and path). The parameter summaries show the user which performance status reports to request if they want further information.

### **Performance Status Reports**

These reports provide a detailed profile of the current and previous eight hours in quarter-hour (15-minute) increments, as well as the current and previous day's performance. Threshold-crossing alerts are clearly identified, and the time the performance registers were last initialized is also shown. Any registers that may have been affected by this initialization are marked. There are separate reports for optics plus section, line, and path parameters.

## **Event History**

An event history report containing the past alarm, status, protection switching, and user (CIT and TL1) interaction (for example, provisioning, loopback request, manual protection, etc.) events is provided. This summary contains time stamps indicating when each condition was detected and when it cleared. CIT and TL1 events contain a time stamp indicating when the command was entered. See the user/service manual for details on the history log.

## States

The state report shows the state of the following:

- Slots in the system (equipped or AUTO)
- Individual low-speed channels (NMON, IS, or AUTO)
- Individual ports (NMON, IS, or AUTO)
- Protection switching state of protected equipment (active or standby)
- Protection switching state of the protected paths (active or standby)

AUTO refers to a slot that is available for automatic provisioning.

## Provisioning

The provisioning reports contain the current values of all electronically provisionable parameters and switch-selectable parameters.

## Version/Equipment List

The DDM-2000 FiberReach Multiplexer (applies to both narrowband and wideband) provides a full inventory report on all hardware and software installed in local and remote systems. The following information is reported:

- Circuit pack name
- Ten-character common language *CLEI*<sup>\*</sup> code
- Six-digit equipment catalog item (ECI)
- Ten-character apparatus code
- Six-character series number
- Twelve-character serial number (includes date and location of manufacture)
- Six-digit program version (software generic) code

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\* COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Telcordia Technologies.

## Wideband Shelf Administration

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### Software Upgrades

The DDM-2000 FiberReach wideband shelves provide an in-service software installation capability to update the generic program in local and remote systems. In-service software installation is done via the CIT port on local systems and via the host on remote systems. Upgrades are distributed on MS-DOS formatted diskettes, containing the new software and an installation program. These software upgrades are the primary mechanism to add new feature enhancements to the in-service DDM-2000 FiberReach network. All software upgrades are in service and do not affect any provisionable parameters. For example, cross-connections are left unchanged by the software upgrade.

The software upgrade can be performed locally via the CIT port on the local FiberReach wideband shelf or remotely via the SONET DCC. In either case, the procedure is straight forward. The technician connects an MS-DOS personal computer serial port to the CIT port on the DDM-2000 FiberReach (for local upgrades) or to the CIT port of another DDM-2000 in the subnetwork (for remote upgrades), starts the installation program, and is prompted with a few safety questions before the upgrade installation actually begins. After the technician confirms to proceed, the PC takes over the process and completes the installation. When finished, the DDM-2000 FiberReach shelf automatically restarts with the new software.

On command, the new software may be copied from the upgraded system to other systems over the DCC, allowing software version changes without having to dispatch technicians to any remote site. Because FiberReach Release 3.0/3.1 is not OI-compatible with earlier releases of FiberReach, FiberReach Release 3.0/3.1 software can **not** be copied (NE-NE) to a FiberReach Release 2.2 or earlier NE. Refer to the *Lucent Technologies 2000 Product Family Multi-Vendor Operations Interworking Guide*, 824-102-144.

### Data Base Backup and Restoral

The DDM-2000 FiberReach databases can be backed up and restored from a file using CPro-2000 to protect valuable system information after a catastrophic failure. Catastrophic failures may include:

- Shelf destruction by fire, hurricane, flood, or other natural event or intentional damage
- Cabinet housing the shelf damaged by a vehicle
- Manual errors during provisioning or maintenance

The backup can be done using CPro-2000 through the CIT port on any shelf in the subnetwork to all DDM-2000 FiberReach shelves in the same subnetwork or from the host. The information that can be backed up and restored includes:

- Major NE provisionable parameters on the circuit packs and line ports
- Cross-connections
- Performance thresholds

In addition, the following information is backed up for reference only, and will not be restored by CPro-2000:

- Target identifier (TID)
- Software version
- System equipage
- Software readable hardware switch settings
- User names

These parameters are either not settable or should be set manually before or after restoration by CPro.

The database backup and restoral capability of CPro-2000 can be used to significantly simplify the installation of several shelves having similar or identical configurations. See 190-523-101 and/or 365-576-1xx, *CPro-2000 User Manual* for more information.

## Security

The DDM-2000 FiberReach Multiplexers offer security against unauthorized access to system functions. The use of security is provisionable for the CIT port and through the DCC and is always required for the TL1 user. In addition, the DCC can be disabled, thus securely isolating that DDM-2000 FiberReach from possible remote intrusion.

Four types of users are able to access the DDM-2000 FiberReach wideband shelf. They are as follows:

- Privileged Users: These users have access to all commands, including restricted commands. Privileged users may set system security and assign login and password pairs to general and reports-only users.
- General Users: These users have access to all commands, except restricted commands.

- Maintenance-Only Users: These users (available in Release 2.2 and later) have access to basic commands and maintenance commands only (for example, loopbacks and forced switches) but cannot execute any provisioning commands or restricted commands.
- Reports-Only Users: These users may only obtain reports and execute several basic commands.

A provisionable inactive timeout is available for each CIT and DCC access port. This enables automatic termination of inactive or unattended sessions. An additional lockout feature is available that prohibits access to all users except privileged users.

On wall distant terminal enclosures, a security lock is provided to restrict access to circuit packs.

### **Enhanced Security Features**

In DDM-2000 FiberReach Release 4.0, security feature enhancements include:

- User Provisionable Banner - a "Welcome Banner" that appears when a user signs on to the system
- 30-Day Aging on Passwords for Privileged Accounts
- Individual Accountability
  - Allowable number of Privileged Users has increased
  - Allowable number of General Users, Maintenance-Only Users, and Reports-Only Users has increased

## Software Compatibility

Table 5-1 lists the SONET software compatibility within a subnetwork for the Lucent 2000 Product Family systems. All configurations listed support Operations Interworking (OI). The table lists all possible software combinations. Combinations not listed are not supported.

**Table 5-1. Software Compatibility**

Release	Fiber Reach R2.2 with 26G2-U	Fiber Reach R3.0 with 26G2-U	Fiber Reach R3.1 with 26G2-U	Fiber Reach R4.0 with 26G2-U	Fiber Reach R2.2 with 28G-U	Fiber Reach R3.1 with 28G-U	Fiber Reach R4.0 with 28-Type	Fiber Reach R4.0 with 29-Type
OC-3, R7.2	X*				X			
OC-3, R8.0	X*				X*			
OC-3, R8.1	X*				X*			
OC-3, R9.1	X				X			
OC-3, R11.0	X				X			
OC-3, R11.1	X				X			
OC-3, R13.0		X	X	X		X	X	X
OC-3, R15.0		X	X	X		X	X	X
OC-12, R5.1	X*				X			
OC-12, R5.2	X*				X			
OC-12, R7.0		X*	X*	X*		X	X	X
FiberReach, R3.0		X	X	X		X*	X*	X*
FiberReach, R3.1		X	X	X		X	X	X*
FiberReach, R4.0		X	X	X		X	X	X
SLC-2000, R3.3								
SLC-2000, R4.4†								
SLC-2000, R4.6†								
FT-2000, R7.2	X*				X			
FT-2000, OC-48 R8.0		X*	X*	X*		X	X	X
FT-2000, OC-48 R8.1		X*	X*	X*		X	X	X
FT-2000, R9.0		X*	X*	X*		X	X	X

\* FiberReach shelf is not directly connected.

† SLC-2000 R4.4 through 4.6 can be used for NBS FITL applications. Contact Technical Support, Access Products for compatibility details.

## Network Element Management Software Compatibility

It is recommended that a graphical user interface and provisioning tool (CPro-2000 or ITM SNC) be used to simplify and mechanize administration, maintenance, and provisioning operations for ring networks, especially when dealing with multiproduct subnetworks. Table 5-2 indicates which tool can be used for the NEs in a subnetwork. For more information, refer to 365-576-1x0, *CPro-2000 User Manual*, or 107-564-270, *ITM SNC User's Guide*.

**Table 5-2. Network Element Management Software Compatibility**

Product/ Release	CPro-2000										ITM SNC									
	3.0	4.0	5.0	6.0	6.1	7.0	8.0	9.0	10.0	11.0	2.1	2.2	3.0	4.0	5.0	6.0	8.0	9.0	10.0	11.0
FiberReach, R2.2				X	X										X	X	X	X	X	
FiberReach, R3.0						X	X	X	X					X	X	X	X	X	X	
FiberReach, R3.1						X	X	X	X					X	X	X	X	X	X	
FiberReach, R4.0									X										X	
SLC <sup>®</sup> -2000, R3.2																X	X	X	X	
SLC-2000, R3.3	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
SLC-2000, R4.2		X	X	X	X					X						X	X	X	X	
SLC-2000, R4.3																				
SLC-2000, R4.4			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	
SLC-2000, R4.6			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	
DDM-2000 OC-3, R7.2	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	
DDM-2000 OC-3, R8.0		X	X	X	X					X	X	X	X	X	X					
DDM-2000 OC-3, R8.1			X	X	X							X	X	X	X	X	X	X	X	
DDM-2000 OC-3, R9.0	X	X	X	X	X					X	X	X	X	X	X					
DDM-2000 OC-3, R9.1			X	X	X						X	X	X	X	X					
DDM-2000 OC-3, R11.0				X	X								X	X	X	X	X	X	X	
DDM-2000 OC-3, R11.1				X	X										X	X	X	X	X	

**Table 5-2. Network Element Management Software Compatibility—Continued**

Product/ Release	CPro-2000									ITM SNC									
	3.0	4.0	5.0	6.0	6.1	7.0	8.0	9.0	10.0	2.1	2.2	3.0	4.0	5.0	6.0	8.0	9.0	10.0	11.0
DDM-2000   OC-3, R13.0						X	X	X	X					X	X	X	X	X	X
DDM-2000   OC-3, R13.5						X	X	X	X					X	X	X	X	X	X
DDM-2000   OC-3, R15.0									X									X	
DDM-2000   OC-12, R5.0	X	X	X	X	X					X	X	X	X	X	X		X	X	
DDM-2000   OC-12, R5.1			X	X	X						X	X	X	X	X	X	X	X	X
DDM-2000   OC-12, R5.2			X	X	X						X	X	X		X	X	X	X	X
DDM-2000   OC-12, R7.0						X	X	X	X					X	X	X	X	X	X
FT-2000,   R6.0	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X
FT-2000,   R7.0		X	X	X	X					X	X	X	X	X	X	X	X	X	X
FT-2000,   R7.1				X	X							X	X	X	X	X	X	X	X
FT-2000,   R7.2				X	X							X	X	X	X	X	X	X	X
FT-2000,   R8.1						X	X	X						X	X	X	X	X	X
FT-2000,   R9.0						X	X	X	X						X	X	X	X	X
FT-2000,   R9.1																		X	X

Table 5-3 is a software and circuit pack compatibility matrix for FiberReach Releases 2.2 through 4.0.

**Table 5-3. Software and Circuit Pack Compatibility Matrix**

FiberReach Product/Release	MAIN	FN	Low-Speed Groups	SYSTL
Release 2.2	26G-U 26G2-U	—	BBF1B BBF3B BBF6 177A*	BBG8 BBG8B
	28G-U	—	BBF1B BBF3B BBF6 BBF8 <sup>+</sup> 177A*	
Release 3.0	26G-U 26G2-U	—	BBF1B BBF3B BBF6 177A*	BBG8 BBG8B
Release 3.1	26G-U 26G2-U	—	BBF1B BBF3B BBF6 177A*	BBG8 BBG8B
	28G-U	22-Type	—	BBG8 BBG8B
BBG19 BBG4 BBG4B		BBF1B BBF3B BBF6 BBF8* + 177A*		
Release 4.0	26G-U 26G2-U	BBG19 BBG4 BBG4B		BBG8 BBG8B
	26G-U 26G2-U		BBF1B BBF3B BBF6 177A*	
	28G-U	22-Type	—	BBG8 BBG8B
		BBG19 BBG4 BBG4B	BBF1B BBF3B BBF6 BBF8* + 177A*	
29G-U/ 29H-U	22-Type	BBF1B	BBG8 BBG8B	
	BBG19 BBG4 BBG4B	BBF3B BBF6 BBF8* + 177A*		

\* The 177A retainer is required in any unused low-speed slots when partially equipped and 1X7 protected.

<sup>+</sup>Cannot be mixed with any Low Speed circuit pack types.

## **Narrowband Shelf Features**

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 **NOTE:**  
The narrowband shelf's common equipment and channel units are not protected.

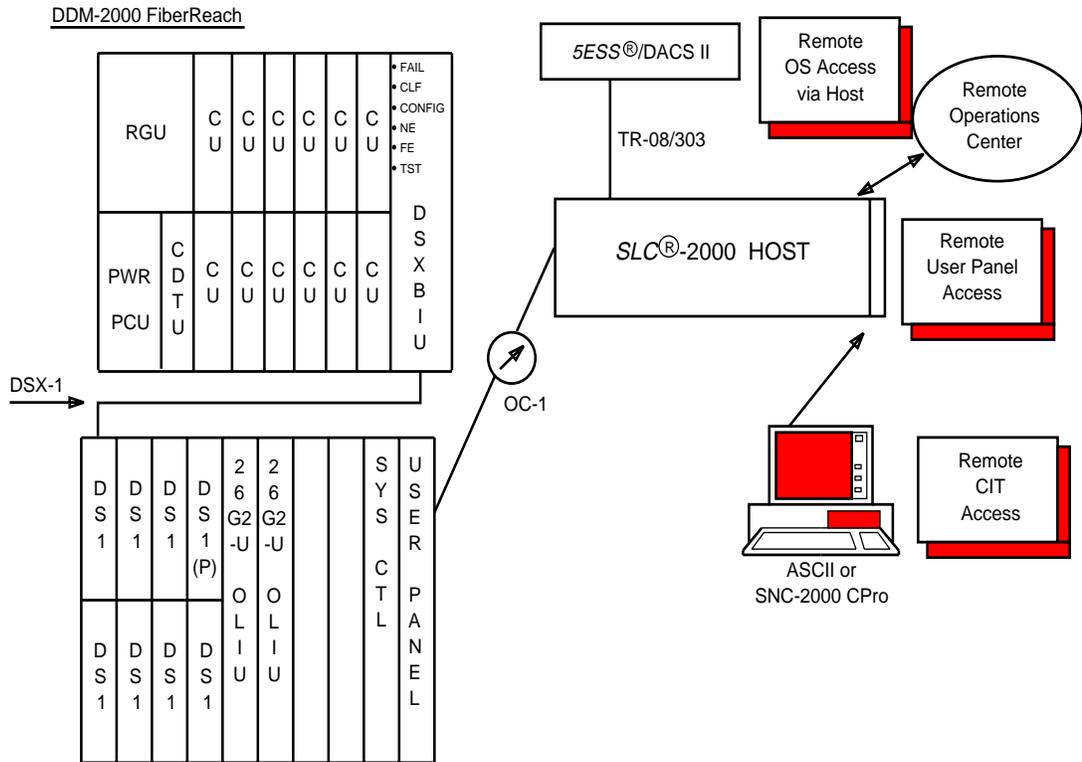
## **Narrowband Shelf Maintenance**

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### **Single-Ended Operations**

The DDM-2000 FiberReach narrowband shelf offers integrated maintenance operations with the host. (See Note.) Communication between the host and the narrowband shelf takes place via the extended superframe (ESF) data link and terminates on the digital signal cross-connect backplane interface unit (DSXBIU) circuit pack. The user can initiate commands at the host digital terminal (HDT), specifying an appropriate address in the command to operate a circuit on the narrowband shelf. All alarms and events on the narrowband shelf are treated as local events at the *SLC-2000* HDT System. The ESF data link also provides TBOS, TL1/X.25, and parallel telemetry interfaces via the HDT. Figure 5-4 shows the single-ended operations philosophy for the narrowband shelf.

 **NOTE:**  
The HDT accesses lines from customer equipment terminating on an optical network unit (ONU) that is "hosted" by the *SLC-2000* system. In this case, *SLC-2000* HDT "extends" its Metallic Distribution Shelf (MDS) assembly channel slots to a FiberReach narrowband shelf that is usually located even closer to the customer. This is referred to as FITL distribution.



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**Figure 5-4. DDM-2000 FiberReach Narrowband Shelf Single-Ended Operations Philosophy**

## Channel and Drop Testing

Channel testing and drop testing of subscriber loops is done via the host *SLC-2000* System, as specified in TR-TSY-000008 and TR-TSY-000303. Test results are returned by the DSXBIU to the *SLC-2000* HDT through the ESF data link.

Channel testing is done by introducing a standard test signal into the system. The response to the signal will be interpreted by the HDT.

Drop testing is initiated by the first channel test command received by the narrowband shelf and is executed autonomously by the channel and drop test unit (CDTU) circuit pack. The DT server at the HDT translates the drop test results received into a set of PASS/FAIL-FAULT-FOUND signals. A test facility, either internal or external to the *SLC-2000* HDT interprets the test results.

## Narrowband Shelf Performance Monitoring

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The DSXBIU supports up to four ESF datalinks that serve as operation links for handling operations between the narrowband shelf and the host *SLC-2000*. The following types of messages are supported:

- Single-ended and remote OAM&P
- Sanity
- G-bits
- F-bits
- Channel unit virtual bank control link (BCL)
- TR303 testing

The microwire protocol is used for intra-shelf operations between the DSXBIU and the common channel units. The microwire interface communicates inventory information to the DSXBIU in a serial data format. Alarm and status information flows between the DSXBIU and the narrowband shelf common units.

Since the DSXBIU supports the DSX-1 interface, it also contains features to control and monitor the interface, including loss of clock, loss of signal, line code operation, loopbacks, equalizer control, alarm test, and shutdown.

## Performance Monitoring Between the *SLC-2000* HDT and the NBS

The DDM-2000 FiberReach narrowband shelf offers DS1 performance monitoring via the DSXBIU. Signal thresholds are programmable from the *SLC-2000* HDT. The DSXBIU monitors DS1 signals for the following:

- CRC-6 coding violations (CV)

- Errored seconds (ES)
- Severely errored seconds (SES)

Any errors are reported by the DSXBUI to the HDT via the ESF data link. The errors are then reported to the user via *SLC-2000* user interfaces.

## **Narrowband Shelf Provisioning**

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### **Channel Unit Provisioning**

The FiberReach narrowband shelf consists of upper and lower subshelves for channel units. Each subshelf can contain up to 6 channel units each, for a total of 12 channel units per narrowband shelf. Each channel unit in the narrowband shelf requires the following DS0 timeslots depending on the type of service provided by the channel units.

- POTS or Special Services: up to 4 DS0 time slots per channel unit
- ISDN services:(2B&D): up to 9 DS0 time slots per channel unit

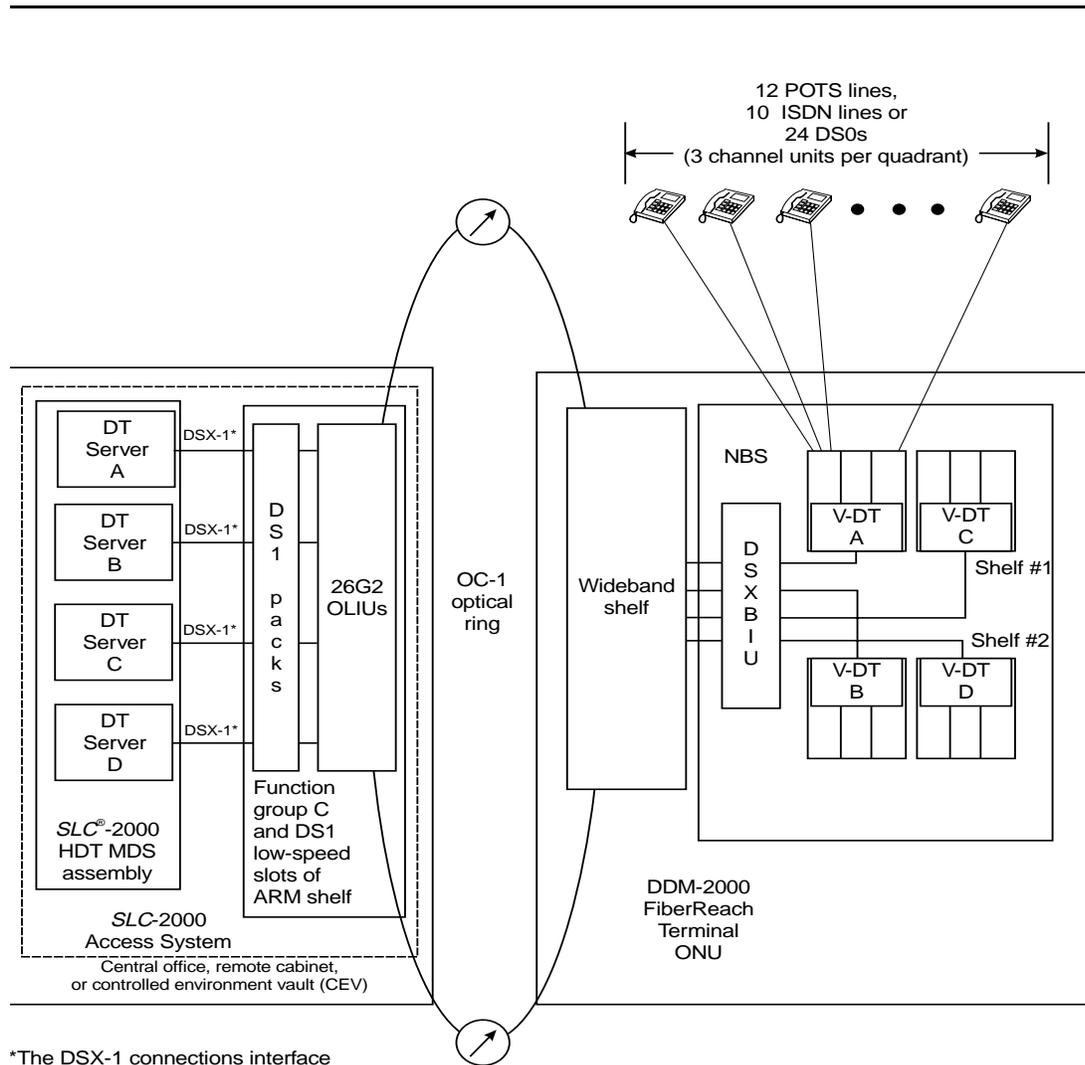
Refer to LTP 363-208-001, *SLC<sup>®</sup>-2000 Access System User/Service Manual*, for additional details on channel unit provisioning.

### **DDM-2000 FiberReach Narrowband Shelf ONU (SLC-2000 Software Release 4.4 and Later)**

Using the CIT at the *SLC-2000* HDT, you can provision each DSX-1 signal feeding a *V-DT* in the NBS to any one of the following two modes:

- **Quad Mode:** In this state, the DSXBUI continuously attempts to find or frame-up on the DS1 input, establish the message link, alarm any DS1 faults, and provide service to a set of six channel unit slots in the NBS. This mode allows a single DT server to feed a six-slot *V-DT* for 24-line service. You can also provision the quad mode for 12-line service.
- **Octet Mode:** In this state, the DSXBUI continuously attempts to find or frame-up on the DS1 input, establish the message link, alarm any DS1 faults and provide service to a set of three channel unit slots in the NBS. In the octet mode, each channel unit slot can support eight DS0s instead of the four DS0s supported in the quad mode. The octet mode allows the narrowband shelf to provide the maximum number of ten ISDN lines in the from each *VDT* when using the *SPQ494* quad ISDN channel units along with the *AUA94* dual ISDN channel units. You can provision the octet mode for 24-line service only.

Figure 5-5 shows a basic configuration with the *SLC-2000* HDT hosting an NBS in the octet mode.



\*The DSX-1 connections interface through external cables and are not part of the SLC-2000 system.

nwoctr13.eps

**Figure 5-5. Basic Octet Mode Configuration**

When in the octet mode, each of the four three-slot V-DTs can contain SPQ494 quad ISDN channel units in the first two slots. The third slot can contain an

AUA94 dual ISDN channel. This will allow the V-DT to support a total of ten ISDN lines with each line offering 2B+D service. The third slot can also contain any of the other channel units available for the NBS. This allows the V-DT to offer a combination of services, depending on the channel units installed. Therefore, an NBS with all quadrants in octet can provide 40 ISDN lines.

To provide ISDN 2B+D service in the octet mode, you must manually provision the cross-connections using the SLC-2000 HDT CIT. Figure 5-6 shows the following process of how the V-DT uses the 24 time slots of its DS1 feeder signal to support two *SPQ494* quad ISDN channel units and an AUA94 dual ISDN channel unit. This combination can produce ten ISDN lines providing 2B+D service:



**NOTE:**

The time slot representation shown in Figure 5-6 is used to explain the concept of how the system uses the 24 time slots of a DS1 signal to build the 2B+D ISDN lines. The actual time slots are assigned by the system and vary according to system requirements. However, the concept for building the 2B+D ISDN lines is the same as described below.

- The ISDN lines providing 2B+D service are *built* as follows:
  - A “B” data channel equates to a 64-kb/s DS0 signal that can be used for voice connections or equipment connections such as a computer. As shown in Figure 5-6, each “B” channel uses 1 time slot of the 24 time slots in the DS1 signal (therefore, “2B” uses 2 time slots). In Figure 5-6, the first ISDN line uses time slots 1 and 2 for its “B” channels.
  - A “D” signaling channel equates to a 16-kbs signal that is used to carry signaling and overhead data. As shown in Figure 5-6, each “D” channel uses one-fourth of a time slot. In Figure 5-6, the first ISDN line uses one-fourth of time slot 22 for its “D” channel.
  - Added together, each 2B+D ISDN line takes  $2\frac{1}{4}$  time slots of the 24 time slots in the DS1 feeder signal.
- As shown in Figure 5-6, each *SPQ494* quad ISDN channel unit provides four 2B+D ISDN lines. These four lines use a total of 9 time slots of the 24 time slots in the DS1 feeder signal (8 time slots for the 8 “B” channels and 1 time slot for the 4 “D” channels). This allows the V-DT to contain two *SPQ494* channel units using 18 time slots.
- As shown in Figure 5-6, the V-DT can also contain an AUA94 dual ISDN channel unit. This unit provides two 2B+D ISDN lines using a total of  $4\frac{1}{2}$  time slots (four time slots for the four “B” channels and one-half time slot for the two “D” channels).
- Therefore, a V-DT provisioned for the octet mode can provide ten ISDN lines with each line offering 2B+D service. These ten lines use a total of  $22\frac{1}{2}$  of the 24 time slots provided by the DS1 feeder.

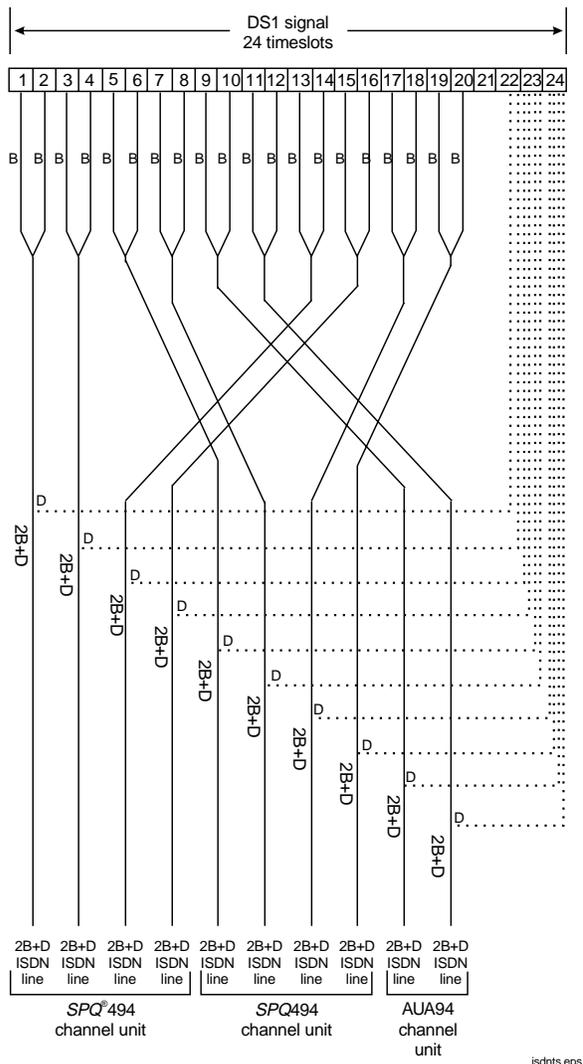
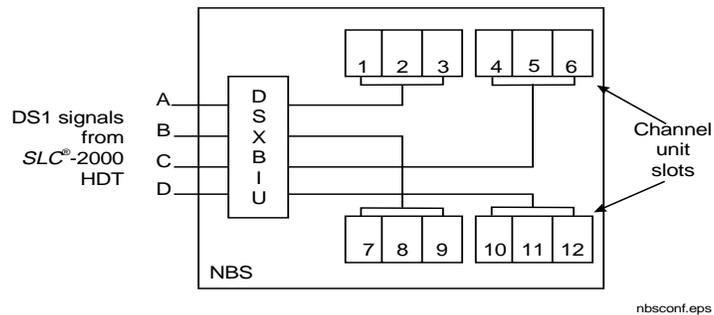


Figure 5-6. Building an ISDN 2B+D Line from a DS1 Signal in the NBS (Octet Mode)

For these time slots to be correctly associated with the actual channel unit slots in the MDS assembly, the system uses a *virtual channel unit slot* concept. You must use the SLC-2000 host digital terminal CIT to cross-connect the real and virtual time slots to the appropriate VRTs. Figure 5-7 shows the actual NBS configuration with its four DS1 feeder signals.



**Figure 5-7. Actual NBS V-DT Configuration (Octet Mode)**

Using the *virtual* concept as shown in Figure 5-8, the SLC-2000 HDT software, when provisioning ISDN circuits, “thinks it sees” a six-slot V-DT instead of a three-slot V-DT. As Figure 5-8 shows, slots 4, 5, and 6 of the V-DT are *not* physically present. However, they are present in the software and are called *virtual slots*, actually representing the third and fourth lines on the SPQ494 ISDN channel units.

When installing and cross-connecting ISDN circuits in an NBS with DS1 feeders provisioned for the octet mode, you must understand the relationships between the NBS, octet mode, and actual or virtual slots. Refer to Figure 5-8 to understand these concepts.

- **Addressing the NBS Quadrant.** You must address each quadrant of the octet NBS using its DT Servers address in the MDS assembly at the SLC-2000 HDT (MDS shelf number, MDS shelf slot number).
- **Addressing the Slots in the NBS Quadrant.** Each quadrant's slots (both real and virtual) are numbered the same for provisioning (Figure 5-8). For example, the physical slots fed by DS1 signal D are numbered 10, 11, and 12 in the NBS. But when provisioning with the software from the SLC-2000 host digital terminal CIT, they are numbered 1, 2, and 3 (plus 4, 5, and 6 virtual slots).



**NOTE:**

Virtual slot 6 is *never* addressed in the software.

- **SPQ494 Channel Unit Drop Identifications.** The four ISDN 2B+D drops are identified in the software as follows:

- **SPQ494 channel unit in slot 1 of the quadrant:**

- drop 1 = slot 1, line 1
  - drop 2 = slot 1, line 2
  - drop 3 = slot 4, line 1 (virtual slot 4)
  - drop 4 = slot 4, line 2 (virtual slot 4)

- **SPQ494 channel unit in slot 2 of the quadrant:**

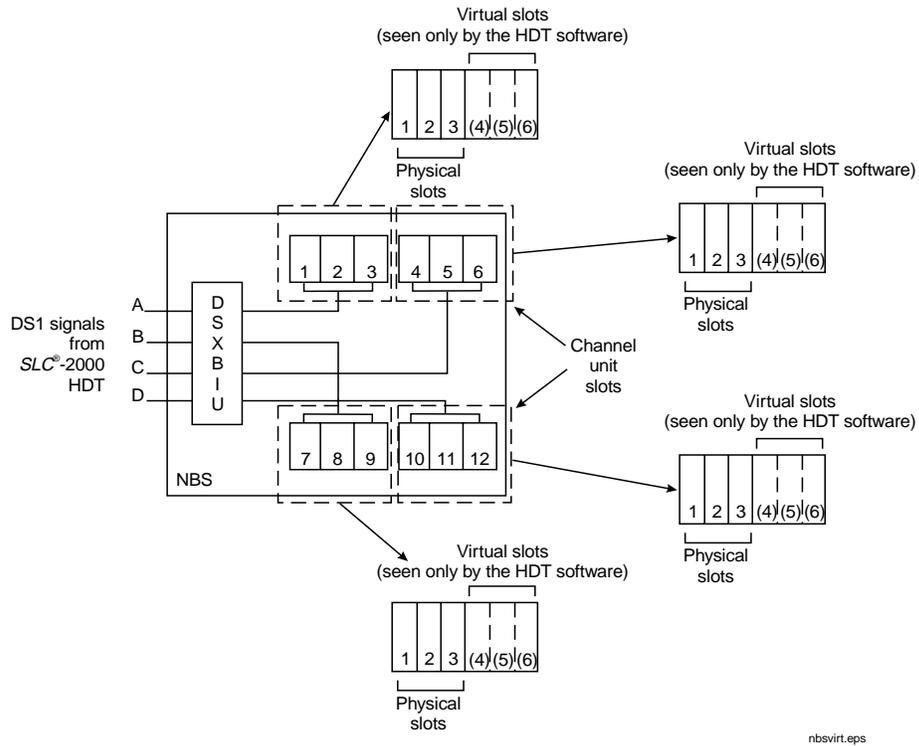
- drop 1 = slot 2, line 1
  - drop 2 = slot 2, line 2
  - drop 3 = slot 5, line 1 (virtual slot 5)
  - drop 4 = slot 5, line 2 (virtual slot 5)

- **AUA94 Channel Unit Drop Identifications.** The drops for the AUA94 in slot 3 do not need virtual slots. The two ISDN 2B+D drops in slot 3 are identified in the software as follows:

- drop 1 = slot 3, line 1
  - drop 2 = slot 3, line 2

- **POTS and Special Service Channel Units.** Other channel units do not use virtual slots. For example, the four drops from a POTS quad channel unit in physical slot 8 of the NBS are identified in the software as follows:

- drop 1 = slot 2, line 1
  - drop 2 = slot 2, line 2
  - drop 3 = slot 2, line 3
  - drop 4 = slot 2, line 4



**Figure 5-8. Virtual Slot Concept (Octet Mode)**



**NOTE:**

For the specific procedure and software commands to perform this function, see the following documents:

- 363-208-001, *SLC-2000 Access System, User/Service Manual*
- 363-208-003, *SLC-2000 Access System, Commands and Messages* (see the **ENT-CRS-T0** command).

Table 5-4 shows the possible combinations of channel units for a three-slot octet V-DT.

**Table 5-4. Channel Unit Slot Restriction When Using an *SPQ494* in a Three-Slot V-DT**

Slot 1 can contain ...	Slot 2 can contain ...	Slot 3 can contain ...
<ul style="list-style-type: none"> <li>• <i>SPQ494</i></li> <li>or</li> <li>• <i>AUA94</i></li> <li>or</li> <li>• Any other channel unit supported by the NBS</li> </ul>	<ul style="list-style-type: none"> <li>• <i>SPQ494</i></li> <li>or</li> <li>• <i>AUA94</i></li> <li>or</li> <li>• Any other channel unit supported by the NBS</li> </ul>	<ul style="list-style-type: none"> <li>• <i>AUA94</i></li> <li>or</li> <li>• Any other channel unit supported by the NBS (except the <i>SPQ494</i> channel unit)</li> </ul>

Provisioning channel units other than the *SPQ494* channel unit in the NBS is done the same way as provisioning channel units at the *SLC-2000* RT/HDT. Once you provision the shelves in the HDT for fiber distribution (via the *SLC-2000* CIT or UIP) and you set the number of lines hosted by each DT Server (via the CIT), provisioning of individual channels in the ONU follows the service order flows described for the RT/HDT.



**NOTE:**

See 363-208-001, *SLC-2000 Access System User/Service Manual*, and 363-205-004, *SLC-2000 MSDT User/Service and Ordering Manual*, for details on provisioning the MSDT or DT Server.

Through the OSMINE process, *SLC-2000* AIDs are supported in FACS and OPS/INE. In addition, *TIRKS* OS and *NMA* OS organizations provide OSIA and methods to inventory and assign *SLC-2000* FITL facilities and equipment.

## **Narrowband Shelf Reports**

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### **Alarms and Statuses**

The *SLC-2000* HDT DLC subsystem provides an alarm and status report that lists all of the active alarm and/or status conditions on the *DDM-2000* FiberReach Multiplexer narrowband shelf. The report includes a description of the alarm, the alarm severity, and a time stamp indicating when the condition was detected.

### **Equipment Inventory**

Inventory for the *DDM-2000* FiberReach narrowband shelf is maintained on the *SLC-2000* host system. An inventory of both the narrowband shelf common circuit packs (DSXBUI, RGU, CDTU, and PCU circuit packs) and wideband shelf channel units are available.

## **Narrowband Shelf Administration**

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### **Software Downloads and Upgrades**

Software is downloaded into the narrowband shelf DSXBUI from the *SLC-2000* HDT via the ESF datalink of the DS1 signals that carry the narrowband services. Upgrades to the software are distributed on MS-DOS formatted diskettes that contain the new software and an installation program for installing the software. These software upgrades are the mechanism to upgrade from one system software release to the next. All software upgrades maintain the provisionable parameters of the previous software generic (for example, cross-connections are left unchanged by the software upgrade).

Software can be downloaded locally or remotely from an MS-DOS PC using the CIT port on a *SLC-2000* Access System or *DDM-2000* Multiplexer. The software is first loaded into the *SLC-2000* host which, in turn, automatically downloads to the narrowband DSXBUI circuit pack. After the DSXBUI software is installed, the DSXBUI resets and all narrowband shelf calls are dropped.

### **Security**

The narrowband shelf OAM&P functions are provided by the *SLC-2000* HDT, which are supported through several interfaces including the user interface panel, the CIT, and the TL1 interface to operations systems. In addition to these interfaces, remote access is available via the SONET DCC to provide control to the *DDM-2000* OC-3 Multiplexer network, and an embedded operations channel (EOC) interface is available to provide control to the local digital switch for TR303 functions.

The SLC-2000 Access System offers security against unauthorized access via its CIT port or through a remote operations port. The use of security is provisionable via the front CIT port, the rear CIT (modem) port, and through the SONET DCC. Three user levels are supported:

- Privileged Users: These users have full read/write access to all information on the system, including passwords.
- Standard Users: These users have read/write access to system provisioning and maintenance information.
- Reports-Only Users: These users have read access to system information but no ability to change provisioning or maintenance parameters.

Each user has an individual login and password, and each user selects and maintains his/her own password.

The TL1 interfaces to operations systems provide a security option feature which allows the administrator to control access by general users (for provisioning and retrieval) and retrieve-only users.

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## Overview

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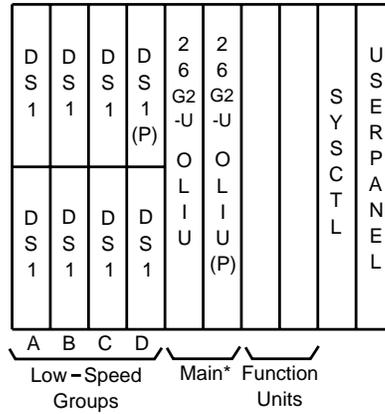
This section summarizes descriptive information used with applications information to plan procurement and deployment of the DDM-2000 FiberReach Multiplexers. There are a number of factors that should be considered when planning the DDM-2000 FiberReach Multiplexers' role in the network. Projected customer requirements will determine the initial capacity needed, as well as evolution to higher capacities. The advanced networking capabilities of the DDM-2000 FiberReach Multiplexers can offer many economic and planning benefits, and certain guidelines should be followed to maximize these benefits. Physical installation considerations will be guided by the installation location (central office, uncontrolled, or customer locations). Initial network configuration will determine synchronization requirements. Synchronization should be planned on a network basis, considering items like topology, reliability, internetwork connectivity, and service evolution.

## DDM-2000 FiberReach Wideband Shelf Transmission Capacity

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The DDM-2000 FiberReach Multiplexer provides multiplexing and transport for one STS-1 optic signal when equipped with OC-1 optics or for up to 3 STS-1s when equipped with OC-3 optics or multiplex 4 STS-1s and transport up to 12 STS-1s when equipped with OC-12 optics in the Main slots in a ring configuration. This capacity may be utilized in many combinations of low-speed inputs. The following shelf configurations represent some examples of the low-speed input combinations.



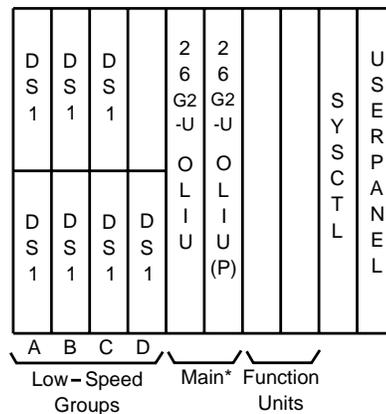


\* 28G-U for OC-3  
 29G-U for OC-12

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**Figure 6-2. DDM-2000 FiberReach 1X7 Protected DS1 Services Only**

This same configuration would also be used for unprotected DS1s, as shown in Figure 6-3. The low-speed interface growth proceeds in four DS1 increments by equipping the low-speed slots with DS1 or DS1PM circuit packs for a maximum of seven service units per multiplexer.



\* 28G-U for OC-3  
29G-U for OC-12

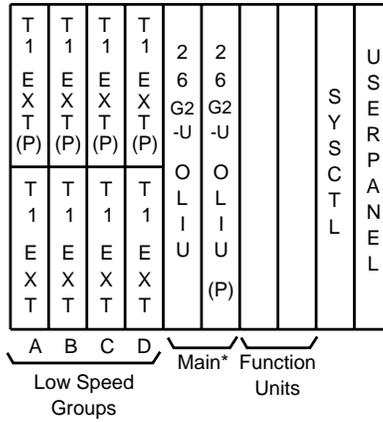
tpa 843667/01

**Figure 6-3. DDM-2000 FiberReach Unprotected DS1 Services Only**

### T1 Extensions Only

Figure 6-4, Figure 6-5, and Figure 6-6 show examples of the DDM-2000 FiberReach in a T1 extension configuration. The wideband shelf is a complete DS1 to OC-1 solution; therefore, the narrowband shelf is not used for this application. The wideband shelf uses the two main OLIU slots to interface an OC-1 or OC-3 or OC-12 line to the low-speed group(s). The OLIU circuit packs are equipped in pairs, one service and one protection [denoted (P)]. Low-speed interface growth proceeds in two DS1 increments by equipping the low-speed slots with dual T1 extension circuit packs. The SYSCTL is always required for these applications. Primary lightning protection (Lucent Technologies' protector unit 4B3EW or equivalent) and the secondary lightning and surge protection assembly (mounted externally to the DDM-2000 FiberReach shelf) are required for outside plant applications. Refer to "T1EXT Engineering Rules," presented later in this chapter, for specific engineering rules for T1 extension applications.

Figure 6-4 shows a 1x1 low-speed protection configuration with four low-speed groups (A, B, C, D) for a maximum of four service and four protection units per multiplexer. Primary (Lucent's protector unit 4B3EW or equivalent) and secondary lightning protection assemblies are required for each tip/ring pair of a T1 extension.



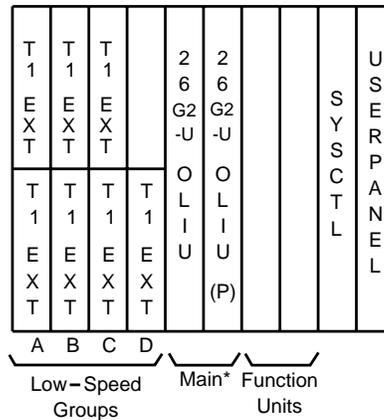
\* 28G-U in Main slots for OC-3  
 \* 29G-U in Main slots for OC-12

tpa 843637/01

**Figure 6-4. DDM-2000 FiberReach with 1x1 Protected T1 Extension Services**

A 1x7 protection architecture, shown in Figure 6-5, allows up to seven service and one protection unit per multiplexer. A 177A apparatus blank is required in any unused slots.





\* 28G-U in Main slots for OC-3  
29G-U in Main slots for OC-12

tpa 843669/01

**Figure 6-6. DDM-2000 FiberReach with Unprotected T1 Extension Services**

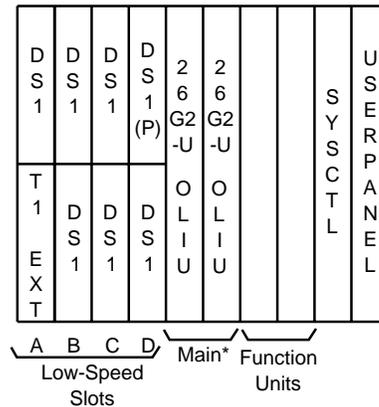
### T1 Extensions and DS1 Service

Figure 6-7 shows an example of the DDM-2000 FiberReach in a combination configuration of T1 extensions and DS1 service. The low-speed slots would be equipped based on the service needs in either two DS1 increments for T1 extensions, protected or unprotected, or four DS1 increments for DS1 service, protected or unprotected. The combination shown here is four protected T1 extensions with eight protected DS1 services. Primary lightning protection (WE4B tubes or equivalent) and the secondary lightning and surge protection assembly (mounted externally to the DDM-2000 FiberReach shelf) are required for outside plant applications. Refer to "T1EXT Engineering Rules," presented later in this chapter, for specific engineering rules for T1 extension applications.



A configuration with unprotected T1 extension service and protected DS1 services is shown in Figure 6-8.

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\* 28G-U in Main slots for OC-3

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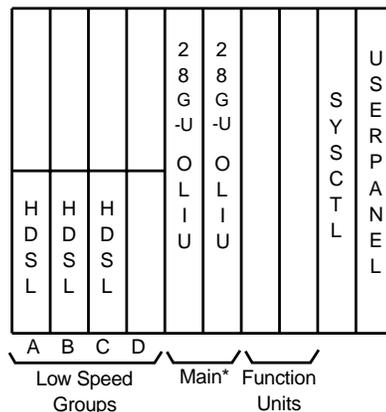
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**Figure 6-8. DDM-2000 FiberReach with Unprotected T1 Extensions and 1x7 Protected DS1 Services**

## HDSL Services

Figure 6-9 and Figure 6-10 show examples of the DDM-2000 FiberReach in a wideband application providing HDSL interface capability. The wideband shelf uses the two main optical line interface unit (OLIU) slots to interface an OC-3 or OC-12 line to the low-speed group(s). The OLIU circuit packs are equipped in pairs. Low-speed interface growth proceeds in two HDSL circuit packs increments by equipping the low-speed slots with a HDSL circuit pack. The SYSCTL and user panel are always required in this application.

Figure 6-9 shows an unprotected low-speed configuration with the maximum of three HDSL packs (six HDSL circuits). The Main slots are equipped with OC-3 OLIUs in this example.

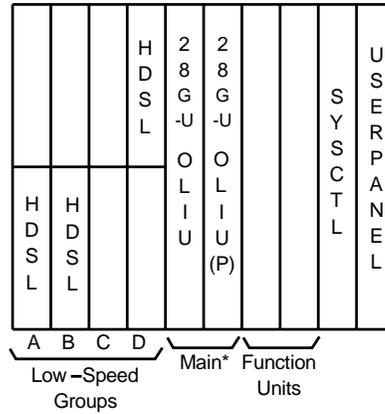


tpa 852385/01

**Figure 6-9. DDM-2000 FiberReach — 6 Unprotected HDSL Circuits (Unprotected)**

Figure 6-10 shows examples of the DDM-2000 FiberReach in a wideband application providing protected HDSL services. The wideband shelf uses the two Main optical line interface unit (OLIU) slots to interface an OC-3 line to the low-speed group(s). The OLIU circuit packs are equipped in pairs. Low-speed interface growth proceeds in four DS1 increments by equipping the low-speed slots with HDSL circuit packs. The SYSCTL and user panel are always required in this application.

Figure 6-10 shows a 1x2 low-speed protection configuration with a maximum of 3 HDSL packs (six HDSL circuits).



\* 29-Type in Main slots for OC-12

tpa 852386/01

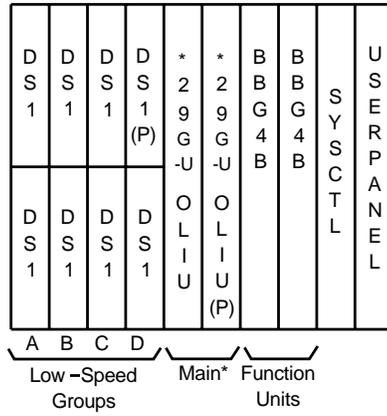
**Figure 6-10. DDM-2000 FiberReach — 1x2 Protected HDSL Services (1X2 Protection Mode)**

### DS3 and DS1 Services

When equipped with OC-1 OLIUs, the DS3 uses all of the capacity of the line. Hence, there is no capacity for DS1 service. See Figure 6-11 and Figure 6-12.

### DS3 Interface (BBG4B)

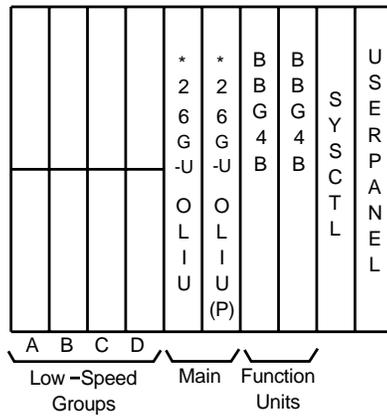
Protected DS3 access is available by using the BBG4(B) in the Function Unit slots of Figure 6-13. DS3 access is through BNC connectors on the rear of the FiberReach shelf.



\* 26 G-type for OC-1  
 28 G-type for OC-3

tpa 853762/02

**Figure 6-11. DDM-2000 FiberReach with OC-12 Optics in Main Slot Providing DS1 and DS3 Services**



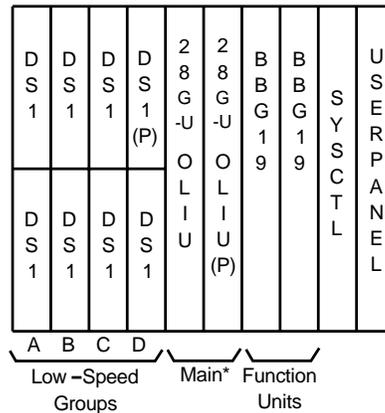
tpa 853762/03

**Figure 6-12. DDM-2000 FiberReach with OC-1 Optics in Main Slot Providing DS3 Services**

## Data Services Interface

Figure 6-13 shows an example of BBG19 (DS3) data services interface application. Figure 6-14 shows an example with OC-1 optics in the Main providing Data Services.

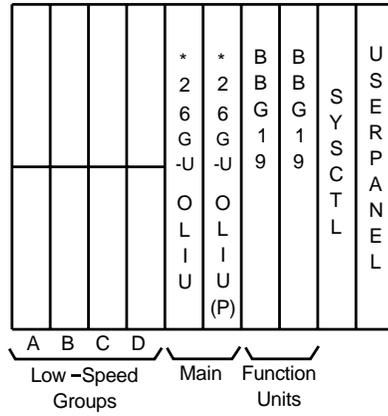
A BBG19 is installed in each Function Unit slot. These circuit packs provide a clear channel DS3 interface to external data communications equipment like LAN routers/ATM switches. Such products support data services interfaces like NMLI, FDDI, and ATM DS3 rate. DS3 access is through BNC connectors on the circuit pack faceplate. Protection switching is performed external to the FiberReach shelf. When the main slots are equipped with 26-type (OC-1) OLIUs, there is no capacity for mixing DS3 and DS1.



\* For 29-Type for OC-12

tpa 852436/01

**Figure 6-13. DDM-2000 FiberReach Data Services Application**



tpa 853762/04

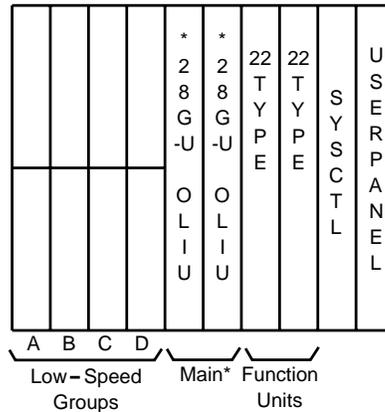
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**Figure 6-14. DDM-2000 FiberReach with OC-1 Optics in Main Slot Providing Data Services**

### STS-3c 0 X1 Application

Figure 6-15 shows a FiberReach shelf configured to provide an OC-3c customer interface. Both Main slots must be equipped with 28G-U OC-3 OLIUs or 29-Type OC-12 OLIUs and Function Unit slots with one or two 22-type OLIUs.

**⇒ NOTE:**  
 The features described above also apply to the 29-Type OLIU circuit pack.



\* 29G-U for OC-12

tpa 852437/01

**Figure 6-15. STS-3c 0 x 1 Application**

## T1EXT Engineering Rules

The T1EXT circuit pack supports two T1 loops. The drivers and receivers for both loops comply with requirements specified in the Telcordia Technologies document Compatibility Bulletin No. 113 (Low Power T1 Line Repeater Compatibility Specification, Issue 2, April 1978), except for the sections specifying line configurations and fault location.

To ensure proper operation, the T1 loop must be designed so that the driver, receiver, and simplex current source meet the performance requirements. The following parameters should be used in the loop design:

- Driver: (For details, refer to Section 3.0 of CB No. 113)
  - Pulse amplitude: 3 V peak (nominal)
  - Pulse width at 50% amplitude:  $324 \pm 30$  nsec
- Receiver:
  - Gain: 35 dB maximum at 772 KHz
  - Dynamic range: 0 to 35 dB
- Current Regulator:
  - Constant current of 60 mA, voltage 14 V  $\pm 5\%$
  - Maximum simplex resistance ( $R_s$ ) is 221 Ohms  
[ $14 \text{ V} \times (1 - .05)/60\text{mA} = 221 \text{ Ohms}$ ]

The span resistance ( $R_s$ ) can be determined by inserting the maximum resistance ( $R_{max}$ ) and minimum resistance ( $R_{min}$ ) values from Table 6-1 in the following equations and choosing the smaller number:

$$R_{smax} = \text{Cable Length (kft)} \times R_{max} [1 + 0.0022 (\text{maximum temp. in degrees F minus } 68)]$$

$$R_{smin} = \text{Cable Length (kft)} \times R_{min} [1 + 0.0022 (\text{minimum temp. in degrees F minus } 68)]$$

The  $R_{max}$  and  $R_{min}$  values depend on the gauge and the material of the cable. Use Table 6-1 to choose the proper values for  $R_{max}$  and  $R_{min}$ . The maximum temperature ( $T_{max}$ ) and minimum temperature ( $T_{min}$ ) values are the temperatures the cable is expected to experience in the area of installation.

**Table 6-1. Maximum and Minimum Cable Resistance Coefficients (Notes)**

Wire Gauge		Ohms per 1000 ft. of Span Line	
Copper	Aluminum	Maximum Resistance (Rmax)	Minimum Resistance (Rmin)
	17	8.33	8.04
19		8.33	8.04
21		13.24	12.79
	20	16.70	16.13
22		16.70	16.13
24		26.55	25.65
25		33.48	32.34
26		42.22	40.78

**Notes:**

1. Spans for T1EXT packs installed in a central office should be limited to 3000 feet ( $\pm 1500$  feet). T1EXT packs in an outside plant application or wall distant terminal can support span lengths up to 6000 feet. The T1 secondary lightning and surge protection shelf is miscellaneously mounted externally to the wall distant terminal.
2. The T1EXT does not support fault locating using traditional bipolar violation techniques.
3. The T1EXT will interface with looping regulator type repeaters only.
4. The T1EXT does not have the ability to loop the simplex current back to a T1 line repeater.
5. The T1EXT does not have any surge or lightning protection or power cross protection. An external assembly (ED-8C783) must be collocated with a FiberReach shelf containing T1EXT circuit packs to provide these capabilities.

## **DDM-2000 FiberReach Narrowband Shelf Transmission Capacity**

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The DDM-2000 FiberReach narrowband shelf consists of upper and lower subshelves for channel units. The upper and lower subshelves can contain up to six channel units each.

The narrowband shelf will support the following telephony services:

- Plain Old Telephone Service (POTS)
- Super POTS (SPOTS®)
- Integrated Services Digital Network (ISDN) - Basic Rate Interface
- POTS/SPOTS + On-Hook Transmission
- POTS/SPOTS (Current Feed) + On-Hook Transmission
- Coin
- Four-Wire Voice Frequency (Current Feed/Current Sink)
- Extended SPOTS (Current Feed/Current Sink)
- Ringing Repeater
- Direct Inward Dialing
- Private Line Ringdown
- All-Rate Data Port
- Switched 56 kb/s Wire Data
- RS-232
- DC Alarm

The narrowband shelf can support two modes of operation: quad mode and octet mode. Quad mode operation assigns four DS0s to one physical slot. Octet mode operation assigns eight DS0s to one physical slot. In the octet mode, two DS1s are required for each of the upper and lower subshelves, for a total of four DS1s per shelf.

For POTS or special services 12 quad channel units can be provided by the narrowband shelf operating in the quad mode. In quad mode, 48 DS0s are also available, provided by two DS1 links.

For more than 48 DS0s (needed for ISDN only), the narrowband shelf can be configured in the octet mode. In this mode, two DS1s are provided to the upper subshelf and 2 DS1s are provided to the lower subshelf. In the octet mode, each subshelf has one DS1 available to each group or quadrant of three channel unit slots.

The upper and lower subshelves may operate in these two different modes.

Almost all of the *SLC*<sup>®</sup>-2000 telephony service channel units can be plugged into the narrowband shelf operating in the quad mode. The exception is when the ISDN channel units are used. When either a dual-ISDN channel unit or quad-ISDN channel unit is used, slot restrictions are necessary for populating channel unit slots. When the narrowband shelf is operating in the quad mode, only four of the six slots in each subshelf can be populated with dual-ISDN channel units. The remaining two slots in each subshelf can be used for other telephony services. In the octet mode, all the slots may be populated with dual-ISDN channel units. The quad-ISDN channel units can only be used when the narrowband shelf is operating in the octet mode. The channel units may only be installed in slots 1, 2, 4, and 5 in the upper subshelf and slots 7, 8, 10, and 11 in the lower subshelf. The remaining slots can be used for other telephony services, including AUA94 dual-ISDN channel units.

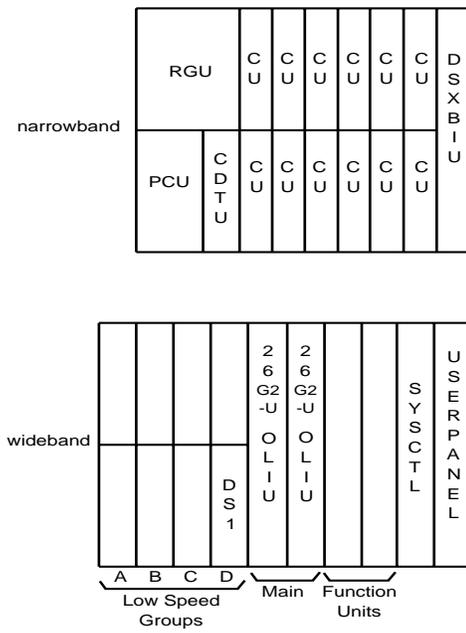
See Chapter 5, "Operations, Administration, Maintenance, and Provisioning" for details of provisioning ISDN service.

### **DS0 Services Only (Narrowband/Wideband Configuration)**

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Figure 6-16 shows an example of the DDM-2000 FiberReach in a narrowband services application providing telephony and special services only. The wideband shelf and narrowband shelf are both needed for this configuration. The digital signal cross-connect backplane interface unit (DSXBIU) in the narrowband shelf multiplexes the DS0s from the 12 channel unit slots to DS1 transmission interfaces. The wideband shelf uses a DS1 circuit pack (protected or unprotected) housed in any low-speed slot to receive this transmission interface and feed a VT1.5 group (VTG) to the OLIU in the Main slots. The number of DS1s connected between the WBS and the NBS are dependent on the modes of the NBS. DS0 growth proceeds in a 1 through 4 increment by equipping the channel unit slots with single, dual, or quad channel unit packs for a maximum of 12 slots. The power converter unit (PCU) and the ringing generator unit (RGU) are always required in this application. The OLIU circuit packs in the wideband shelf are equipped in pairs.

If the demand for DS0 service exceeds the capacity of a single narrowband shelf, this configuration can be enhanced to accommodate additional narrowband shelves connected to a single wideband shelf. The addition would simply be another DS1 circuit pack (protected or unprotected) in any unoccupied low-speed slot of the wideband shelf.



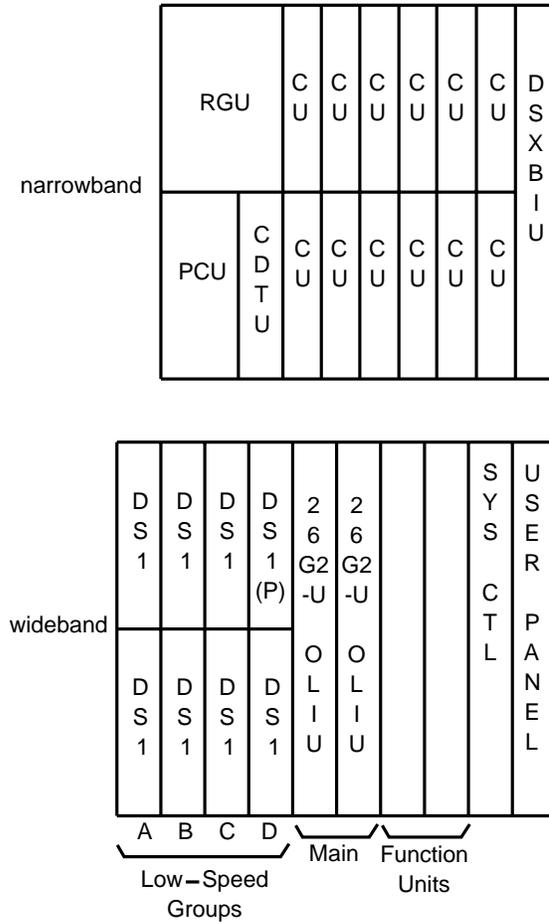
**Figure 6-16. DDM-2000 FiberReach DS0 Services Only**

## **DS0 and DS1 Service (Narrowband /Wideband Configuration)**

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Figure 6-17 shows an example of the DDM-2000 FiberReach in a narrowband services application providing telephony, special services, and protected DS1 service. The wideband shelf and narrowband shelf are both needed for this configuration. The DSXBIU in the narrowband shelf multiplexes the DS0s from the 12 channel unit slots to a DS1 transmission interface. The wideband shelf uses a DS1 interface circuit pack housed in any low-speed slot to receive this transmission interface and feed a VTG to the OLIU in the Main slots. The OLIU circuit packs in the wideband shelf are equipped in pairs. DS0 growth in the narrowband shelf proceeds in a 1 through 4 increment by equipping the channel unit slots with single, dual, or quad channel unit packs, for a maximum of 12 slots. The PCU and the RGU are always required in this application. Low-speed growth in the wideband shelf proceeds in four DS1 increments by equipping the low-speed slots with DS1 or DS1PM circuit packs for a maximum of four 1x1 protected, seven 1x7 protected, or seven unprotected service units per multiplexer. The SYSCTL is always required in this application.

If the demand for DS0 service exceeds the capacity of a single narrowband shelf, this configuration can be enhanced to accommodate a second narrowband shelf connected to a single wideband shelf. The addition would simply be a second DS1 circuit pack (protected or unprotected) in any unoccupied low-speed slot of the wideband shelf. In this case, however, the DS1 service capacity would be reduced.



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**Figure 6-17. DDM-2000 FiberReach Supporting 24 1x7 Protected DS1s and a 48-Line ONU**

## **Network Size Consideration**

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DDM-2000 FiberReach has a maximum subnetwork size limit of 50 nodes (with OC-3 Release 9.1 and OC-12 Release 5.1). Since each DDM-2000 OC-3 node can host multiple OC-1 rings, it is conceivable that a single OC-3 or OC-12 ring, with its OC-1 ring extensions could make up a very sizable subnetwork. However, the actual subnetwork size is usually constrained by considerations such as the number of available timeslots on the main OC-3 or OC-12 ring and/or the cross-connect capacity of each node. Refer to 824-102-147, *Lucent 2000 Product Family Operations Interworking Guide* for additional information about subnetwork size in these releases.

In FiberReach Release 3.0 and later, OC-12 Release 7.0, and OC-3 Release 13.0, the limit is 256 NEs. Refer to 824-102-144, *Lucent 2000 Product Family Multi-Vendor Operations Interworking Guide* for additional information about subnetworks size in these releases.

## **Synchronization — Wideband Shelf**

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### **Network Synchronization Environment**

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Careful consideration should be given to proper design of the SONET synchronization environment. Proper synchronization engineering minimizes timing instabilities, maintains quality transmission network performance, and limits network degradation due to unwanted propagation of synchronization network faults. The synchronization features of the DDM-2000 FiberReach Multiplexer are designed to complement the existing and future synchronization network and, hence, allow it not only to make use of network timing but also to take on an active role in facilitating network synchronization. A number of published sources give generic recommendations on setting up a synchronization network. The DDM-2000 FiberReach is designed to operate in a network that complies with recommendations stated in TR-NPL-000436, *Digital Synchronization Network Plan*; TA-TSY-000378, *Timing Signal Generator (TSG) Requirements and Objectives*; and ANSI\* T1.101-1993 (letter ballot), *Synchronization Interface Standards for Digital Networks*. The following are some key recommendations from these documents. For further detailed explanation, the sources should be consulted directly.\*

1. A node can only receive the synchronization reference signal from another node that contains a clock of equivalent or superior quality (Stratum level).
2. The facilities with the greatest availability (absence of outages) should be selected for synchronization facilities.
3. Where possible, all primary and secondary synchronization facilities should be diverse, and synchronization facilities within the same cable should be minimized.
4. The total number of nodes in series from the Stratum 1 source should be minimized. For example, the primary synchronization network would ideally look like a star configuration with the Stratum 1 source at the center. The nodes connected to the star would branch out in decreasing Stratum level from the center.
5. No timing loops may be formed in any combination of primary and secondary facilities.

Special considerations specific to digital loop carrier (DLC) systems, like the SLC-2000 Access System, must be taken into account when planning the synchronization environment when these DLC systems are included in a SONET subnetwork. See LTP 363-208-000, *SLC-2000 Access System, Applications, Planning, and Ordering Guide*, for more information.

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\* Registered trademark of American National Standards Institute, Inc.

## **Wideband Shelf Synchronization Features**

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### **Timing Modes**

DDM-2000 FiberReach wideband shelves can be used in a number of synchronization environments. Each DDM-2000 FiberReach wideband shelf is provisioned to be line-timed from an incoming high-speed interface. This timing mode can be combined with the host network into two subnetwork configurations: free running/line timing or external timing/line timing (with a DDM-2000 OC-3/OC-12 Multiplexer or a *SLC-2000* ARM shelf). In a future release, FiberReach may be provisioned to be free running from an internal oscillator.

### **Line Timing**

In line timing mode, the OLIU circuit pack derives local shelf timing from the incoming service OC-1 on OC-3 high-speed signal in the Main slot. The OLIU digital phase-locked loop (DPLL) also serves to remove any timing transients for improved network jitter performance. If one of the OC-N references is corrupted or unavailable, the OLIU will make a nonrevertive protection switch to the other reference without causing timing degradations. If both OC-N signals are lost (for example, due to a cable cut), the OLIU circuit pack will switch to holdover mode. The OLIU will normally switch back to the line timing mode when a reference is no longer corrupted, but it can be provisioned to require a manual switch.

## **Subnetwork Configurations**

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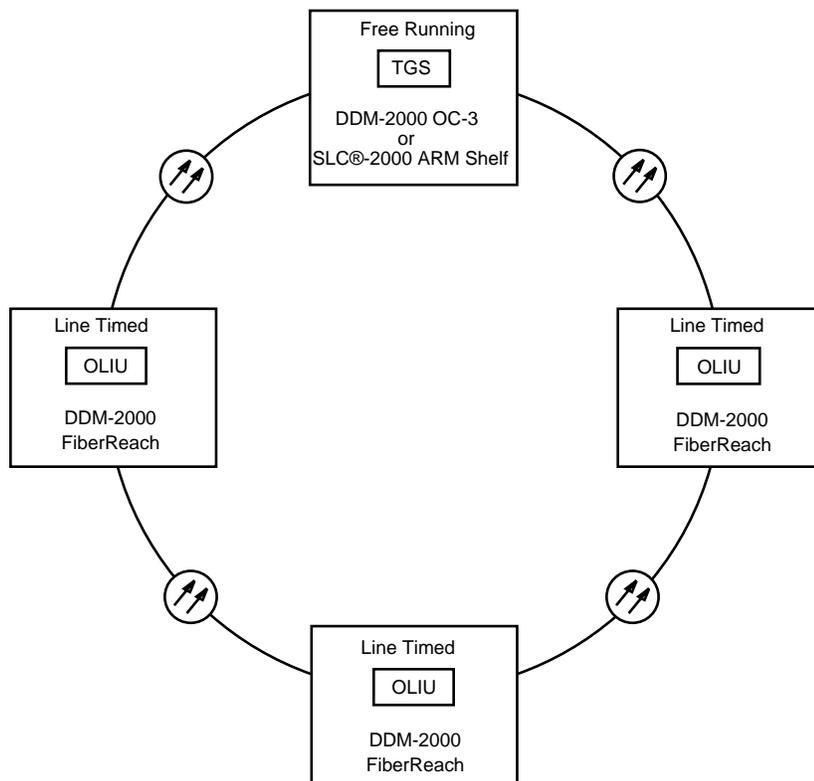
### **Free Running/Line Timing**

For initial SONET deployment with low-speed interfaces, minimum first cost may be a primary concern. The free running/line timing network can operate without an external clock source, so the expense of connecting to one is eliminated. This configuration may be useful for initial loop feeder and customer location applications, and it also meets the needs of an end-office trunk facility. This configuration should not be used to provide OC-N timing distribution or where SONET interconnections to other SONET subnetworks are needed. The local DDM-2000 host times its transmitted signals at the low- and high-speed interfaces from the internal  $\pm 15$  ppm oscillator. The DDM-2000 FiberReach Multiplexer connected to the host recovers timing from the incoming OC-N signal and uses this timing for its transmitted signals.

Because the free running/line timed DDM-2000 network is asynchronous to the DS1 services carried over it, additional jitter will be experienced on the demultiplexed DS1s. Certain interconnected equipment may be sensitive to such jitter, and this configuration should not be used in cases where it would cause a

problem for that equipment. In particular, downstream equipment containing Stratum 3 or better clocks could be sensitive to this jitter.

Figure 6-18 shows a DDM-2000 FiberReach Multiplexer ring application. In this figure, the host DDM-2000 OC-3 Multiplexer or SLC-2000 ARM shelf is free-running, and the DDM-2000 FiberReach wideband shelves are line-timed.



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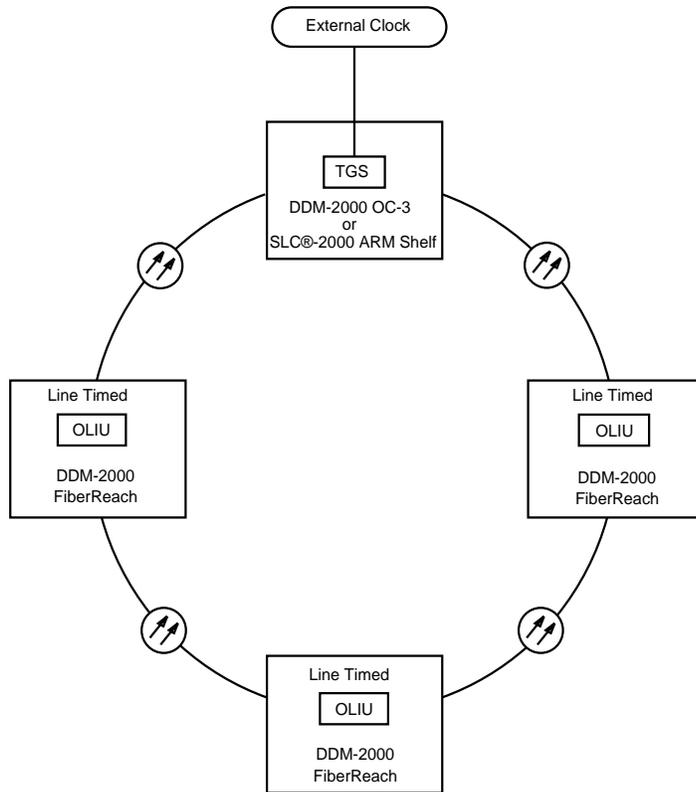
**Figure 6-18. Free Running/Line Timing Synchronization in a Ring Configuration**

## **External Timing/Line Timing Configuration**

The external timing/line timing configuration (Figure 6-19) integrates loop feeder and customer location networks into the digital synchronization network as required by the SONET standard. This application is ideal for networks where only one location has a building integrated timing supply (BITS), for example, a loop feeder. The network is synchronized to a local central office clock via DS1 references. The local office clock should be Stratum 3 or better, with timing traceable to a primary reference source. The local DDM-2000 multiplexer times its transmitted signals at the low- and high-speed interfaces from the internal oscillator that is locked on the external reference. The remote DDM-2000 FiberReach Multiplexer recovers timing from the incoming OC-1 signal and unidirectional timing path and uses this timing for its transmitted signals.

External timing is required when EC-1 low-speed interfaces are used to interconnect the local DDM-2000 with other SONET equipment. Thus, the external timing/line timing configuration should be the long-term goal for all loop feeder and customer applications.

This timing configuration is also recommended for multispans topologies. Line timing can be extended to many DDM-2000 sites without any degradation of timing quality. In the ring topology, synchronization messaging allows automatic synchronization reconfiguration in the event of a fiber or equipment failure.



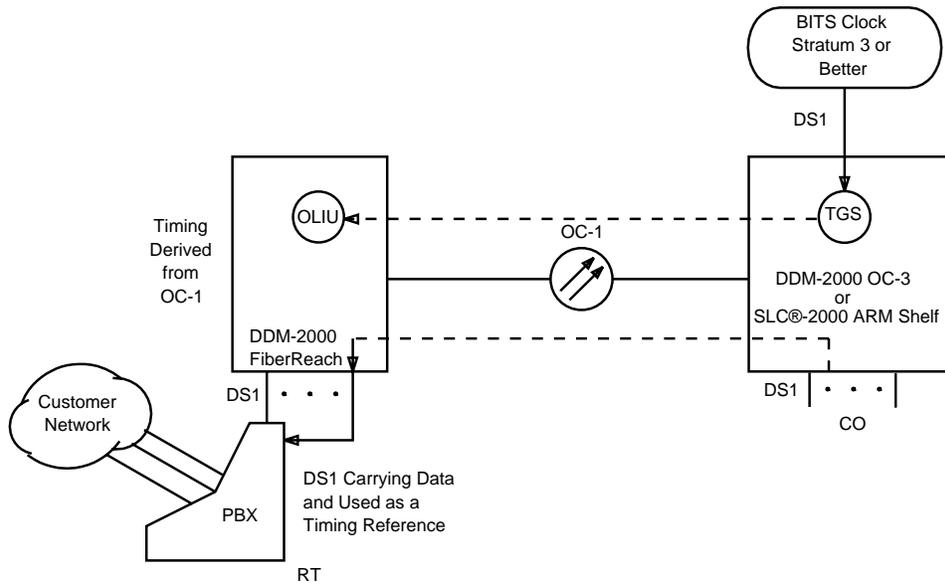
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**Figure 6-19. External Timing in a Ring Configuration**

## Timing Distribution

In many applications, all elements in a SONET network will be directly traceable to a single master clock via line-timing (for example, loop access networks, outside trunks, private networks). In this environment, the high-performance desynchronizer design of the DDM-2000 FiberReach Multiplexer allows a DS1 timing reference to be carried as a multiplexed DS1 payload to a customer premise. It is recommended that, where possible, the DS1 sources (switch, PBX, or other equipment) be traceable to the same timing source used to time the DDM-2000 SONET network. Multiplexed DS1 reference transport is also consistent with current planning and administration methods. Applications include passing synchronization from the public switched network to a PBX-based private network (Figure 6-20). Network timing failures are identified by a DS1 alarm indication signal (AIS) and will cause selection of an alternate timing source.



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**Figure 6-20. Timing from a Multiplexed DS1**

## **Synchronization Messaging**

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The DDM-2000 FiberReach Multiplexers provide a synchronization messaging feature to ensure the integrity of network synchronization during both normal and abnormal conditions. Through the use of synchronization messaging, the current quality of the timing source can be conveyed from one DDM-2000 FiberReach Multiplexer to the next. This capability allows the DDM-2000 FiberReach Multiplexers to automatically change their timing reference in order to always maintain the highest quality timing available.

### **Applications**

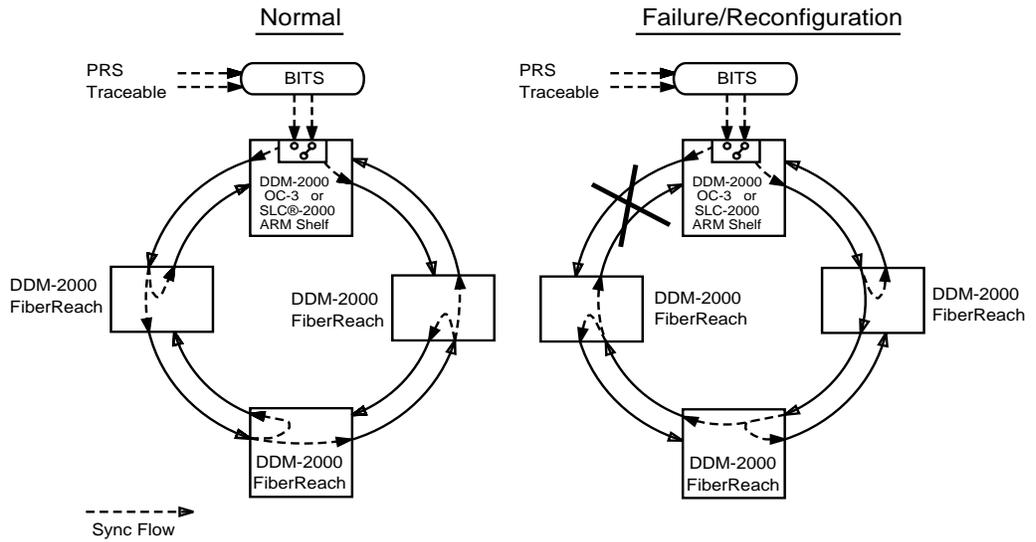
The applications that are currently supported with the synchronization messaging feature can be divided into two categories:

- Automatic synchronization reconfiguration
- Synchronization provisioning integrity

#### **Automatic Synchronization Reconfiguration**

SONET was designed to operate optimally in a synchronous environment. Although plesiosynchronous and asynchronous operation can be supported through the use of pointer adjustments, transmission quality is affected by the generation of additional jitter and wander due to pointer adjustments. Because of this, it is desirable to maintain synchronous operation whenever possible. Through the use of synchronization messages, the quality of the different timing references can be made available at each DDM-2000 FiberReach Multiplexer. The DDM-2000 FiberReach Multiplexer shelf can always determine the best timing reference available to it and switch to that reference. Through this mechanism, the synchronous operation of the subnetwork can be maintained. The switching of timing references is hitless, and the synchronization messages also allow it to be done without creating timing loops in the process.

Consider the access ring network in Figure 6-21. Under normal operation, the ring has one DDM-2000 Multiplexer externally timed and the other FiberReach multiplexers line-timed in the counterclockwise direction. If a fiber failure occurs between the host DDM-2000 and the DDM-2000 FiberReach Multiplexers, the synchronization auto-reconfiguration feature will cause the DDM-2000 FiberReach Multiplexers to change their line timing directions to clockwise. The result is that the ring is again operating synchronously. The ring already provides self-healing of the traffic, so it is especially important to maintain synchronous operation during this type of failure to prevent service degradation due to increased jitter and wander.



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**Figure 6-21. Synchronization Failure and Reconfiguration**

## Synchronization Provisioning Integrity

A welcome byproduct of synchronization messaging is the prevention of provisioning errors. Provisioned timing loops on the DDM-2000 FiberReach Multiplexers will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

### Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1 through 3 of the K2 byte found in the SONET overhead. If a DDM-2000 FiberReach system is deriving timing from a given OC-N interface and synchronization messaging is enabled on that interface (Kbyte messages are enabled using the `set-ocn` user interface command or `ent-rr` TL1 command.), the system interprets the received message to determine its internal timing status. The DDM-2000 FiberReach system also transmits over the particular OC-N interface, and all other OC-N interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing and its active timing mode. Table 6-2 lists the associated internal timing status that is associated with synchronization messages received from the OC-N interface when synchronization messaging is enabled. The table lists the messages from low to high quality.

**Table 6-2. Synchronization Messages Using K2 Byte**

Received Message	Active Timing Mode
Don't Use	Holdover
Timing Looped Back (TLB)	Holdover
Stratum 4*	Holdover
Internal Clock (IC)	OK to use
Stratum 3*	OK to use
Stratum 2*	OK to use
Sync Quality Unknown (SQU)	OK to use
Stratum 1*	OK to use

\* Presently, DDM Multiplexers cannot generate these messages, but they could be transmitted and supported for auto-reconfiguration if any of these are received by DDM-2000 Multiplexer.

The "Don't Use" message is sent when the system determines that its timing is not suitable for synchronization, for example, due to failure.

When the DDM-2000 FiberReach system is in holdover mode, the Internal Clock message will be sent on all OC-N interfaces.

When the DDM-2000 FiberReach system is configured for line timing, the Timing Looped Back message will be sent on the OC-N interfaces toward the network element from which the timing is being derived. The message received on the OC-N interface will be sent on all other OC-N interfaces where synchronization messaging is enabled.

With automatic synchronization reconfiguration, the DDM-2000 FiberReach Multiplexer systems use and compare the incoming synchronization messages on the OC-N main interfaces available for line timing to select the highest quality synchronization reference available. If the received quality levels are the same on the references available for timing, the existing line timing reference takes precedence. This feature guarantees the nonrevertive operation of reconfiguration. The line timing reference is provisioned by the `set-sync` command.

The existence of automatic synchronization reconfiguration does not change the system's behavior on traditional line failures, for example, loss of frame (LOF), loss of pointer (LOP), loss of signal (LOS), and others.

## Examples

In this section, some detailed examples are given to show specifically how the synchronization messages propagate through the DDM-2000 FiberReach network and assist in the recovery from a fiber failure. Through these examples, one can extend the same concept to any other network that may include different topologies, number of sites, failure locations, and number of BITS clocks.

**Table 6-3. Synchronization Messages using S1 Byte\***

<b>Received Message</b>	<b>Active Timing Mode<sup>†</sup></b>
Don't Use	Holdover
Traceable SONET Clock	OK to use
Traceable Stratum 3 <sup>‡</sup>	OK to use
Traceable Stratum 2 <sup>‡</sup>	OK to use
Sync Trace Unknown	OK to use
PRS Traceable <sup>‡</sup>	OK to use

\* This table is applicable when an 28-Type or 29-Type OC-3 OLIU is in the Main slots.

† This column applies only when provisioned for line timing mode.

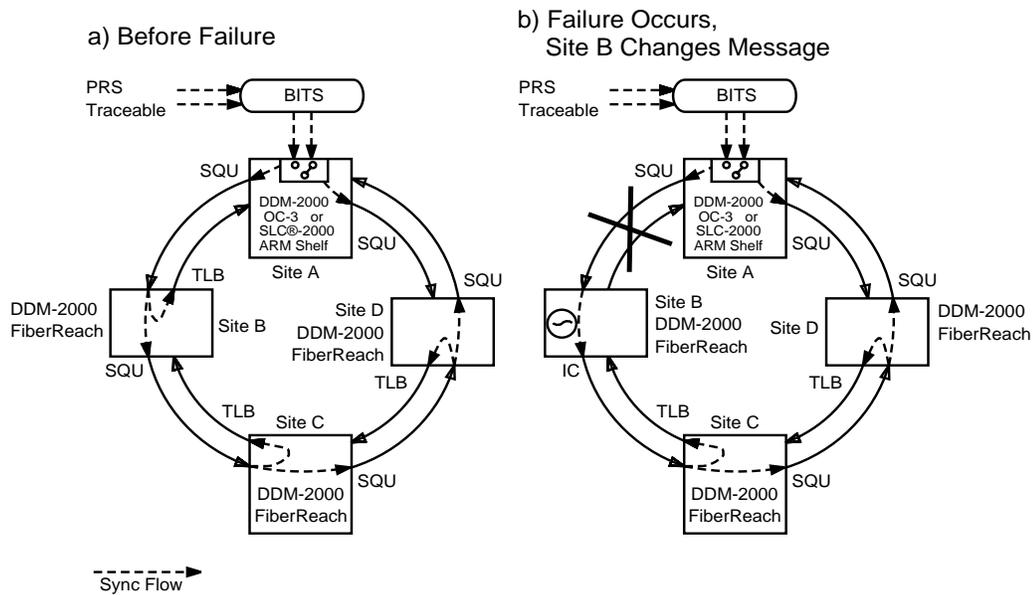
‡ Presently, DDM-2000 FiberReach Multiplexers cannot generate these messages, but they could be transmitted and supported for autoreconfiguration if any of these are received by DDM-2000 FiberReach Multiplexer.

Synchronization messaging using the SONET K2 byte and S1 byte can be disabled on a per OC-N interface using the `set-ocn` command. (See Table 6-3.) Zeros will be transmitted on bits 1-3 of the K2 byte if this is done; all ones will be transmitted on bits 5-8 of the S1 byte if this is done. The timing and synchronization status of a shelf can be determined using the `rtrv-sync` command.

### Synchronization Reconfiguration in an Access Ring

Figure 6-22a shows the access ring operating in its normal configuration. The DDM-2000 Multiplexer at the central office (CO) is externally timed, and each of the other DDM-2000 FiberReach Multiplexers are line-timed in a counterclockwise direction. The sync quality unknown (SQU) message is sent to indicate where timing is traceable to an external BITS and where it is valid to be used. The timing looped back (TLB) message is sent on the interface that is being used as the line timing reference and, thus, where using that timing would create a timing loop. Synchronization messaging and automatic synchronization have both been enabled for this network.

In Figure 6-22b, a fiber has been cut between sites A and B. Immediately, the DDM-2000 FiberReach Multiplexer at site B enters holdover and sends out the internal clock (IC) message to site C. The DDM-2000 FiberReach Multiplexer at site B cannot switch to line time from site C because it is receiving the TLB message on that interface.

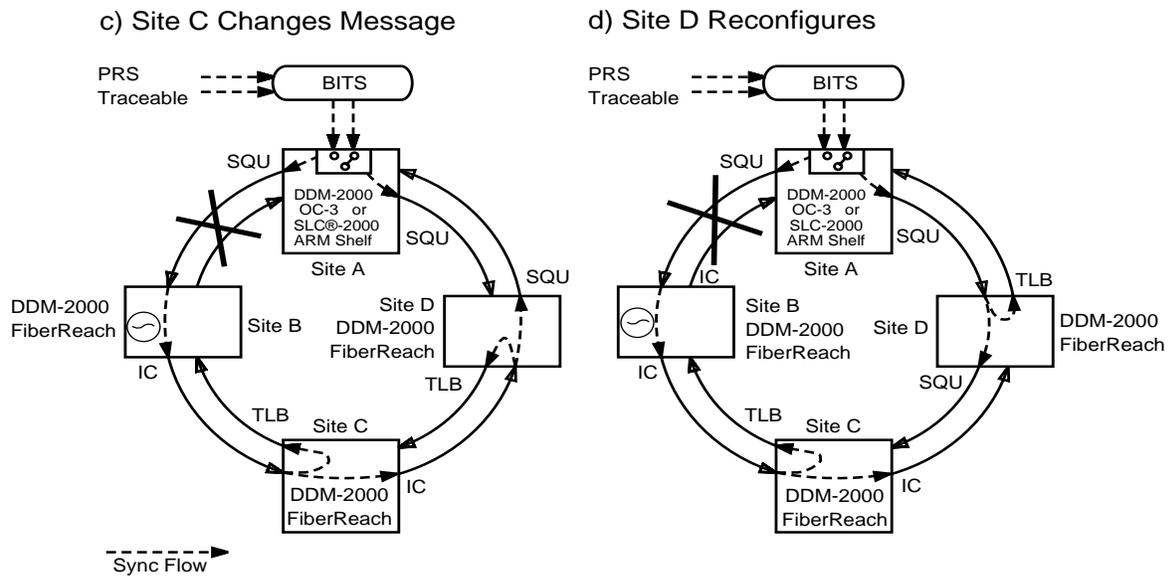


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Figure 6-22. Synchronization Reconfiguration — Access Ring (Sheet 1 of 3)

In Figure 6-22c, the DDM-2000 FiberReach Multiplexer at site C detects the incoming IC message and sends out the IC message to site D. The DDM-2000 FiberReach Multiplexer at site C cannot switch to line time from the other rotation because it is receiving the TLB message on that interface.

In Figure 6-22d, the DDM-2000 FiberReach Multiplexer at site D detects the incoming IC message. Because this DDM-2000 FiberReach Multiplexer is receiving the SQU message from site A, it will switch to line time from site A because SQU is higher quality than IC. After the switch occurs, the TLB message is sent back to site A and the SQU message is retransmitted to site C.

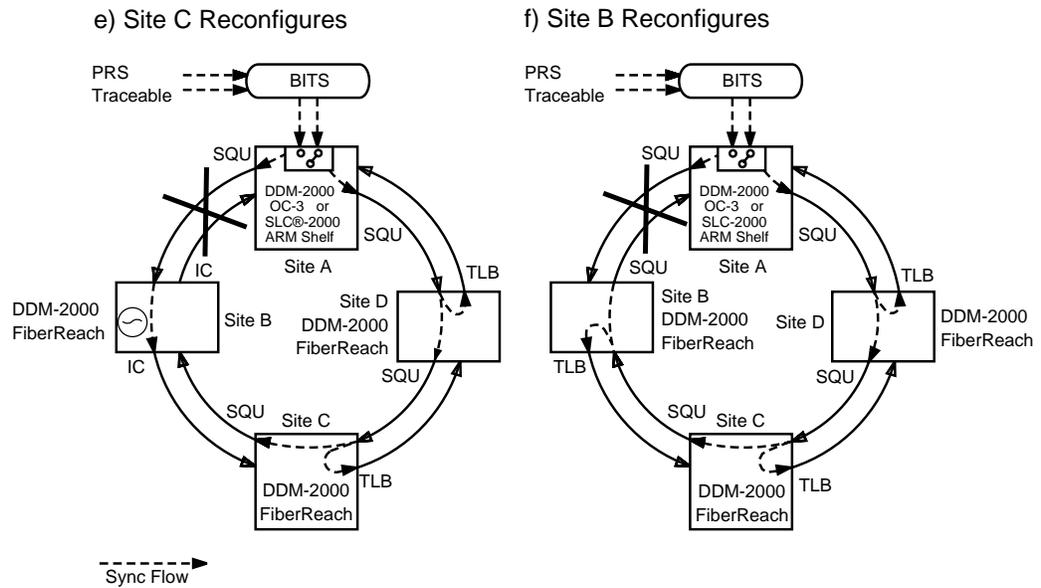


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**Figure 6-22. Synchronization Reconfiguration — Access Ring (Sheet 2 of 3)**

In Figure 6-22e, the DDM-2000 FiberReach Multiplexer at site C detects the incoming SQU message from site D. The SQU message is a better quality message than the IC message being received from site B, so the DDM-2000 FiberReach Multiplexer at site C switches to line time from site D. After the switch occurs, the TLB message is sent back to site D, and the SQU message is retransmitted to site B.

In Figure 6-22f, the DDM-2000 FiberReach Multiplexer at site B detects the incoming SQU message from site C. The SQU message is a better quality message than the internal holdover capability, so the DDM-2000 FiberReach Multiplexer at site B switches to line time from site C. After the switch occurs, the TLB message is sent back to site C, and the SQU message is forwarded to site A. When the failure clears, the synchronization remains in the new configuration unless it is manually switched back.



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**Figure 6-22. Synchronization Reconfiguration — Access Ring (Sheet 3 of 3)**

## Physical Arrangements (Wideband/ Narrowband)

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### Rack Mounting Arrangements

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The DDM-2000 FiberReach Multiplexers can be mounted in both ED-8C500 and ED-8C501 network bay frames. Figure 6-23 shows FiberReach rack mount options. Figure 6-24 shows a sample configuration for the FiberReach Multiplexers. Two wideband shelves, two narrowband shelves, or a wideband and a narrowband shelf may be mounted adjacent to each other in a carrier assembly. A heat baffle assembly may be mounted below each carrier assembly to ensure that the shelf remains cool.

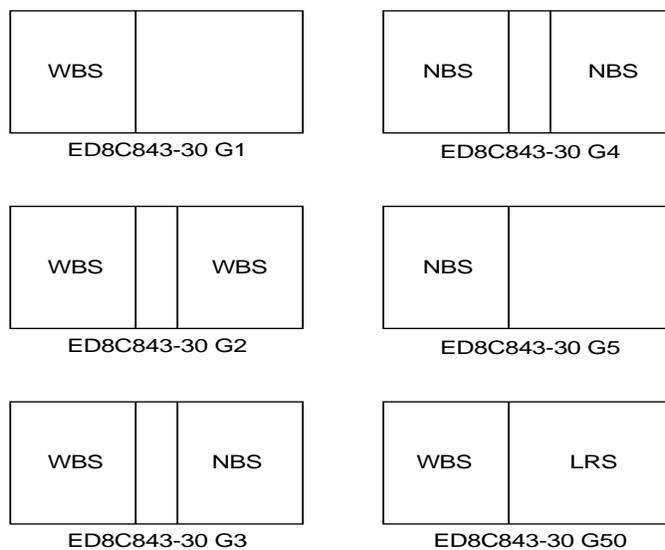


**NOTE:**

The heat baffle should be installed above the shelf. However, if the shelf is mounted above heat producing equipment that does not provide its own heat baffle, a second heat baffle is required under the shelf.

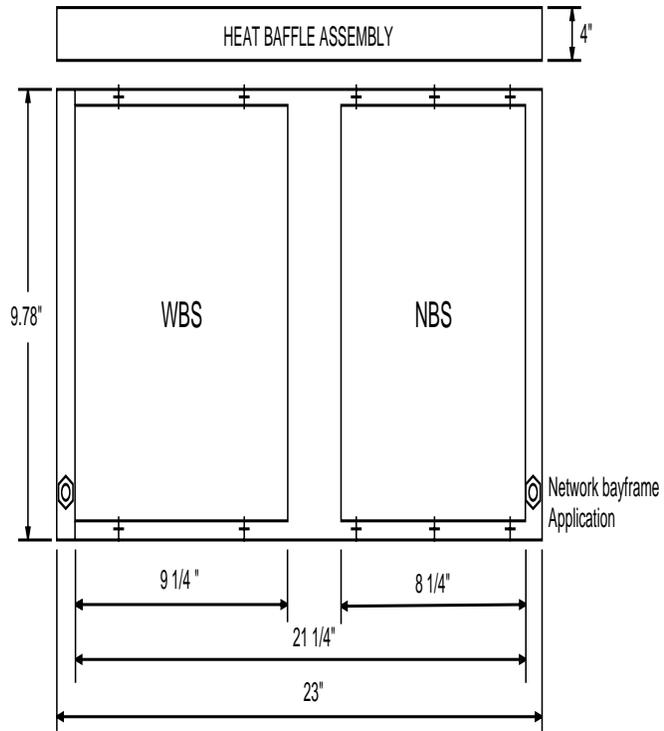
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#### FiberReach Carrier Assembly Group Configurations



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**Figure 6-23. DDM-2000 FiberReach Rack Mount Options**



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**Figure 6-24. DDM-2000 FiberReach Shelf Assembly**

## Seismic Bay Frames

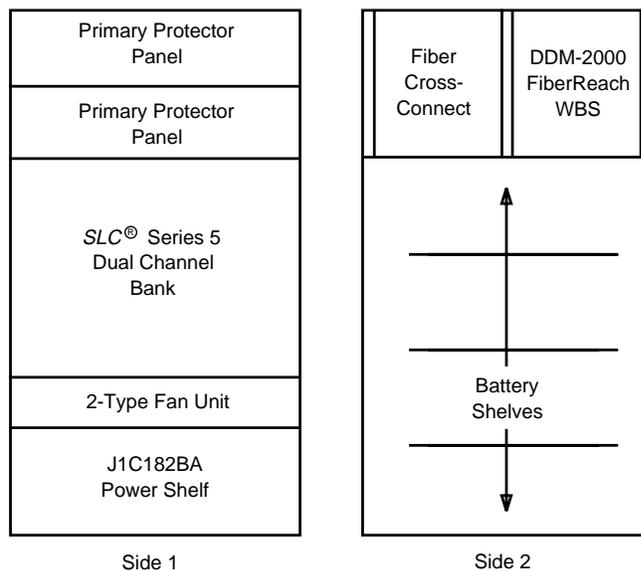
The ED-8C800-50 and ED-8C801-50 seismic network bay frames are designed for use in all earthquake zones and, in general, do not require top support at the 7-foot level. These frames meet Pacific Bell Equipment Framework Standard PBS-000-102PT. Shelf arrangements may be different for these bays.

## Outside Plant Cabinet Arrangements

### 51A Cabinet Arrangement

The DDM-2000 FiberReach Multiplexer is offered in a standard 51A cabinet configuration. Figure 6-25 shows a current configuration that includes the wideband shelf and a *SLC*<sup>®</sup> Series 5 Carrier System.

**⇒ NOTE:**  
The 51A cabinet arrangement is for the host application.



Note: A DS1 cross-connect is also provided in this cabinet.

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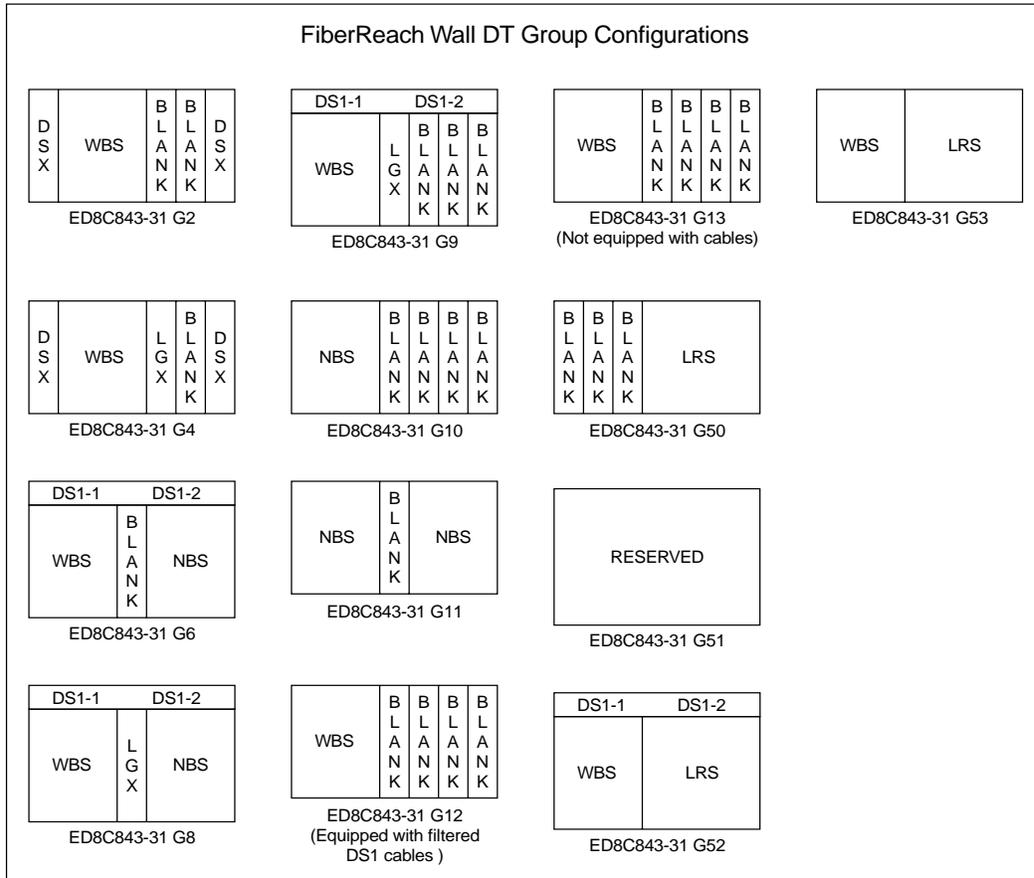
**Figure 6-25. DDM-2000 FiberReach 51A Cabinet Arrangement**

## Wall-Mount Distant Terminal

The DDM-2000 FiberReach Multiplexer is available in a wall-mount enclosure. This enclosure is approximately 23 inches wide by 11 inches high and will accommodate the following:

- a single DDM-2000 FiberReach wideband shelf
- a wideband and a narrowband shelf
- two narrowband shelves
- a *SLC LineReach* Access System shelf
- a wideband shelf and a *SLC LineReach* Access System shelf

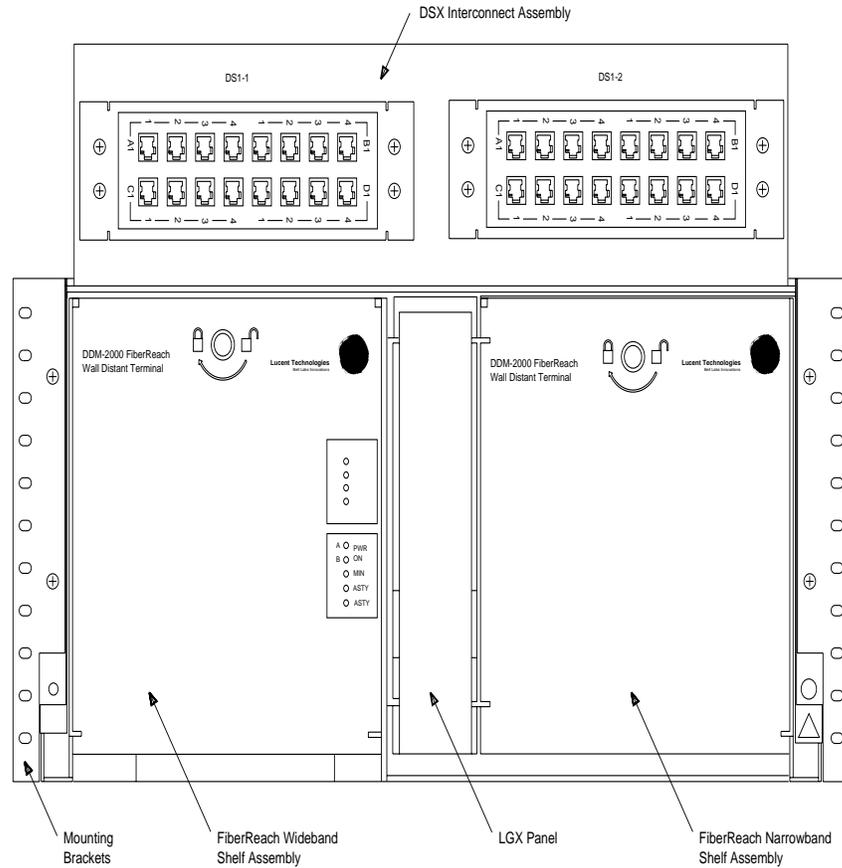
Figure 6-26 shows some of the different configurations available for this enclosure. Each DSX panel supports up to 16 DS1 circuit packs, so two DSX panels are needed for 1x7 protection. The *LGX*<sup>®</sup> panel is for lightguide cross-connections.



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**Figure 6-26. DDM-2000 FiberReach Wall Mount Enclosure Options**

Figure 6-27 shows a Wall Distant Terminal equipped with one wideband and one narrowband shelf, two DSX panels, and an LGX panel. Refer to the ordering section of this manual for details on these arrangements.



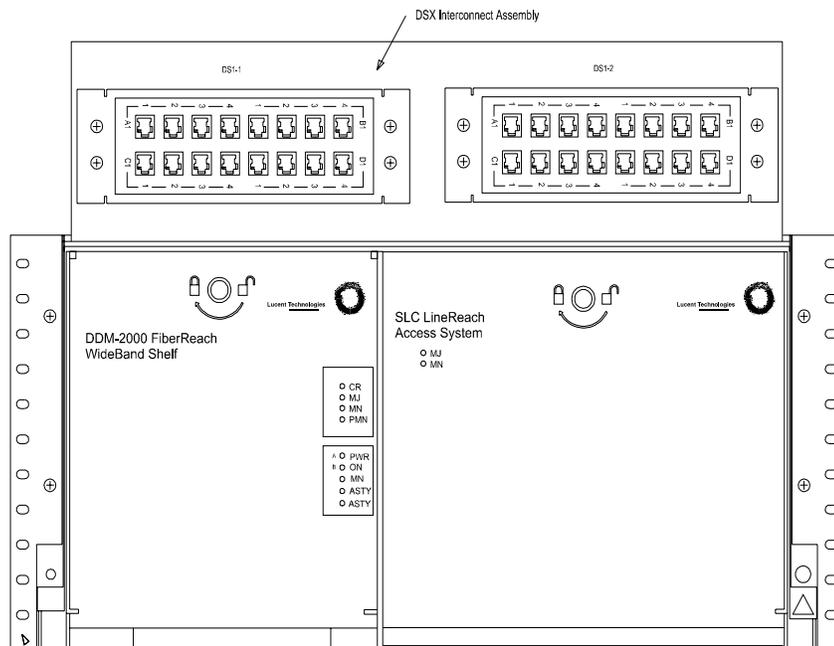
tpa 851643/01

**Figure 6-27. DDM-2000 FiberReach Wall Mount Distant Terminal**

The Wall Mount Distant Terminal can also accommodate a single LineReach shelf and one DDM-2000 FiberReach wideband shelf. The *SLC LineReach* Access System comes in three preassembled configurations for the Wall Mount DT:

- *SLC LineReach* Access System in Wall DT (no DSX cross-connect) (ED8C843-31 G50, comcode 601923634)
- WBS and *SLC LineReach* Access System in Wall DT (with dual DSX cross-connect) (ED8C843-31, G53, comcode 601925969)
- WBS and *SLC LineReach* Access System in Wall DT (no DSX cross-connect) (ED8C843-31, G53, comcode 601925969)

Figure 6-28 shows the configuration for a Wall Mount DT containing a *SLC LineReach* Access System and DDM-2000 FiberReach wideband shelf. The Wall Mount DT also comes with a dual DSX cross-connect. Each DSX panel supports up to 16 DS1 circuit packs, so two DSX panels are needed to support 28 DS1s. One DSX panel (DS1-1) receives 16 DS1s from the WBS while the other DSX panel (DS1-2) receives 12 DS1s.



**Figure 6-28. Wall Mount Distant Terminal with *SLC LineReach* Shelf and DDM-2000 FiberReach Wideband Shelf**

## **Secured-Area Telecommunication Applications Cabinet (STAC) System**

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The DDM-2000 FiberReach Narrowband and Wideband Multiplexers are available in the new modular indoor cabinet. The STAC System targets the needs of the local access market with a flexible and affordable configuration.

Each cabinet is assembled and can be completely wired and system tested at the factory to assure the highest standard of quality and quick trouble free installation.

There are two modules available:

- the FRC-2000 module (26" W x 15" D x 12" H)
- the pedestal battery module (26" W x 15" D x 24" H)

Features of the 12" module include:

- wall mountable
- floor mountable with spacer
- spacer that allows the user to stack modules on top of each other
- holds a combination of two FiberReach shelves
  - 1 wideband shelf and 1 narrowband shelf
  - 2 narrowband shelves
- holds up to two rectifiers
  - Lucent Technologies RSO 400 Series
  - 400 watts each
- fiber administration shelf
- tilts down for easy access to back of equipment
- allows access to rear of module to facilitate cable administration

Features of the pedestal battery module include:

- floor mountable
- front door removable and provisioned for padlock
- spacer that allows electronic module to be stacked on top
- holds up to 2 strings of batteries
  - Lucent Technologies' HR Series Battery
- provides up to 8 hours of battery backup
- includes low voltage disconnect and fusing unit

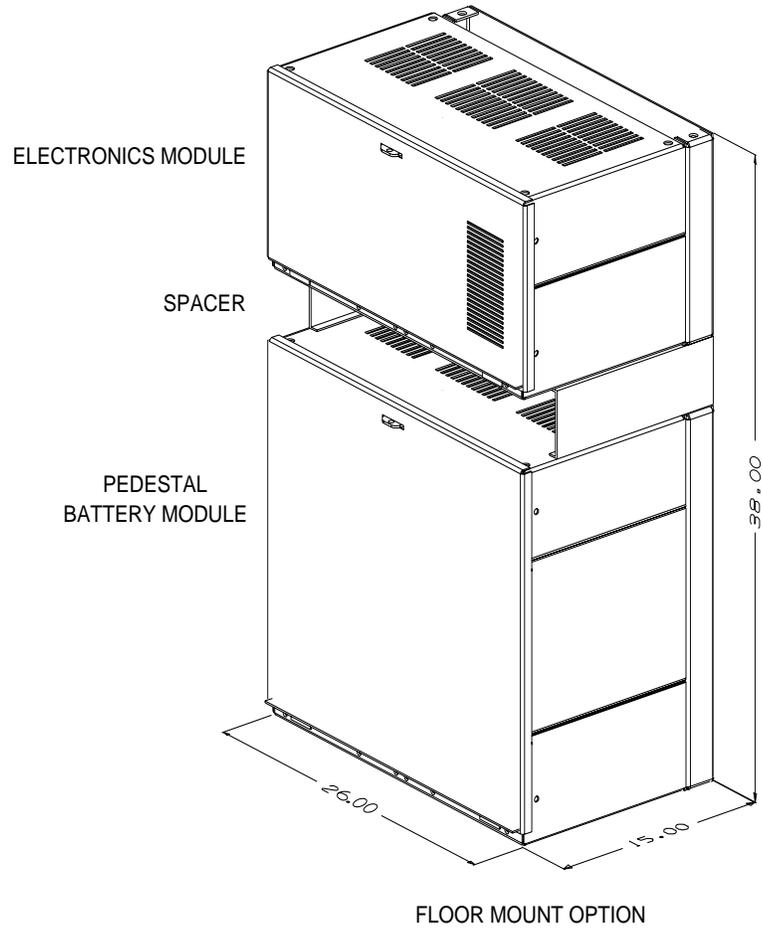
Figure 6-29 and Figure 6-30 illustrate two possible mounting configurations. Refer to Cabinet Practice 640-030-206 for more information.

### **Construction**

This space efficient modular cabinet is manufactured with corrosion resistant materials. Aluminum is used for the cabinet body and the majority of the cabinet components. The electronics modules are equipped with power and battery alarms which can be connected to a monitoring system, at a central location to notify the user in the event of equipment trouble.

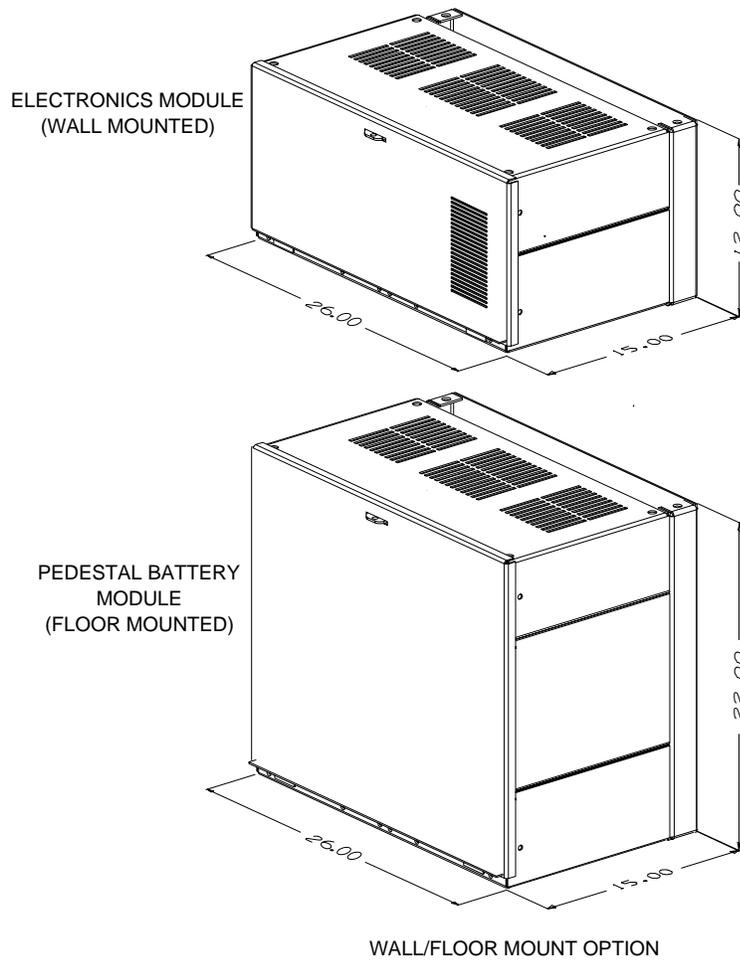
### **Reliability**

The cabinet has undergone extensive system testing and qualification by Bell Laboratories based on expected worst case conditions to ensure high reliability and trouble free field performance. These test results are correlated with actual field data to validate cabinet performance. This extensive testing provides assurance that Lucent Technologies cabinet solutions meet specific application and performance needs of the customer.



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**Figure 6-29. STAC System, FRC-2000 Module with Pedestal Battery Base**



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**Figure 6-30. STAC System, FRC 2000 Module Wall Mount Option with Separate Pedestal Battery Module**

## **Cabling**

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All the interfaces to the DDM-2000 FiberReach Multiplexers are connectorized. Both front and rear access cabling arrangements are available.

The 26-gauge (1249C) and 22-gauge (613C) cabling options are available to interface the DDM-2000 FiberReach Multiplexer to a DSX-1 cross-connect bay. For ease of installation, 26-gauge (1249C) cabling is recommended for interfacing the DSX-1 cross-connect bay unless prohibited due to distance requirements.

## **Environmental Specifications**

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The DDM-2000 Multiplexers meet the applicable standards for use in central office and uncontrolled environments, electromagnetic compatibility (EMC) requirements, and fire resistance. The following is a list of environmental specification requirements that DDM-2000 Multiplexers meet or exceed:

- Temperature and humidity: Telcordia Technologies Network Equipment Building System (NEBS)
- EMC requirements: FCC Rules Part 15
- Earthquake requirements: Telcordia Technologies TR-NWT-000063, Pacific Bell Standard PBS-000-102PT
- Fire resistance: T1Y1.4/88-014, *UL*\*1459

In addition, DDM-2000 FiberReach meets the standards set by Canadian Standards Association C22.2 Number 225.M90.

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\* Registered trademark of Underwriters Laboratories Inc.

## **Bibliography**

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- ANSI T1.101-1993* — American National Standard for Telecommunications — Synchronization Interface Standards for Digital Networks.
- TA-TSY-000378* — Timing Signal Generator Requirements and Objectives.
- TR-NPL-000436* — Digital Synchronization Network Plan.

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# Contents

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# DDM-2000 FiberReach Ordering



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## Overview

This section provides equipment, software, and cabling ordering information for the DDM-2000 FiberReach Multiplexer.

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## Introduction

This section is designed to facilitate the equipment engineer's job when issuing a telephone equipment order (TEO). It is not intended to replace standard engineering documentation, for example, schematic drawings, equipment drawings, etc. This section is not required as a part of a DDM-2000 FiberReach Multiplexer order. However, if this section is used, it will ensure that all elements of the DDM-2000 FiberReach Multiplexer and related interfaces arrive and are installed on schedule to assure the timely turn-up of DDM-2000 FiberReach Multiplexer equipment.

This section has four major tabs covering ordering information for DDM-2000 FiberReach Multiplexer shelves and cabling (FiberReach Ordering tab), software (Software Ordering tab), plug-ins (Plug-Ins tab), and miscellaneous equipment and tools (Miscellaneous Equipment and Tools tab).

Each shelf can be ordered separately and may be mounted as a stand-alone item. DDM-2000 FiberReach Multiplexer equipment is also available in all the traditional loop enclosure arrangements as described in Chapter 3, "Applications."

The DDM-2000 FiberReach Multiplexer shelf is completely connectorized. Since shelves, standardized cable assemblies, and plug-ins are stocked, order turnaround is substantially reduced for most common arrangements.

The following documents contain ordering information for the host equipment for the DDM-2000 FiberReach Multiplexer:

- 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*
- 363-208-000, *SLC-2000 Applications, Planning, and Ordering Guide*

## **Completing an Order Blank**

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Complete the appropriate order blank:

- Shelf Order Blank
- Appropriate Cable Order Blanks
- Software Order Blank
- Plug-In Order Blank
- Miscellaneous Equipment and Tools Table

### **Ordering Tab**

Shelf Order Blank ..... Table 7-1

### **Cable Ordering Tab**

Figures 7-1 through 7-11 ..... FiberReach Shelf Cabling  
Figures 7-12 and 7-13..... FiberReach Wall DT Cabling  
Order Blanks (after Figure 7-13) ..... Cable Ordering

### **Software Ordering Tab**

FiberReach Software Order Blank..... Table 7-3  
SLC<sup>®</sup>-2000 Software Order Blank ..... Table 7-4  
CPro-2000 Software Order Blank ..... Table 7-5

### **Plug-Ins Tab**

Plug-In Order Blank ..... Table 7-9

### **Miscellaneous Equipment and Tools Tab**

Miscellaneous Equipment..... Table 7-11  
Miscellaneous Fiber Cabling ..... Table 7-12  
Miscellaneous Accessories ..... Table 7-13

The forms in this section may be reproduced for order placement. This section is structured in the form of a questionnaire, requiring the entering of quantities or other data to assist in the engineering of the job. Only those forms pertaining to this particular order should be attached to the order sheet (tables and cable order blanks).

## Shelf and Cable Ordering

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This section provides cable and shelf ordering information for DDM-2000 FiberReach Multiplexer arrangements.

### DDM-2000 FiberReach Shelf Rack Mount Assembly, ED-8C843-30

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A single DDM-2000 FiberReach Multiplexer shelf rack mount assembly, ED-8C843-30, can accommodate many different network applications. The wideband shelf supports DS1, T1, OC-1, OC-3, OC-12, DS3, and OC-3c interfaces, including the *SLC LineReach* shelf in a carrier assembly. The narrowband shelf supports DS0 services. For bay arrangements, the heat baffle assembly is also required. Several additional features will be available in the future through the simple addition of new plug-ins without the need for shelf modifications. Some of these future arrangements may require new or changed cabling interfaces; however, for bay arrangements—where plans are known—it may be prudent to include this cabling on initial orders to facilitate later installations.

### DDM-2000 FiberReach Wall Distant Terminal Assembly, ED-8C843-31

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The DDM-2000 FiberReach Wall Distant Terminal (Wall DT) assembly can accommodate many different arrangements. The Wall DT assembly has room for one or two wideband shelves, one or two narrowband shelves, or one wideband and one narrowband shelf. Three new configurations now available are:

- DDM-2000 FiberReach wideband shelf and *SLC LineReach* shelf in a Wall DT (no DSX panels)
- DDM-2000 FiberReach wideband shelf and *SLC LineReach* shelf in a Wall DT with two DSX panels
- A Wall DT with a single *SLC LineReach* shelf

A DSX panel is provided for cable interfacing and the LGX panel for fiber connection, terminating, and splicing. The Wall DT assembly is shipped with a power cable, an additional AC power supply cable with alarm outputs, and ground wiring. Optional DS1 cables and a miscellaneous discretes cable can be ordered.

### T1 Lightning and Surge Secondary Protection Assembly, ED-8C783-30

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Since T1 or HDSL digital lines may be exposed to lightning power surges and power crosses in outside plant applications, an external secondary lightning and surge protection assembly, ED-8C783-30, is required with all outside plant T1 or HDSL applications. This assembly is mounted externally to the DDM-2000 FiberReach shelf and can be installed in racks or cabinets. Users must provide

external mounting for an assembly used with a Wall DT. The assembly can hold up to two backplanes, enough to protect a DDM-2000 FiberReach shelf with maximum T1 service. Two LPROT lightning protection cards must be ordered for each BBF6 T1EXT or BBF8 HDSL circuit pack that is ordered. The lightning and surge protection assembly is for secondary protection only. The tip and ring conductors must have gas tubes (Lucent Technologies' protector unit 4B3EW or equivalent) installed at the point of entry into a cabinet or building.

### **Shelf Order Blanks**

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Table 7-1 and associated cable order blanks, completed with the help of the appropriate cable drawings, provide an ordering package for a single DDM-2000 FiberReach shelf and all the cabling interfaces. For DDM-2000 FiberReach Multiplexers, only one set of cables is required for either front or rear access cabling.

**Table 7-1. Shelf Order Blank**

**SHELF ORDER BLANK**  
(Provide one blank per shelf ordered)

<b>Qty Ord</b>	<b>Equipment Code</b>	<b>See Note(s)</b>	<b>Description</b>
	ED-8C762-30,G2	1,2	DDM-2000 FiberReach Multiplexer Wideband Shelf for Wall Distant Terminal
	ED-8C762-30,G3	1,2	DDM-2000 FiberReach Multiplexer Wideband Shelf for Rack Mount
	ED-8C762-30,GA	3	DDM-2000 FiberReach Multiplexer User/Service Manual (Release 2 or earlier.)
	ED-8C762-30,GB	3	DDM-2000 FiberReach Multiplexer User/Service Manual
	ED-8C843-30,G1	1,4,8	DDM-2000 FiberReach Multiplexer shelf assembly equipped with 1 wideband shelf and 1 user panel in a 23" rack mount
	ED-8C843-30,G2	1,4,8	DDM-2000 FiberReach Multiplexer shelf assembly equipped with 2 wideband shelves and 2 user panels in a 23" rack mount
	ED-8C843-30,G3	1,4,8	DDM-2000 FiberReach Multiplexer shelf assembly equipped with 1 wideband shelf, 1 user panel, and 1 narrowband shelf in a 23" rack mount
	ED-8C843-30,G4	4,8	DDM-2000 FiberReach Multiplexer shelf assembly equipped with 2 narrowband shelves in a 23" rack mount
	ED-8C843-30,G5	4,8	DDM-2000 FiberReach Multiplexer shelf assembly equipped with 1 narrowband shelf in a 23" rack mount
	ED-8C843-30,G50	1,4,8	DDM-2000 FiberReach Multiplexer shelf assembly with 1 WBS and 1 SLC LineReach shelf
	ED-8C843-30,GA	3,8	DDM-2000 FiberReach Multiplexer User/Service Manual (Release 2 or earlier)
	ED-8C843-30,GB	3,8	DDM-2000 FiberReach Multiplexer User/Service Manual (Release 3)
	ED-8C843-31,G2	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, cables, 1 user panel, and 2 DSX
	ED-8C843-31,G4	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, cables, 1 user panel, 2 DSX, and 1 LGX
	ED-8C843-31,G6	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, 1 narrowband shelf, cables, user panel and 2 DSX
	ED-8C843-31,G8	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, 1 narrowband shelf, cables, user panel, 2 DSX, and 1 LGX
	ED-8C843-31,G9	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, cables, user panel, 2 DSX (mounted on top so that a narrowband shelf can be added), and 1 LGX
<b>See notes at end of table.</b>			

**Table 7-1. Shelf Order Blank - Continued**

**SHELF ORDER BLANK**  
(Provide one blank per shelf ordered)

Qty Ord	Equipment Code	See Note(s)	Description
	ED-8C843-31,G10	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer narrowband shelf
	ED-8C843-31,G11	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 2 DDM-2000 FiberReach Multiplexer narrowband shelves
	ED-8C843-31,G12	1,8	DDM-2000 FiberReach Carrier Assembly equipped with 1 WBS, filtered DS1 cables
	ED-8C843-31,G13	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 WBS
	ED-8C843-31,G50	8	DDM-2000 FiberReach Carrier Assembly equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf and 1 <i>SLC LineReach</i> shelf
	ED-8C843-31,G52	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, 1 <i>SLC LineReach</i> shelf, cables, and 2 DSX's
	ED-8C843-31,G53	1,8	DDM-2000 FiberReach Wall Distant Terminal equipped with 1 DDM-2000 FiberReach Multiplexer wideband shelf, 1 <i>SLC LineReach</i> shelf, and cables
	ED-8C843-31,GA	3	DDM-2000 FiberReach User/Service Manual (Release 2 or earlier)
	ED-8C843-31,GB	3	DDM-2000 FiberReach User/Service Manual (Release 3)
	ED-8C785-30,G1		DDM-2000 FiberReach Narrowband Shelf equipped with backplane and card cage (for central office applications)
	ED-8C785-30,G2		DDM-2000 FiberReach Narrowband Shelf equipped with backplane and card cage (for wall distant terminal applications)
	ED-8C785-30,GA		DDM-2000 FiberReach Narrowband Shelf equipped with backplane and card cage (for wall distant terminal applications) (Release 2 or earlier)
	ED-8C785-30,GB		DDM-2000 FiberReach Narrowband Shelf equipped with backplane and card cage (for wall distant terminal applications) (Release 3)
	ED-8C783-30,G2	5	DDM-2000 Secondary Lightning and Surge Protection Assembly equipped with 2 backplanes
	847552627	6	DDM-2000 FiberReach 23" Carrier Assembly Only
	107659229		Wall mount 120 VAC (1145B1) power supply and 1147B1 battery backup
	107659211		Rack mount 120 VAC (1145B1) power supply and 1147B1 battery backup
	ED-8C733-30,G1	7	Heat Baffle Assembly
<b>See notes at end of table.</b>			

### SHELF ORDER BLANK (Continued)

**Notes:**

1. Included with each DDM-2000 FiberReach wideband shelf is the ECC2 user panel. Also included is a 1x1 protection bus (installed) and an additional 1x7 protection bus module.
2. Included with each ED-8C762-30 is the hardware required for mounting to the carrier assembly.
3. Group A is *LTP 363-206-301, DDM-2000 FiberReach Multiplexer User/Service Manual*. This manual may be ordered separately or in conjunction with other groups. The manual can also be ordered using the software ordering blank in the "Software Ordering" section.
4. Included with each ED-8C843-30 is hardware required for mounting the carrier assembly to the bay frame.
5. The secondary lightning and surge protection assembly is mounted externally to the DDM-2000 FiberReach Shelf. Two backplane assemblies protect up to 7 T1EXT circuit packs. Cabling for this assembly is ordered separately. See the Cable Order Blank for details.
6. The carrier assembly can be ordered separately via a COMCODE number for the ED-8C843-30, G1 or G3 wideband shelf.
7. The heat baffle assembly is required in bay arrangements and recommended in cabinet arrangements where thermal requirements are specified.
8. A 48V power kit with 8.0 AH battery (with or without mounting brackets) is needed for powering. See the Miscellaneous Equipment Ordering blank, presented later in this chapter.
9. The LGX panel for the DDM-2000 FiberReach Wall DT requires at least 4 or up to 8 universal buildout blocks, which are ordered separately. Also required is a 12A1 clamp, which is also ordered separately. Mechanical or fusion splice kits for lightwave fiber may also be ordered, if needed.

## **DDM-2000 FiberReach Cabling**

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The following pages show DDM-2000 FiberReach Multiplexer cable drawings to which the user may refer when completing the cable ordering blanks. Figures 7-1 through 7-11 show cabling arrangements for the DDM-2000 FiberReach Multiplexer shelf assembly. Figures 7-12 and 7-13 show the optional cables that may be ordered for the DDM-2000 FiberReach Wall DT assembly.



**NOTE 1:**

Since both rear access and front access installations are accommodated with the same cables, a front access installation will require longer cable lengths in order to dangle the cable from the backplane to the front of the DDM-2000 FiberReach shelf.

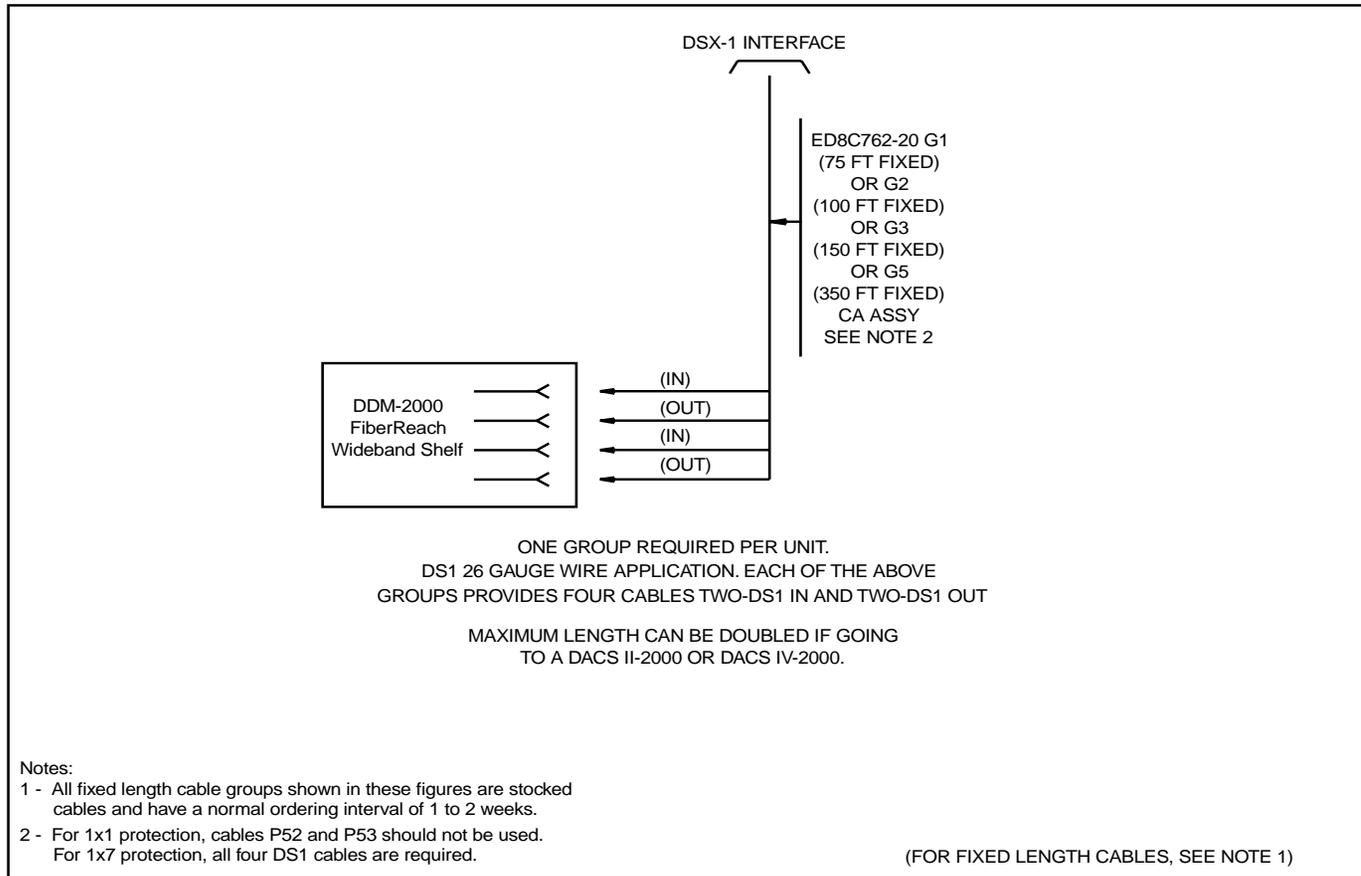


**NOTE 2:**

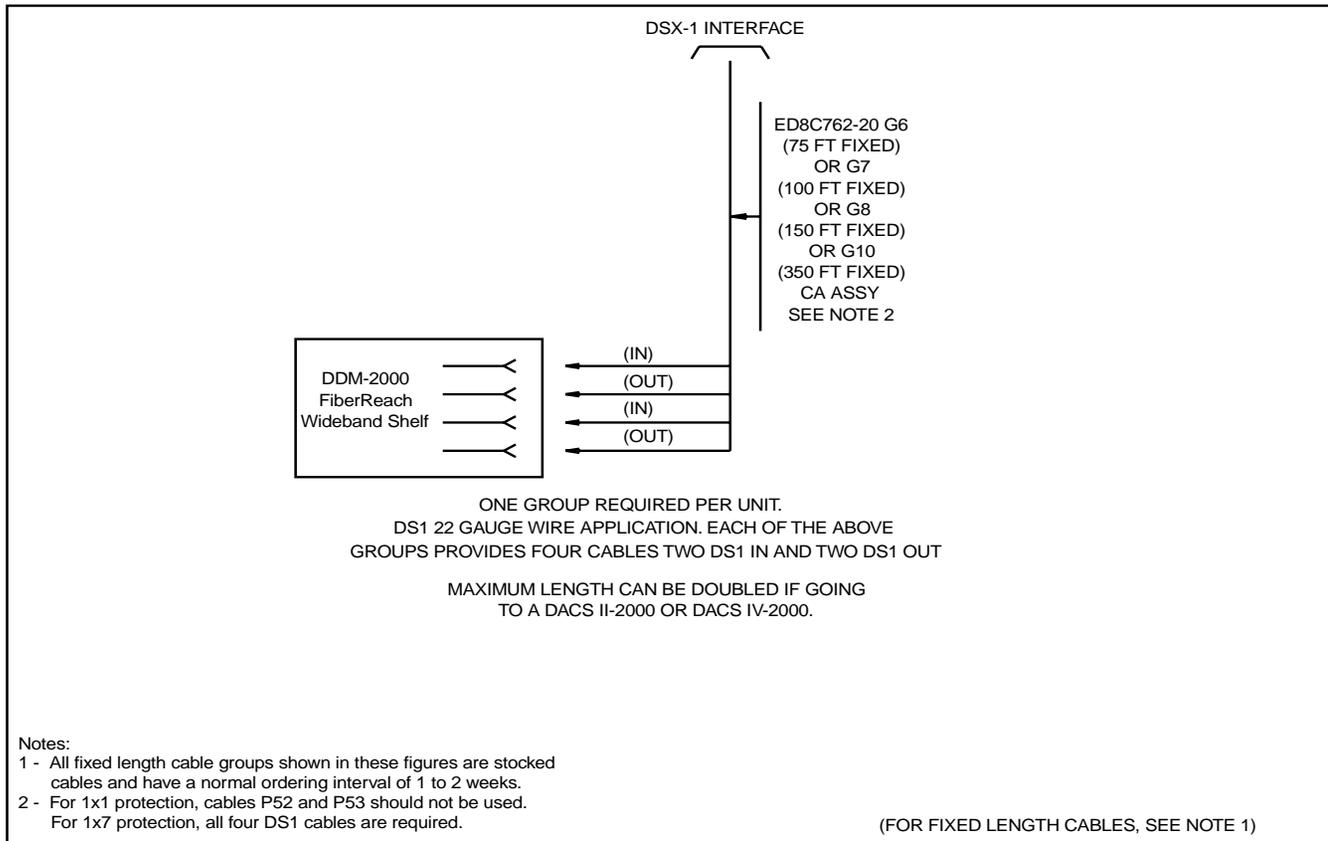
Cabling information for the *SLC-2000* HDT that hosts the DDM-2000 FiberReach NBS can be found in LTP 363-208-000, *SLC-2000 Access System Applications, Planning, and Ordering Guide*. Please note that the *SLC-2000* HDT has a new set of MDS-to-DSX1 interface cables that include:

- ED-7C723-35 G17 (4 ft.) — connects the DT server in the MDS assembly to one of the pair of cables shown below.
- One pair of the following cables that connect the ED-7C723-35 G17 to the DSX cross-connect (depending on the length needed):
  - ED-7C723-35 G19 (30 ft.)
  - ED-7C723-35 G20 (50 ft.)
  - ED-7C723-35 G21 (100 ft.)
  - ED-7C723-35 G22 (200 ft.)

Consult LTP 363-208-000 for additional information.



**Figure 7-1. Wideband Shelf Cabling — DS1 Transmission Cables, 26 Gauge**



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**Figure 7-2. Wideband Shelf Cabling — DS1 Transmission Cables, 22 Gauge**

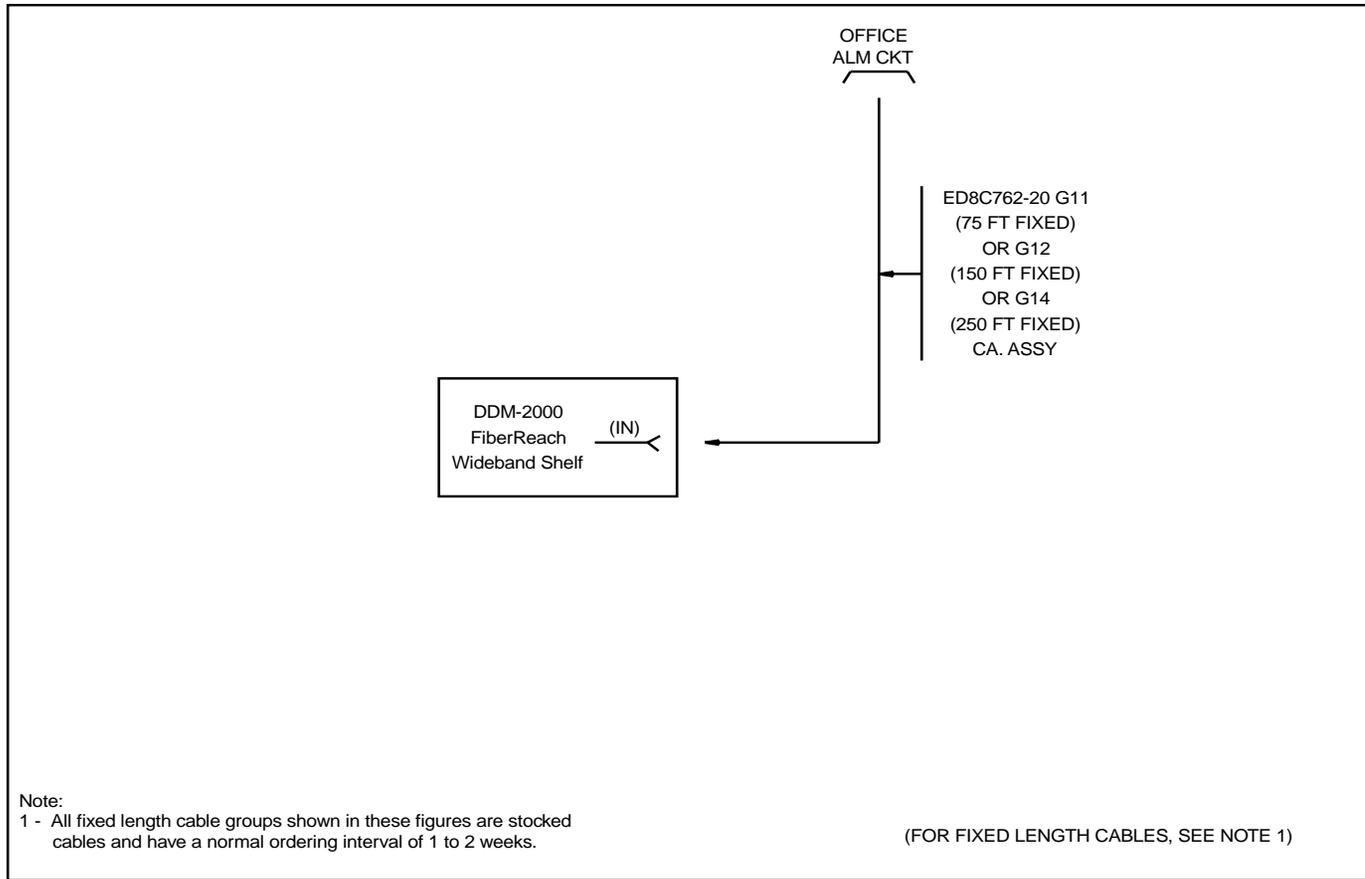
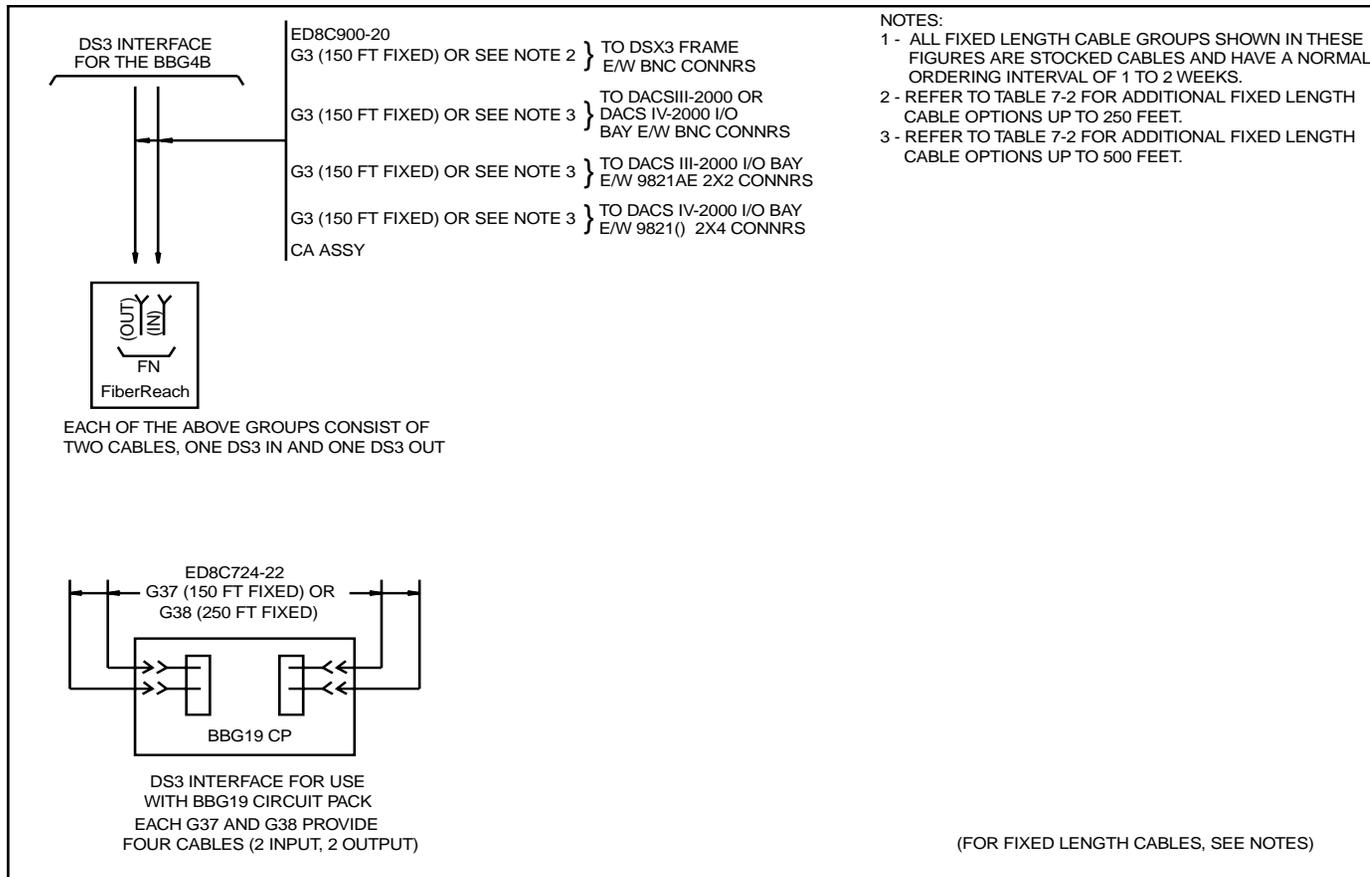


Figure 7-3. Wideband Shelf Cabling — Office Alarm Interface Cable



**Figure 7-4. Wideband Shelf Cabling — 735A DS3 Transmission Cable**

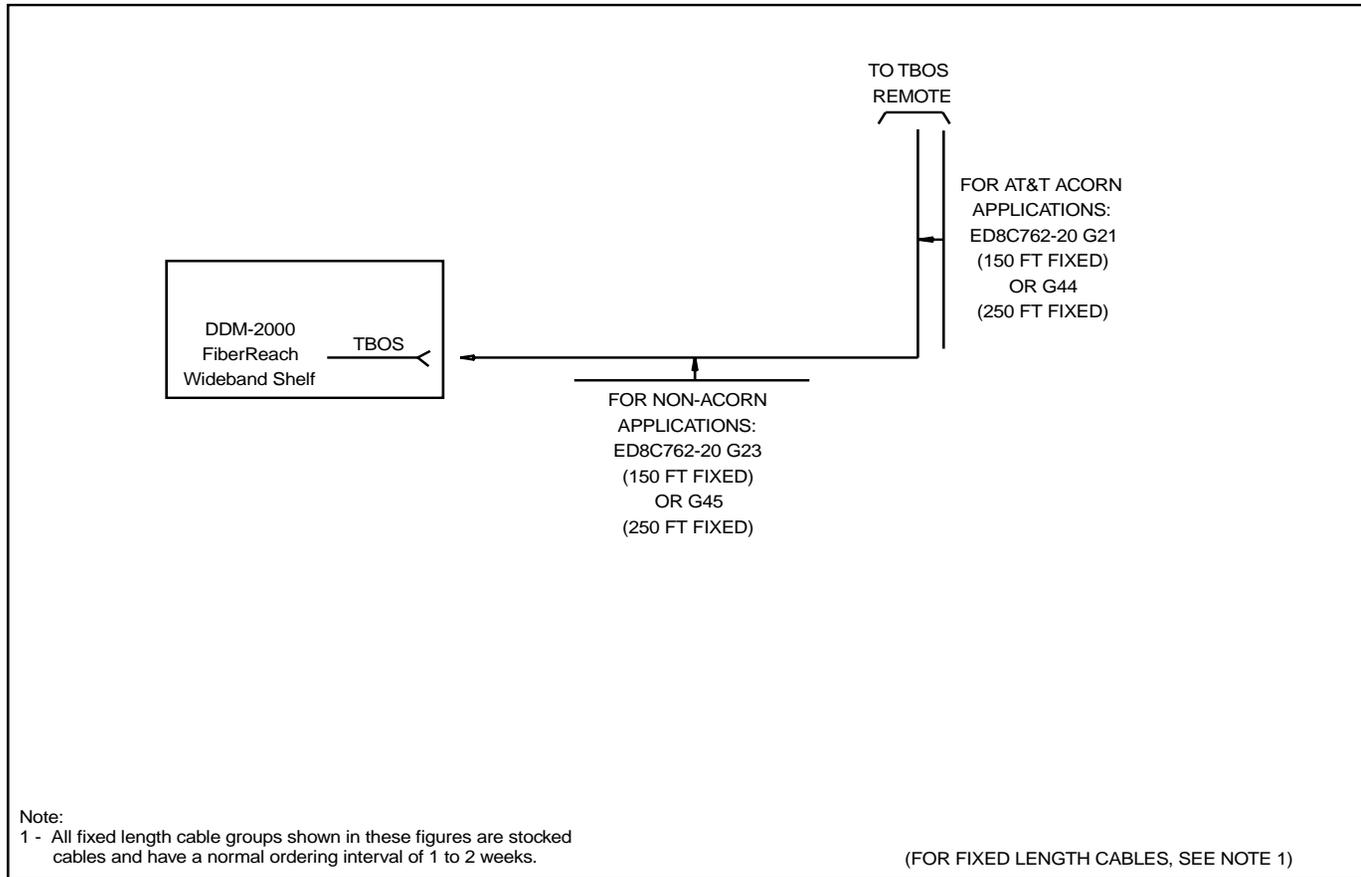


Figure 7-5. Wideband Shelf Cabling — TBOS Interface (Not Supported in Release 3.0)

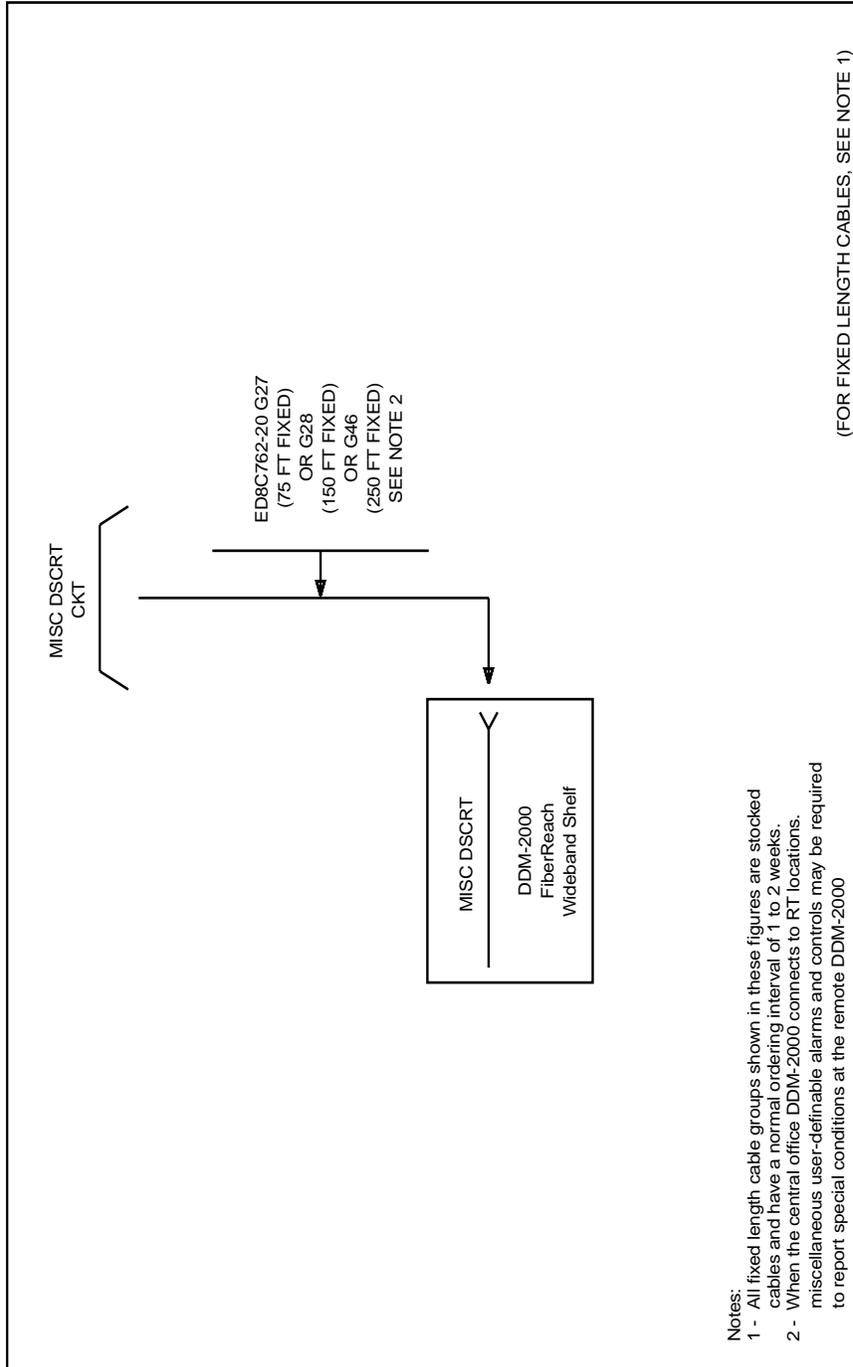


Figure 7-6. Wideband Shelf Cabling — Miscellaneous Discretes

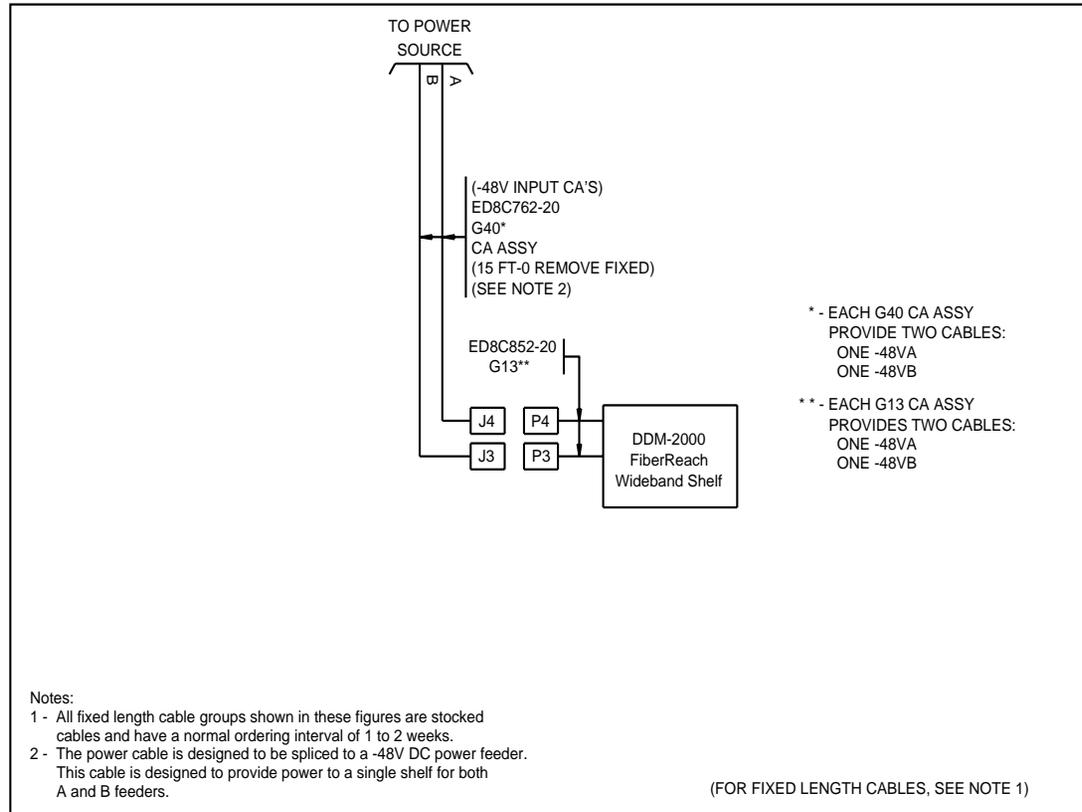
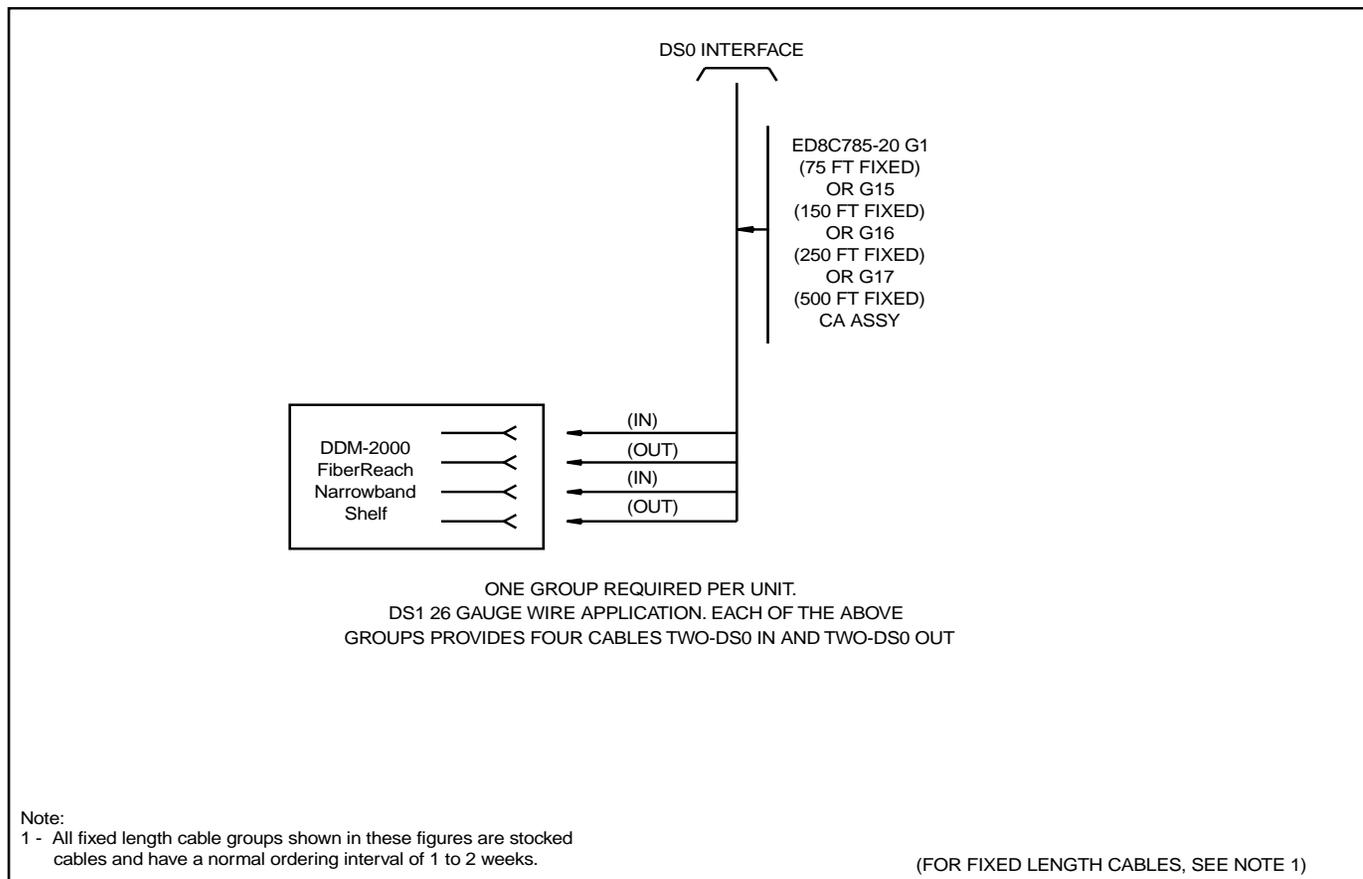


Figure 7-7. Wideband Shelf Cabling — Power for Single FiberReach Unit



**Figure 7-8. Narrowband Shelf Cabling — DS0 Transmission Cables, 26 Gauge**

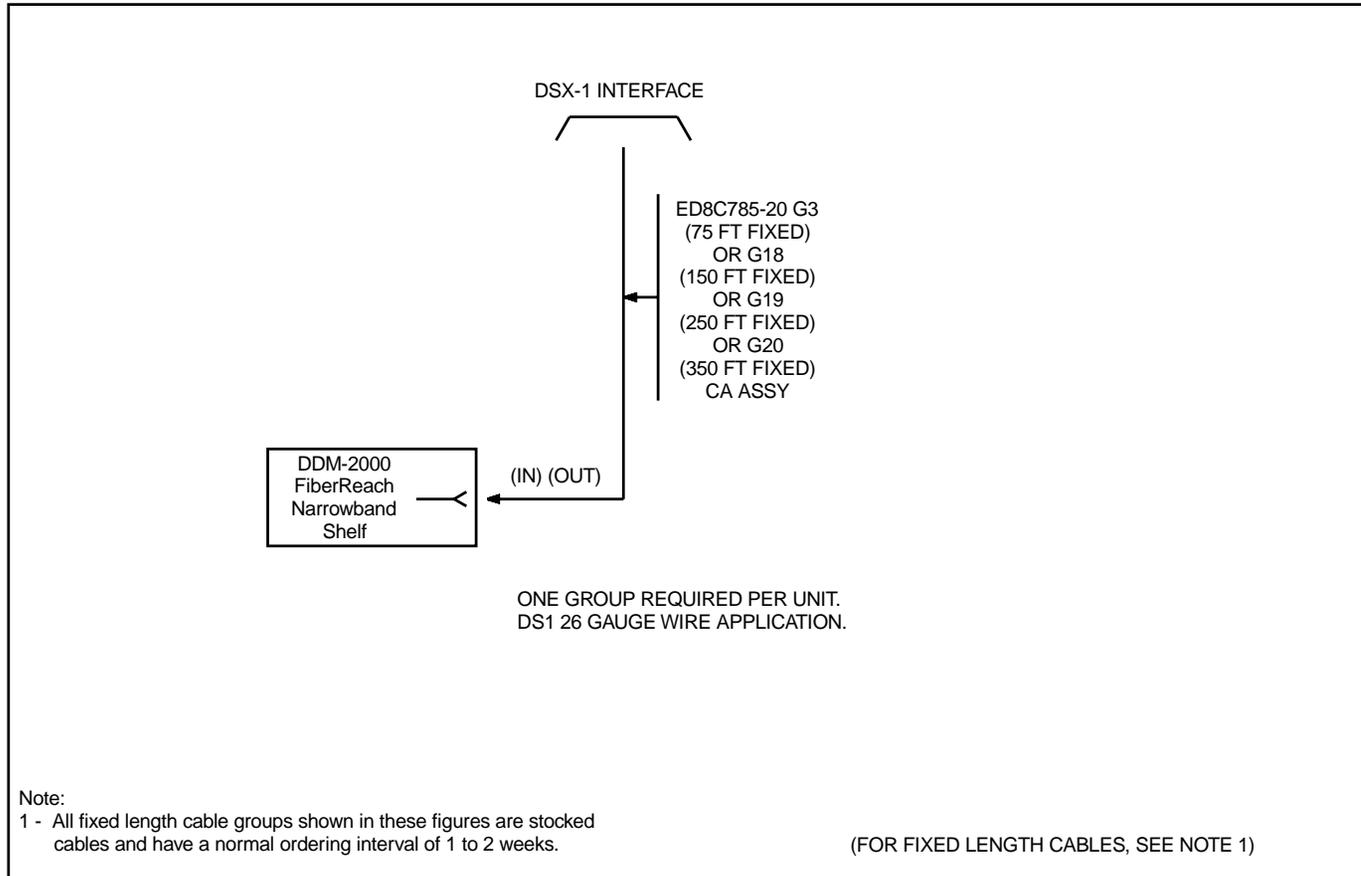
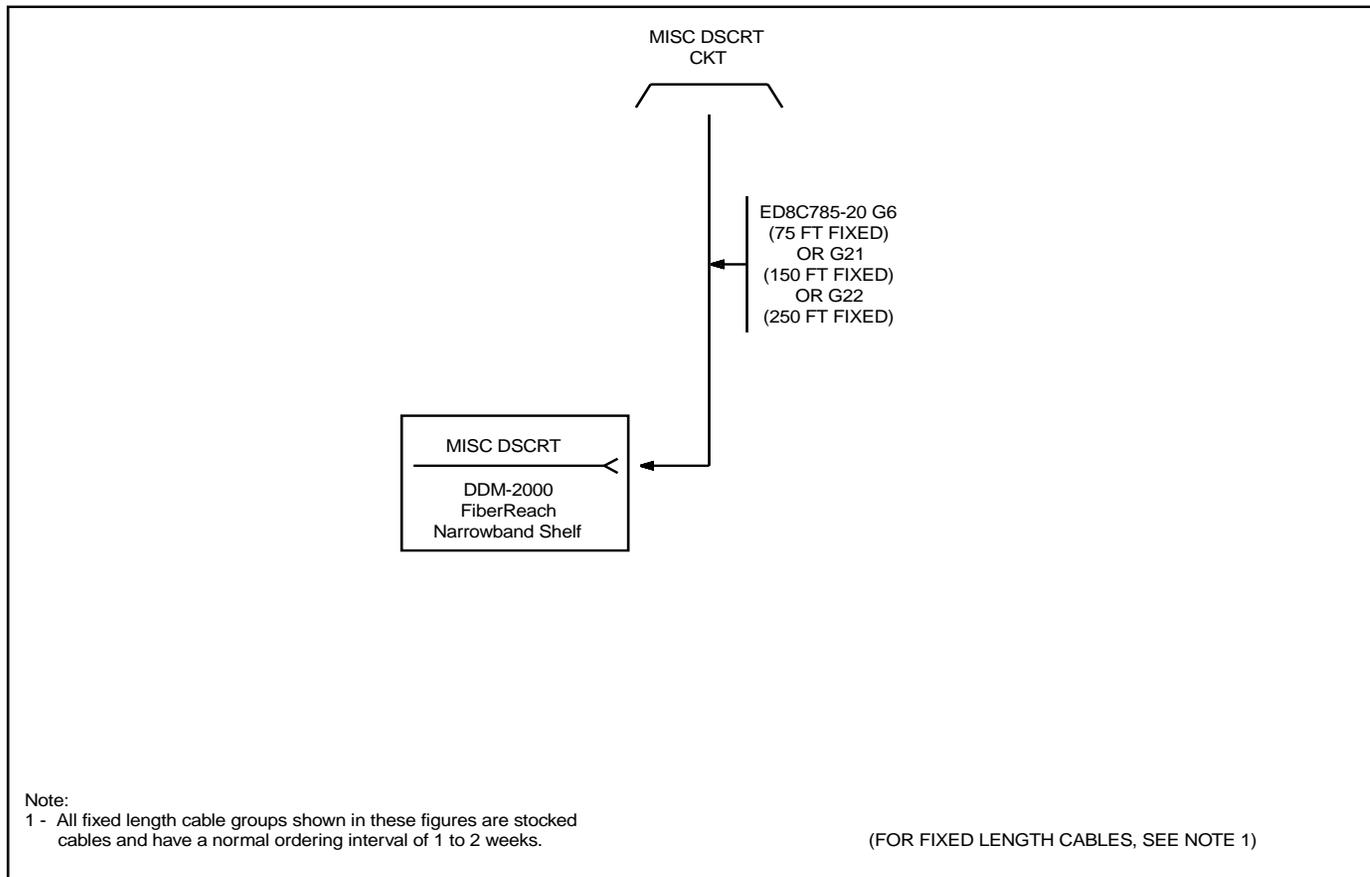
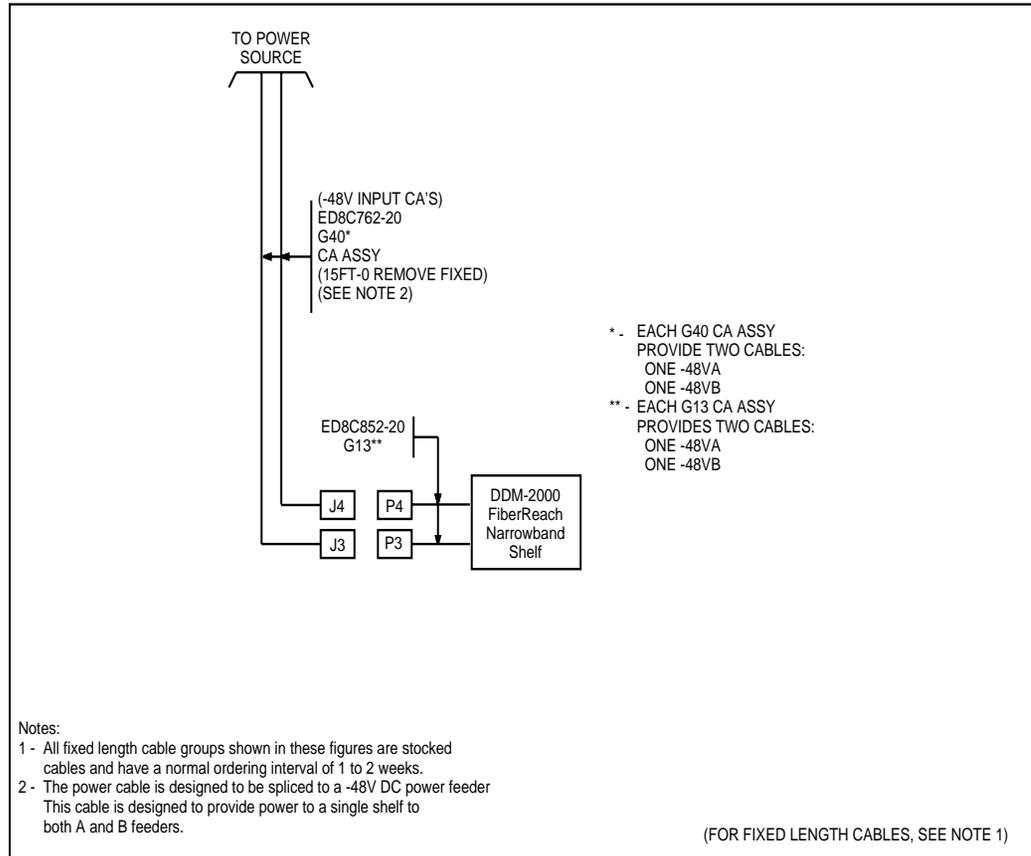


Figure 7-9. Narrowband Shelf Cabling — DSX-1 Transmission Cables, 26 Gauge



**Figure 7-10. Narrowband Shelf Cabling — Miscellaneous Discretes**



**Figure 7-11. Narrowband Shelf Cabling — Power for Single FiberReach Unit**

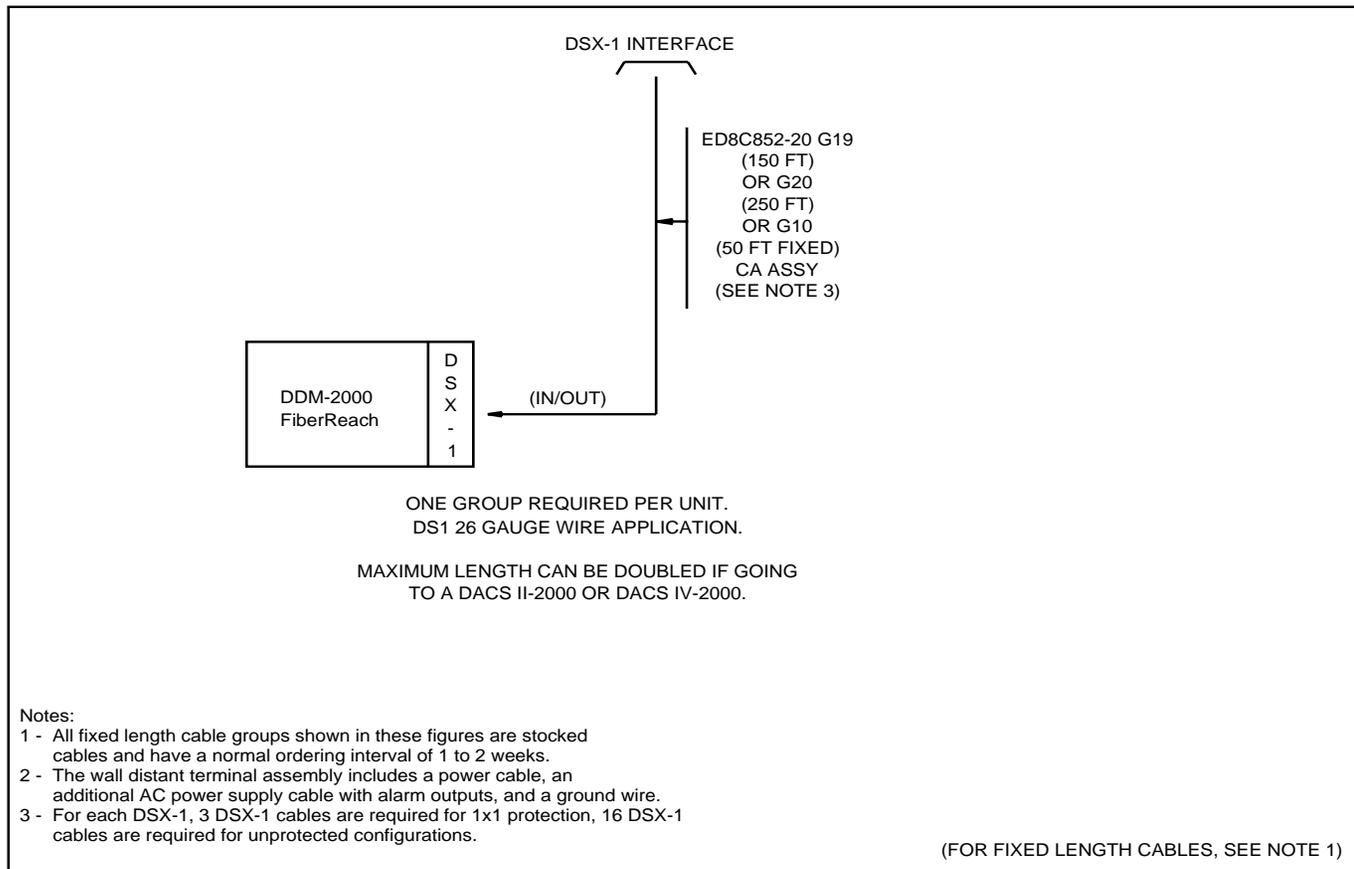


Figure 7-12. Wall Distant Terminal Shelf Cabling — DSX-1 Transmission Cables, 26 Gauge

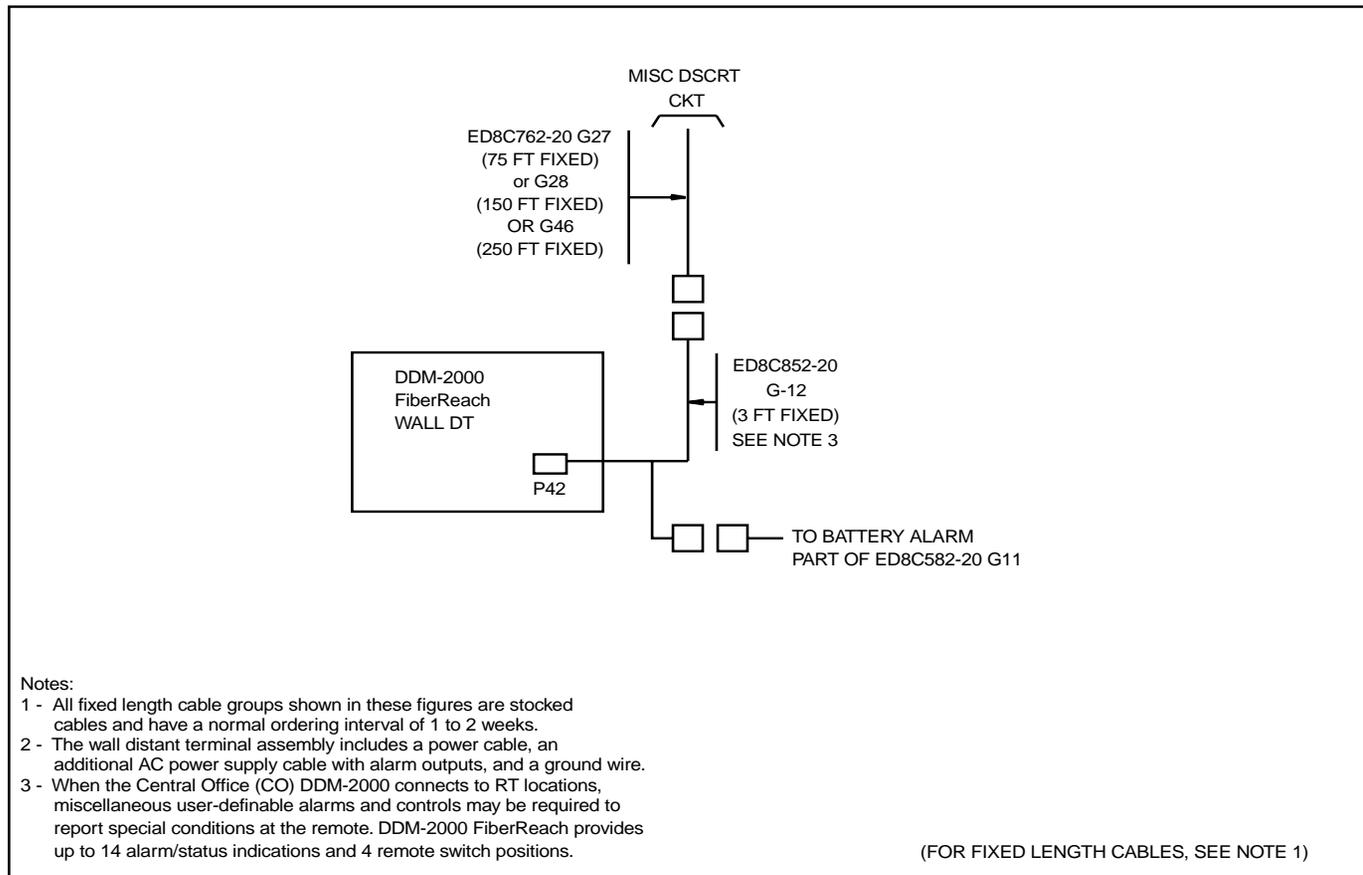


Figure 7-13. Wall Distant Terminal Shelf Cabling — Miscellaneous Discretes

**DDM-2000 FiberReach Multiplexer Shelf Cable Order Blank**

<b>Fig. Description</b>	<b>Fig</b>	<b>Code</b>	<b>Group No.</b>	<b>Cable Length (Feet)</b>	<b>Qty. Reqd. for Each Added Unit</b>	<b>Qty. to be Ordered</b>	<b>Notes</b>	
DS1 26-Gauge Wire Application ≥ 30 Feet (Wideband Shelf)	7-1	ED-8C762-20	G1	75	1		DS1 Interface Length ≥ 30 Feet One group required per unit.	
			G2	100				
			G3	150				
			G5	350				
DS1 22-Gauge Wire Application ≥ 30 Feet (Wideband Shelf)	7-2	ED-8C762-20	G6	75	1		DS1 Interface Length ≥ 30 Feet One group required per unit.	
			G7	100				
			G8	150				
			G10	350				
Office Alarm Interface Cable (Wideband Shelf)	7-3	ED-8C762-20	G11	75			One group required per unit.	
			G12	150				
			G14	250				
735A Cable for DS3 Applications	7-4	ED-8C900-20	G3	150	2 (Also qty. reqd. for first unit in bay)		To DSX3 Frame E/W BNC Connectors	
			Refer to Table 7-2 up through 250 feet.*				To DACSIII-2000 or DACSIV-2000 I/O Bay E/WBNC Connectors	
			G3	150				
			Refer to Table 7-2.*				To DACSIII-2000 or DACSIV-2000 I/O Bay E/WBNC Connectors	
			G3	150		2 each (Also qty. reqd. for first unit in bay)		To DSX3 Frame E/W BNC Connectors
			Refer to Table 7-2.*			2 each (Also qty. reqd. for first unit in bay)		To DACSIII-2000 or DACSIV-2000 I/O Bay E/WBNC Connectors

Fig. Description	Fig	Code	Group No.	Cable Length (Feet)	Qty. Reqd. for Each Added Unit	Qty. to be Ordered	Notes	
			G3	150	1 each (Also qty. reqd. for first unit in bay)		To DSX3 Frame E/W BNC Connectors	
			Refer to Table 7-2.*		1 each (Also qty. reqd. for first unit in bay)		To DACSIII-2000 or DACSIV-2000 I/O Bay E/WBNC Connectors	
		ED8C724-21	453		1			
			454		1			
			455		1			
			413		See Note		One Group 413 may be used in place of Groups 453 to 455	
735A Cable for DS3 Interface with BBG19	7-4	ED8C724-22	37	150	2		BBG19 requires right-angle mini-BNC cable assembly kit	
			38		2			
734D Cable for DS3 Applications When Cable Length Exceeds the 735 Type Cable Requirements	7-4	ED8C900-20	G305 () F/E DA, 1LA		2	2	Two Groups (cables)	
			G305 () F/E DA, LCD					
			G305 () F/E DA, LDD, and G305 () F/E DA, LED		1 each	1 each		
		ED8C724-21	453		1			
			454		1			
			455		1			
			413		See Notes	See Note		One Group 413 may be used in Place of Groups 453 to 455

Fig. Description	Fig	Code	Group No.	Cable Length (Feet)	Qty. Reqd. for Each Added Unit	Qty. to be Ordered	Notes	
TBOS Interface Cable Application (Wideband Shelf) <i>(Note: Not applicable for Release 3.0)</i>	7-5	ED-8C762-20	G21	150	1		TBOS One group required per unit	For ACORN Applications
			G44	250				For non-ACORN Applications
			G23	150				
			G45	250				
Miscellaneous Discretes (Wideband Shelf)	7-6	ED-8C762-20	G27	75	1		Miscellaneous Discrete One group required per unit.	
			G28	150				
			G46	250				
Power for Single Unit (Wideband Shelf)	7-7	ED-8C852-20	G13	2	1		Power to Unit One group required per unit	
		ED-8C762-20	G40	15	1		Power Riser One group required per unit.	
DS0 26-Gauge Wire Application ≥ 30 Feet (Narrowband Shelf)	7-8	ED-8C785-20	G1	75	1		DS0 Interface Length ≥ 30 Feet One group required per unit.	
			G15	150				
			G16	250				
			G17	500				
DSX-1 26-Gauge Wire Application ≥ 30 Feet (Narrowband Shelf)	7-9	ED-8C785-20	G3	75	1		DS1 Interface Length ≥ 30 Feet One group required per unit.	
			G18	150				
			G19	250				
			G20	350				
Miscellaneous Discretes (Narrowband Shelf)	7-10	ED-8C785-20	G6	75	1		Miscellaneous Discrete One group required per unit.	
			G21	150				
			G22	250				
Power for Single Unit (Narrowband Shelf)	7-11	ED-8C852-20	G13	2	1		Power to Unit One group required per unit.	
		ED-8C762-20	G40	15	1		Power Riser One group required per unit.	

<b>Fig. Description</b>	<b>Fig</b>	<b>Code</b>	<b>Group No.</b>	<b>Cable Length (Feet)</b>	<b>Qty. Req'd. for Each Added Unit</b>	<b>Qty. to be Ordered</b>	<b>Notes</b>
Interface Cable for Secondary Lightning and Surge Protection Shelf		105419428 (807AS Cable)		length must be specified	4		T1 interface and DSX interface cables
DSX-1 26-Gauge Wire Application	7-12	ED-8C852-20	G10	50	1		DS1 Interface
	7-12	ED-8C852-20	G19	150			
	7-12	ED-8C852-20	G20	250			
Miscellaneous Discretes	7-13	ED-8C852-20	G12	3	1		If required for miscellaneous discretes, one group required per unit.
	7-13	ED-8C762-20	G27	75	1		
	7-13		G28	150			
	7-13		G46	250			
Interface cable for Secondary Lightning and Surge Protection Shelf		105419428 (807AS Cable)		length must be specified	4		T1 interface and DSX interface cables
Interface cable between Narrowband shelf and DSX		ED-8C785-20	G12	length must be specified	See note		Each cable provides 4 DS1 inputs and outputs from a Narrowband shelf. A maximum of 6 cables may be ordered.

\* Table 7-2 includes multiple fixed length cables that are available.

**Table 7-2. ED8C900-20 G Fixed Cable Lengths**

<b>Length in Feet</b>	<b>Cable Type 735A</b>
3	G23
10	G24
20	G25
30	G26
40	G6
50	G7
60	G8
75	G1
80	G9
100	G2
120	G11
140	G13
150	G3
160	G14
180	G16
200	G18
220	G20
240	G22
250	G4
260	G27
280	G28
300	G29
320	G30
340	G31
360	G32
380	G33
400	G34

Length in Feet	Cable Type 735A
420	G35
440	G36
460	G37
480	G38
500	G39

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# Software Ordering

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## DDM-2000 FiberReach Multiplexer Software Ordering

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### Available Software Releases

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This section details the DDM-2000 FiberReach Multiplexer Wideband Shelf (WBS) software available for ordering. Currently, Releases 2.2, 3.0, 3.1, and 4.0 are available to customers.

For the WBS, all system controller (SYSCTL) circuit packs are shipped without software loaded on them. Therefore, software must be loaded at or before installation.

In addition to DDM-2000 FiberReach software, this section also includes ordering information for *SLC*<sup>®</sup>-2000 Releases 4.4 and 4.5 that is installed on the *SLC*-2000 HDT and is automatically downloaded to the NBS. It also includes information on CPro-2000 graphical user interface software.

**⇒ NOTE:**  
All DDM software will be transitioning from Equipment Codes and Group Structures to Comcodes starting with Release 4.0.

## Software Ordering Blanks

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The DDM-2000 FiberReach software ordering blank is shown in Table 7-3. The following qualifications should be noted:

- DDM-2000 FiberReach Multiplexer software is separate from the hardware.
- Order one set of software for each shelf.
- It may be desirable to have spare diskettes for all releases on hand for backup or initial downloading.
- All network elements (NEs) in a ring, which may be part of a larger network, must be running the same software. In a maintenance subnetwork, which may consist of a mixture of ring and linear networks, all NEs must be running compatible software. See "Software Upgrades" in Section 5, "Operations, Administration, Maintenance, and Provisioning," for a table listing software compatibility.
- The optional feature package software should be ordered for each shelf using the feature.
- A user/service manual is **not** shipped with each shelf unless specified on the order. Manuals can be ordered using the software ordering blank.

For narrowband shelf applications, *SLC-200* Software Release 4.7 is needed. Table 7-4 provides an ordering blank for *SLC-2000* software Release 4.7.

CPro-2000 is a graphical user interface software tool that enables users with a PC interface to use graphics for many provisioning-related activities. Table 7-5 provides an ordering blank for CPro-2000 software.

Table 7-6 lists Discontinued Availability Software for FiberReach, *SLC-2000*, and CPro-2000.

Complete the following software order blanks as required.

**Table 7-3. DDM-2000 FiberReach Software Order Blank (Notes)**

<b>Qty Ordered</b>	<b>Ordering Code</b>	<b>Product Release</b>	<b>Description</b>
	ED-8C843-34, G1, GM3R, P3R	R2.2	Release 2.2 system software
	ED-8C843-34, GM3A	R2.2	Release 2.2 spare software
	ED-8C843-34, GM3S, P3S	R2.2	Software upgrade from 2.1 to 2.2
	ED-8C843-34, F1R	R2.2	VT Performance Monitoring option
	ED-8C843-34, F2R	R2.2	DS1 Performance Monitoring option
	108090838	R2.2	DDM-2000 FiberReach Multiplexer User/Service Manual
	ED-8C843-35, G1, M1R, P1R	R3.0	Release 3.0 system software
	ED-8C843-35, M1A	R3.0	Release 3.0 spare software
	ED-8C843-35, M1S, P1S	R3.0	Software upgrade from 2.1 to 3.0
	ED-8C843-35, F1R	R3.0	VT Performance Monitoring option
	ED-8C843-35, F2R	R3.0	DS1 Performance Monitoring option
	108045493	R3.0	DDM-2000 FiberReach Multiplexer User/Service Manual
	ED-8C843-35, G1, M2R, P2R	R3.1	Release 3.1 system software
	ED-8C843-35, G2, M2R, P2R	R3.1	Release 3.1 System Digital Audio (DAT) Tape
	ED-8C843-35, M2A	R3.1	Release 3.1 spare software
	ED-8C843-35, M2S, P2S	R3.1	Software upgrade from 3.0 to 3.1
	ED-8C843-35, M2X	R3.1	Software upgrade from 2.2 to 3.1, applications software
	ED-8C843-35, P2X	R3.1	Software upgrade from 2.2 to 3.1, applications software
	ED-8C843-35, M2Y	R3.1	Software upgrade from 2.1 to 3.1, applications software
	ED-8C843-35, P2Y	R3.1	Software upgrade from 2.1 to 3.1, operations software
	ED-8C843-35, F1R	R3.1	VT Performance Monitoring option
	ED-8C843-35, F2R	R3.1	DS1 Performance Monitoring option

**Table 7-3. DDM-2000 FiberReach Software Order Blank (Notes)**

<b>Qty Ordered</b>	<b>Ordering Code</b>	<b>Product Release</b>	<b>Description</b>
	108045493	R3.1	DDM-2000 FiberReach Multiplexer User/Service Manual
	108680224	R4.0	Software, software release description and right-to-use for Initial Application
	108680406	R4.0	Software, software release description and right-to-use for all Upgrade Applications
	108680232	R4.0	Spare software and software release description
	108680471	R4.0	Digital Audio (DAT) Tape and software release description for Initial Applications
	108680414	R4.0	Digital Audio (DAT) Tape and software release description for all Upgrade Applications
	108680489	R4.0	Spare Digital Audio (DAT) Tape and software release description
	108434101	R4.0	DDM-2000 FiberReach Multiplexer User/Service Manual for Release 3.0 and higher

**NOTES:**

Since the SYSCTL is shipped without software, **software must be loaded into the SYSCTL before or during installation.** This is achieved by downloading software furnished on floppy diskettes (which ship separately from the SYSCTL) using an MS-DOS\*, Windows NT\*, or Windows 95\* PC.

**Software must be ordered for each shelf.** Software orders must be placed in addition to the hardware order to receive software and to properly maintain office records.

**Comcodes are used for DDM R4.0 software since Equipment Codes and Group Structures are being phased out.**

\* Registered trademark of Microsoft Corporation.

**Table 7-4. SLC-2000 Software Order Blank**

Qty Ordered	Equipment Code	Product Release	Description
	J1C265XN-1, LI, P1N, M1N	R4.7	Release 4.7 Software for new sites
	J1C265XN-1, L1, P1Q, M1Q	R4.7	Software Upgrade from Release 3.2 to Release 4.7
	J1C265XN-1, L1, P1R, M1R	R4.7	Software Upgrade from Release 4.0 to Release 4.7
	J1C265XN-1, L1, P1S, M1S	R476	Software Upgrade from Release 4.1 to Release 4.7
	J1C265XN-1, L1, P1T, M1T	R4.7	Software Upgrade from Release 4.2 to Release 4.7
	J1C265XN-1, L1, P1V, M1V	R4.7	Software Upgrade from Release 4.4 to Release 4.7
	J1C265XN-1, L1, P1W, M1W	R4.7	Software Upgrade from Release 4.5 to Release 4.7
	J1C265XN-1, L1, P1X, M1X	R4.7	Software Upgrade from Release 4.6.0, 4.6.1, and 4.6.2 to Release 4.7

The CPro-2000 graphical user interface enables users with a PC to use graphics for many provisioning-related activities. Table 7-5 is an ordering blank for CPro-2000 software. CPro-2000 Releases 5.0 and 6.0 work with FiberReach Release 2.1. CPro-2000 Release 6.1 works with FiberReach Release 2.2 and CPro-2000 Release 8.0 works with FiberReach Releases 3.0. CPro-2000 Release 9.0 works with FiberReach 3.1 and CPro-2000 Release 10.0 works with FiberReach 4.0.

**Table 7-5. CPro-2000 Software Order Blank**

Qty Ordered	Equipment Code (Note)	Product Release	Description
	ED-8C793-32, G1, M1R, P1R	R5.0	New system software
	ED-8C793-32, G1, M1S, P1S	R5.0	Release 5.0 upgrade from 4.x
	ED-8C793-32, G1, M1X, P1X	R5.0	Release 5.0 upgrade from 3.x
	ED-8C793-32, G1, M1Y, P1Y	R5.0	Release 5.0 upgrade from 2.x
	ED-8C793-33, G1, M1R, P1R	R6.0	New system software
	ED-8C793-33, G1, M1S, P1S	R6.0	Release 6.0 upgrade from 5.x
	ED-8C793-33, G1, M1X, P1X	R6.0	Release 6.0 upgrade from 4.x
	ED-8C793-33, G1, M1Y, P1Y	R6.0	Release 6.0 upgrade from 3.x
	ED-8C793-33, G1, M1Z, P1Z	R6.0	Release 6.0 upgrade from 2.x
	ED-8C793-33, G1, M2R, P2R	R6.1	New system software
	ED-8C793-33, G1, M2S, P2S	R6.1	Release 6.1 upgrade from 6.0
	ED-8C793-33, G1, M2X, P2X	R6.1	Release 6.1 upgrade from 5.x
	ED-8C793-33, G1, M2Y, P2Y	R6.1	Release 6.1 upgrade from 4.x
	ED-8C793-33, G1, M2Z, P2Z	R6.1	Release 6.1 upgrade from 3.x
	ED-8C793-33, G1, M2B, P2B	R6.1	Release 6.1 upgrade from 2.x
	ED-8C793-33, G1, M3R, P3R	R6.2	New system software
	ED-8C793-33, G1, M3S, P3S	R6.2	Release 6.2 upgrade from 6.1
	ED-8C793-33, G1, M3X, P3X	R6.2	Release 6.2 upgrade from 6.0
	ED-8C793-33, G1, M3Y, P3Y	R6.2	Release 6.2 upgrade from 5.x
	ED-8C793-33, G1, M3Z, P3Z	R6.2	Release 6.2 upgrade from 4.x
	ED-8C793-33, G1, M3B, P3B	R6.2	Release 6.2 upgrade from 3.x
	ED-8C793-33, G1, M3C, P3C	R6.2	Release 6.2 upgrade from 2.x
	ED-8C793-35, G1, M1R, P1R	R8.0	New system software
	ED-8C793-35, G1, M1S, P1S	R8.0	Release 8.0 upgrade from 7.x
	ED-8C793-35, G1, M1X, P1X	R8.0	Release 8.0 upgrade from 6.1
	ED-8C793-35, G1, M1Y, P1Y	R8.0	Release 8.0 upgrade from 6.0
	ED-8C793-35, G1, M1Z, P1Z	R8.0	Release 8.0 upgrade from 5.x
	ED-8C793-35, G1, M1B, P1B	R8.0	Release 8.0 upgrade from 4.x

Qty Ordered	Equipment Code (Note)	Product Release	Description
	ED-8C793-35, G1, M1C, P1C	R8.0	Release 8.0 upgrade from 3.x
	ED-8C793-35, G1, M1D, P1D	R8.0	Release 8.0 upgrade from 2.x
	ED-8C793-36, G1, M1D, P1D	R9.0	New system software
	ED-8C793-36, G1, M1R, P1R	R9.0	New system software
	ED-8C793-36, G1, M1S, P1S	R9.0	Release 9.0 upgrade from 8.x
	ED-8C793-36, G1, M1X, P1X	R9.0	Release 9.0 upgrade from 7.x
	ED-8C793-36, G1, M1Y, P1Y	R9.0	Release 9.0 upgrade from 6.1
	ED-8C793-36, G1, M1Z, P1Z	R9.0	Release 9.0 upgrade from 6.0
	ED-8C793-36, G1, M1B, P1B	R9.0	Release 9.0 upgrade from 5.x
	ED-8C793-36, G1, M1C, P1C	R9.0	Release 9.0 upgrade from 4.x
	ED-8C793-36, G1, M1D, P1D	R9.0	Release 9.0 upgrade from 3.x
	ED-8C793-36, G1, M1E, P1E	R9.0	Release 9.0 upgrade from 2.x
	ED-8C793-37, G1, M1R, P1R	R10.0	New system software
	ED-8C793-37, G1, M1S, P1S	R10.0	R10.0 upgrade from 9.x
	ED-8C793-37, G1, M1X, P1X	R10.0	R10.0 upgrade from 8.x
	ED-8C793-37, G1, M1Y, P1Y	R10.0	R10.0 upgrade from 7.x
	ED-8C793-37, G1, M1Z, P1Z	R10.0	R10.0 upgrade from 6.2
	ED-8C793-37, G1, M1B, P1B	R10.0	R10.0 upgrade from 6.1
	ED-8C793-37, G1, M1C, P1C	R10.0	R10.0 upgrade from 6.0
	ED-8C793-37, G1, M1D, P1D	R10.0	R10.0 upgrade from 5.x
	ED-8C793-37, G1, M1E, P1E	R10.0	R10.0 upgrade from 4.x
	ED-8C793-37, G1, M1F, P1F	R10.0	R10.0 upgrade from 3.x
	ED-8C793-37, G1, M1G, P1G	R10.0	R10.0 upgrade from 2.x
Note: CPro-2000 User Manual is included with G1.			

**Table 7-6. Discontinued Availability (DA) Software**

Table 7-6 lists discontinued availability software.

Qty Ordered	Ordering Code	Product Release	Description
	ED-8C843-34, G1,M2R, P2R	R2.1	Release 2.1 system software
	ED-8C843-34, M2A	R2.1	Release 2.1 spare software
	ED-8C843-34, M2T	R2.1	Software upgrade from 1.0 and 2.0 to 2.1
	ED-8C843-34, F1R	R2.1	VT Performance Monitoring option
	ED-8C843-34, F2R	R2.1	DS1 Performance Monitoring option
	ED-8C843-34, GA	R2.1	DDM-2000 FiberReach Multiplexer User/Service Manual
	J1C265XM-1, LI, P1R, M1R	R4.6	Release 4.6 Software for new sites
	J1C265XM-1, L1, P1X, M1X	R4.6	Software Upgrade from Release 3.2 to Release 4.6
	J1C265XM-1, L1, P1Y, M1Y	R4.6	Software Upgrade from Release 4.0 to Release 4.6
	J1C265XM-1, L1, P1W, M1W	R4.6	Software Upgrade from Release 4.1 to Release 4.6
	J1C265XM-1, L1, P1S, M1S	R4.6	Software Upgrade from Release 4.2 to Release 4.6
	J1C265XM-1, L1, P1Z, M1Z	R4.6	Software Upgrade from Release 4.4 to Release 4.6
	J1C265XM-1, L1, P1V, M1V	R4.6	Software Upgrade from Release 4.5 to Release 4.6
	ED-8C793-30, G1, M1R, P1R	R3.0	New system software
	ED-8C793-30, G1, M1S, P1S	R3.0	Release 3.0 upgrade from 2.x
	ED-8C793-31, G1, M1R, P1R	R4.0	New system software
	ED-8C793-31, G1, M1S, P1S	R4.0	Release 4.0 upgrade from 3.x
	ED-8C793-31, G1, M1X, P1X	R4.0	Release 4.0 upgrade from 2.x
	ED-8C793-34, G1, M1R, P1R	R7.0	New system software
	ED-8C793-34, G1, M1S, P1S	R7.0	Release 7.0 upgrade from 6.0
	ED-8C793-34, G1, M1X, P1X	R7.0	Release 7.0 upgrade from 5.x
	ED-8C793-34, G1, M1Y, P1Y	R7.0	Release 7.0 upgrade from 4.x
	ED-8C793-34, G1, M1Z, P1Z	R7.0	Release 7.0 upgrade from 3.x
	ED-8C793-34, G1, M1B, P1B	R7.0	Release 7.0 upgrade from 2.x
	ED-8C793-34, G1, M1C, P1C	R7.0	Release 7.0 upgrade from 6.1

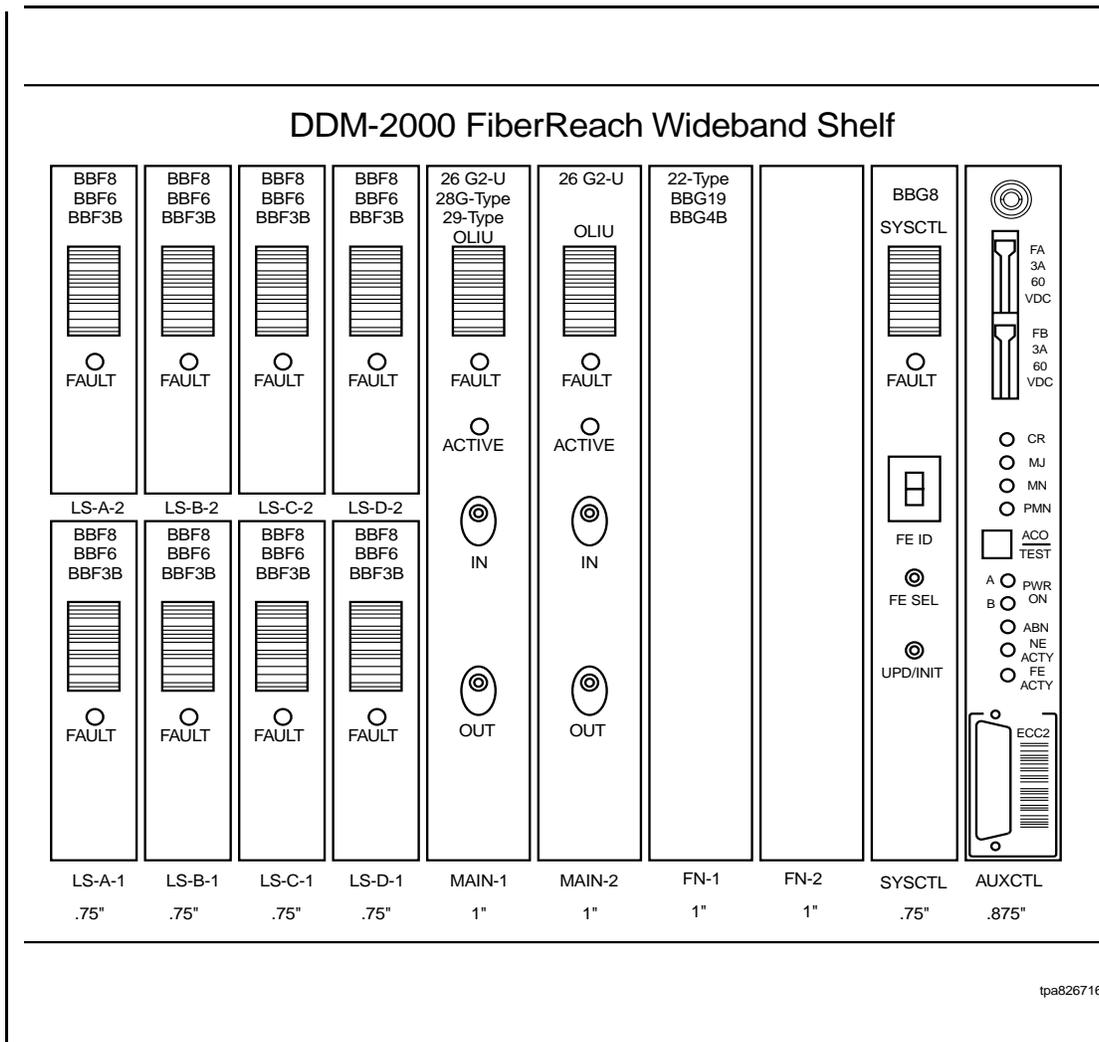
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## **Plug-Ins**

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### **Individual Plug-In Ordering**

This section provides typical application figures and associated order blanks for individual plug-in orders (Table 7-9), as well as sparing recommendations based on reliability projections for each plug-in unit. Before describing the plug-in ordering, a brief description of the shelf layout with required and optional plug-ins is presented. Figure 7-14 and Figure 7-15 show the wideband and narrowband shelves, respectively.



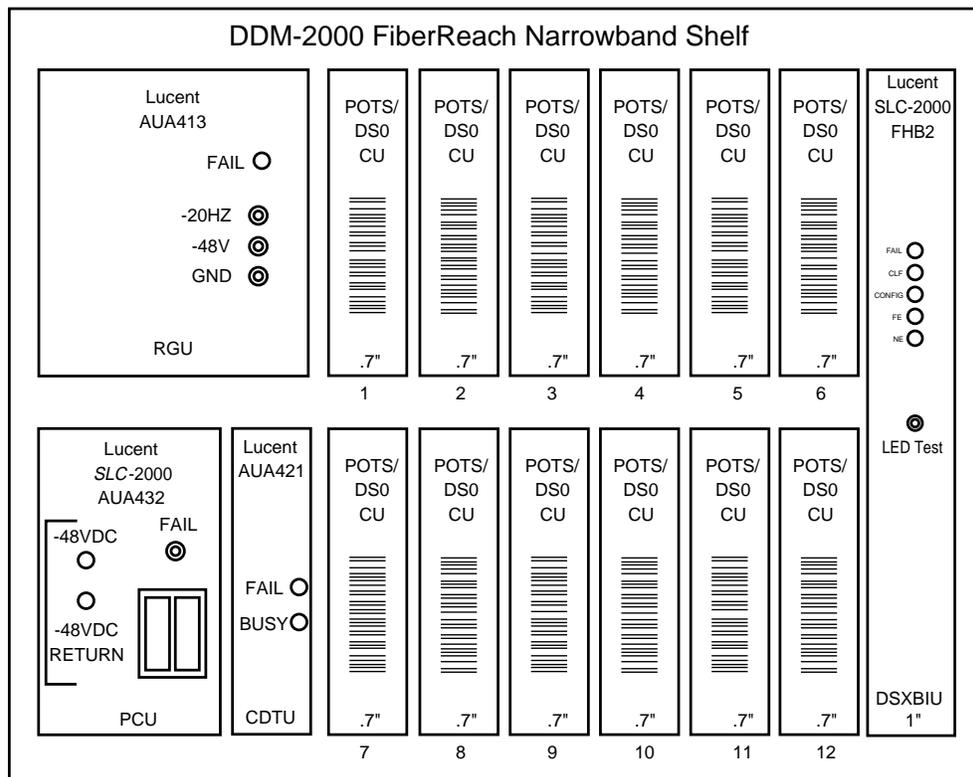
**Figure 7-14. DDM-2000 FiberReach Wideband Shelf**

Figure 7-14 shows the DDM-2000 FiberReach wideband shelf. From left to right, the eight low-speed slots may be equipped with DS1, DS1PM, or T1EXT plug-ins as needed for either no protection, 1x1 protection, or 1x7 protection. When configured for 1x1 protection, the service slots are ls-a-1, ls-b-1, ls-c-1, and ls-d-1. The protection slots are ls-a-2, ls-b-2, ls-c-2, and ls-d-2. When configured for 1x7 protection, the service slots are ls-a-1, ls-b-1, ls-c-1, ls-d-1, ls-a-2, ls-b-2, and ls-c-2. The protection slot is ls-d-2. Each DS1 or DS1PM circuit pack terminates four DS1 circuits. Each T1EXT circuit pack terminates two T1 extensions.

To the right of the low-speed slots are Main slots 1 and 2 for the 26G and 26G-U optical line interface unit (OLIU) circuit packs. Both of these slots must be equipped. Function Unit slots 1 and 2 are to the right of the Main slots. With 28G-U type OLIUs in the Main slot, the Function Unit slots support BBG4/4B, BBG19,

and 22-type OLIUs and the low-speed slots can support the BBF8 HDSL circuit pack.

The SYSCTL circuit pack slot is to the right of the Function Unit slots. The SYSCTL plug-in is always required in this slot. To the right of the SYSCTL is the AUXCTL slot. For all current releases, this slot is equipped with a user panel circuit pack.



**Figure 7-15. DDM-2000 FiberReach Narrowband Shelf**

Figure 7-15 shows a typical DDM-2000 FiberReach narrowband shelf configured for 24-lines of POTS service. The DDM-2000 FiberReach narrowband shelf is divided into an upper and lower subshelf. From left to right, the upper subshelf contains the ringing generator unit (RGU), and slots for up to six channel units. The lower subshelf contains the power conversion unit (PCU), the channel and drop test unit (CDTU), and slots for up to six channel units. The digital signal cross-connect backplane interface unit (DSXBIU) resides at the far right of the shelf, with the slot spanning both the upper and lower subshelves.

## Typical Equipage Applications

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The following figures and associated tables show some typical shelf applications for the DDM-2000 FiberReach Multiplexer:

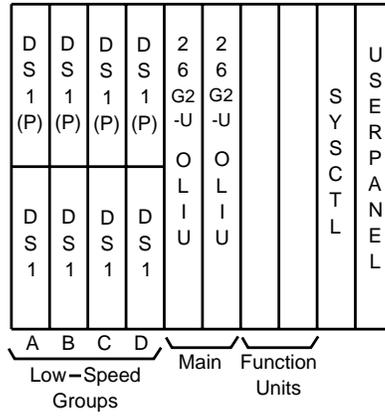
### Wideband Shelf:

- DS1 Services Only (Figure 7-16) — This application may be configured for 1x1 or 1x7 protection.
- T1 Extension Service Only (Figure 7-17) — This application may be configured for 1x1 or 1x7 protection.
- T1 Extensions Plus DS1 Service - OC-1 Rate (Figure 7-18) — This application may be configured for 1x1 or 1x7 protection, with either the T1 or DS1 service protected.
- T1 Extensions Plus DS1 Service - OC-3 Rate (Figure 7-19) — This application may be configured for 1x1 or 1x7 protection, with either the T1 or DS1 service protected.
- DS1 Service and DS3 Locked (Figure 7-20) — This application may be configured for 1x1 or 1x7 protection, with either the DS1 or DS3 service protected.
- T1 Extensions, DS1 Service, and DS3 (Figure 7-21) — This application may be configured for 1x1 or 1x7 protection, with either the T1, DS1, or DS3 service protected.
- STS-3c 0x1 Application (Figure 7-22) — This application may be configured for 1x1 or 1x0 Function Unit protection.
- Unprotected HDSL Circuit Application (Figure 7-23) — This application shows a 1x1 low-speed shelf protection configuration.
- FiberReach with OC-12 Optics in Main Slot Providing VT1.5 Services (Figure 7-24)
- FiberReach with OC-12 Optics Providing STS-1 Services (Figure 7-25)

### Wideband and Narrowband Shelf:

- FiberReach DS0 Services Only (Figure 7-26)

Configurations are shown on the following pages.



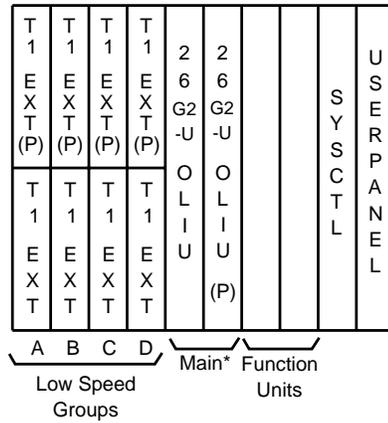
tpa 843679/01

**Figure 7-16. DDM-2000 FiberReach DS1 Services Only (1x7 Protected)**

Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly (for CO applications)	See Figure 6-23 or 6-26.
2	OC-1 Optical Line Interface Unit	26G-U/26G2-U
1	System Controller	BBG8/BBG8B
8	DS1 or DS1 PM	BBF1B/BBF3B
	Apparatus Blank*	177A
1	FiberReach Release 2.2, 3.0, 3.1, 4.0 Software†	

\* For 1x7 protection, an apparatus blank is required in any low-speed slot that is not equipped with a DS1/DS1PM circuit pack.

† Software must be ordered separately. See "Software Ordering" section.



\* 28G-U in Main slots for OC-3

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**Figure 7-17. DDM-2000 FiberReach with T1 Extension Services (1x1 Protected)**

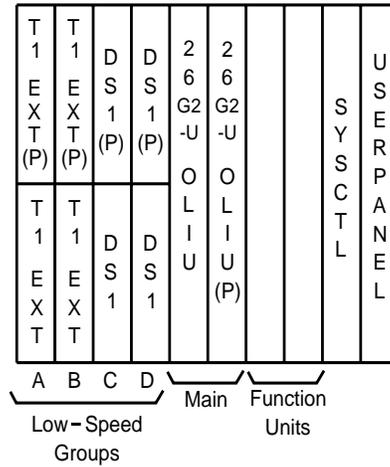
Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
2	OC-1 Optical Line Interface Unit	26G-U/26G2-U
8	T1 Extension CPs	BBF6*
1	SYSCTL System Controller	BBG8/BBG8B
1	Lightning and Surge Protection Assembly	ED-8C783-30†
	Apparatus Blank	177A‡
1	FiberReach R 2.2, 3.0, 3.1, 4.0 software§	

\* For each BBF6 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

† This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf and must be ordered separately. See "Shelf Ordering" section.

‡ For 1x7 protection, an apparatus blank is required in any low-speed slot that is not equipped with a circuit pack.

§ Software must be ordered separately. See "Software Ordering" section.



**Figure 7-18. DDM-2000 FiberReach with T1 Extensions and DS1 Service (1x1 Protected) (OC-1 Rate)**

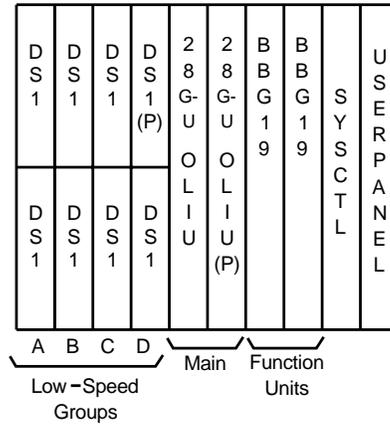
Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-24.
2	OC-1 Optical Line Interface Unit	26G-U/26G2-U
4	T1 Extension CPs	BBF6*
4	DS1 or DS1 PM	BBF1B/BBF3B
1	SYSCTL System Controller	BBG8/BBG8B
1	Lightning and Surge Protection Assembly	ED-8C783-30†
1	FiberReach Release 2.2, 3.1, or 4.0 software§	

\* For each BBF6 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

† This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf, and must be ordered separately. See "Shelf Ordering" section.

§ Software must be ordered separately. See "Software Ordering" section.





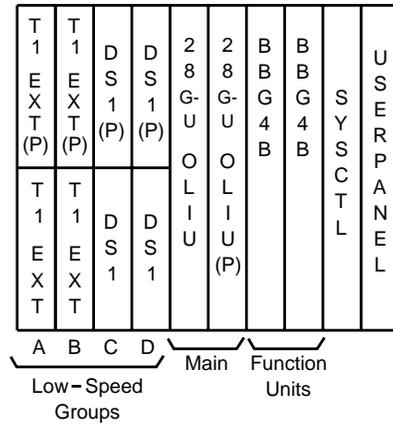
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**Figure 7-20. DDM-2000 FiberReach with DS1 Service (1x7 Protected) and DS3 Locked**

Qty.	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
2	OC-3 Optical Line Interface Unit	28G-U
4	DS1 or DS1 PM	BBF1B/BBF3B
2	DS3 data services interface	BBG19s
1	SYSCTL System Controller	BBG8/BBG8B
1	Lightning and Surge Protection Assembly	ED-8C783-30*
1	FiberReach Releases 3.1 and 4.0 software†	

\* This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf, and must be ordered separately. See "Shelf Ordering" section.

† Software must be ordered separately. See "Software Ordering" section.



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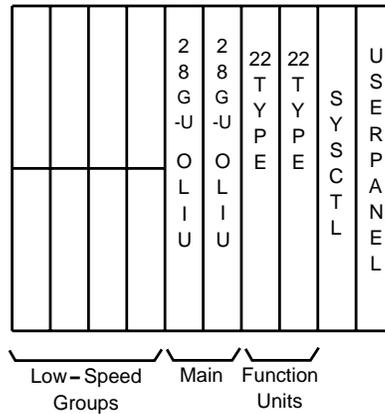
**Figure 7-21. DDM-2000 FiberReach with T1 Extensions, DS1 Service (1x1 Protected), and DS3**

Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
2	OC-1 Optical Line Interface Unit	28G-U
4	T1 Extension CPs	BBF6*
4	DS1 or DS1 PM	BBF1B/BBF3B
2	BBG4Bs	DS-3 Low-Speed Interface
1	SYSCTL System Controller	BBG8/BBG8B
1	Lightning and Surge Protection Assembly	ED-8C783-30†
1	FiberReach Release 3.1 software§	

\* For each BBF6 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

† This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf, and must be ordered separately. See "Shelf Ordering" section.

§ Software must be ordered separately. See "Software Ordering" section.



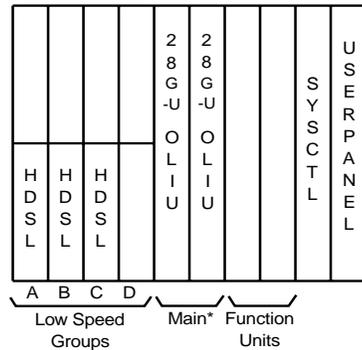
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**Figure 7-22. DDM-2000 FiberReach with STS-3c 0x1 Application**

Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-2q.
2	OC-3 Optical Line Interface Unit	28G-U/28G2-U
1	SYSCTL System Controller	BBG8/BBG8B
2	22-Type	22D-U or 22F2-U
1	Lightning and Surge Protection Assembly	ED-8C783-30*
1	FiberReach Release 3.1 software†	

\* This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf, and must be ordered separately. See "Shelf Ordering" section.

† Software must be ordered separately. See "Software Ordering" section.



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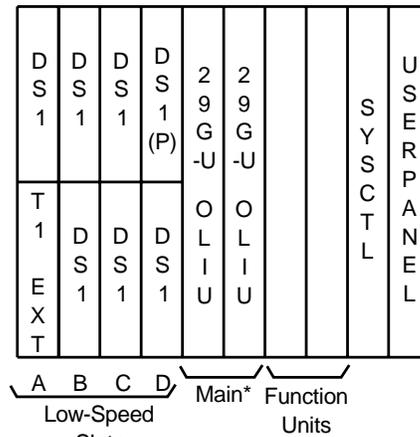
**Figure 7-23. DDM-2000 FiberReach with Unprotected HDSL Circuits**

Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
2	OC-3 Optical Line Interface Unit	28G-U/28G2-U
1	SYSCTL System Controller	BBG8/BBG8B
3	HDSL	BBF8*
1	Lightning and Surge Protection Assembly	ED-8C783-30 <sup>†</sup>
1	FiberReach Release 3.1 software <sup>§</sup>	

\* For each BBF8 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

<sup>†</sup> This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf, and must be ordered separately. See "Shelf Ordering" section.

<sup>§</sup> Software must be ordered separately. See "Software Ordering" section.



\* 28G-U in Main slots for OC-3

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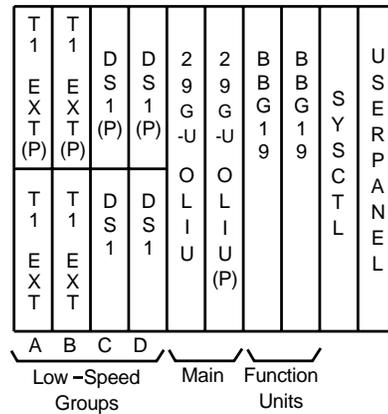
**Figure 7-24. DDM-2000 FiberReach with OC-12 Optics in Main Slot Providing VT1.5 Services**

Qty.	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
	OC-12 Optical Line Interface Unit	29G-U/29H-U
	T1 Extension CPs	BBF6*
	DS1 or DS1 PM	BBF1B/BBF3B
	DS3 Data Services Interface	BBG19s
1	SYSCTL System Controller	BBG8/BBG8B
1	Lightning and Surge Protection Assembly	ED-8C783-30†
1	FiberReach Release 4.0 software§	

\* For each BBF6 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

† This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf and must be ordered separately. See "Shelf Ordering" section.

§ Software must be ordered separately. See "Software Ordering" section.



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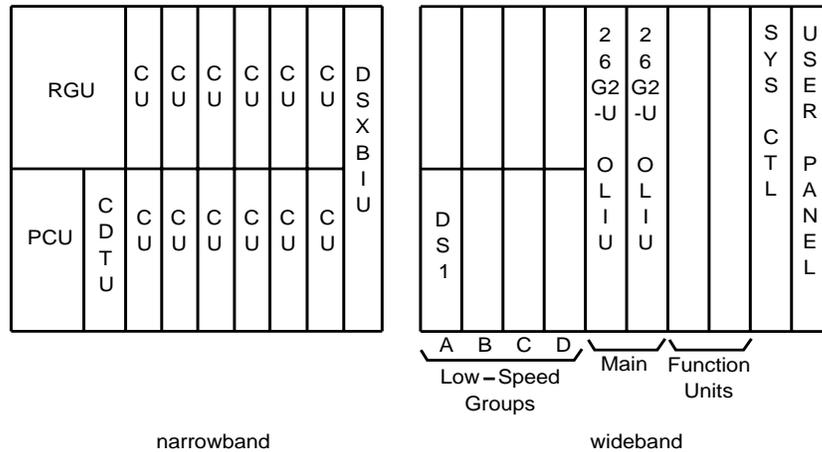
**Figure 7-25. DDM-2000 FiberReach with OC-12 Optics Providing STS-1 Services**

Quantity	Description	Apparatus/ED Code
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
	OC-12 Optical Line Interface Unit	29G-U/29H-U
	T1 Extension CPs	BBF6*
	DS1 or DS1 PM	BBF1B/BBF3B
	DS3 Data Services Interface	BBG19s
1	SYSCTL System Controller	BBG8/BBG8B
1	Lightning and Surge Protection Assembly	ED-8C783-30†
1	FiberReach Release 4.0 software§	

\* For each BBF6 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

† This shelf is required for secondary lightning and surge protection in outside plant applications. It is mounted externally to the DDM-2000 FiberReach Shelf, and must be ordered separately. See "Shelf Ordering" section.

§ Software must be ordered separately. See "Software Ordering" section.



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**Figure 7-26. DDM-2000 FiberReach DS0 Services Only**

Quantity	Description	Apparatus/ED Code
<b>Narrowband Shelf</b>		
1	FiberReach Shelf Assembly	See Figure 6-23 or 6-26.
1	Ringing Generator Unit (RGU)	AUA413
1	Channel and Drop Test Unit (CDTU)	AUA421
1	Power Conversion Unit (PCU)	AUA432
1	Digital Signal Cross-Connect	FHB2
	Backplane Interface Unit (DSXBIU)	
12	Quad POTS Channel Units	SPQ909B*
<b>Wideband Shelf</b>		
1	DS1 or DS1 PM	BBF1B/BBF3B
2	OC-1 Optical Line Interface Units	26G-U/26G2-U
1	System Controller	BBG8/BBG8B
1	FiberReach Release 2.2 software†	

\* See Table 7-7 for other channel units that may be used in this application.

† Software must be ordered separately. See "Software Ordering" section.

## Plug-In Maintenance Sparing Guidelines

Table 7-7 provides a guideline for determining the number of DDM-2000 FiberReach plug-in spares needed for a given number of plug-ins in the field. The sparing guide serves as an initial estimate and is calculated with the following assumptions:

- The method for calculating spares follows the procedure described in Telcordia Technologies SR-TSY-000385, Issue 1.
- The steady-state failure rate is assumed. Failure rates are based on the reliability prediction procedure (RPP) method described in TR-TSY-000332, Issue 3.
- The spare availability objective (SAO) is 99 percent. The SAO is the long-term probability that a spare plug-in is available when it is needed.
- A no-trouble-found (NTF) factor of 1.67 is multiplied to the failure rate. This accounts for replacements of plug-ins when actually no failure has occurred. The NTF factor is expected to approach 1.25 as the product matures. The likelihood of an NTF decreases as the product matures, and sparing needs will therefore diminish over time.
- Turnaround time of a returned plug-in is two weeks.

**Table 7-7. Sparing Guidelines**

SAO = 99%

DDM-2000 OC-3 and OC-12, FiberReach

NTF factor = 1.67

Turn around time(weeks) = 2

Turn around time(hours) = 336

Plug-In Code (FIT)	Number of Spares						Revised Date
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6	
	<b>NRT</b>						
	<b>0.14</b>	<b>0.43</b>	<b>0.82</b>	<b>1.27</b>	<b>1.78</b>	<b>2.3</b>	
BBF1 (745)	335	1029	1962	3038	4258	5502	
BBF1B (859)	290	892	1701	2635	3693	4772	09/02/1998
BBF2 (2739)	91	280	534	826	1158	1497	
BBF2B (2311)	108	332	632	979	1373	1774	
BBF2C (2345)	106	327	623	965	1353	1748	08/24/1999
BBF3 (1310)	190	585	1116	1728	2422	3129	09/02/1998
BBF3B (1235)	202	621	1183	1833	2569	3319	09/02/1998
BBF4 (2345)	106	327	623	965	1353	1748	08/24/1999
BBF6 (1427)	175	537	1024	1586	2223	2872	09/02/1998
BBF8 (5216)	48	147	280	434	608	786	09/02/1998

Plug-In Code (FIT)	Number of Spares						Revised Date
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6	
	NRT						
	0.14	0.43	0.82	1.27	1.78	2.3	
BBF9 (2037)	122	376	717	1111	1557	2012	08/24/1999
BBF10 (2277)	110	337	642	994	1393	1800	08/24/1999
BBG1 (4917)	51	156	297	460	645	834	
BBG2 (902)	277	850	1620	2509	3517	4544	
BBG2B (820)	304	935	1782	2760	3869	4999	08/24/1999
BBG3 (1088)	229	704	1343	2080	2916	3767	
BBG4 (902)	277	850	1620	2509	3517	4544	09/02/1998
BBG4B (1056)	236	726	1384	2143	3004	3882	09/02/1998
BBG5 (5284)	47	145	277	428	600	776	
BBG6 (2193)	114	349	666	1032	1447	1869	
BBG7 (3433)	73	223	426	659	924	1194	
BBG8 (4505)	55	170	324	502	704	910	09/02/1998
BBG8B (4442)	56	173	329	510	714	923	09/02/1998
BBG9 (4084)	61	188	358	554	777	1004	08/24/1999
BBG10 (4409)	57	174	331	513	719	930	08/24/1999
BBG11 (3144)	79	244	465	720	1009	1304	
BBG12 (2586)	96	296	565	875	1227	1585	
BBG19 (729)	342	1051	2005	3105	4351	5623	09/02/1998
BBG20 (6550)	38	117	223	346	484	626	11/06/1997
BCP1 (5050)	49	152	289	448	628	812	
BCP2 (2922)	85	262	500	775	1086	1403	
BCP3 (2692)	93	285	543	841	1178	1523	
BCP4 (10000)	25	77	146	226	317	410	
21D (1959)	127	391	746	1155	1619	2092	
21D-U (1355)	184	566	1078	1670	2341	3025	08/24/1999
21G (6348)	39	121	230	357	500	646	
21G-U (3935)	63	195	371	575	806	1042	
21G2-U (4087)	61	188	358	554	776	1003	08/24/1999
21G3-U (1768)	141	433	827	1280	1794	2318	08/24/1999
22D-U (1959)*	127	391	746	1155	1619	2092	08/24/1999
22F (3317)	75	231	441	682	956	1236	
22F2-U (2033)	123	377	719	1113	1560	2016	09/02/1998

Plug-In Code (FIT)	Number of Spares						Revised Date
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6	
	<b>NRT</b>						
	<b>0.14</b>	<b>0.43</b>	<b>0.82</b>	<b>1.27</b>	<b>1.78</b>	<b>2.3</b>	
22G-U (2880)*	87	266	507	786	1101	1423	
22G2-U (2197)	114	349	665	1030	1444	1866	09/02/1998
22G3-U (4078)	61	188	358	555	778	1005	08/24/1999
22G4-U (1426)*	175	537	1025	1587	2225	2874	08/24/1999
23G (10029)	25	76	146	226	316	409	
23G-U (9023)	28	85	162	251	352	454	
23H (12836)	19	60	114	176	247	319	
23H-U (11552)	22	66	127	196	275	355	
23R (8364)	30	92	175	271	379	490	
23R-U (9807)	25	78	149	231	323	418	
23S (11470)	22	67	127	197	277	357	
24G-U (2080)*	120	368	703	1088	1525	1971	08/24/1999
24H-U (2388)	104	321	612	948	1328	1716	08/24/1999
26G-U (2468)	101	311	592	917	1285	1661	
26G2-U (2525)	99	303	579	896	1256	1623	08/24/1999
27G-U (3176)	79	241	460	713	999	1291	
27G2-U (2823)	88	271	518	802	1124	1452	08/24/1999
28G-U (3860)	65	199	379	586	822	1062	09/02/1998
29G-U (3264)*	76	235	448	693	972	1256	12/22/1999
29H-U (3049)*	82	251	479	742	1040	1344	12/28/1999

\* These OLIU circuit packs are equipped with a factory installed, removable SC-type buildout lightguide connector. Two 0 dB S7<sup>®</sup> connectors are shipped loose with the circuit pack.

Example:

- For the 22F, if circuit pack population is between 76 and 231, number of recommended spares is 2.

## Universal Optical Connectors

All the DDM-2000 FiberReach Wideband Shelf OLIU circuit packs have a universal optical connector. This connector is a two-part connector consisting of a faceplate-mounted block and an optical buildout. The faceplate block optionally supports an S7<sup>®</sup>, SC, or FC-PC type optical buildout.

A 0 dB *ST*-type connector is shipped as standard with each OLIU, Optional SC, or FC-PC 0 dB, or attenuated buildouts can be ordered separately as listed in Table 7-8. Table 7-8 lists single-mode (SM) and multimode (MM) attenuated buildouts.

**⇒ NOTE:**  
Two 0 dB SC-type removable connectors are installed on 22D-U, 22G-U, 22G4-U, 24G-U, 29G-U, and 29H-U OLIUs. Two 0 dB *ST*<sup>®</sup> connectors are shipped loose with these packs.

**Table 7-8. Universal Buildout Attenuators**

Description	Connection	Loss (dB)	Comcode
A3060 SC 0 dB buildout	SM-SM	0	106708951
A3060B1 SC 5 dB buildout	SM-SM	5	107406142
A3060D1 SC 10 dB buildout	SM-SM	10	107406159
A3060F1 SC 15 dB buildout	SM-SM	15	107406167
ASCM5 SC 5dB buildout	SM-MM	5	108440579
ASCM10 SC 10dB buildout	SM-MM	10	108440595
ASCM15 SC 15dB buildout	SM-MM	15	108440611
A3070 <i>ST</i> <sup>®</sup> 0 dB buildout	SM-SM	0	106795354
A3070B1 <i>ST</i> 5 dB buildout	SM-SM	5	107406183
A3070D1 <i>ST</i> 10 dB buildout	SM-SM	10	107406191
A3070F1 <i>ST</i> 15 dB buildout	SM-SM	15	107406209
ASTM5 SC 5dB buildout	SM-MM	5	108052960
ASTM10 SC 10dB buildout	SM-MM	10	108052994
ASTM15 SC 15dB buildout	SM-MM	15	108053018
A3080 FC 0 dB buildout	SM-SM	0	106795404
A3080B1 FC 5 dB buildout	SM-SM	5	107406225
A3080D1 FC 10 dB buildout	SM-SM	10	107406233
A3080F1 FC 15 dB buildout	SM-SM	15	107406241
AFCM5 FC 5dB buildout	SM-MM	5	108107285
AFCM10 FC 10dB buildout	SM-MM	10	108107301
AFCM15 FC 15dB buildout	SM-MM	15	108107327
A2060B SC 5 dB buildout	MM-MM	5	106795271
A2060D SC 10 dB buildout	MM-MM	10	106795289
A2060F SC 15 dB buildout	MM-MM	15	106795297
A2070B <i>ST</i> 5 dB buildout	MM-MM	5	106795313
A2070D <i>ST</i> 10 dB buildout	MM-MM	10	106795321
A2070F <i>ST</i> 15 dB buildout	MM-MM	15	106795339

## **DDM-2000 FiberReach Plug-In Order Blank**

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Table 7-9, on the following pages, is an order blank for the plug-ins available for the DDM-2000 FiberReach wideband and narrowband shelves. Many of the narrowband shelf plug-ins are the same as those used with the *SLC-2000* Multi-Services Distant Terminal and are available with *SLC-2000* Software Releases 4.4 and/or 4.5. Refer to Table 4-2 in Chapter 4, "Product Description," to see which of the narrowband channel units are available with each *SLC-2000* software release.

**Table 7-9. DDM-2000 FiberReach Plug-In Order Blank**

Qty	Product Code	Comcode	HECT <sup>*</sup> Code	Function
	BBF1B (DS1)	106543606	SNCLA70	DS1 Low-Speed Interface
	BBF3B	107966582	SNPQB03	DS1 Performance Monitoring
	BBF6 (T1EXT) <sup>†</sup>	107436610	SNC3AA0	T1 Extensions
	BBF8 <sup>†</sup> (HDSL)	108038035	SNCRLP0	HDSL Interface
	BBG8B	107830549	SNC5U79	System Controller
	BBG4B	107486490	SNPQBMF	DS3 Low-Speed Interface
	BBG19 <sup>‡</sup>	107834814	SNI2540	DS3 data services interface
	LPROT <sup>†</sup>	847689783	—	Lightning Protection Card
	22D-U <sup>§</sup>	106926595	SNCMVE0	OC-3 IS-3 OLIU w/TSI
	22G3-U <sup>¶</sup> **	108057944	SNRXDZ0	OC-3 OLIU w/TSI
	22G4-U	108215492	SNRXDZN	OC-3 OLIU w/ TSI
	26G2-U (OLIU) <sup>††</sup>	107727745	SNC6JG0	OC-1 OLIU w/TSI, w/TIMING, w/MUX
	28G-U (OLIU) <sup>‡‡</sup>	107921900	SNRXDZ0	OC-3 OLIU w/TSI, w/TIMING, w/MUX
	28G-U Assembly Kit	848076873	—	Assembly Kit with two 28G-U OLIUs and one Interconnect Cable Assembly
	29G-U (OLIU)	108219114	SNRXD70AAA	OC-12 OLIU w/TSI
	29G-U Assembly Kit	848345476	—	Assembly Kit with two 29G-U OLIUs and one Interconnect Cable Assembly
	29H-U (OLIU)			OC-12 OLIU w/TSI
	29H-U Assembly Kit	848426607	—	Assembly Kit with two 29H-U OLIUs and one Interconnect Cable Assembly
	177A <sup>§§</sup>	105774061	SNPQWAC	Retainer
	ECC2 (USPNL)	107699076	SNPQBSL	Wideband Shelf User Panel
	AUA413 (RGU)	106275977	5SPQADT***	Ringling Generator Unit
	AUA421 (CDTU)	107500654	5SPQAC7***	Channel & Drop Test Unit
	AUA432 (PCU)	107436388	SAPQAC0 ***	Power Converter Unit
	FHB2 (DSXBIU)	107649287	T1UIMK0***	Digital Signal Backplane Interface Unit
	AUA27	103840435	5SC1DD1	POTS CF + OHT (VerSus feature not available)

\* Humans Equipment Catalog Item.

† Two LPROT cards are required for each circuit pack with lines extending outside building premises. The LPROT card is installed in the secondary lightning and surge protection assembly. **Note:** A 28G-U is required with the BBF8 circuit pack and a maximum of three HDSL circuit packs per shelf is allowed.

‡ BBG19 requires front access right angle mini-BNC Cable Assembly.

§ Shipped with 0 dB buildout. See Table 7-12 if other connector types or attenuators are needed.

¶ Upon availability, the 22G3-U OLIU will replace both the 22F2-U and 22G2-U OLIUs.

\*\* Upon availability, the 22G4-U will replace the 22G3-U OLIU.

†† These wideband shelf OLIU circuit packs are used in conjunction with 27G-U/27G2-U OLIU circuit packs that are installed on the DDM-2000 OC-3 host shelf.

‡‡ 28G-U Assembly Kit (848076873) includes two 28G-U OLIUs and one Interconnect Cable Assembly. (Interconnect Cable Assembly can also be ordered separately.) See Table 7-11.

§§ 177A Retainer is required in any unused low-speed slots.

\*\*\* These codes may be subject to change.

**Table 7-9. DDM-2000 FiberReach Plug-In Order Blank (Continued)**

Qty	Product		HECI*	
Ord	Code	Comcode	Code	Function
	AUA39	106223217	5SC1X0B	POTS/SPOTS CU CS + OHT/CLASS
	AUA41B	106988082	5SC3HJE	4-Wire CF, (FXS/ETO/DX)
	AUA42B	106932189	5SCU6E0	E SPOTS CU at CS
	AUA43B	106932197	5SCU6F0	E SPOTS CU CF
	AUA44B	107391732	5SC27C0	4W VF CS (Includes TDM signalling)
	AUA45B	105717987	5SCUUJ5	Dual Ringing Repeater (Manual Ring)
	AUA52B	106244163	5SC1430	OCU Dataport, All-rate
	AUA53B	108041302	5SC4V1U	Single Coin CF
	AUA54B	107391740	5SC27D0	4 Wire VF Types I and II E+M/PLR
	AUA56B	107392300	5SCU9Y0	Dual DID(DPT)
	AUA57	103840765	5SCUT04	FSR CF
	AUA75	103840963	5SC1FF2	Private Line Automatic Ring (PLAR)
	AUA93	108413154		ISDN Brite II, RU
	AUA94	104043864	5SC18E0	ISDN Dual ANSI-U†
	AUA150C	107627325	5SC3PV0	Dual POTS/SPOTS CF + OHT + CLASS† + ALC
	AUA158D	107794125	5SC4DD0	POTS Channel Unit
	AUA159C	107184798	5SC1WK9	ALC POTS/SPOTS CU + OHT/CLASS
	AUA178B	107744153	5SC4CCC	ALC C-POTS CF OHT/CLASS
	AUA200	107392243	5SCTB0D	2-wire Switched 56-kb/s DPX
	AUA232	107050445	5SC6TV2	RS-232 DSU Dataport
	AUA252B	107727521	5SCTFFF	OCU Dataport
	MCU†5205	107315087	5SC26TV	Metallic Channel Unit (Tollgate)
	SPQ®300	107049660	SAC1ACF	POTS CS + OHT/CLASS + LSAS
	SPQ340	107437956	SAC1ADL	SLC-2000 POTS/SPOTS® CU CS + OHT/CLASS + LSAS
	xSPQ400	107989519	-	SLC-2000 ALC POTS CF + OHT/CLASS
	SPQ401	108053703	SAC1EWT	Channel Unit, 5V
	SPQ402	108415928	SAC1AZ0	
	SPQ419	108057654	SAC1ARV	

\* Humans Equipment Catalog Item.

† Service mark of Telcordia Technologies.

‡ Trademark of Tollgate Communications, Inc.

**Table 7-9. DDM-2000 FiberReach Plug-In Order Blank (Continued)**

Qty	Product		HECI*	
Ord	Code	Comcode	Code	Function
	SPQ340	107437956	SAC1ADL	SLC-2000 POTS/SPOTS® CU CS + OHT/ CLASS + LSAS
	xSPQ400	107989519	-	SLC-2000 ALC POTS CF + OHT/CLASS
	SPQ429†	107504029	SAC1AK0	Quad EBS P-Phone
	SPQ440	106842594	SAC1AAE	Quad SLC-2000 ALC POTS/SPOTS CU (CF + OHT + CLASS + CLSS)
	SPQ440C	107500746	SAC1AC0	
	SPQ440D	108123605	SAC1ACX	Quad POTS/SPOTS CU (Available by 2Q98)
	SPQ442	107100562	SAC1AH0	SLC-2000 E SPOTS CU CS
	SPQ443	107098873	SAC1AEH	SLC-2000 E SPOTS CU CF
	SPQ450	107001596	SAC1AAD	ALC POTS/SPOTS CU CF + OHT/CLASS + ALIC5 + LSAS
	SPQ452	107590150	5SCTFFG	Dual OCU Dataport
	SPQ453	108041310	5SC4V2U	
	SPQ456	107580417	SACPDC0	Quad DID
	SPQ478	107295016	SAC1AAK	SLC-2000 ALC C-POTS CF OHT/CLASS
	SPQ494	107354458	5SC2120	Quad ISDN ANSI-U
	SPQ909	107188179	SAC1A00	Low-power POTS CF + OHT/CLASS

\* Humans Equipment Catalog Item.

† Customer should order directly from Tollgate Communications, Inc. (1-800-878-3399)

### **Discontinued Availability Hardware**

Discontinued hardware is listed in Table 7-10.

**Table 7-10. Discontinued Availability Hardware**

Qty	Product Code	Comcode	HECI Code	Function
	BBF3 (DS1PM)	106008071	SNPQAM4	DS1 Performance Monitoring
	22F2-U†	107762809	SNI23Z0	OC-3 OLIU w/TSI
	22G2-U‡	107432403	SNRXD1C	OC-3 OLIU w/TSI
	AUA53	106210396	5SCU261	Coin CF
	AUA53B	107590101	5SC3RS0	Single Coin CF
	AUA90	104043823	5SC1EEC	ISDN T- Brite
	AUA93	104043856	5SC1HE0	ISDN Brite II, ANSI-U
	AUA150	106018500	5SCU1V	POTS/SPOTS CU CF + OHT/CLASS
	AUA152	106018526	5SCU48Z	OCU Dataport (GTE)
	AUA158C	107184780	5SC1WK0	ALC POTS CF + OHT/CLASS
	AUA178	107184806	5SC1WX0	ALC C-POTS CF OHT/CLASS
	AUA179	106856776	5SCIHW9	ALC POTS/SPOTS CU + ALIC5 + OHT/CLASS
	SPQ400	106731821	SAC1AAA	SLC-2000 ALC POTS CF + OHT/CLASS
	SPQ401	107848558	SAC1EW0	SLC-2000 ALC POTS CF + OHT/CLASS
	SPQ401B	108049107	SAC1EWU	SLC-2000 Quad POTS CU (CF+OHT/CLASS) [Available by 2Q98]
	SPQ419	107590143	SAC1ARM	Quad Coin CF
	SPQ440C	107500746	SAC1AC0	Quad Extended Range SPOTS
	SPQ453	107500753	5SC3EEC	Dual Coin CF

\* Humans Equipment Catalog Item.

† 22F2-U supports VT signal degrade protection switching. Replaces 22F, 22F-U. Shipped with 0 dB ST buildout. See Table 7-11 if other connector types or attenuators are needed.

‡ Requires no external attenuator for loopback testing. Shipped with 0 dB ST buildout. See Table 7-12 if other connector types or attenuators are needed.

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## **Miscellaneous Equipment and Tools**

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### **Miscellaneous Equipment and Tools**

Although the DDM-2000 FiberReach Multiplexer was designed with built-in self-test capability for facilitating installation and normal maintenance routines and troubleshooting, certain ancillary equipment and tools may be useful to installers and maintenance personnel to aid in more sophisticated performance monitoring and testing. Table 7-11, Table 7-12, and Table 7-13 list these items with recommended quantities per central office. Many of these items may already be a part of normal central office equipment.

**Table 7-11. Miscellaneous Equipment**

<b>Description</b>	<b>Comcode or Equipment Code</b>	<b>Minimum Quantities Recommended at CO</b>	<b>See Note</b>	<b>Qty. Ordered</b>
1x7 protection bus module	847850658			
DSX interconnect assembly for DDM-2000 FiberReach	ED8C852-30,G1		16	
Cabling for DSX interconnect assembly	ED8C852-20, G2/G3 or G4/G5		16	
28G-U Assembly Kit	848076873		19	
29G-U Assembly Kit	848345476		20	
29H-U Assembly Kit	848426607		21	
28G-U/29G-U/29H-U Interconnect Cable Assembly	847721271			
LGX panel for Wall DT	ED8C843-32,G1		17	
Universal Buildout Blocks	106795354	4-8	17	
12A1 Clamp	104384490	1	17	
48 Volt Power Kit (1145B1 power supply) with 8.0 AH Battery (with rack mounting brackets)	107659229		18	
48 Volt Power Kit (1145B1 power supply) with 8.0 AH Battery (with wall mounting brackets)	107659211		18	

See notes at end of tables.

**Table 7-12. Miscellaneous Fiber Cabling**

<b>Description</b>	<b>Comcode or Equipment Code</b>	<b>Minimum Quantities Recommended at C O</b>	<b>See Note</b>	<b>Qty. Ordered</b>
FS1EP-EP-2 Lightguide jumper <i>ST<sup>®</sup> II+</i> - <i>ST II+</i> single-mode (SM) (2 feet)	105357727	2	2,3	
FL1E-E-2 Lightguide jumper <i>ST-ST</i> multimode (MM) (2 feet)	105351795	2	2,3	
Fiber optic cable <i>ST</i> -to-biconic (4 ft.)	105420913	2	8	
Fiber splitter w/ <i>ST</i> connectors	407059047	1	14	
Fiber coupler w/ <i>ST</i> connectors	105271142	2	14	
Fiber splitter w/FC connectors	407059054	1	14	
Fiber coupler w/FC connectors	Local supplier	2	14	
Fiber splitter w/SC connectors	407059062	1	14	
Fiber coupler w/SC connectors	106703200	2	14	
FC Fiber Connector Tool	847525284			
FC Fiber Connector Tool Assembly	847525300		15	

See notes at end of tables.

**Table 7-13. Miscellaneous Accessories**

<b>Description</b>	<b>Comcode or Equipment Code</b>	<b>Minimum Quantities Recommended at C O</b>	<b>See Note</b>	<b>Qty. Ordered</b>
Craft interface terminal		1	1	
Strap, wrist > 6-1/2" circumference	901011320		4,5	
Strap, wrist < 6-1/2" circumference	900557075		4,5	
Terminal, ESD grounding	845264118		5	
Fuse, 3 amp	406204230		6	
Fuse extraction tool	406420273		6	
Modem			7	
Microduster Nozzle Assy with 10 oz. can, valve, and hose	406100321	1	9	
Microduster Air six 10 oz. refill cans	406852285		9	
Microduster Air twelve 10 oz. refill cans	406100339		9	
Absorbond Cleaner (Pkg.) or Equivalent	900709379	1	9	
Alcohol Squirt Bottle or Equivalent	900726464	1	9	
Lint-free Pipe Cleaners (Pkg.) or Equivalent	403780570	1	9	
CERJAC SONET test set (OC-12, OC-3, STS-1, VT1.5, DS3, and DS1)	407024637		10	
CERJAC SONET test set (OC-3, STS-1, VT1.5, DS3, and DS1)	407024629		10	
Circuit pack carrying case	406529289		11	
Double density edge card repair kit	106423502		12	
Duct Notching Tool		1	13	

See notes at end of table.

### Notes for Tables 7-11, 7-12, and 7-13

1. A craft interface terminal (CIT) is recommended for maintenance and administrative activities. A personal computer (PC) is required for software download and to run CPro-2000 software. The DDM-2000 FiberReach Multiplexer CIT port (mounted on the user panel) is a standard EIA-232-D (supersedes RS-232C specification) interface configured as DCE for direct connection to a CIT. The CIT port will support rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud and should be compatible with most ANSI\* 3.64 ASCII terminals; however, it is optimized for standard CIT screens with display areas of 24 lines by 72 (or more) columns. A pager function is included in the DDM-2000 FiberReach Multiplexer to accommodate screen lengths from 3 lines to 150 lines.

Those CITs compatible with DDM-1000 (see LTP 363-206-100 for a list of DDM-1000 compatible terminals) should be directly compatible with the DDM-2000 FiberReach Multiplexer, although some may not be as convenient to use with the DDM-2000 FiberReach Multiplexer.

Any terminal compatible with the ANSI\* 3.64 standard should be compatible with the DDM-2000 FiberReach Multiplexer.

The selected personal computer (PC) used for software download should have:

- A minimum of 640K of random access memory (RAM)
- MS-DOS† version 2.0 or newer
- Hard disk
- At least one floppy disk drive of 360K or larger capacity. Although the disk drive may accommodate either floppy or hard disk, a hard disk is preferred for its better performance. The disk requirement is met with most portable MS-DOS PCs with a single 3.5-inch disk (720K or larger capacity). An MS-DOS PC with a hard disk and either a 3.5-inch 720K or 5.25-inch 360K (or larger) floppy disk may also be used.



**NOTE:**

The selected personal computer (PC) used for software download also works with Windows NT†.

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\* Registered trademark of American National Standards Institute, Inc.

† Registered trademark of Microsoft Corporation.

**Notes for Tables 7-11, 7-12, and 7-13 (Continued)**

2. Equipment noted is not required for normal maintenance routines but may be helpful for installation and troubleshooting testing.
3. Lightguide jumpers noted are 2-foot jumpers with *ST<sup>®</sup>//+* lightguide cable connectors that can be used for a manual optical loopback at the OLIU plug-in interface. For other lightguide jumpers, refer to Tables 7-14 and 7-15.
4. It is recommended that one wrist strap be provided for each DDM-2000 FiberReach bay arrangement for protection against plug-in damage resulting from electrostatic discharge.
5. Each DDM-2000 FiberReach carrier comes equipped with 2 electrostatic discharge (ESD) jacks on the front panel for ESD wrist straps (see Note 4). ESD grounding terminals may be also mounted miscellaneously in unused #12-24 tapped holes in typical bay framework. If rear access activities are anticipated, at least one of these terminals is recommended for rear access bay mounting.
6. The two –48 V feeders (A and B) required for each DDM-2000 FiberReach shelf are protected by 3-amp fuses that ship with the shelf. It is recommended that a supply of spare fuses be provided at DDM-2000 FiberReach Multiplexer locations.

Fuses and a fuse extraction tool for the shelf may be ordered through Lucent using Comcode 406204230 for fuses and Comcode 406420273 for the extraction tool, or through SAN-O Industrial Corporation, 91-3 Colin Drive, Sherwood Corporation Center, Holbrook, NY 11741, or by calling 516-472-6666 and ordering:

Fuse, 3-amp, Part No. AX-1-3B or

Fuse Extraction Tool, Part No. F-0431

7. Where remote access is desired, an external modem may be furnished. Operation has been verified for Lucent models 4024 and 2296; however, many other manufacturers' modems should also be compatible. The DDM-2000 FiberReach shelf terminal port is compatible with the *ANSI 3.64* ASCII EIA-232-D standard (supersedes RS-232C specification).
8. Lightguide connectors at the OLIU plug-in interfaces are *ST* connectors. If interfaces for testing, etc., to biconic entities are required, the specified adapters or equivalent may be used. When using attenuator buildouts with universal connectors, the fiber must be the same on both sides of the attenuator to achieve the designated value. For example, if a single-mode (SM) jumper is used, the buildout must be SM and be on the transmit side; if a multimode (MM) jumper is used, the buildout must be MM and on the receive side.

**Notes for Tables 7-11, 7-12, and 7-13 (Continued)**

9. It is very important that optical fiber connections be thoroughly cleaned whenever they are removed and reconnected to avoid potential service-affecting optical losses. For 0db buildouts, use a pipe cleaner moistened with alcohol. For attenuated buildouts, do *not* use a pipe cleaners. Attenuated buildouts have a lens which could be damaged by a pipe cleaner. Use an air nozzle to clean. Consult the TOP section of LTP 363-206-301, *DDM-2000 FiberReach Multiplexer User/Service Manual* for cleaning procedures.
10. The CERJAC Model 156 SONET and T-carrier test set, Comcode 407024637, is designed for use in system installation, qualification, and maintenance. The intermediate reach optical interface allows easy connection at the optical tributary ports or at the OC-3 or OC-12 transport interfaces. STS-1 ports facilitate testing of electrical SONET connections. The system also provides complete DS3 and DS1 testing capability. Full transmission, multiplexing, overhead, and synchronization testing are supported. This system package includes a BITS clock (1.544 Mhz) input and output, Data-Event Logging, and RS-232 Remote Front Panel control interface.  
  
The CERJAC Model 156 SONET and T-carrier test set, Comcode 407024629, is the same as described previously but omits testing at the OC-12 rate. This lower-cost configuration provides full tributary and transport testing in OC-3 networks, and tributary testing (OC-3, STS-1, DS3, and DS1) in OC-12 networks.
11. The Lucent circuit pack carrying case offers protection from ESD, mishandling, drops, and jolts. The case protects packs from 0 to 25,000 volts of static electricity fields and discharge. Ground cord, wrist strap, static-shielding bag, and grounded work surface are included with every case. This case is manufactured by the Silton Company.
12. This repair kit is not required for normal maintenance routines, but it may be advisable to have it available for installation or maintenance personnel.
13. Order from PANDUIT Corporation, Tinley Park, Illinois. Part Number DNT-100.

**Notes for Tables 7-11, 7-12, and 7-13 (Continued)**

14. A fiber splitter is required to perform the in-service point-to-point to ring upgrade. The splitter can be reused to support multiple in-service upgrades. Many commercial fiber splitters are available. Models: 22-10131-50-13121 (w/ST connectors), 22-10131-50-13131 (w/FC connectors), and 22-10131-50-13141 (w/SC connectors) have been tested with the DDM-2000 and are recommended. For more information, contact Gould Fiber Optics, 6740 Baymeadow Drive, Glen Burnie, Maryland 21060. The customer service telephone number is 1-800-544-6853.  
  
Two fiber couplers are needed with the fiber splitters. Obtain the FC coupler from your local supplier.
15. The FC Fiber Connector Tool Assembly includes the tool, tool holder, and instructions.
16. If the user is installing the first DSX, cables ED8C852-20, Groups 2 and 3 should be ordered. If the user is installing the second DSX, cables ED8C852-20, Groups 4 and 5 should be ordered.
17. The LGX panel for the DDM-2000 FiberReach wall DT requires at least 4 or up to 8 universal buildout blocks, which are ordered separately. Also required is a 12A1 clamp, which is also ordered separately. Mechanical or fusion splice kits for lightwave fiber may also be ordered if needed.
18. The 48V power kit with 8.0 AH Battery includes: 1145B1 power cord, A/C power cord, wall mounting plates, 8.0 AH battery (mono block), 25 foot power distribution cable, battery extension cable, and FiberReach Instruction Manual. Comcode 107659229 also includes a pair of 23 inch rack-mounting angle brackets.
19. The 28G-U Assembly Kit Includes two 28G-U OLIUs and one 28G-U Interconnect Cable Assembly. (Comcode 848076973). (Interconnect Cable Assembly can also be ordered separately.) See Table 7-9 for ordering individual circuit packs.
20. The 29G-U Assembly Kit Includes two 29G-U OLIUs and one 29G-U Interconnect Cable Assembly. (Comcode 848345476). (Interconnect Cable Assembly can also be ordered separately.) See Table 7-9 for ordering individual circuit packs.
21. The 29H-U Assembly Kit Includes two 29H-U OLIUs and one 29H-U Interconnect Cable Assembly. (Comcode 848426607). (Interconnect Cable Assembly can also be ordered separately.) See Table 7-9 for ordering individual circuit packs.

## Lightguide Jumpers

The DDM-2000 FiberReach lightguide interface uses both single-mode and multimode jumpers for connecting to and from the outside plant LGX<sup>®</sup> panel and the DDM-2000 FiberReach Multiplexer.

When the outside plant lightguide is multimode, single-mode or multimode jumpers can be used between the LGX panel and the DDM-2000 FiberReach Multiplexer on the transmit (OUT) side and multimode must be used on the receive (IN) side of all OLIUs.

When the outside plant lightguide is single-mode, single-mode jumpers must be used for the transmit side and either single-mode or multimode jumpers can be used for the receive side of all OLIUs.

Single-mode jumpers are listed in Table 7-14. Multimode jumpers are listed in Table 7-15. For other types of lightguide jumpers, contact your Lucent Account Representative.

**Table 7-14. Single-Mode Lightguide Jumpers**

Code	Comcode	Description	Length (Feet)	Connectors
FS1EP-EP-2	107149494	Lightguide Jumper	2	ST <sup>®</sup> II+-STII+
FS1EP-EP-10	107149536	Lightguide Jumper	10	STII+-STII+
FS1EP-EP-25	107149569	Lightguide Jumper	25	STII+-STII+
FS1EP-EP-50	107149601	Lightguide Jumper	50	STII+-STII+
FS1EP-EP-100	107149627	Lightguide Jumper	100	STII+-STII+
FS1E-A-2	105420905	Lightguide Jumper	2	ST-2016A Biconic
FS1E-A-10	105420947	Lightguide Jumper	10	ST-2016A Biconic
FS1E-A-25	105423958	Lightguide Jumper	25	ST-2016A Biconic
FS1E-A-50	105424006	Lightguide Jumper	50	ST-2016A Biconic
FS1E-A-100	105424022	Lightguide Jumper	100	ST-2016A Biconic
LS1SC-SC-2	106908247	Lightguide Jumper	2	SC-SC
LS1SC-SC-10	106908270	Lightguide Jumper	10	SC-SC
LS1SC-SC-25	106908304	Lightguide Jumper	25	SC-SC
LS1SC-SC-50	106908346	Lightguide Jumper	50	SC-SC
LS1SC-SC-100	106908395	Lightguide Jumper	100	SC-SC
LS1FP-FP-10	106593825	Lightguide Jumper	10	FCPC-FCPC
LS1FP-FP-25	106932908	Lightguide Jumper	25	FCPC-FCPC
LS1FP-FP-50	106932916	Lightguide Jumper	50	FCPC-FCPC
LS1FP-FP-100	106932924	Lightguide Jumper	100	FCPC-FCPC

**Table 7-15. Multimode Lightguide Jumpers**

<b>Code</b>	<b>Comcode</b>	<b>Description</b>	<b>Length(Feet)</b>	<b>Connectors</b>
FL1E-E-2	105351795	Lightguide Jumper	2	ST <sup>®</sup> -ST
FL1E-E-10	105351837	Lightguide Jumper	10	ST-ST
FL1E-E-25	105351860	Lightguide Jumper	25	ST-ST
FL1E-E-50	105351910	Lightguide Jumper	50	ST-ST
FL1E-E-100	105351936	Lightguide Jumper	100	ST-ST
FL1E-A-2	105613954	Lightguide Jumper	2	ST-2016A Biconic
FL1E-A-10	105613988	Lightguide Jumper	10	ST-2016A Biconic
FL1E-A-25	105614010	Lightguide Jumper	25	ST-2016A Biconic
FL1E-A-50	105614051	Lightguide Jumper	50	ST-2016A Biconic
FL1E-A-100	105614119	Lightguide Jumper	100	ST-2016A Biconic
LL1SC-SC-2	106908668	Lightguide Jumper	2	SC-SC
LL1SC-SC-10	106908692	Lightguide Jumper	10	SC-SC
LL1SC-SC-25	106908734	Lightguide Jumper	25	SC-SC
LL1SC-SC-50	106908775	Lightguide Jumper	50	SC-SC
LL1SC-SC-100	10690879	Lightguide Jumper	100	SC-SC
LL1FC-FC-10	107095549	Lightguide Jumper	10	FC-FC
LL1FC-FC-25	107095556	Lightguide Jumper	25	FC-FC
LL1FC-FC-50	107095564	Lightguide Jumper	50	FC-FC
LL1FC-FC-100	107095572	Lightguide Jumper	100	FC-FC

## **In-Line Attenuators**

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Table 7-16 lists the in-line attenuators.

**Table 7-16. In-Line Attenuators**

<b>Product</b>	<b>Connection</b>	<b>Connector</b>	<b>Attenuation (dB)</b>	
<b>Code</b>	<b>Type</b>	<b>Type</b>	<b>at 1300 nm</b>	<b>Comcode</b>
502A	MM-MM	Biconic	5.0 ± 1	105347827
502B	MM-MM	Biconic	7.0 ± 1	105347835
502C	MM-MM	Biconic	9.0 ± 1	105347843
602A	SM-MM	Biconic	3.0 ± 1	105167803
602B	SM-MM	Biconic	5.0 ± 1	105167845
602C	SM-MM	Biconic	7.0 ± 1	105167894
702A	SM-SM	Biconic	2.5 ± .05	105347884
702B	SM-SM	Biconic	5.0 ± .05	105347892
702C	SM-SM	Biconic	7.5 ± .05	105347900
A2000B	MM-MM	<i>ST</i>	5.0	106597297
A2000D	MM-MM	<i>ST</i>	10.0	106597446
A3000B	SM-SM	<i>ST</i>	5.0	106060718
A3000D	SM-SM	<i>ST</i>	10.0	106060734



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### **Overview**

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This section describes how Lucent Technologies supports the DDM-2000 FiberReach Multiplexers. This includes technical support, engineering and installation services, documentation support, and training. Figure 8-1 shows the product support structure.

### **Customer Technical Support (CTS)**

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Customer Technical Support is available through a toll free technical assistance number. Lucent Technologies maintains a highly-skilled, multi-tier support structure consisting of regional engineers, product specialists, and system designers to support your network equipment. All levels of technical expertise may be called upon to solve the customer problem.

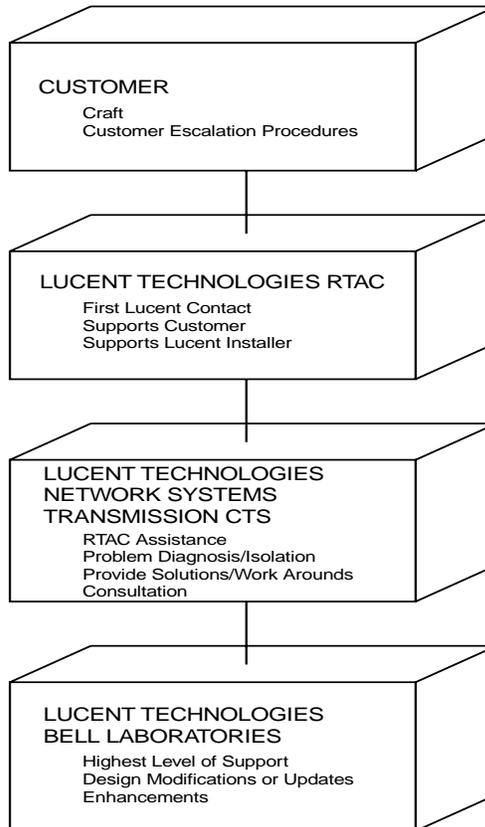
The CTS organization provides remote, diagnostic support. On-site assistance is available on a billable contract or time and materials basis. Support services may include the following activities:

- Responding to all requests for assistance
- Tracking and maintaining visible ownership of all reported problems, from inception through resolution
- Analyzing and diagnosing reported problems
- Providing restoration and recovery service
- Providing preventive and/or circumvention measures

- Communicating the actions, plans, and problems status to the reporting customer
- Initiating action to establish Modification Requests (MRs) for design issues
- Writing and distributing technical bulletins (Urgent Problem Notification)

Customer Technical Support services are available on a contract basis in three levels to meet varying customer needs: Preferred, Standard, and Basic Agreements. The preferred level of support guarantees 24 x 7 (24 hour, 7 day-a-week) coverage of the customer's network. Guaranteed performance commitments for response, service restoration, and problem resolution times are validated by published Service Performance Reports. The Standard level of support guarantees 8 x 5 (8 hour, 5 day-a-week) coverage. Performance commitments are also validated by Service Performance Reports. Out-of-hours support is available for an additional fee. The Basic level of support guarantees 8 x 5 coverage with hourly billing for each support call. Out-of-hours coverage is available with additional fees.

When the customer experiences a problem, the initial point of contact within Lucent Technologies is the Regional Technical Assistance Center (RTAC). RTAC is divided into three regions covering North America: region East (includes Canada), region South, and region West. They can be reached by calling 1-800-CAL-RTAC (1-800-225-7822). Lucent Technologies works with the customer to define the problem and determine its severity. Problems are worked during the customer's contracted coverage period. By prior agreement, service-affecting problems are worked immediately regardless of contracted coverage with billing reconciliation, if required. Acting as a single point of contact with the customer, the RTAC engineer will involve all necessary tiers of support to solve the customer problem.



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**Figure 8-1. Product Support**

## **Engineering and Installation Services**

The Lucent Technologies Customer Support and Operations (CS&O) organization provides customers with quality product support services. Whether you need assistance in engineering, installation, normal system maintenance, or disaster recovery, the support staff provides you with the quality technical support you need to get your job done. Each segment of the CS&O organization regards the customer as its highest priority and understands your obligation to maintain quality service for your customer.

Within the CS&O organization, the Engineering and Installation Services group provides a highly skilled force of support personnel to provide customers with quality engineering and installation services. These engineering and installation specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services. These services include analyzing your equipment request, preparing a detailed specification for manufacturing and installation, creating and maintaining job records, installing the equipment, and testing and turning over a working system.

When the CS&O organization provides job records and installs the equipment, operationally affective changes to the system are automatically identified and applied to the system at no additional cost.

The Engineering and Installation Services group provides the customer with an individually tailored, quality-tested job that meets our published high standards and the customer's operational requirements. The group ensures that the customer's system order is integrated into a complete working system tailored to office conditions and preferences. This process provides for the customer's complete needs. It includes provisions for cabling, lightning protection, power equipment, and ancillary connections to local and/or remote alarm systems. The group will also respond to any customer changes that occur during installation.

All equipment engineered and installed by Lucent is thoroughly tested and integrated into a reliable system at cutover. Once approved by Lucent's Quality Assurance Test group, the system is turned over to the customer.

The group also provides any specialized engineering and installation services required for unusual or highly individualized applications. These services may include engineering consultations and database preparation. Your local Account Executive can provide more information about these services.

## **Customer Technical Support Enhanced Services**

The goal of Lucent Technologies Customer Technical Support Enhanced Services is to keep Lucent Transmission Systems' products operating at maximum performance and to prevent problems from interrupting service to customers.

Typical Enhanced Services include:

- Network design, growth planning, and performance analysis
- Multivendor troubleshooting
- Network Integration
- Preventive and remedial maintenance
- Hardware and software upgrade services
- On site maintenance programs
- Customized MOP (Method of Procedure) development

For more information on Lucent's Customer Technical Support Services, contact your Lucent Technologies Account Executive.

## **Documentation Support**

The Lucent Technologies' Customer Training and Information Products Organization provides a contact for reporting errors or asking questions about information in this document. The document support telephone number is **1-800-645-6759** (Monday through Friday, 8:00 a.m. to 4:00 p.m. EST).

## **Related Training**

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The National Product Training Center at Dublin, Ohio, provides management courses for planning, engineering, and ordering, as well as training for telecommunications technicians in installation, operations, and maintenance. Suitcasing of these courses is available. Consult your local Lucent Technologies Account Executive for more information or reservations. Call **1-888-LUCENT8 (1-888-582-3688)**, **prompt 2** for enrollment.

The following courses are provided by the National Product Training Center:

- Number: LW2211 (CD-ROM)  
Title: DDM-2000 OC-3/OC-12 Multiplexer Fundamentals  
Audience: This is a CD-ROM based course for anyone interested in learning the fundamentals of operation of the DDM-2000 OC3 and OC-12 Multiplexers.  
Content: General information about the DDM-2000 OC-3 and OC-12 Multiplexers, including a product overview, applications, and architecture.
- Number: LW2212  
Title: DDM-2000 OC-3 and OC-12 Multiplexer Applications and Architecture  
Audience: Fundamental planners, account executives, and private telecommunications network technical consultants.  
Content: General information about the DDM-2000 OC-3 and OC-12 Multiplexers including a product overview, applications, architecture, and deployment planning. This course is a prerequisite for LW2312.
- Number: LW2312  
Title: DDM-2000 OC-3 and OC-12 Multiplexer Equipment Engineering and Planning  
Audience: Facility planners, outside plant engineers, central office equipment engineers, and private network design engineers.  
Prerequisite: LW2212  
Content: Information and guidelines required to plan and order DDM-2000 OC-3 and OC-12 Multiplexer equipment for loop feeder and interoffice applications.

- Number: LW2604

Title: DDM-2000 OC-3 Multiplexer Ring/Linear Networks, Operations and Maintenance

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance.

Content: Information supporting operations, maintenance, and provisioning of ring and/or DDM-2000 OC-3 Multiplexers. On-site shelves are used for extensive hands-on experience.

- Number: LW2605

Title: DDM-2000 OC-3 Multiplexer Rings Operations and Maintenance for TARP network.

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance operating in OC-3 TARP networks.

Prerequisite: LW2211, TR9203

Content: Describes DDM-2000 OC-3 equipment in terms of the procedures required for system turn-up, provisioning and maintenance of the Multiplexer. The course provides the details that are required to perform the tasks associated with the overall operation of the DDM-2000 OC-3 Ring System in a TARP environment. On-site shelves are used for extensive hands-on experience.

- Number: LW2610

Title: DDM-2000 FiberReach Wideband Shelf, Operations and Maintenance

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in DDM-2000 FiberReach network functions.

Prerequisite: LW22212, LW2312, LW2604

Content: Information supporting operations, maintenance, and provisioning of DDM-2000 FiberReach Wideband Shelf. On-site shelves are used for extensive hands-on experience.

- Number: LW2611

Title: DDM-2000 FiberReach Release Multiplexer Self-Paced Course

Audience: Technicians, planners, supervisors, account executives, maintenance engineers, and operation support personnel involved in DDM-2000 FiberReach network functions.

Prerequisite: LW22212, LW2312, LW2604

Content: This is a self-paced course for anyone interested in learning the fundamental operations of the DDM-2000 FiberReach Multiplexer. This course provides information on applications, OAM&P functions, and system planning and engineering.

■ Number: LW2612

Title: DDM-2000 OC-12 Multiplexer Operations and Maintenance

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance.

Content: Information supporting operations, maintenance, and provisioning the DDM-2000 OC-12 Multiplexer and the DDM-2000 OC-3/OC-12 interworking network. Includes information on DDM-2000 OC-12 linear and rings applications. On-site shelves are used for extensive hands-on experience.

■ Number: LW2613

Title: DDM-2000 OC-12 Multiplexer Rings Operations and Maintenance for a TARP Network

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance of the DDM-2000 OC-12 operating in a TARP network.

Prerequisite: TR9203

Content: Describes DDM-2000 OC-12 equipment in terms of the procedures required for system turn-up, provisioning and maintenance of the Multiplexer. The course provides the details that are required to perform the tasks associated with the overall operation of the DDM-2000 OC-12 Ring System in a TARP environment. On-site shelves are used for extensive hands-on experience.

■ Number: LW2614

Title: 2000 Product Family Surveillance and Performance Monitoring

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance.

Content: Information supporting operations interfaces using X.25 links to an operations center.

- Number: LW2618  
Title: Advanced Ring Network Applications, Operations, and Maintenance  
Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day operations of FT-2000 and/or DDM-2000 OC-3/OC-12 rings having dual ring interworking (DRI) traffic.  
Prerequisite: LW2604  
Content: Information supporting operations interfaces using X.25 links to an operations center.
- Number: LE2000  
Title: *SLC*<sup>®</sup>-2000 Management Overview  
Audience: Telecommunications managers responsible for the planning, implementation, and maintenance of the *SLC*-2000 Access System  
Prerequisite: Previous knowledge of DDM-2000 Multiplexers, as provided in courses LW2211 or LW2212.  
Content: Applications, planning, features and benefits, functional description, testing, basic maintenance, and ordering.
- Number: LE2010  
Title: *SLC*-2000 Overview  
Audience: This course is designed for anyone who would like an overview of the *SLC*-2000 Access System.  
Prerequisite: Students need to be familiar with basic transmission concepts as provided by TR0510, *Transmission Principles*.  
Length: 4 hours  
Content: This interactive multimedia course is intended to provide students with an overview of the *SLC*-2000 Access System. Many topics are covered in an overview fashion that will help the student better understand the purpose of the *SLC*-2000 Access System and how it fits into the telephony network.  
Media: CD-ROM-based self-paced course. Students who wish to take this training must have an MPCII compatible computer. All software needed to view the training is included on the CD-ROM.

- Number: TR4610

Title: *SLC-2000 Access System Operations and Maintenance*

Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day operations of the *SLC-2000 Access System*.

Prerequisite: Previous knowledge of DDM-2000 Multiplexers, as provided in courses LW2604 and LW2612.

Content: A comprehensive study of the *SLC-2000 Access System*, including physical description, functional description, testing, and maintenance.

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# Contents

## **Overview**

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This section provides the Lucent Technologies' Quality Policy, describes the reliability program, and describes the International Standards Organization (ISO) certification awarded to Lucent Technologies' Transmission Business Unit.

## **Introduction**

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***POLICY — Quality excellence is the foundation for the management of our business and the keystone of our goal of customer satisfaction. It is, therefore, our policy to:***

- Consistently provide products and services that meet the quality expectations of our customers.
- Actively pursue ever-improving quality through programs that enable each employee to do his or her job right the first time.

- Richard A. McGinn, Chairman and CEO

This Lucent Quality Policy guided the development of the DDM-2000 Multiplexers and will continue affecting this product throughout its lifetime. The primary tool ensuring product quality is the Quality Plan used with the Lucent Transmission Systems Reliability Program.

## **Reliability Program**

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Reliability is a key ingredient of the product life cycle, beginning at the earliest planning stage. Major efforts at the start of the project were system reliability modeling, creating the project quality team (with representatives of all major activity areas), and writing and imposing the quality plan. A key part of the quality plan is the reliability plan.

During the design and developmental stage, reliability predictions, qualification and selection of components, definition of quality assurance audit standards, and prototyping of critical areas of the system ensured built-in reliability.

During manufacturing and field deployment, techniques such as premanufacturing, qualification, production quality tracking, failure mode analysis, and feedback and correction further enhance the ongoing reliability of the DDM-2000 multiplexers.

Detailed reliability specifications for the DDM-2000 Multiplexers are included in the Technical Specifications section of this document.

## **International Standards Organization (ISO) Certification**

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Lucent's Transmission Systems Business Unit received ISO 9001 certification for its Merrimack Valley manufacturing facility and associated development organization on September 15, 1992. Merrimack Valley manufactures systems for transporting data, voice, and images over public and private telecommunications networks. Major product lines consist of digital access and cross-connect systems, network multiplex systems, and lightwave systems.

ISO 9001 is an international quality standard recognized by more than 50 countries. ISO 9001 is the most comprehensive standard in the ISO 9000 series, requiring well documented and implemented controls for design development, production, delivery, installation, and service. Its purpose is to ensure manufacturers produce products with consistently high levels of quality and service.

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# Contents

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**Overview**

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This section contains the technical specifications for Releases 2.2, 3.0, 3.1, and 4.0 of the DDM-2000 FiberReach Multiplexer.

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**DDM-2000 FiberReach Wideband Shelf Specifications**

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**External Transmission Interfaces**

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The DDM-2000 FiberReach Multiplexer transmission interfaces adhere to industry standards as listed in Table 10-1.

**Table 10-1. Transmission Interface Standards**

<b>Interface</b>	<b>Standard</b>	<b>Comments</b>
DS1 low-speed	CB-119, ANSI <sup>*</sup> T1.102-1992 (Draft), GR-499, Iss. 5, ANSI/T1.403-1989	B8ZS/AMI option SF, ESF
OC-1/OC-3	ANSI T1.106/88, ANSI/T1.105/90 & T1.105a/90 GR-253, Iss. 2, TR-496, Iss.	

\* Registered trademark of American National Standards Institute, Inc.

## Electrical Interfaces

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The DDM-2000 OC-3 Multiplexer supports a DS1 low-speed interface.

### DS1 Low-Speed (BBF1B)

- Electrical Specification

The DS1 low-speed interface transmits and receives a standard electrical DS1 signal as specified in ANSI T1.102-1992 (draft), Section 2 (1.544 Mb/s nominal rate, DSX-1 interconnect specification). Line coding is provisionable to alternate mark inversion (AMI) with or without bipolar 8-zero substitution (B8ZS). Line buildout is provisionable as follows:

- 613C (22 gauge): 30 to 655 ft.
- 1249-C (26 gauge) 30 to 450 ft.

- Format Specification

The DS1 low-speed interface provides clear channel transport of any DSX-1 compatible signal. There are no format constraints on this interface.

- Alarm Thresholding

The following parameters are monitored at the DS1 interface:

- Loss of signal (LOS)
- Line coding violations (CV-L)

The alarm level for each of the monitored parameters can be provisioned to critical (CR), major (MJ), minor (MN), or status. B8ZS and AMI coding violation failure thresholds are user settable to  $10^{-3}$  or  $10^{-6}$  bit error ratio (BER).

## DS3 Low-Speed (BBG4/4B)

### ■ Electrical Specification

The low-speed DS3 interface transmits/receives a standard electrical DS3 signal as specified in ANSI T1.102-1993, Section 5 (44.736 Mb/s rate, DSX-3 interconnect specification, B3ZS encoding). However, the signal does not have to contain a standard DS3 frame.

LBO is provisionable as follows:

- 734A/D: 0 to 450 ft.
- 735A: 0 to 250 ft.

### ■ Format Specification

The DS3 low-speed interface provides clear channel transport of any DSX-3 compatible signal (M13 mode, framed clear channel, unframed clear channel). Thus, there are no format requirements on this interface.

### ■ Alarm Thresholding

The following parameters are monitored at the DS3 interface to the DSX-3:

- LOS
- CV-L

The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B3ZS coding violation failure threshold is user settable to  $10^{-3}$  or  $10^{-6}$  BER.

### ■ PM (See Table 10-22.)

- DS3 parity errors (P-Bits)
- SEFS

If provisioned in the VMR or VM modes (Table 10-2), DS3 P-bit violations and SEFS are counted, and the counts are thresholded to flag detected performance degradation of the DS3 signal incoming from the fiber.

**Table 10-2. DS3 Interface Modes**

	<b>Monitor P-Bits</b>	<b>Correct P-Bits</b>
VMR mode	Yes	Yes
VM mode	Yes	No
CC mode	No	No

- Enhanced DS3 PM (See Table 10-3.)
  - CV-P Coding Violations
 

These errors are counted and thresholded independently for all DS3 interfaces provisioned in VM or VMR mode. When the F&M bit or C-bit option (C-bit is Release 8.0 and later releases) is selected, NEs could be provisioned in VMR or VM mode. See Table 10-3.
  - Errored Seconds (ES-P)
  - Severely Errored Seconds (SES-P)
  - Unavailable Seconds (UAS-P)
  - Severely Errored Frame Seconds (SEFS)
  - CV-L Coding Violations Line (Release 7.2 and later of OC-3)
  - ES-L Errored Seconds (Release 7.2 and later of OC-3)
  - SES-L Severely Errored Seconds Line (Release 7.2 and later of OC-3)

**Table 10-3. Enhanced DS3 Performance Monitoring Modes**

Mode	PM Option	Monitor P-Bits	Monitor F&M Bits	Monitor C-Bits	Correct P-Bits	Correct F&M Bits	Correct C-Bits	Monitor Line PM
VMR	P-bit	Yes	No	No	Yes	No	No	Yes
VMR	F&M-bit	No	Yes	No	Yes	No	No	Yes
VMR	C-bit	No	No	Yes	Yes	No	No	Yes
VM	P-bit	Yes	No	No	No	No	No	Yes
VM	F&M-bit	No	Yes	No	No	No	No	Yes
VM	C-bit	No	No	Yes	No	No	No	Yes
CC	P-bit	No	No	No	No	No	No	Yes
CC	F&M-bit	No	No	No	No	No	No	Yes
CC	C-bit	No	No	No	No	No	No	Yes

## DS3 Data Services Interface (BBG19)

### ■ Electrical Specification

The low-speed DS3 interface transmits/receives a standard electrical DS3 signal as specified in ANSI T1.102-1993, Section 5 (44.736 Mb/s rate, DSX-3 interconnect specification, bipolar 3-zero substitution [B3ZS] encoding). However, the signal does not have to contain a standard DS3 frame.

LBO is provisionable as follows:

- 734A/D: 0 to 450 ft.
- Mini-coax (KS-19224, L2): 0 to 150 ft.
- 735A: 0 to 250 ft.

### ■ Format Specification

The DS3 low-speed interface provides clear channel transport of any DSX-3 compatible signal (M13 mode, framed clear channel, unframed clear channel). Thus, there are no format requirements on this interface.

### ■ Alarm Thresholding

The following parameters are monitored at the DS3 interface to the DSX-3:

- LOS
- CV-L

The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B3ZS coding violation failure threshold is user settable to  $10^{-3}$  or  $10^{-6}$  BER.

### ■ Performance Monitoring (See Table 10-3 and Table 10-22.)

- DS3 parity errors
- SEFS

If provisioned in the VMR or VM modes (Table 10-2), DS3 P-bit violations and SESF are counted, and the counts are thresholded to flag detected performance degradation of the DS3 signal incoming from the fiber.

### ■ Enhanced DS3 Performance Monitoring (See Table 10-3.)

The Enhanced DS3 PM for the BBG19 is the same as for the BBG4/BBG4B. Refer to the DS3 Low-Speed (BG4/4B) Enhanced DS3 Performance Monitoring section for a list of parameters.

The DS3 interface is accessed through a BNC connector on the circuit pack faceplate.

## DS1PM Low-Speed (BBF3/BBF3B)

### ■ Electrical Specification

The DS1PM low-speed interface transmits and receives a standard electrical DS1 signal as specified in ANSI T1.102-1993, Section 2 (1.544 Mb/s nominal rate, DSX-1 interconnect specification). Line coding is provisionable to AMI with or without B8ZS. Line buildout is provisionable as follows:

- 613C (22 gauge): 30 to 655 ft.
- 1249-C (26 gauge): 30 to 450 ft.

### ■ Format Specification

The DS1Pm low-speed interface can be provisioned for the following DS1 formats: clear channel (default), superframe (SF) as specified in ANSI T1.403-1989, or extended superframe (ESF) as specified in ANSI T1.403-1989. In the case of SF or ESF format selections, DS1 performance information is collected by monitoring the associated DS1 framing format.

### ■ Alarm Thresholding

The following parameters are monitored at the DS1PM interface:

- Loss of signal (LOS)
- Line coding violations (CV-L)

The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B8ZS and AMI coding violation failure thresholds are user settable to  $10^{-7}$  or  $10^{-8}$  BER.

### ■ Loopback

- Quad DS1 facility loopback (BBF3)
- Single DS1 facility loopback (BBF3B) (Release 3.0 and later)

### ■ Performance Monitoring (See Table 10-22.)

Near-End DS1 Path Parameters:

- Errored Seconds (ES)
- Severely Errored Second (SES)
- Unavailable Seconds (UAS)
- SF or ESF framed signals incoming to the DSX-1
- CV-P Coding Violations (Release 3.0 and later)
- CV-PFE Coding Violations (Release 3.0 and later)

Far-End DS1 Path Parameters:

- SES, and UAS for ESF framed signals using performance reportant messages (PRM) incoming from the DSX-1

DS1 Line Parameters:

- ES-L Errored Seconds (Release 3.0 and later)

## T1 Carrier Low-Speed (BBF6 T1EXT)

### ■ Electrical Specification

The T1 carrier low-speed interface (T1EXT) transmits and receives a standard electrical T1 carrier signal as specified in CB No. 113, Issue 2, April 1978. The T1EXT supports two interfaces. Line coding is provisionable to AMI with or without B8ZS. The following are specifications for the driver/receiver:

- Driver Output: 3 V peak pulse
- Receiver Gain: 35 dB maximum at 772 KH
- Receiver Dynamic Range: 0 to 35 dB (no pad at input)

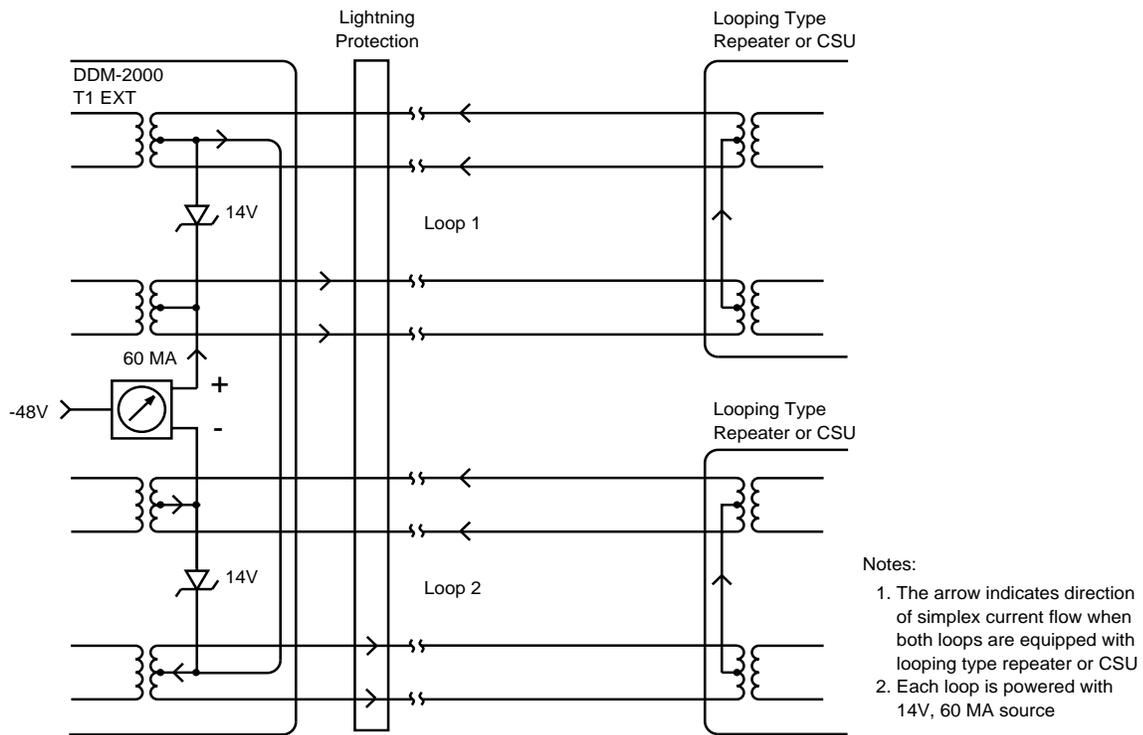
The driver/receiver does not require any special provisioning to support up to 6,000 feet of 22-gauge copper cable (at 22 degrees Celsius) used in a T-Carrier system.

The T1EXT will support a single span of the following distances:

- In a central office: up to 3000 feet ( $\pm 1500$  feet)
- In an outside plant cabinet or wall DT: up to 6,000 feet

The 60 mA constant current regulator will support a simplex loop resistance of 221 ohms.

- The T1EXT does not support fault locating using bipolar violations
- The T1EXT can interface with "looping regulator" type repeaters only
- The T1EXT does not have the capability to loop the simplex current back to a T1 line repeater
- The T1EXT does not include any components for primary or secondary lightning protection/surge protection or power cross. Primary protection (Lucent Technologies' protector unit 4B3EW or equivalent) is always required for tip/ring lines exposed to lightning and surges either in cabinet or as lines enter a building. An external secondary lightning and surge protection assembly (ED-8C783) must be collocated with the FiberReach shelf for all outside plant applications. Refer to Figure 10-1 for T1EXT span powering.



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**Figure 10-1. T1EXT Span Powering**

■ Format Specification

The T1EXT BBF6 low-speed interface can be provisioned for the following formats: clear channel (default), SF as specified in ANSI T1.403-1989, or ESF as specified in ANSI T1.403-1989. In the case of SF or ESF format selections, T1EXT performance information is collected by monitoring the associated T1EXT framing format.

■ Alarm Thresholding

The following parameters are monitored at the T1EXT interface:

- Loss of signal
- Line coding violations

The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B8ZS and AMI coding violation failure thresholds are user settable to  $10^{-7}$  or  $10^{-8}$  BER.

■ Performance Monitoring (PM) (See Table 10-22.)

- Near-end T1EXT path parameters (ES, SES, and UAS) for SF or ESF framed signals incoming to the DSX-1
- Far-end T1EXT path parameters (ES, SES, and UAS) for ESF framed signals using performance report messages (PRM) incoming from the DSX-1
- Coding violations (CV) for near-end and far-end
- T1EXT line PM monitoring and ES reporting

Refer to Chapter 6, "System Planning and Engineering," for specific engineering rules regarding T1EXT lines.

## HDSL Interface (BBF8)

- Electrical Specification

The High Bit-rate Digital Subscriber Line (HDSL) circuit pack transmits and receives a 2B1Q signal as specified in Telcordia Technologies TA-NWT-001210.

  - Data is scrambled/descrambled with a pseudo-random sequence.
  - Line buildout is automatically provisioned.
  - Compensated for data inversion caused by tip-ring reversals.
- Format Specification

The HDSL allows for clear channel transport of a framed or unframed DS1. Its data stream consists of two 78 Kb/s signals transported on separate wire pairs. Together, the aggregate bi-directional bit rate is 1.554 MB/s. The remaining 24 Kb/s is used for training and diagnostic information.

  - Compatible with *PairGain*<sup>\*</sup> equipment
- Alarm reporting
  - LOS

A LOS is reported if either HDSL line experiences a synchronization failure.
- Loopback

DS1 facility loopback for each HDSL interface
- Performance Monitoring (PM) — Available through the HDSL link management port only
  - User-configurable alarm thresholds
  - 15-minute, 24-hour, and 7-day performance histories
  - Asynchronous serial interface for provisioning and PM
- Management
  - SONET Management

This link is accessible via the SONET DCC and DDM-2000 CIT. It allows the HDSL circuit pack to be provisioned for DS1 facility loopbacks.

  - HDSL Link Management

This link is accessible via a faceplate mounted RS-232 interface. It allows management of each HDSL port only. Management of the DDM-2000 is not accessible through this interface. This management port supports a menu driven interface for each HDSL port. Managed features include:

  - PM features listed above

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\* *PairGain* is a registered trademark of PairGain Technologies, Inc.

- Local and remote loopbacks
  - Programmable loopback time-out
  - Alarm status
- Described in *PairGain* Specifications, OEM-HMO-SW1-02

## Optical Interfaces

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The DDM-2000 FiberReach Multiplexer supports either an OC-1 or OC-3 high-speed interface that is synchronous optical network (SONET) compliant. When equipped with the 26G2-U OLIU, the companion OLIU at the host node is the 27G-U OLIU. The nominal OC-1 rate is 51.84 Mb/s for these OLIUs. When equipped with the 28G-U OLIU, the OLIU on the neighboring DDM-2000 OC-3 shelf may be any 22-type OLIU, or 21-type on an OC-12 shelf.

## Lightguide Jumpers

The DDM-2000 FiberReach Multiplexer provides Lucent's universal optical connector on the OLIU. The universal optical connectors are receptacles on the faceplate of the OLIU that allow a single OLIU to support either *ST*<sup>®</sup>, FC-P, or SC connectors as needed. Both 0 dB and attenuating buildouts are supported.

The DDM-2000 OC-1/OC-3 lightguide interface uses single-mode jumpers for connecting to and from the outside plant *LGX*<sup>®</sup> panel and the DDM-2000 OC-3.

When the outside plant lightguide is single-mode, a single-mode jumper must be used for the transmit side and either single-mode or multimode jumpers can be used for the receive side of all OLIUs (except the 29-Type which requires single-mode fiber on both the transmit and receive sides due to potential optical path degradations).

The 29-Type OLIU must be used with single mode fiber.

Lightguide jumpers can be ordered from Lucent. See the appropriate "Miscellaneous and Tools" section for ordering information.

## Intra-office (IS-3) OC-3 Rate Interface (22D-U OLIUs)

- Optical Specification  
The 22D-U OLIUs are short-reach optical interfaces used to interconnect between the DDM-2000 OC-3 and OC-12 Multiplexers. The nominal line rate is 155.520 Mb/s. The LED transmitter supplies an NRZ-coded signal. Table 10-4, Table 10-5, and Table 10-8 provide detailed specifications and link budget information for the 22D-U OLIUs.
- Alarm Thresholding

The following parameters are monitored at the OC-3 interface:

- LOS
- LOF
- LOP
- Line AIS
- B2 thresholding signal fail
- B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.)
- Line PM (See Table 10-22.)
  - Section SEFS
  - B2 parameters
  - STS-1 Path PM (See Table 10-22.)

Table 10-4 lists the 22D-U OLIU specifications.

**Table 10-4. 22D-U OLIU Specifications**

<b>System Information:</b>	
Terminal Equipment Identification	22D-U OLIU
Optical Line Rate (Mb/s)	155.520 Mb/s
Optical Line Coding	Scrambled NRZ
Optical Wavelength	1310 nm
Performance	Not applicable
<b>Transmitter Information:</b>	
Optical Device Temperature Controller	No TEC
FDA Classification	Class I
Optical Source	LED
Faceplate Optical Connector	UOC buildout assembly * Multimode
<b>Receiver Information:</b>	
Optical Device Temperature Controller	None
Optical Detector	InGaAsP PIN
Faceplate Optical Connector	UOC buildout assembly * Multimode

**Note:**

\* The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, *SC*, or *FC*-type connectors.

**Table 10-5. 22D-U OLIU Link Budgets (Note 1)**

Parameter	22D-U
Minimum Wavelength ( $\lambda_{Tmin}$ )	1270/1260* nm
Maximum Wavelength ( $\lambda_{Tmax}$ )	1380 nm
Spectral Width ( $\delta\lambda_{rms}$ )	170 nm †
Maximum Transmitter Power ( $P_{Tmax}$ )	-14.0 dBm
Minimum Transmitter Power ( $P_{Tmin}$ )	-18.8/-21.8 dBm
Maximum Received Power ( $P_{Rmax}$ )	-14.0 dBm
Minimum Received Power ( $P_{Rmin}$ )	-33.8/-31.8* dBm
Minimum System Gain (S-R)‡	15/10.0* dB
Optical Path Penalty ( $P_O$ )§	1.6 dB
Connector Loss¶	1.5 dB
Unallocated Margin**	2.0 dB
Minimum Loss Budget	0.0 dB
Maximum Loss Budget††	9.9/4.9* dB
Maximum Span Length†††	(Note 2)

**Notes:**

1. All terminology is consistent with GR-253, Issue 2. All specifications for the 22D OLIU meet or exceeds intermediate reach (IR) values described in GR-253, Iss. 2.
  2. Multimode only (See Table 10-8.).
- \* When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions.
- † Full width at half maximum (FWHM) spectral width.
- ‡ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.
- § Optical path penalty includes effects of dispersion, reflection, and jitter that occur on the optical path.

**Table 10-5. 22D-U OLIU Link Budgets (Continued)**

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- ¶ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.
- \*\* Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.
- †† Budget available for both station and transmission cable and splices.
- ‡‡ Attenuation and dispersion can be the limiting factors in span length. For OC-3 single-mode fiber systems, dispersion is not a factor and all applications are attenuation limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

### **Intermediate Reach OC-3 Interface (22F/22F-U/ 22F2-U OLIU)**

- **Optical Specification**

The 22F/22F-U/22F2-U OLIU photonics meet or exceed SONET intermediate reach specifications (GR 253-IR-1 MLM category). The MLM laser transmitter supplies an NRZ-coded signal. The PINFET receiver allows direct optical loopback without the use of an external attenuator.

The 22F/22F-U/22F2-U OLIU intermediate reach OC-3 interface supports span lengths up to 33 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 10-7. Transmit and receive powers are referenced to Points S and R as shown in Figure 10-2. Table 10-6, Table 10-7, and Table 10-8 provide detailed specifications and link budget information for the 22F OLIU.

- **Alarm Thresholding**

The following parameters are monitored at the OC-3 interface.

- LOS
  - LOF
  - LOP
  - Line AIS
  - B2 thresholding signal fail
  - B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.)
- **Line PM (See Table 10-22.)**
    - Section SEFS
    - Line parameter B2
    - STS pointer justification
    - STS-1 Path PM (See Table 10-22.)

### **Long Reach OC-3 Interface (22G-U/22G2-U/ 22G3-U OLIU)**

- **Optical Specification**

The multilongitudinal mode laser transmitter supplies an NRZ-coded signal. For direct optical loopbacks, at least 7.0 dB (use 10 dB attenuator, see Table 10-20) of attenuation is needed for the 22G-U. No attenuation is needed for the 22G2-U or 22G3-U.

The 22G-U/22G2-U OLIU long reach OC-3 interface supports span lengths up to 51 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 10-7. Transmit and receive powers are referenced to Points S and R. Table 10-6, Table 10-7, and Table 10-8 provide detailed specifications and link budget information for the 22G-U/22G2-U OLIU.

The 22G3-U OLIU is a SONET compliant long reach OC-3 interface supporting span lengths up to 55 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 10-7. Transmit and receive powers are referenced to Points S and R. Table 10-6, Table 10-7, and Table 10-8 provide detailed specifications and link budget information for the 22G3-U OLIU.

- **Alarm Thresholding**

The following parameters are monitored at the OC-3 interface.

- Loss of signal (LOS)
- Loss of frame (LOF)
- Loss of pointer (LOP)
- Line AIS
- B2 thresholding signal fail
- B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.)

- **Line PM (See Table 10-22.)**

- Section SEFS
- Line parameter B2
- STS pointer justifications
- STS-1 Path PM (See Table 10-22.)

Table 10-6 lists the 22F/22F-U/22F2-U, 22G-U, 22G2-U and 22G3-U OLIU specifications.

**Table 10-6. 22F/22F-U/22F2-U, 22G-U/22G2-U, and 22G3-U OLIU Specifications**

<b>System Information:</b>			
Terminal Equipment Identification	22F/22F-U/22F2-U OLIU	22G-U/22G2-U OLIU	22G3-U OLIU
Optical Line Rate (Mb/s)	155.520 Mb/s	155.520 Mb/s	155.520 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ	Scrambled NRZ
Optical Wavelength	1310 nm	1310 nm	1310 nm
Performance	SONET IR-1 MLM (Intermediate Reach)	Not applicable	SONET LR- (Long Reach)
<b>Transmitter Information:</b>			
Optical Device Temperature Controller	No TEC	No TEC	No TEC
FDA Classification	Class I	Class I	Class I
Optical Source	InGaAsP Laser, MLM Structure *	InGaAsP Laser, MLM Structure *	InGaAsP Laser, MLM Structure *
Faceplate Optical Connector	Lucent <i>ST</i> <sup>®</sup> C3000-A-2 (22F) UOC buildout assembly † (22F-U/22F2-U) Single Mode	UOC buildout assembly † Single Mode	UOC buildout assembly † Single Mode
<b>Receiver Information:</b>			
Optical Device Temperature Controller	None	None	None
Optical Detector	InGaAsP PIN	InGaAsP PIN (22G-U) InGaAs PIN (22G2-U)	InGaAs PIN
Faceplate Optical Connector	Lucent <i>ST</i> <sup>®</sup> C2000-A-2 (22F) UOC buildout assembly † (22F-U/22F2-U) Multimode	UOC buildout assembly † Multimode	UOC buildout assembly † Multimode

**Notes:**

\* A tighter specification DFB laser (part #1243TAF A) may be supplied instead of the MLM laser. The DFB laser meets all the requirements of the MLM laser and DFB requirements in GR-253-CORE, Issue 2, December 1995.

† The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, *SC*, or *FC*-type connectors.

**Table 10-7. 22F/22F-U/22F2-U, 22G-U, 22G2-U, and 22G3-U OLIU Link Budgets (Note 1)**

Parameter	22F/22F-U/ 22F2-U	22G-U	22G2-U	22G3-U*
Minimum Wavelength ( $\lambda_{Tmin}$ )	1260 nm	1272 nm	1272 nm	1280 nm
Maximum Wavelength ( $\lambda_{Tmax}$ )	1360 nm	1350 nm	1350 nm	1335 nm
Spectral Width ( $\delta\lambda_{rms}$ )	7.7 nm	3.0 nm	3.0 nm	4.0 nm
Maximum Transmitter Power* ( $P_{Tmax}$ )	-8.0 dBm	0.0 dBm	0.0 dBm	0.0 dBm
Minimum Transmitter Power ( $P_{Tmin}$ )	-15.0 dBm	-7.0 dBm	-7.0 dBm	-5.0 dBm
Maximum Received Power ( $P_{Rmax}$ )	-7.0 dBm	-7.0 dBm	0.0 dBm	0.0 dBm
Minimum Received Power ( $P_{Rmin}$ )	-34.0 dBm	-34.0 dBm	-34.0 dBm	-34.0 dBm
Minimum System Gain (S-R)‡	19.0 dB	27.0 dB	27.0 dB	29.0 dB
Optical Path Penalty ( $P_O$ )§	1.0 dB	1.0 dB	1.0 dB	1.0 dB
Connector Loss¶	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Unallocated Margin**	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Minimum Loss Budget	0.0 dB	7.0 dB	0.0 dB	0.0 dB
<b>Maximum Loss Budget‡‡</b>	<b>15.0 dB</b>	<b>23.0 dB</b>	<b>23.0 dB</b>	<b>25.0 dB</b>
Maximum Span Length§§	33 km	51 km	51 km	55 km

**Notes:**

1. All terminology is consistent with GR-253, Issue 2. All specifications for the 22F OLIU meet or exceeds intermediate reach (IR) values described in GR-253, Iss. 2.
- \* The 22G3-U OLIU is fully compliant with SONET long reach applications. It is fully compatible with the 22F-type, 22G-U, and 22G2-U OLIUs and will replace them.
- † Transmit and receive powers are referenced to points S and R.
- ‡ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

**Table 10-7. 22F/22F-U/22F2-U, 22G-U, and 22G2-U OLIU Link Budgets (Continued)**

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- § Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path.
- ¶ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.
- \*\* Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.
- ‡‡ Budget available for both station and transmission cable and splices.
- §§ Attenuation and dispersion can be the limiting factors in span length. For OC-3 single-mode fiber systems, dispersion is not a factor and all applications are attenuation limited. For OC-12 systems, the maximum distance could be either attenuation limited or dispersion limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

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**Table 10-8. OC-3 OLIU Link Budget - Multimode Operation**

Fiber Bandwidth	Maximum Span Length (km)		
	22F/22F-U/ 22F2-U (Note 2)	22G/22G-U/ 22G2-U/ 22G3-U (Note 4)	28G-U
1000 MHz-km	6.5	6.5	6.5
800 MHz-km	5.1	5.1	5.1
500 MHz-km	3.1	3.1	3.1
300 MHz-km	1.8	1.8	1.8

**Notes:**

1. Maximum 22F-type MM Link Budget (dB) for multimode operation is 12.0 dB.
2. The 22G3-U will replace the 22F-type and the 22G/22G-U and 22G2-U OLIUs

The system is dispersion limited for all the fiber bandwidths listed in Table 10-8.

Multimode fiber operation on the DDM-2000 OC-3 Multiplexer requires a minimum exit bandwidth of 120 MHz to ensure that dispersion loss is kept below acceptable levels. If the fiber is already installed and the exit bandwidth is measured to be 120 MHz or greater, then the maximum link budget values (see Notes 1 and 2) can be used to determine if the loss budget is sufficient for that fiber.

If planning a new fiber installation, the values at the end of the table, given for a number of commercially available fiber bandwidth-distance products, can be used. Fiber distances are calculated using the 120 MHz exit bandwidth limit; however, actual exit bandwidths may be higher for these distances due to the existence of splices. This may permit longer span lengths to be achieved, for the given fiber bandwidths, than those specified in the table. In this case, however, the span length can only be increased to the point where the system is loss limited as specified by the maximum multimode link budget given in the table (1 dB/km cable is assumed).

## Long Reach OC-1 Interface (26G2-U OLIU)

### ■ Optical Specification

The multilongitudinal mode laser transmitter supplies a non-return to zero (NRZ)-coded signal. For direct optical loopbacks, at least 7.0 dB (use 10 dB of attenuation) is needed for the 26-type.

The 26-type OLIU long reach OC-1 interfaces support span lengths up to 44 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 10-11. Transmit and receive powers are referenced to Points S and R as shown in Figure 10-2. Table 10-9 and Table 10-10 provide detailed specifications and link budget information for the 26-type OLIU.

### ■ Alarm Thresholding

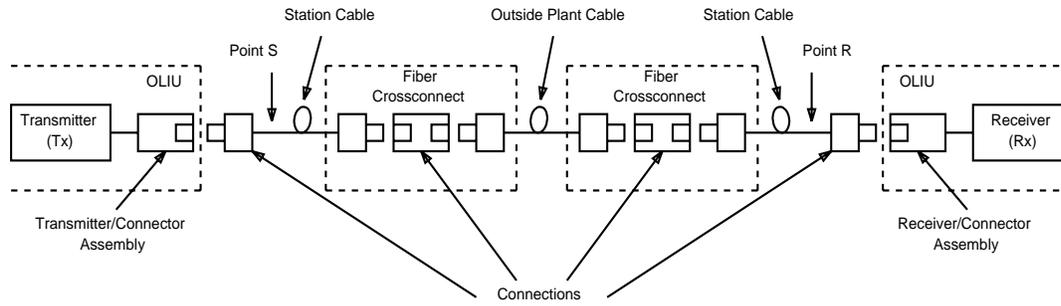
The following parameters are monitored at the OC-1 interface:

- Loss of signal
- Loss of frame
- Loss of pointer
- Line AIS
- B2 thresholding signal fail
- B2 thresholding signal degrade

B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.

### ■ Performance Monitoring (See Table 10-22.)

- Section severely errored frame seconds (SEFS)
- Line parameter B2



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**Figure 10-2. Optical System Interfaces (Points S and R)**

Table 10-9 lists the 26G2-U OLIU specifications.

**Table 10-9. 26G2-U OLIU Specifications**

<b>System Information:</b>	
Terminal Equipment Identification	26-type OLIU
Optical Line Rate (Mb/s)	51.84 Mb/s
Optical Line Coding	Scrambled NRZ
Optical Wavelength	1310 nm
Performance	Not applicable
<b>Transmitter Information:</b>	
Optical Device Temperature Controller	No TEC
FDA Classification	Class I
Optical Source	InGaAsP Laser, MLM Structure*
Faceplate Optical Connector	UOC buildout assembly <sup>†</sup> Single Mode
<b>Receiver Information:</b>	
Optical Device Temperature Controller	None
Optical Detector	InGaAsP PIN
Faceplate Optical Connector	UOC buildout assembly* Multi-Mode

\* A tighter specification DFB laser (part #1243TAFA) may be supplied instead of the MLM laser. The DFB laser meets all the requirements of the MLM laser and DFB requirements in GR-253-CORE, Issue 2, December 1995.

† The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either S7<sup>®</sup>, SC, or FC-type connectors. FC-type connectors are not available for multimode cabling.

Table 10-10 and Table 10-11 list the link budgets for the 26-type OLIU circuit packs.

**Table 10-10. 26G2-U OLIU Link Budgets (Note 1)**

Parameter	Value
Minimum Wavelength ( $\lambda_{Tmin}$ )	1272 nm
Maximum Wavelength ( $\lambda_{Tmax}$ )	1350 nm
Spectral Width ( $\delta \lambda_{rms}$ )	3.0 nm
Maximum Transmitter Power ( $P_{Tmax}$ ) *	-0.0 dBm
Minimum Transmitter Power ( $P_{Tmin}$ ) *	-7.0 dBm
Maximum Received Power ( $P_{Rmax}$ )	-13.8 dBm
Minimum Input Power ( $P_{Rmin}$ )	-30.8 dBm
Minimum System Gain (S-R) ‡	23.8 dB
Optical Path Penalty ( $P_o$ ) †	1.0 dB
Connector Loss ‡	1.5 dB
Unallocated Margin	1.5 dB
Minimum Loss Budget	13.8 dB
Maximum Loss Budget	19.8 dB
Maximum Span Length §	44 km

**Notes:**

1. All values are for both controlled and uncontrolled environmental conditions.
- \* Transmit and receive powers are referenced to points S and R as shown in Figure 10-2.
- † Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path.
- ‡ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.
- § The 26G2-U OLIUs are dispersion limited at 44 km, due to the wider wavelength range. Assuming fiber with zero dispersion wavelength between 1300 and 1320 nm, the worst case dispersion over the transmitter wavelength range of 1272 to 1350 nm is 4.88 psec/nm km. This implies a 44 km span would have a total dispersion of about 215 psec/nm.

**Table 10-11. 26G2-U OLIU Link Budgets — Multimode Operation (Note)**

Fiber Bandwidth	Maximum Span Length (km)
1000 MHz-km	19.8
800 MHz-km	19.8
500 MHz-km	19.8
300 MHz-km	13.6

**Note:** The maximum Link Budget loss is 19.8 dB

Multimode fiber operation requires a minimum exit bandwidth of 44 MHz to ensure that dispersion loss is kept below acceptable levels. If the fiber is already installed and the exit bandwidth is measured to be 44 MHz or greater, then the maximum link budget values can be used to determine if the loss budget is sufficient for that fiber.

If planning a new fiber installation, the values given in the table (given for a number of commercially available fiber bandwidth-distance products) can be used. Fiber distances are calculated using the 44 MHz exit bandwidth limit; however, actual exit bandwidths may be higher for these distances due to the existence of splices. This may permit longer span lengths to be achieved for the given fiber bandwidths than those specified in the table. In this case, however, the span length can only be increased to the point where the system is loss limited as specified by the maximum multimode link budget given in the table (1 db/km cable is assumed).

## Long Reach OC-3 Interface (28G-U OLIU)

### ■ Optical Specification

The multilongitudinal mode laser transmitter supplies a non-return to zero (NRZ)-coded signal. For direct optical loopbacks, no attenuations are needed for the 28-type.

The 28-type OLIU long reach OC-3 interface supports span lengths up to 51km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 10-13. Transmit and receive powers are referenced to Points S and R as shown in Figure 10-2. Table 10-12 and Table 10-13 provide detailed specifications and link budget information for the 28-type OLIU.

### ■ Alarm Thresholding

The following parameters are monitored at the OC-3 interface:

- Loss of signal
- Loss of frame
- Loss of pointer
- Line AIS
- B2 thresholding signal fail
- B2 thresholding signal degrade

B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.

### ■ Performance Monitoring (See Table 10-22.)

- Section severely errored frame seconds (SEFS)
- Line parameter B2

**Table 10-12. 28G-U OLIU Specifications**

<b>System Information:</b>	
Terminal Equipment Identification	28-type OLIU
Optical Line Rate (Mb/s)	155.520 Mb/s
Optical Line Coding	Scrambled NRZ
Optical Wavelength	1280-1335 nm
Performance	Not applicable
<b>Transmitter Information:</b>	
Optical Device Temperature Controller	None
FDA Classification	Class I
Optical Source	InGaAsP Laser, SLM Structure
Faceplate Optical Connector	UOC buildout assembly* Single Mode
<b>Receiver Information:</b>	
Optical Device Temperature Controller	None
Optical Detector	InGaAsP PIN
Faceplate Optical Connector	UOC buildout assembly* Multi-Mode

\* The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *S7*<sup>®</sup>, SC, or FC-type connectors. FC-type connectors are not available for multimode cabling.

Table 10-13 lists the link budgets for the 28-type OLIU.

**Table 10-13. 28G-U OLIU Link Budgets (Note 1)**

Parameter	Value
Minimum Wavelength ( $\lambda_{Tmin}$ )	1280 nm
Maximum Wavelength ( $\lambda_{Tmax}$ )	1335 nm
Spectral Width ( $\delta \lambda_{rms}$ )	4.0 nm
Maximum Transmitter Power ( $P_{Tmax}$ )	0.0 dBm
Minimum Transmitter Power ( $P_{Tmin}$ )	-5.0 dBm
Maximum Received Power ( $P_{Rmax}$ )	0.0 dBm
Minimum Input Power ( $P_{Rmin}$ )	-34.0 dBm
Minimum System Gain (S-R) *	29.0 dB
Optical Path Penalty ( $P_o$ ) †	1.0 dB
Connector Loss‡	1.5 dB
Unallocated Margin**	1.5 dB
Minimum Loss Budget	0.0 dBm
Maximum Loss Budget	25.0 dB
Maximum Span Length§	55 km

**Notes:**

1. All terminology is consistent with GR-253, Issue 2. All specifications for 28G-U OLIU meets or exceeds long reach long reach (LR) values described in GR-253, Iss. 2.
- \* One connector (0.75) on each end is assumed to connect station cable to outside plant.
- † Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path
- ‡ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-100 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

- § Attenuation and dispersion can be the limiting factors in span length. For OC-3 single-mode fiber systems, dispersion is not a factor and all applications are attenuation limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems is 0.45 dB/km. This estimate includes typical value loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber.
- \*\* Unallocated margin, or safety margin, is typically specified from 0 dB to 3dB.

### **Long Reach OC-12 Interface (29G-U OLIU)**

- **Optical Specification**

The distributed feedback laser supplies an NRZ-coded signal. For direct optical loopbacks, at least 10 dB of optical attenuation is needed for the 29G-U.

The 29G-U OLIU long reach OC-12 interface supports span lengths up to 51 km, assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 10-15. Transmit and receive powers are referenced to points S and R as shown in Figure 10-3. Table 10-14 and Table 10-15 provide detailed specifications and link budget information for the 29G-U OLIU. Note that the 29G-U OLIU is not specified to operate over multimode fiber.

- **Alarm Thresholding**

The following parameters are monitored at the OC-12 interface.

- Loss of signal (LOS)
- Loss of frame (LOF)
- Loss of pointer (LOP)
- Line AIS
- B2 thresholding signal fail
- B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.)

- **Performance Monitoring**

- Section SEFS
- Line parameter B2
- STS pointer justifications

## Long Reach OC-12 Interface (29H-U OLIU)

### ■ Optical Specification

The distributed feedback laser supplies a NRZ-coded signal. For direct optical loopbacks, at least 10 dB of optical attenuation is needed for the 29H-U.

The 29H-U OLIU long reach OC-12 interface supports span lengths up to 96 km, assuming 0.25 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 10-15. Transmit and receive powers are referenced to points S and R as shown in Figure 10-3. Table 10-14 and Table 10-15 provide detailed specifications and link budget information for the 29H-U OLIU. Note that the 29H-U OLIU is not specified to operate over multimode fiber.

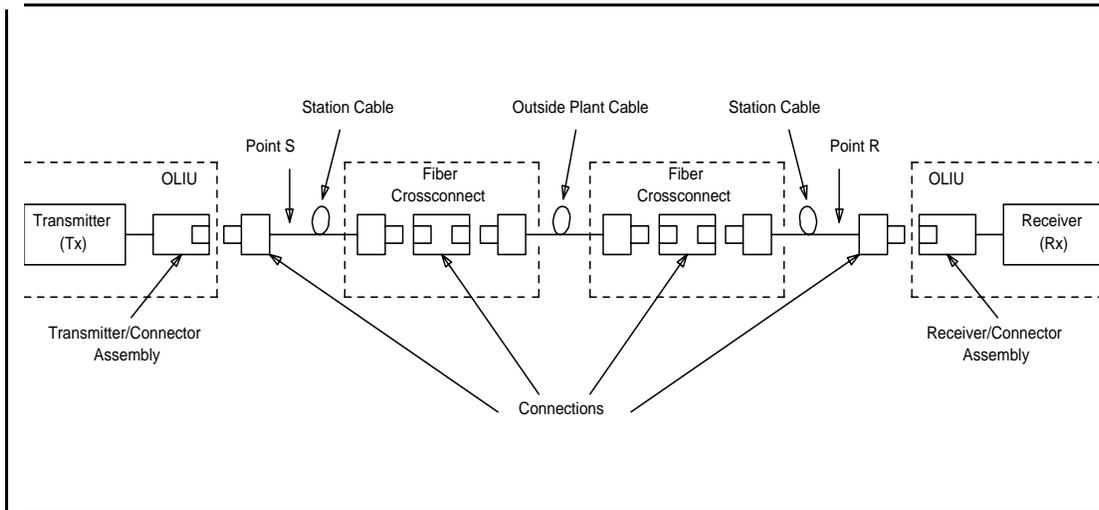
### ■ Alarm Thresholding

The following parameters are monitored at the OC-12 interface.

- Loss of signal (LOS)
- Loss of frame (LOF)
- Loss of pointer (LOP)
- Line AIS
- B2 thresholding signal fail
- B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from  $10^{-5}$  to  $10^{-9}$  BER.)

### ■ Performance Monitoring

- Section SEFS
- Line parameter B2
- STS pointer justifications



**Figure 10-3. Optical System Interfaces (Points S and R)**

**Table 10-14. 29G-U/29H-U OLIU Specifications**

<b>System Information:</b>	<b>29G-U</b>	<b>29H-U</b>
Terminal Equipment Identification	29G-U OLIU	29H-U OLIU
Optical Line Rate (Mb/s)	622.080 Mb/s	622.080 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ
Optical Wavelength (nm)	1310 nm	1550 nm
Performance	SONET LR-1 DFB (Long Reach)	SONET LR-1 DFB (Long Reach)
<b>Transmitter Information:</b>		
Optical Device Temperature Controller	None	None
FDA Classification	Class I	Class I
Optical Source	InGaAsP Laser, SLM Structure	InGaAsP Laser, SLM Structure
Faceplate Optical Connector	UOC Buildout Assembly (single-mode) *	UOC Buildout Assembly (single-mode) *
<b>Receiver Information:</b>		
Optical Device Temperature Controller	None	None
Optical Detector	InGaAs PIN	InGaAs PIN
Faceplate Optical Connector	UOC Buildout Assembly (multi-mode) *	UOC Buildout Assembly (multi-mode) *

\* The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either ST, SC, or FC-type connectors.

**Table 10-15. 29G-U/29H-U OLIU Link Budgets (Notes)**

Parameter	29G-U	29H-U
Minimum Wavelength ( $\lambda_{Tmin}$ )	1280 nm	1530 nm
Maximum Wavelength ( $\lambda_{Tmax}$ )	1335 nm	1570 nm
Spectral Width ( $\delta\lambda_{20}$ )	1.0 nm	1.0 nm
Maximum Transmitter Power *( $P_{Tmax}$ )	+1.9 dBm	+2.0 dBm
Minimum Transmitter Power ( $P_{Tmin}$ )	-2.5 dBm	-2.5 dBm
Maximum Received Power ( $P_{Rmax}$ )	-8.0 dBm	-8.0 dBm
Minimum Received Power ( $P_{Rmin}$ )	-30.5 dBm	-31.0 dBm
Minimum System Gain (S-R) †	28.0 dB	28.5 dB
Optical Path Penalty ( $P_O$ ) ‡	1.0 dB	1.0 dB
Connector Loss §	1.5 dB	1.5 dB
Unallocated Margin ¶	1.5 dB	2.0 dB
Minimum Loss Budget **	8.0 dB	10.0 dB
<b>Maximum Loss Budget ††</b>	<b>24.0 dB</b>	<b>24.0 dB</b>
Maximum Span Length ‡‡	51 km	96 km

**Notes:**

1. All terminology is consistent with TR-253, Iss. 2. All values are worst-case end of life.
  2. All specifications for the 29G-U/29H-U meet or exceed long reach (LR) values described in TR-253, Iss. 2.
- \* Transmit and receive powers are referenced to points S and R as shown in Figure 10-3.
- † The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.
- ‡ Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path. The 29G-U has 4.0 dB of total margin. Optical path penalty is normally 1.0 dB. The 29H-U has 4.5 dB of total margin. Optical path penalty is normally 1.0 dB, which implies 1800 psec/nm total dispersion. Typical nondispersion fiber has 10 psec/nm km dispersion in the 1550 nm wavelength range.
- § One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

- ¶ Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.
- \*\* The 29G-U/29H-U requires an external lightguide buildout as part of the connector assembly for loopbacks and for loss budgets less than 10 dB.

†† Budget available for both station and transmission cable and splices.

‡‡ Attenuation can be the limiting factors in span length. A rough rule of thumb for attenuation-limited systems operating in the 1310 nm wavelength range is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber in the 1310 nm range.

For the 29G-U, the maximum distance is not dispersion limited because single longitudinal mode laser is used. Given the attenuation assumption, the maximum span length for the 29G-U is 51 km.

Attenuation can be the limiting factors in span length. A rough rule of thumb for attenuation-limited systems operating in the 1550 nm wavelength range is 0.25 dB/km, including cable and splice loss.

For the 29H-U, the maximum distance is not dispersion limited because single longitudinal mode laser is used. Given the attenuation assumption, the maximum span length for the 29H-U is 96 km.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

### OC-3 Optical Interface Mixing

Mixing different OC-3 rate OLIUs at opposite ends of an optical link is often necessary for technical reasons or for convenience. The following information will aid in planning and engineering optical links having different types of OC-3 rate OLIUs at each end of the fiber. Table 10-16 details the minimum link budget necessary for each pairing of OC-3 rate OLIUs.

To use Table 10-16, locate the number at the intersection of the transmitter/receiver pair of interest. This number is the minimum attenuation necessary for proper operation of that transmitter/receiver pair. The link must have at least this much attenuation either from fiber loss, splice loss, connector loss, external attenuators, or a combination of these, or the receiver will be overdriven and the link will not operate properly.

**Table 10-16. OC-3 Rate OLIU Mixes - Minimum Link Budgets (dB)**

Transmitter	Receiver					
	22F	22F-U/ 22F2-U	22G-U	22G2-U/ 22G3-U	21D/21D-U/ 22D-U (Ctrl'd/ Unctrl'd Env.)	28G-U
22F	0.0	0.0	0.0	0.0	6.0	0.0
22F-U/22F2-U	0.0	0.0	0.0	0.0	6.0	0.0
22G-U	7.0	0.0	7.0	0.0	14.0	0.0
22G2-U/ 22G3-U	7.0	0.0	7.0	0.0	14.0	0.0
28G-U	7.0	0.0	7.0	0.0	14.0	0.0

Note that the minimum link budget is not always symmetrical. A transmitter/receiver pair may have one minimum link budget in one direction and another in the opposite direction. Be careful of this asymmetry when planning and engineering a link having mixed OLIUs.



**NOTE:**

When using universal optical buildout attenuators for OLIUs equipped with Universal Optical Connectors (for example, 28G-U and 22D-U), the buildout must have the same type fiber on both sides, that is, single-mode to single-mode or multimode to multimode. The buildout must also match the mode of the fiber. Therefore, when a single-mode jumper is used, the buildout would be on the transmit side (OUT) of the OLIU and when a multimode jumper is used, the buildout would be on the receive side (IN) of the OLIU. When using in-line attenuators for non-U OLIUs, place the attenuator in the bay frame PANDUIT. Make sure that the mode type of the attenuator matches the mode of the fiber to ensure proper attenuation.

Table 10-17 details the maximum link budgets for each pairing of OC-3 rate OLIUs when operating on single-mode (SM) fiber. These numbers give the maximum attenuation acceptable for proper operation of each transmitter/receiver pair. The link must have no more than this much attenuation either from fiber loss, splice loss, connector loss, external attenuators or a combination of these or the link will not operate properly. The maximum link budgets for SM fiber were calculated using the following margins:

- Optical Path Penalty (dB) 1.0
- Connector Loss (dB) 1.5

**Table 10-17. OC-3 Rate OLIU Mixes - Maximum Link Budgets for SM Fiber (dB)**

---

Transmitter	Receiver		
	22E, 22F-U, 22F2-U	22G-U/ 22G2-U/ 22G3-U	28G-U
22F	15.0	15.0	15.0
22G-U/22G2-U	23.0	23.0	23.0
22G3-U	25.0	25.0	25.0
28G-Type	25.0	25.0	25.0



**NOTE:**

The maximum link budget is not always symmetrical. A transmitter/receiver pair may have one maximum link budget in one direction and another in the opposite direction. For example, a 28G-U OLIU transmitting to a 22F OLIU has a maximum SM link budget of 25.0 dB. In the opposite direction, though, a 22F OLIU transmitting to a 28G-U OLIU has a maximum SM link budget of 15.0 dB. Be careful of this asymmetry when planning and engineering a link having mixed OLIUs. Note also that the 22D-U OLIUs will not operate when transmitting into single-mode fiber.

Table 10-18 details the maximum link budgets for each pairing of OC-3 rate OLIUs when operating on multimode (MM) fiber. These numbers give the maximum attenuation acceptable for proper operation of each transmitter/receiver pair. The link must have no more than this much attenuation either from fiber loss, splice loss, connector loss, external attenuators or a combination of these or the link will not operate properly. The maximum link budgets for MM fiber were calculated using the following margins. The first column of margins applies to any link where there is at least one OC-3 OLIU (28G-U, 22F or 22G-U/22G2-U/22G3-U). The second column of margins applies to links having two IS-3 (22D-U) OLIUs.

	<b>At Least One OC-3 OLIU</b>	<b>IS-3 OLIUs Only</b>
MM Optical Path Penalty (dB)	4.0	1.6
Connector Loss (dB)	1.5	1.5
Unallocated Margin (dB)	1.5	2.0

**⇒ NOTE:**  
 The maximum link budget is not always symmetrical. A transmitter/receiver pair may have one maximum link budget in one direction and another in the opposite direction. For example, a 28G-U transmitting to a 22F has a maximum MM link budget of 22.0 dB. In the opposite direction, though, a 22F transmitting to a 28G-U has a maximum MM link budget of 12.0 dB. Be careful of this asymmetry when planning and engineering a link having mixed OLIUs.

**Table 10-18. OC-3 Rate OLIU Mixes—Maximum Link Budgets for MM Fiber (dB)**

<b>Transmitter</b>	<b>Receiver</b>		
	<b>22F/ 22F-U/ 22F2-U</b>	<b>22G-U/ 22G2-U/ 22G3-U</b>	<b>28G-U</b>
22F/22F-U/22F2-U	12.0	12.0	12.0
22G-U*/22G2-U 22G3-U	20.0 22.0	20.0 22.0	20.0 22.0
28G-U	22.0	22.0	22.0

## Plug-In Maintenance Sparing Guidelines

Table 10-19 provides a guideline for determining the number of DDM-2000 FiberReach plug-in spares needed for a given number of plug-ins in the field. The sparing guide serves as an initial estimate and is calculated with the following assumptions:

- The method for calculating spares follows the procedure described in Telcordia Technologies SR-TSY-000385, Issue 1.
- The steady-state failure rate is assumed. Failure rates are based on the reliability prediction procedure (RPP) method described in TR-TSY-000332, Issue 3.
- The spare availability objective (SAO) is 99 percent. The SAO is the long-term probability that a spare plug-in is available when it is needed.
- A no-trouble-found (NTF) factor of 1.67 is multiplied to the failure rate. This accounts for replacements of plug-ins when actually no failure has occurred. The NTF factor is expected to approach 1.25 as the product matures. The likelihood of an NTF decreases as the product matures, and sparing needs will therefore diminish over time.
- Turnaround time of a returned plug-in is two weeks.

**Table 10-19. Sparing Guidelines**

SAO = 99%

DDM-2000 OC-3 and OC-12, FiberReach

NTF factor = 1.67

Turn around time(weeks) = 2

Turn around time(hours) = 336

Plug-In Code (FIT)	Number of Spares						Revised Date
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6	
	<b>NRT</b>						
	<b>0.14</b>	<b>0.43</b>	<b>0.82</b>	<b>1.27</b>	<b>1.78</b>	<b>2.3</b>	
BBF1 (745)	335	1029	1962	3038	4258	5502	
BBF1B (859)	290	892	1701	2635	3693	4772	09/02/1998
BBF2 (2739)	91	280	534	826	1158	1497	
BBF2B (2311)	108	332	632	979	1373	1774	
BBF2C (2345)	106	327	623	965	1353	1748	08/24/1999
BBF3 (1310)	190	585	1116	1728	2422	3129	09/02/1998
BBF3B (1235)	202	621	1183	1833	2569	3319	09/02/1998

Plug-In Code (FIT)	Number of Spares						Revised Date
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6	
	<b>NRT</b>						
	<b>0.14</b>	<b>0.43</b>	<b>0.82</b>	<b>1.27</b>	<b>1.78</b>	<b>2.3</b>	
BBF4 (2345)	106	327	623	965	1353	1748	08/24/1999
BBF6 (1427)	175	537	1024	1586	2223	2872	09/02/1998
BBF8 (5216)	48	147	280	434	608	786	09/02/1998
BBF9 (2037)	122	376	717	1111	1557	2012	08/24/1999
BBF10 (2277)	110	337	642	994	1393	1800	08/24/1999
BBG1 (4917)	51	156	297	460	645	834	
BBG2 (902)	277	850	1620	2509	3517	4544	
BBG2B (820)	304	935	1782	2760	3869	4999	08/24/1999
BBG3 (1088)	229	704	1343	2080	2916	3767	
BBG4 (902)	277	850	1620	2509	3517	4544	09/02/1998
BBG4B (1056)	236	726	1384	2143	3004	3882	09/02/1998
BBG5 (5284)	47	145	277	428	600	776	
BBG6 (2193)	114	349	666	1032	1447	1869	
BBG7 (3433)	73	223	426	659	924	1194	
BBG8 (4505)	55	170	324	502	704	910	09/02/1998
BBG8B (4442)	56	173	329	510	714	923	09/02/1998
BBG9 (4084)	61	188	358	554	777	1004	08/24/1999
BBG10 (4409)	57	174	331	513	719	930	08/24/1999
BBG11 (3144)	79	244	465	720	1009	1304	
BBG12 (2586)	96	296	565	875	1227	1585	
BBG19 (729)	342	1051	2005	3105	4351	5623	09/02/1998
BBG20 (6550)	38	117	223	346	484	626	11/06/1997
BCP1 (5050)	49	152	289	448	628	812	
BCP2 (2922)	85	262	500	775	1086	1403	
BCP3 (2692)	93	285	543	841	1178	1523	
BCP4 (10000)	25	77	146	226	317	410	
21D (1959)	127	391	746	1155	1619	2092	
21D-U (1355)	184	566	1078	1670	2341	3025	08/24/1999
21G (6348)	39	121	230	357	500	646	
21G-U (3935)	63	195	371	575	806	1042	

Plug-In Code (FIT)	Number of Spares						Revised Date
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6	
	NRT						
	0.14	0.43	0.82	1.27	1.78	2.3	
21G2-U (4087)	61	188	358	554	776	1003	08/24/1999
21G3-U (1768)	141	433	827	1280	1794	2318	08/24/1999
22D-U (1959)*	127	391	746	1155	1619	2092	08/24/1999
22F (3317)	75	231	441	682	956	1236	
22F2-U (2033)	123	377	719	1113	1560	2016	09/02/1998
22G-U (2880)*	87	266	507	786	1101	1423	
22G2-U (2197)	114	349	665	1030	1444	1866	09/02/1998
22G3-U (4078)	61	188	358	555	778	1005	08/24/1999
22G4-U (1426)*	175	537	1025	1587	2225	2874	08/24/1999
23G (10029)	25	76	146	226	316	409	
23G-U (9023)	28	85	162	251	352	454	
23H (12836)	19	60	114	176	247	319	
23H-U (11552)	22	66	127	196	275	355	
23R (8364)	30	92	175	271	379	490	
23R-U (9807)	25	78	149	231	323	418	
23S (11470)	22	67	127	197	277	357	
24G-U (2080)*	120	368	703	1088	1525	1971	08/24/1999
24H-U (2388)	104	321	612	948	1328	1716	08/24/1999
26G-U (2468)	101	311	592	917	1285	1661	
26G2-U (2525)	99	303	579	896	1256	1623	08/24/1999
27G-U (3176)	79	241	460	713	999	1291	
27G2-U (2823)	88	271	518	802	1124	1452	08/24/1999
28G-U (3860)	65	199	379	586	822	1062	09/02/1998
29G-U (3264)*	76	235	448	693	972	1256	12/22/1999
29H-U (3049)*	82	251	479	742	1040	1344	12/28/1999

\* These OLIU circuit packs are equipped with a factory installed, removable SC-type buildout lightguide connector. Two 0 dB S7<sup>®</sup> connectors are shipped loose with the circuit pack.

Example:

- For the 22F, if circuit pack population is between 76 and 231, number of recommended spares is 2.

## Universal Optical Connectors

The DDM-2000 FiberReach Multiplexers provide Lucent's universal optical connector on the OLIUs. This connector is a 2-part connector consisting of a faceplate-mounted block and an optical buildout. The faceplate block optionally supports an *ST*, *SC*, or *FC*-type optical buildout.

A 0 db *ST*-type connector is shipped as standard with each OLIU. Optional *SC* or *FC* 0 dB, or attenuated buildouts can be ordered separately as listed in Table 10-20.

**⇒ NOTE:**  
 Two 0 dB *SC*-type removable connectors are installed on 22D-U, 22G-U, 22G4-U, 24G-U, 29G-U, and 29H-U OLIUs. Two 0 dB *ST*<sup>®</sup> connectors are shipped loose with these packs.

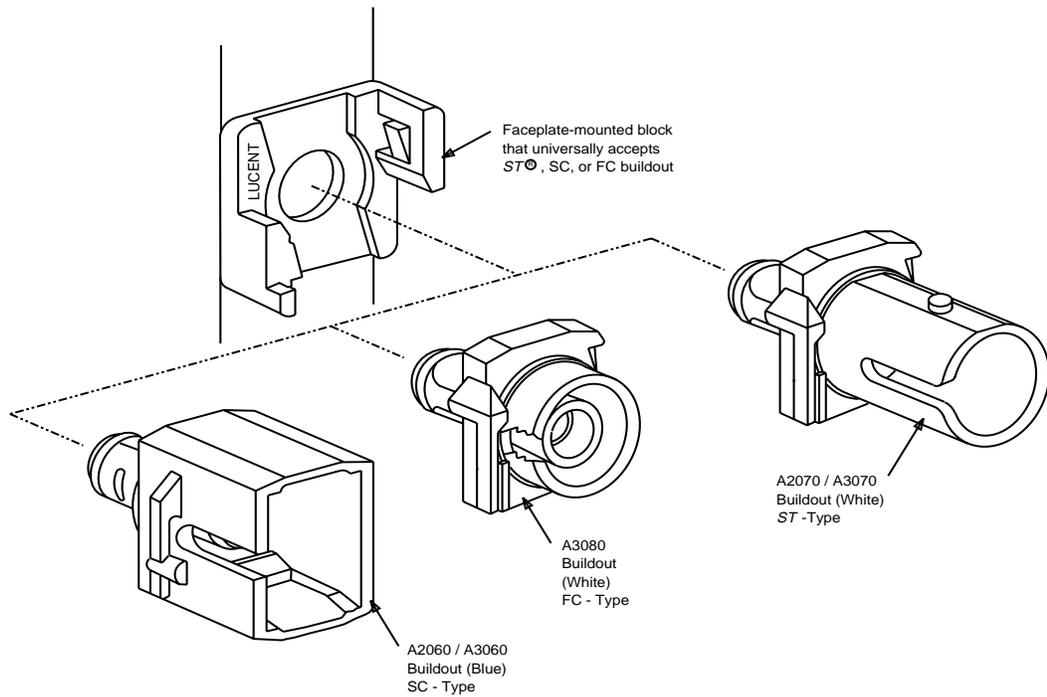
**Table 10-20. Universal Buildout Attenuators**

Description	Connection	Loss (dB)	Comcode
A3060 SC 0 dB buildout	SM-SM	0	106708951
A3060B1 SC 5 dB buildout	SM-SM	5	107406142
A3060D1 SC 10 dB buildout	SM-SM	10	107406159
A3060F1 SC 15 dB buildout	SM-SM	15	107406167
ASCM5 SC 5dB buildout	SM-MM	5	108440579
ASCM10 SC 10dB buildout	SM-MM	10	108440595
ASCM15 SC 15dB buildout	SM-MM	15	108440611
A3070 <i>ST</i> <sup>®</sup> 0 dB buildout	SM-SM	0	106795354
A3070B1 <i>ST</i> 5 dB buildout	SM-SM	5	107406183
A3070D1 <i>ST</i> 10 dB buildout	SM-SM	10	107406191
A3070F1 <i>ST</i> 15 dB buildout	SM-SM	15	107406209
ASTM5 SC 5dB buildout	SM-MM	5	108052960
ASTM10 SC 10dB buildout	SM-MM	10	108052994
ASTM15 SC 15dB buildout	SM-MM	15	108053018
A3080 FC 0 dB buildout	SM-SM	0	106795404
A3080B1 FC 5 dB buildout	SM-SM	5	107406225
A3080D1 FC 10 dB buildout	SM-SM	10	107406233
A3080F1 FC 15 dB buildout	SM-SM	15	107406241
AFCM5 FC 5dB buildout	SM-MM	5	108107285
AFCM10 FC 10dB buildout	SM-MM	10	108107301

**Table 10-20. Universal Buildout Attenuators**

Description	Connection	Loss (dB)	Comcode
AFCM15 FC 15dB buildout	SM-MM	15	108107327
A2060B SC 5 dB buildout	MM-MM	5	106795271
A2060D SC 10 dB buildout	MM-MM	10	106795289
A2060F SC 15 dB buildout	MM-MM	15	106795297
A2070B ST 5 dB buildout	MM-MM	5	106795313
A2070D ST 10 dB buildout	MM-MM	10	106795321
A2070F ST 15 dB buildout	MM-MM	15	106795339

Figure 10-4 shows the universal optical connector used on the OLIU circuit packs.



**Figure 10-4. Universal Optical Connector**

## **SONET Overhead Bytes**

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The DDM-2000 FiberReach Multiplexer currently uses the K2 byte in the SONET format for synchronization signaling. The reserved V4-byte in the VT1.5 superframe is used for internal fault detection in a DDM-2000 FiberReach Multiplexer. This internal usage of the V4-byte may cause the value of the transmitted V4-byte to vary.

The DDM-2000 FiberReach Multiplexer does not depend on, and always ignores, the value of the V4-byte received on its optical interface.

## **Performance**

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### **Wander/Jitter**

- The OC-1 interface accommodates at least 10 microseconds of wander per 24-hour period without buffer overflow or depletion.
- For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference.
- Jitter transfer, tolerance, and generation requirements are met as specified in GR-253 and GR-499.
- The SONET interfaces meet the T1.101 OC-N output short-term stability mask.

### **Signal Performance**

The DDM-2000 FiberReach Multiplexer significantly exceeds the following specifications for the standard networks, as defined in GR-499, Issue 1.

- For systems interfacing at the DS1 rate, the number of errored seconds, during a two-hour, one-way loopback test, is less than ten.
- The bit error rate (BER) is less than  $10^{-9}$  for both the DS1 and DS3 rates. Burst-errored seconds are excluded.
- The frequency of burst-errored seconds, other than those caused by protection switching induced by hard equipment failures, averages less than four per day.

## Protection Switching

### Ring Networks

Path protection rings feed a SONET payload (STS or VT) from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring exit point. The node that terminates the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on loss of signal (LOS), path alarm indication signal (AIS), and path bit error rate (BER) performance. On pass-through paths, all detected hard failures (LOS, LOF, LOP, line AIS, STS-1 path AIS, or STS-1 path signal failure based on BER) result in VT AIS insertion in the outgoing signals. This allows the terminating node to be aware of the failure and to switch to protection. Protection switching is completed within 50 milliseconds of failure detection. Similarly, for dropped nonterminated paths, if both incoming STS-1s have any of the previous failures, VT AIS will be inserted in the dropped signal.

Under normal conditions, both incoming SONET path signals to the switch selection point are of high quality, and the signal can be selected from either ring. A failure or a transmission degradation on one of the rings requires that the other ring path be selected. DDM-2000 FiberReach provides nonrevertive switching to minimize the impact on critical customer services by giving the service provider control when, and if, the critical service should revert to a particular ring. A manual path protection switching command allows switching back to the original path for ease of ring maintenance, if desired.

## Transient Performance

### Power Loss Restart

After system shutdown due to power loss, the system will begin error free transmission within one minute of restoration of power.

### Transmission Start-Up on Signal Application

The system, after having no signal applied for greater than one minute at the DSX-n interface, will begin error free transmission within five seconds of the reapplication of a signal.

## Delay

Table 10-21 lists the worst-case measured 1-way transmission delay within a DDM-2000 FiberReach Multiplexer.

**Table 10-21. DDM-2000 OC-1 Transmission Delay in Microseconds**

Mode (High-Speed)	DS1 Low-Speed Interface
Ring (OC-1)*	100

\* Ring delay is based on an OC-1 to low-speed DS1.

### Performance Monitoring

Table 10-22 shows the provisionable range of the thresholds for monitored parameters and, in brackets, the default thresholds. Thresholding of any parameter(s) can be disabled.

**Table 10-22. Performance Monitoring Parameters Provisionable via the CIT**

Parameter Definition		Threshold Range [Default]		Command
Facility	Measure	Current Quarter Hour	Current Day	set-pmthres-
OC-1/OC-3* Section	SE Frame Seconds (SEFS)	1-63[10]	1-4095[30]	sect
OC-1 Line	B2 Coding Violations (CV)	1-4613[461]	1-442848 [44285]	line
	B2 Errored Seconds (ES)	1-900[40]	(1-65535)[900]	line
	B2 Errored Seconds Type A (ESA)	1-900[30]	(1-65535)[90]	line
	B2 Errored Seconds Type B (ESB)	1-900[30]	(1-65535)[90]	line
	B2 Severely Errored Seconds (SES)	1-63[20]	(1-4095)[60]	line
	B2 Unavailable Seconds (UAS) STS Pointer Justification Counts (PJC)†	1-63[30] (1-65535)[60]	(1-4095)[90] 1-9999999 [5760]	line line
OC-3 Line*	B2 Coding Violations (CV)‡	1-13841[1384]	1-1328736 [132874]	line
	B2 Errored Seconds (ES)‡	1-900[40]	(1-65535)[900]	line
	B2 Errored Seconds Type A (ESA)‡	1-900[30]	(1-65535)[90]	line
	B2 Errored Seconds Type B (ESB)‡	1-900[30]	(1-65535)[90]	line
	B2 Severely Errored Seconds (SES)‡	1-63[20]	(1-4095)[60]	line
	B2 Unavailable Seconds (UAS)‡	1-63[30]	(1-4095)[90]	line
OC-12 Section§	SE Frame Seconds (SEFS)	1-63[10]	1-4095[30]	sect
OC-12 Line¶	B2 Coding Violations (CV)	1-55365 [5537]	1-5315040 [531504]	line
	B2 Errored Seconds (ES)	1-900 [40]	1-65535 [900]	line
	B2 Errored Seconds Type A (ESA)	1-900 [30]	1-65535 [90]	line
	B2 Errored Seconds Type B (ESB)	1-900 [30]	1-65535 [90]	line
	B2 Severely Errored Seconds (SES)	1-63 [20]	1-4095 [60]	line
	B2 Unavailable Seconds (UAS)	1-63 [30]	1-4095 [90]	line
	STS Pointer Justification (PJC)	1-63 [30]	1-9999999 [5760]	line
			1-65535 [60]	
STS-1 Path	B3 Coding Violations (CV)	1-4510[451]	1-432960 [43296]	sts1
	B3 Errored Seconds (ESA)	1-900[40]	1-65535[900]	sts1
	B3 Errored Seconds Type A (ESA)	1-900[30]	1-65535[90]	sts1
	B3 Errored Seconds Type B (ESB)	1-900[30]	1-65535[90]	sts1
	B3 Severely Errored Seconds (SES)	1-63[20]	1-4095[60]	sts1
	B3 Unavailable Seconds (UAS)	1-63[30]	1-4095[90]	sts1
VT1.5 Path	V5 Errored Seconds (ES)**	1-900 [40]	1-65535 [900]	vt1
	V5 Severely Errored Seconds (SES)**	1-63[20]	1-4095 [60]	vt1
	V5 Unavailable Seconds (UAS)**	1-63[30]	1-4095 [90]	vt1

**Table 10-22. Performance Monitoring Parameters Provisionable via the CIT**

Parameter Definition		Threshold Range [Default]		Command
Facility	Measure	Current Quarter Hour	Current Day	set-pmthres-
DS-1 Path	ES-P Errored Seconds <sup>§</sup>	1-900[65]	1-65535 [648]	t1
	SES-P Severely Errored Seconds <sup>§</sup>	1-63[10]	1-4095 [100]	t1
	UAS-P Unavailable Seconds <sup>§</sup>	1-63[10]	1-4095 [10]	t1
	ES-PFE Errored Seconds <sup>§</sup>	1-900[65]	1-65535 [648]	t1
	SES-PFE Severely Errored Seconds <sup>§</sup>	1-63[10]	1-4095 [100]	t1
	UAS-PFE Unavailable Seconds <sup>§</sup>	1-63[10]	1-4095 [10]	t1
	CV-P (SF) Coding Violations <sup>§</sup>	1-16383[72]	1-1048575 [691]	t1
	CV-P (ESF) Coding Violations <sup>§</sup>	1-16383[13296]	1-1048575 [132960]	t1
	CV-PFE Coding Violations <sup>§</sup>	1-16383[13296]	1-1048575 [132960]	t1
DS-1 Line	ES-L Line Errored Seconds	1- 900[65]	1-65535 [648]	t1
DS3 Path	P-Bit Error Counts	1-4026 [403]	1-386500 [38650]	t3
	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]	t3
Enhanced DS3 Path for P-Bits, F&M Bits, and C-Bits from Fiber and DSX	CV-P Coding Violations	1-16383 [40]	1-1048575 [3820]	t3
	ES-P Errored Seconds	1-900 [25]	1-65535 [250]	t3
	SES-P Severely Errored Seconds	1-63 [4]	1-4095 [40]	t3
	UAS-P Unavailable Seconds	1-63 [10]	1-4095 [10]	t3
	SEFS	1-63 [2]	1-4095 [8]	t3
DS3 Line	CV-L Coding Violations	1-16383 [40]	1-1048575 [3865]	t3
	Errored Seconds, Line (ES-L)	1-900 [25]	1-65535 [250]	t3
	Severely Errored Seconds, Line (SES-L)	1-63 [4]	1-4095 [40]	t3

\* When equipped with a 28G-U OLIU in the Main slots.

† Only applies to Release 3.0 and later.

‡ Only applies to Release 2.2.

§ When equipped with a 29-Type OLIU in the Main slots.

¶ When equipped with a 29-Type OLIU in the Main slots.

\*\* Feature package option.

## Signaling Mode

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Loop start signaling with fast forward disconnect is provided with the channel units used in the *SLC* Series 5 and *SLC-2000* systems with the *SLC-2000* MSDT feature.

## Digital Data Performance

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The AUA52B OCU (office channel unit) dataport is designed to provide end links in DDS. These end links have certain features as follows:

- One 4-wire circuit per plug-in pair.
- Data rate — 2.4, 4.8, 9.6, 19.2, 56, or 64 kb/s.
- Error correction. A digital line bit error rate of  $10^{-3}$  is improved to  $10^{-8}$  for any data rate without reducing the channel capacity of the bank.
- Zero Code Allowed option. Allows an all-zero byte to be transmitted toward the digital line (which must be optioned for B8ZS zero code suppression).
- Secondary channel. An option which permits a feature of DDS that provides the customer with a low-speed telemetry channel supplementing the primary data channel at any data rate. (See RL83-01-163.)

## Operations Interfaces

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This section presents the operation interfaces that are required to support technician access to the system and allow alarms and status information generated by the system to be reported. The local operations interfaces include the craft interface terminal (CIT) interface, the user panel, and the equipment indicators. The DDM-2000 FiberReach Multiplexer supports a direct serial TBOS interface\* and user-definable miscellaneous discretes. Remote office alarms\*, parallel telemetry\*, and TL1/X.25 interfaces are provided by the host multiplexer.

### Craft Interface Terminal

The system provides an EIA-232-D compatible front access CIT interface configured as data communications equipment (DCE). The CIT interface provides data rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud.

The CIT interface operates full duplex using one start bit, eight data bits, and one stop bit. Table 10-23 describes the pins supported on the CIT interfaces.

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\* This is not applicable for users of Release 3.0/3.1 due to the introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI). Refer to Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

**Table 10-23. CIT Interface Pin Connections**

<b>EIA-232-D Pin</b>	<b>Front Access CIT (DCE)</b>
Pin 2 - Circuit BA Transmitted Data	carries data from terminal to DDM-2000 FiberReach
Pin 3 - Circuit BB Received Data	carries data from DDM-2000 FiberReach to terminal
Pin 7 - Circuit AB Signal Ground	signal ground
Pin 8 - Circuit CF Received Line Signal Detector	not used
Pin 20 - Circuit CD DTE Ready	indicates to DDM-2000 FiberReach that modem or terminal is connected

Although not required for routine installation and maintenance, a CIT is recommended for more sophisticated maintenance and administrative activities. A personal computer (PC) is required for software download and to run the CPro-2000 software. The DDM-2000 FiberReach Multiplexer CIT port (mounted on the user panel) is a standard EIA-232-D (supersedes RS-232C specification) interface configured as DCE for direct connection to a CIT. The CIT port is compatible with most ANSI 3.64 ASCII terminals; however, it is optimized for standard screens with display areas of 24 lines by 72 (or more) columns. A pager function is included in the DDM-2000 FiberReach Multiplexer to accommodate screen lengths from 3 lines to 150 lines.

Those CITs compatible with DDM-2000 OC-3 or OC-12 Multiplexers are directly compatible with the DDM-2000 FiberReach Multiplexer.

### **Personal Computer Specifications for Software Download**

The personal computer (PC) used for software download should have:

- A minimum of 640K of random access memory (RAM)
- MS-DOS<sup>\*</sup> version 2.0 or newer
- Hard disk

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\* Registered trademark of Microsoft Corporation.

- At least one floppy disk drive of 360K or larger capacity. Although the disk drive may accommodate either floppy or hard disk, a hard disk is preferred for its better performance. The disk requirement is met with most portable *MS-DOS* PCs with a single 3.5-inch disk. An MS-DOS PC with a hard disk and either a 3.5-inch 1.44M floppy disk may also be used.
- Windows NT available to work with the OC-3 Releases 7.2 and earlier, and 13.0 and later, and OC-12 Releases 7.0 and later, and FiberReach 4.0.

### Compatible Modems

A compatible modem must meet the following minimum requirements:

- 300, 1200, 2400, 4800, 9600, or 19,200 baud
- Full duplex
- 8 data bits
- No parity bits
- 1 start bit
- 1 stop bit
- No flow control

The following stand-alone modems meet the modem requirements and can be used with the DDM-2000 System. *Western Electric*<sup>®</sup> 103-compatible and 212A-compatible modems are also suitable for use with the DDM-2000 system. This is not an exhaustive list of compatible modems:

- Lucent *Paradyne*<sup>®</sup> 2224-CEO modem (at 1200 and 2400 baud)
- Lucent *Paradyne* 2224 modem (at 1200 and 2400 baud)
- Lucent *Paradyne* 4024 modem (at 1200 and 2400 baud)
- Lucent *Paradyne* 2296 modem (at 4800 and 9600 baud)
- Hayes *V-series*<sup>\*</sup> Smartmodems
- *Penril*<sup>†</sup> Alliance V.32 modem.

The NCR 3170 computer and the AT&T *Safari*<sup>®</sup> computer have a built-in modem and meet the modem requirements.

### CPro-2000 Graphical User Interface and Provisioning Tool

The CPro-2000 Graphical User Interface and Provisioning Tool is a *Microsoft Windows*<sup>‡</sup> based user interface that can optionally be used with the DDM-2000 OC-3 Multiplexer. The tool simplifies and mechanizes administration,

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\* Trademark of Hayes Microcomputer Products, Inc.

† Registered trademark of Penril Corporation, Inc.

‡ Microsoft is a registered trademark and Windows is a trademark of Microsoft Corporation.

maintenance, and provisioning operations for ring networks. CPro-2000 supports DDM-2000 OC-3 Multiplexers, DDM-2000 OC-12 Multiplexers, and FT-2000 OC-48 Lightwave Systems. A minimum platform configuration is:

- 486 SX *IBM*<sup>\*</sup>-compatible desktop or laptop PC
- 3.5 inch Floppy Disk drive
- 8 Megabyte RAM required (12 Megabyte RAM preferred)
- Hard disk with at least 40 Megabytes of available space
- Serial port (EIA-232-D) — configured as COM1 or COM2
- MS-DOS operating system version 5.0 or later
- Windows NT or Windows 95
- Mouse
- VGA color monitor

CPro-2000 is a software environment based on Microsoft Windows 3.1. Windows NT may also be used, as well as Microsoft Windows 95. CPro-2000 has been tested with AT&T, NCR, IBM, NEC<sup>†</sup>, and Gateway-2000<sup>‡</sup> personal computers. CPro-2000 has also been tested to work on a SUN<sup>§</sup> SPARC<sup>¶</sup> station 10 workstation that has a SUNPC3.1 software environment setup on a PC emulator hardware and running Windows in the enhanced mode.

## User Panel

The user panel contains red light emitting diodes (LEDs) for CR and MJ alarms, yellow LEDs for MN and PMN alarms, and for abnormal (ABN), far-end activity (FE-ACTY)<sup>\*\*</sup>, and near end activity (NE-ACTY) status. These LEDs are used in conjunction with the far-end identification (FE-ID) seven-segment display on the front panel of the adjacent SYSCTL circuit pack to provide CIT-less single-ended operations.

Two green PWR ON LEDs are lighted when the shelf is receiving –48 V power for each of two independent –48 V DC power feeders. A green ACO LED is lighted when the ACO function is active.

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\* IBM is a registered trademark of International Business Machines Corporation.

† NEC is a registered trademark of NEC Corporation.

‡ Gateway 2000 is a trademark of Gateway 2000, Inc.

§ SUN is a registered trademark of SUN Microsystems, Inc.

¶ SPARC is a registered trademark of SPARC International, Inc., licensed exclusively to SUN Microsystems, Inc.

\*\* This is not applicable for users of Release 3.0 due to the introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI). Refer to Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

The FE SEL test, ACO/TEST, and UPD/INIT pushbuttons are provided to control system operation.

### **Equipment Indicators**

A red LED FAULT indicator is provided on each circuit pack. A green LED ACTIVE indicator is provided on all 1x1 protected circuit packs to indicate which circuit packs are actively carrying traffic.

### **Office Alarms**

The office alarms interface is a set of discrete relays that controls office audible and visual alarms. Separate relays handle critical, major, and minor alarms. Each contact closure is rated at 1 A, 60 V maximum. The CR and MJ alarms can be wire-ORed. The critical alarm relays are fail safe against unprotected power failures.

### **Serial Telemetry\***

Serial telemetry is provided using the telemetry byte-oriented serial (TBOS) protocol. TBOS telemetry provides detailed alarm, status, and control (AS&C) information to and from a remote maintenance center via a 2400 baud RS-422 port. The AS&C TBOS link can be shared among multiple DDM-2000 OC-3 Multiplexer shelves. A TBOS link can support up to eight displays.

### **Parallel Telemetry\***

Parallel telemetry brings a minimum set of alarm and status information to an operations center. A parallel telemetry interface to a DDM-2000 FiberReach Multiplexer is provided through a host system (for example, a DDM-2000 OC-3 Multiplexer).

### **User-Definable Miscellaneous Discrete Environmental Alarms and Controls**

The user-definable miscellaneous discrete environmental alarm and control interface allows the DDM-2000 FiberReach Multiplexer to monitor and control collocated equipment at the remote site. At the remote terminal (RT) site, 15 alarm or status environmental inputs can monitor environmental conditions (for example, open door, high temp); these inputs are activated by contact closures. The 15th environmental alarm or status input is provided to monitor the condition of the power shelf and fans at the RT site; this closure is activated by -48 V DC. Four environmental control outputs are provided to control external equipment (for

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\* This is not applicable for users of Release 3.0 or later due to the introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI). Refer to Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

example, pumps or generators). The miscellaneous discrete outputs (control outputs at an RT, alarm/status outputs at a CO) tolerate –60 V maximum open circuit voltage and 35 mA maximum current. Transient voltages up to –135 V are tolerated for up to 1 ms. The miscellaneous discrete inputs provide –48 V nominal (–60 V maximum) open circuit voltage and 2 mA maximum current.

The miscellaneous discrete output closures generated by the optoisolator require external voltage and ground to operate.

### **TL1/X.25 Interface**

A TL1/X.25 interface to a DDM-2000 FiberReach Multiplexer is provided through a host system (for example, a DDM-2000 OC-3 Multiplexer). The DDM-2000 FiberReach Multiplexer host supports a TL1/X.25 interface for communication between local and remote DDM-2000s, and alarm surveillance and provisioning operations systems such as Telcordia Technologies's Network Monitoring and Analysis (NMA) and Operations Systems/Intelligent Network Element (OPS/INE) operations systems. The DDM-2000 OC-3 Multiplexer TL1/X.25 interface is based on Telcordia Technologies TR-TSY-000833, Issue 5.

### **Lucent 2000 Product Family OI Specifications**

Applicable for Release 2.2 only:

Maximum number of NEs per subnetwork	50
Maximum number of alarm groups per subnetwork	255
Maximum number of NEs per alarm group	25
Maximum number of directory services NEs per subnetwork	1

Applicable for Release 4.0:

Maximum number of alarm groups per subnetwork	255
Maximum number of NEs per alarm group	25



**NOTE:**

DDM-2000 FiberReach 3.0 or later supports large subnetworks of up to 256 NE. Refer to *Lucent Technologies 2000 Product Family Multi-Vendor Operations Interworking Guide*, 824-102-144 for additional information.

### **Physical Specifications**

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#### **Wideband Shelf Physical Characteristics**

- Dimensions: 9.65 in. H x 9.17 in. W x 13.11 in. D

- Weight (Max.): 20 lb. (9 kg)
- Appearance: Coordinated with other equipment in the Lucent 2000 Product Family.

## Network Bay and Cabinet Mounting

The DDM-2000 FiberReach Multiplexer can be mounted in both ED-8C500 and ED-8C501 network bay frames and in 23-inch network bay frames. Up to two shelves (any combination of wideband and narrowband shelves) can be mounted side by side in a carrier assembly. In addition to bay mounting, the DDM-2000 FiberReach Multiplexer can be packaged with other equipment in 51A or 61A cabinets, wall mount enclosures, controlled environment vaults (CEVs), or huts.

## Environmental Specifications

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### Temperature and Humidity

A DDM-2000 FiberReach Multiplexer shelf meets Telcordia Technologies Network Equipment Building System (NEBS) requirements\* for use in central office environments without fans. \*

A heat baffle assembly is required for all applications in a bay frame and for cabinet configurations where thermal environments are specified. The baffle should be installed above and below any DDM-2000 FiberReach shelves. Refer to Chapter 7, "DDM-2000 FiberReach Ordering", for information for detailed information on heat baffles in typical bay arrangements.

The DDM-2000 FiberReach Multiplexer operates in uncontrolled environments at temperatures of  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$  and humidity of 5 to 95 percent (noncondensing). Forced convection cooling (fans) is required when the air inlet temperature is above  $50^{\circ}\text{C}$ . The DDM-2000 FiberReach Multiplexer provides optional control and alarming of the 2-type fan units used in Lucent cabinets and alarming of the DDM-2000 fan shelf.

### EMC Requirements

The DDM-2000 FiberReach Multiplexer has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residence is likely to cause harmful interference in which case the user will be required to correct the interference at the user's own expense.

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\* "NEBS Generic Equipment Requirements," GR-63-CORE, Issue 1, October 1995.

## Earthquake Requirements

The DDM-2000 FiberReach Multiplexer meets the earthquake requirements defined in Telcordia Technologies TR-NWT-000063, Issue 5 and Pacific Bell Standard PBS-000-102PT. Installations in Zone 4 regions require the ED-8C800-50 or ED-8C801-50 bay frame. Drawing ED-8C800-70 provides ordering and engineering application information for these frames.

## Fire Resistance

The DDM-2000 FiberReach Multiplexer meets the ignitability requirements specified in T1Y1.4/88-014. In addition, the DDM-2000 FiberReach Multiplexer meets the fire resistance requirements of *UL*<sup>\*</sup> 1459, 2nd Edition.

## Underwriters Laboratories (*UL*)

The DDM-2000 FiberReach Multiplexer is *UL* listed for restricted access installations in business and customer premises applications installed in accordance with Articles 110-16 and 110-17 of the *National Electric Code*<sup>†</sup>, *ANSI/NFPA* Number 70-87. Other installations exempt from the requirements of the *National Electric Code* may be engineered according to the accepted practices of the local telecommunications utility.

## Canadian Standards Association

The DDM-2000 FiberReach Multiplexer has been certified by the Canadian Standards Association per standard C22.2, Number 225-M90.

## Power Requirements

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### Shelf Fuses

Up to four –48 V feeders (A and B) are required for each DDM-2000 FiberReach shelf. Each shelf power is protected by 3-amp fuses provided with the shelf.

### Power Dissipation

Table 10-24 lists the power dissipation and current drains for the listed configurations for the wideband shelf. The maximum current drain can be calculated for any configuration by dividing the total power dissipation by 40 V (the minimum battery voltage).

When reviewing Table 10-24, the following items should be noted:

- The DDM-2000 FiberReach wideband shelf accommodates two –48 V power feeders ("A" and "B" office power feeders). The DDM-2000 FiberReach narrowband shelf has two –48 V power feeds.

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\* Registered trademark of Underwriters Laboratories Inc.

† Registered trademark of the National Fire Protection Association, Inc.

- Loss of one power feeder does not cause a loss of service.
- All supply voltages other than –48V required by the system are generated by DC-to-DC converters within the system.
- The system meets all performance requirements when the DC input voltage varies between –40.0 V and –60.0 V.
- The system tolerates DC input voltages between 0 V and –60 V without damage.
- The system complies with electrical noise tolerance requirements in Section 13.2 of TR-TSY-000499.

**Table 10-24. Power Dissipation — Wideband Shelf**

Configuration	Power Dissipation		
	with 2 26G2-U	with 2 28G-U	with 29G-U or 29H-U
DDM-2000 FiberReach WBS with 8 BBF3 circuit packs (16 DS1s, 1x1 protected)	41 Watts	44 Watts	48 Watts
DDM-2000 FiberReach WBS with 8 BBF3 circuit packs (28 DS1s, 1x7 protected)	38 Watts	41 Watts	45 Watts
DDM-2000 FiberReach WBS with 8 BBF6 (T1EXT) circuit packs (8 T1EXT, 1x1 protected)	66 Watts	69 Watts	73 Watts
DDM-2000 FiberReach WBS with 8 BBF6 (T1EXT) circuit packs (14 T1EXT, 1x7 protected)	65 Watts	68 Watts	72 Watts
DDM-2000 FiberReach WBS with 3* BBF8 circuit packs (6 HDSL, unprotected)	—	46 Watts	50 Watts
DDM-2000 FiberReach WBS with 8 BBF3 circuit packs (16 DS1s, 1x1 protected) and 2 BBG4B circuit packs	—	50 Watts	54 Watts
DDM-2000 FiberReach WBS with 8 BBF3 circuit packs (28 DS1s, 1x7 protected) and 2 BBG4B circuit packs	—	47 Watts	51 Watts
DDM-2000 FiberReach WBS with 8 BBF6 (T1EXT) circuit packs (8 T1EXT, 1x1 protected) and 2 BBG4B circuit packs	—	75 Watts	79 Watts
DDM-2000 FiberReach WBS with 8 BBF6 (T1EXT) circuit packs (14 T1EXT, 1x7 protected) and 2 BBG4B circuit packs	—	74 Watts	78 Watts
DDM-2000 FiberReach WBS with 3* BBF8 circuit packs (6 HDSL, unprotected) and 2 BBG4B circuit packs	—	52 Watts	56 Watts
DDM-2000 FiberReach WBS with 8 BBF3 circuit packs (16 DS1s, 1x1 protected) and 2 BBG19 circuit packs	—	50 Watts	54 Watts
DDM-2000 FiberReach WBS with 8 BBF3 circuit packs (28 DS1s, 1x7 protected) and 2 BBG19 circuit packs	—	47 Watts	51 Watts
DDM-2000 FiberReach WBS with 8 BBF6 circuit packs (16 DS1s, 1x1 protected) and 2 BBG19 circuit packs	—	75 Watts	79 Watts

\* Limited to 3 due to power limitations from a single 28G-U.



**CAUTION:**

*This information is for a typical application only. Consult 801-525-168, DDM-2000 Floor Plan Data Sheets, and T82046-30, Power Systems DC Distribution Circuit for Digital Transmission System, for proper engineering of battery plant and feeders.*

**Table continued on next page**

**Table 10-24. Power Dissipation — Wideband Shelf—Continued**

Configuration	Power Dissipation		
	with 2 26G2-U	with 2 28G-U	with 29G-U or 29H-U
DDM-2000 FiberReach WBS with 8 BBF6 (T1EXT) circuit packs (14 T1EXT, 1x7 protected) and 2 BBG19 circuit packs	—	74 Watts	78 Watts
DDM-2000 FiberReach WBS with 3* BBF8 circuit packs (6 HDSL, unprotected) and 2 BBG19 circuit packs	—	52 Watts	56 Watts
DDM-2000 FiberReach WBS with 2 22D-U circuit packs	—	44 Watts	48 Watts
DDM-2000 FiberReach WBS with 2 BBG4B circuit packs	—	35 Watts	39 Watts
DDM-2000 FiberReach WBS with 2 BBG19 circuit packs	—	35 Watts	39 Watts
DDM-2000 FiberReach WBS with 2 22G3-U circuit packs	—	43 Watts	47 Watts
* Limited to 3 due to power limitations from a single 28G-U.			



**CAUTION:**

*This information is for a typical application only. Consult 801-525-168, DDM-2000 Floor Plan Data Sheets, and T82046-30, Power Systems DC Distribution Circuit for Digital Transmission System, for proper engineering of battery plant and feeders.*

## **DDM-2000 FiberReach Multiplexer Reliability**

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### **Summary**

This section describes the Telcordia Technologies reliability requirements that apply to the DDM-2000 FiberReach Multiplexer and the calculations used to predict how the DDM-2000 FiberReach Multiplexer meets those standards.

The DDM-2000 FiberReach Multiplexer meets all the applicable Telcordia Technologies reliability requirements that cover transmission availability, operation system (OS) availability, optical module maintenance, and infant mortality. A summary of the reliability predictions and requirements is shown in Table 10-25 and Table 10-26. The applicable Telcordia Technologies requirements and objectives were clarified through interactions with Telcordia Technologies during their audit of the DDM-2000 OC-3 Multiplexer. The basis for these requirements comes from TA-TSY-000418, *Generic Reliability Assurance Requirements for Fiber Optic Transport Systems*. The method and assumptions used to calculate DDM-2000 FiberReach Multiplexer reliability predictions are described in the following paragraphs. Each paragraph is devoted to one of the reliability parameters which must meet a Telcordia Technologies requirement or objective.

### **Transmission Availability**

Telcordia Technologies *requirements* state that the probability of a hardware caused outage on a two-way channel within a SONET multiplexer should be less than 1.75 minutes per year in a central office environment\* and 5.25 minutes per year in a remote terminal environment.† Telcordia Technologies *objectives* for outages are 0.25 minutes per year for the central office‡ and 0.75 minutes per year for remote terminal environments.§

The outage requirements and objectives apply to any part of the product needed to process an incoming high-speed or low-speed signal (DS1 to OC-1 or OC-1 to DS1). An outage is defined, for this and all other outage requirements, as any 1-second interval with a bit error rate of  $10^{-3}$  or worse.¶ The predicted hardware outages for various configurations of the system are given in Table 10-26.

A Markov model was used to calculate the predicted system outage. The model assumes a mean time to repair of 2 hours for the CO environment and 4 hours for

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\* TA-NWT-000418, Issue 3, November 1991, p. 17.

† TA-NWT-000418, Issue 3, November 1991, p. 28.

‡ TA-NWT-000418, Issue 3, November 1991, p. 18.

§ TA-NWT-000418, Issue 3, November 1991, p. 28.

¶ TR-TSY-000009, Issue 1, May 1986, p. 4-11.

the RT environment. Individual circuit pack failure rates used in the model were calculated using the method described in TR-TSY-000332, Issue 4, *Reliability Prediction Procedure for Electronic Equipment (RPP)*. A summary of the circuit pack failure rates is shown in Table 10-26.

### Operation System Interface Availability

The Telcordia Technologies objective states that the OS outage should be less than 28 minutes per year (50 percent hardware, 50 percent software).<sup>\*</sup> Therefore, the objective applies to the TBOS interface<sup>†</sup>. This objective applies to circuitry needed to maintain communication from the DDM-2000 Multiplexer to the central office's telemetry equipment for access by an OS. Since the OS interface is used in the central office, the reliability model assumes the mean time to repair is 2 hours and the environmental factor is 1.0. Table 10-25 lists the predicted outages for the TBOS interface.<sup>‡</sup>

### Optical Module Maintenance Objective

According to Telcordia Technologies, the objective for mean time between failure (MTBF) of a one-way regenerator is a minimum of four years<sup>‡</sup>. A regenerator is defined as any circuit pack that performs the electrical-to-optical and optical-to-electrical conversion. Table 10-26 lists the failure rate and MTBFs of the OLIU circuit packs. All OLIU circuit packs meet Telcordia Technologies objectives.

### Infant Mortality

Telcordia Technologies requires that the number of circuit pack failures in the first year of operation should not exceed 2.5 times the number of failures per year beyond the first year. The ratio of first year failures to failures in subsequent years is known as the infant mortality factor (IMF). The requirement is to have an IMF of less than 2.5.<sup>§</sup>

DDM-2000 FiberReach Multiplexer circuit packs are subjected to an environmental stress-testing (EST) program. The purpose of the program is to eliminate early life failures, conduct failure mode analysis on defective circuit packs, and use corrective action to make the product more reliable. All new circuit pack codes in manufacturing are subjected to EST. However, based on field return data, when the early life failures for any circuit pack codes have been minimal and the IMF is below 2.5, these circuit pack codes may be subjected only to sampling EST.

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\* TA-NWT-000418, Issue 3, November 1991, p. 36.

† Not applicable for Release 3.0

‡ TA-NWT-000418, Issue 3, November 1991, p. 37.

§ TA-NWT-000418, Issue 3, November 1991, p. 40.

## DDM-2000 FiberReach System Reliability Predictions

Table 10-25 and Table 10-26 show the system reliability predictions for the DDM-2000 FiberReach Multiplexer.

**Table 10-25. DDM-2000 FiberReach System Reliability Prediction (Note 1)**

Application	Environment (Note 2)	Telcordia Technologies Criteria (Note 3)		Prediction (Note 4)	
		Requirement	Objective	Outage (min/yr)	MTBF (Yrs)
<b>Point-to-Point</b>					
DS1 to OC-1	CO	1.75	0.25	0.1657	724
DS1 to OC-1(*)	CO	1.75	0.25	0.0463	2590
DS1 to OC-1	RT	5.25	0.75	0.4971	482
DS1 to OC-1(*)	RT	5.25	0.75	0.1391	1723
DS1 to OC-3	CO	1.75	0.25	0.1657	724
DS1 to OC-3 (*)	CO	1.75	0.25	0.0463	2588
DS1 to OC-3	RT	5.25	0.75	0.4972	482
DS1 to OC-3 (*)	RT	5.25	0.75	0.1394	1719
DS3 to OC-3	CO	1.75	0.25	0.1983	605
DS3 to OC-3 (*)	CO	1.75	0.25	0.0219	5479
DS3 to OC-3	RT	5.25	0.75	0.5953	403
DS3 to OC-3 (*)	RT	5.25	0.75	0.0661	3617
<b>Ring Pass-Through</b>					
OC-3c to OC-3c	CO	none	none	0.00006	1554735
OC-3c to OC-3c	RT	none	none	0.00052	345505
<b>OS Interface</b>					
TBOS (Note 5)	CO	—	14.00	4.74	25

\*Field replacement rate estimates, based on field CP returns and repairs, are used for the component whose failure is silent service affecting and/or not service affecting.

### Notes:

1. Hardware failure rates are calculated per the RPP method, TR-NWT-000332, Issue 4, *Reliability Prediction Procedure*.
2. The environmental factor for the CO = 1.0 and for the RT = 1.5, per TR-NWT-000332, Issue 4, *Reliability Prediction Procedure*.

(Notes continued on next page)

3. Telcordia Technologies criteria (Outage Requirements and Objectives) is based on TA-TSY-000418, Issue 3, *Generic Reliability Assurance Requirements for Fiber Optic Transport Systems*. Outage is in minutes per year. |
4. Mean time to repair is assumed to be two hours for the CO and four hours for RT environments.
5. Not applicable for Releases 3.0/3.1 and later. |

**Table 10-26. DDM-2000 FiberReach Circuit Pack Reliability (Note 1)**

Circuit Pack	Central Office		Remote Terminal	
	FITS (Note 2)	MTBF (Years)	FITS (Note 2)	MTBF (Years)
BBF1B (DS1)	859	132.8	1289	88.5
BBF3 (DS1PM)	1310	87.1	1965	58.1
BBF3B (DS1PM)	1235	92.4	1853	61.6
BBG4 (DS3)	902	126.5	1353	84.3
BBG4B (DS3)	1056	108.0	1584	72.0
BBF6 (T1EXT)	1427	79.9	2141	53.3
BBF8 (HDSL)	5216	21.9	7824	14.6
BBG8 (SYSCTL)	4505	25.3	6758	16.9
BBG8B (SYSCTL)	4442	25.7	6663	17.1
BBG19 (DS3)	729	156.5	1094	104.3
22D-U (IS-3 OLIU)	2388	47.80	3582	31.87
22F2-U (OC-3 OLIU)	2033	56.1	3050	37.4
22G-U (OC-3 OLIU)	2880	39.64	4320	26.42
22G2-U (OC-3 OLIU)	2197	51.9	3296	34.6
22G3-U (OLIU)	3533	32.3	5300	21.5
26G2-U (OLIU)	2575	44.3	3863	29.5
28G-U (OLIU)	3860	29.6	5790	19.7
29G-U (OLIU)	3264	34.9	4896	23.3
29H-U (OLIU)	3049	37.4	4574	24.9

**Notes:**

- Calculations are based on Telcordia Technologies RPP Issue 4 data. All KS and Lucent components considered as quality level III. All components evaluated at 40°C ambient and 50 percent electrical stress.
- FITS is the number of failures per billion hours of operation ( $10^9$ ).

## DDM-2000 Narrowband Shelf Specifications

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### Physical Specifications

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#### Narrowband Shelf Physical Characteristics

- Dimensions: 9.65 in. H x 8.03 in. W x 11.93 in. D
- Weight (Max.): 20 lb. (9 kg)
- Appearance: Coordinated with other equipment in the Lucent 2000 Product Family

### Power Requirements

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#### Shelf Fuses

Up to four -48 V feeders (A and B) are required for each DDM-2000 FiberReach shelf. Each shelf power is protected by 3-amp fuses provided with the shelf.

#### Power Dissipation

Table 10-27 lists the power dissipation and current drains for the listed configurations for the narrowband shelf. The maximum current drain can be calculated for any configuration by dividing the total power dissipation by 40 V (the minimum battery voltage).

**Table 10-27. Power Dissipation — Narrowband Shelf**

Configuration	Power Dissipation
DDM-2000 FiberReach NBS with DSXBIU, CDTU, RGU, and PCU (No Channel Units)	14 Watts*
Maximum power available to CUs in narrowband shelf. This power is allocated among different CUs based on the following data for power requirement per channel unit.‡ SPQ909 - 4.0 Watts    AUA159C - 3.2 Watts AUA94 - 1.7 Watts    AUA58C - 3.1 Watts AUA53 - 1.9 Watts    AUA150 - 3.3 Watts SPQ400 - 6.0 Watts    SPQ440B - 6.1 Watts SPQ443 - 6.5 Watts    SPQ494 - 4.7 Watts§	37 Watts†
See footnote at end of table.	

**Notes:**

- \* When the DDM-2000 FiberReach is configured to include a wideband shelf and a narrowband shelf, this power requirement as well as the power requirement for specific channel units and the appropriate wideband shelf configuration should be added to get the total power requirement.
- † This number must be added to the power requirement for the narrowband shelf without channel units to obtain the total power requirements for the narrowband shelf.
- ‡ Other channel units can be used, but the total power requirements must not exceed 37 watts for an enclosed cabinet. However, 82 watts is allowed for a shelf with a heat baffle. These numbers assume all lines off hook simultaneously. A more typical power drain is about one third of the stated drain: equal to a traffic rate of 12.2.us.
- § The SPQ494 channel unit (Quad ISDN) consumes 4.2 watts of power. However, a maximum of eight SPQ494 channel units can be installed in specified physical slots of the narrowband shelf, due to the limit of DSOs carried by the four DS1 links to the host.



**CAUTION:**

*This information is for a typical application only. Consult 801-525-168, DDM-2000 Floor Plan Data Sheets, and T82046-30, Power Systems DC Distribution Circuit for Digital Transmission System, for proper engineering of battery plant and feeders.*

## **Terminal-to-Terminal Voice-Frequency Transmission**

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The CUs used in the central office terminal (COT) and MSDT determine the voice-frequency (VF) transmission characteristics. The specifications for POTS, SPOTS<sup>®</sup>, and coin CUs are given in Table 10-28. Table 10-29 lists the specifications for multiparty and frequency selective ringing (FSR) CUs. Specifications for the dual ringing repeater channel unit are listed in Table 10-30. Table 10-31 lists the specifications for 2- and 4-wire special services. Table 10-32, Table 10-33, Table 10-34, and Table 10-35 list the specifications for quad POTS/SPOTS CUs. Table 10-36 and Table 10-37 list the specifications for the SPQ909 LP-POTS channel units.

**Table 10-28. Transmission Specifications — VF Channel Units with Fixed Settings**

Parameter	Value (Measured at 25° C)		
	POTS	SPOTS <sup>®</sup> Unit	Coin
Loop Resistance (Beyond the HDT excluding the set)	0-1500 Ω	CSA Loops	0-1500 Ω
Loop Current	> 20 mA	> 23 mA	
1,000-Hz Loss (±0.5dB typical, ±1.0dB max)	1 dB ( $R_{EXT} \leq 1,100 \pm 100$ ) * 0 dB ( $R_{EXT} \geq 1,100 \pm 100$ ) *	0 dB †	
Bandwidth (Relative to the 1,000-Hz loss)	0 to -3.0 dB at 300 Hz and 3,000 Hz 0 to -1.5 dB at 400 Hz and 2,800 Hz		
Return Loss at the COT ‡	ERL ≥ 18 dB, SRL ≥ 12 dB		
Return Loss at the HDT §	ERL ≥ 18 dB, SRL ≥ 15 dB		
Idle Channel Noise (at the HDT)	20 dBmC Maximum		
Signal-to-Distortion Ratio (at -10 dBm)	> 33 dB		
Dial Pulse Distortion [Peak to Average Ratio (PAR)]	> 90		
Gain Tracking (1,004 Hz) -37 dBm0 to +3 dBm0 -50 dBm0 to -37 dBm0	±0.5 dB Maximum (±0.25 dB Average) ±1.0 dB Maximum (±0.5 dB Average)		
See footnotes at end of table.		<b>Continued on next page</b>	

**Table 10-28. Transmission Specifications — VF Channel Units with Fixed Settings — *Continued***

Parameter	Value (Measured at 25° C)		
	POTS	SPOTS® Unit	Coin
Intermodulation Distortion (-13 dBm0 Input)	A-B (R2) Product: > 43 dB 2A-B (R3) Product: > 44 dB		
Single Frequency Distortion (0-12 kHz 0 dBm0)	< -28 dBm0		
Impulse Noise ¶	≤ 15 Counts in 15 Minutes		
Overload at COT and HDT	≥ + 3 dBm0		
Longitudinal Balance at the HDT ** (Minimum)	200 Hz, 500 Hz, 1,000 Hz: ≥ 58 dB 3,000 Hz: ≥ 53 dB		
<p>* Measured as insertion loss between 900-ohm terminations. R<sub>EXT</sub> includes both the loop resistance and the station set resistance. Actual threshold value for R<sub>EXT</sub> is 1100 ohms ±100 ohms.</p> <p>† Measured as the ICL with the HDT terminated in 600 ohms and with the COT terminated in 900 ohms.</p> <p>‡ Measured with respect to 900 ohms and 2.16 μF with the 4-wire path broken or with the other end terminated in 1,100 ohms in parallel with 0.03 μF.</p> <p>§ Measured with respect to 600 ohms and 2.16 μF with the 4-wire path broken or with the other end terminated in 900 ohms and 2.16 μF.</p> <p>¶ Measured with a holding tone of -13 dBm0 and a threshold of 59 dBmC0.</p> <p>** Measured by Institute of Electrical and Electronics Engineers (IEEE) method 455-1976.</p>			

**Table 10-29. Transmission Specifications — Multiparty and FSR Channel Units**

Parameter	Value (Measured at 25° C)	
	Multiparty**	FSR
Loop Resistance (Beyond the HDT excluding the set)	0-1500 Ω	0-900 Ω
1,004 Hz On-Hook Loss	≤ 5 dB over 1004 Hz	On-hook transmission not supported
	Off-Hook Loss	
Loop Current	> 20 mA	
1000-Hz Loss (±0.5 dB typical, ±1.0 dB max)	1 dB	
Bandwidth (Relative to the 1,004-Hz loss) *	-0.5 to +1.0 dB at 400 Hz and 2,800 Hz	
Return Loss at the COT †	ERL ≥ 18 dB, SRL ≥ 10 dB	
Return Loss at the HDT ‡	ERL ≥ 18 dB, SRL ≥ 10 dB	
Idle Channel Noise (at the HDT)	20 dBmC Maximum	
Signal-to-Distortion Ratio (at -10 dBm)	> 33 dB	
Dial Pulse Distortion [Peak to Average Ratio (PAR)]	> 90	
Gain Tracking (1,004 Hz) -37 dBm0 to +3 dBm0 -50 dBm0 to -37 dBm0	±0.5 dB Maximum (± 0.25 dB Average) ± 1.0 dB Maximum (± 0.5 dB Average)	
Intermodulation Distortion (-13 dBm0 Input)	A-B (R2) Product: > 43 dB 2A-B (R3) Product: > 44 dB	
Single Frequency Distortion (0-12 kHz 0 dBm0)	< -28 dBm0	
Impulse Noise §	≤ 15 Counts in 15 Minutes	
See footnotes at end of table.	<b><i>Continued on next page</i></b>	

**Table 10-29. Transmission Specifications — Multiparty and FSR Channel  
 Units—Continued**

Parameter	Value (Measured at 25° C)	
	Multiparty**	FSR
Overload at COT and HDT	≥ + 3 dBm0	
Longitudinal Balance at the HDT (Minimum)¶	200 Hz, 500 Hz, 1,000 Hz: ≥ 58 dB 3,000 Hz: ≥ 53 dB	
* Measured with a signal level of 0 dBm0. + means more loss, – means less loss. † Measured with respect to 900 ohms and 2.16 μF and with 900 ohms in series with 2.16 μF in parallel with a hold coil at the HDT. ‡ Measured with respect to 900 ohms in series with 2.16 μF with a hold coil at the HDT and with –48 V battery feed terminated with 900 ohms in series with 2.16 μF at the COT. § Measured with a holding tone of –13 dBm0 at a threshold of 59 dBmC0. ¶ Measured by IEEE Method 455-1976. ** MSDT does not support positive ringing.		

**Table 10-30. Transmission Specifications — AUA45 Dual Ringing Repeater Channel Unit**

<b>Parameter</b>	<b>Value (Measured at 25° C)</b>
Loop Design	The AUA45 channel unit is not limited to CSA design rules. Maximum cable loss should not exceed 9 dB, split in any proportion between the two end cable links. Total combined loop resistance (not including the terminating equipment) should not exceed 1500 ohms.
Structural Impedance	900 ohms +2.16 $\mu$ F
Balance Impedance	900 ohms +2.16 $\mu$ F
1,000-Hz Loss * ( $\pm$ 0.5 dB typical, $\pm$ 1.0 dB max)	0 dB or 3 dB (switch selectable)
Bandwidth (Relative to the 1000-Hz loss)	+1 to -0.5 dB at 400 Hz and 2,800 Hz
Return Loss† (end-to-end)	ERL $\geq$ 26 dB, SRL $\geq$ 20 dB
Idle Channel Noise ‡	20 dBrnC Maximum
Signal-to-Distortion Ratio (at -10 dBm)	> 33 dB
Peak to Average Ratio (PAR) (dial pulse distortion) at -13 dBm	> 90
Gain Tracking (1,004 Hz) -37 dBm0 to +3 dBm0 -50 dBm0 to -37 dBm0	$\pm$ 0.5 dB Maximum $\pm$ 1.0 dB Maximum
Intermodulation Distortion (-13 dBm0 Input)	A-B (R2) Product: > 43 dB 2A-B (R3) Product: > 44 dB
Single Frequency Distortion (0-12 kHz 0 dBm0)	< -28 dBm0
Impulse Noise at 47 dBrnC0	$\leq$ 15 Counts in 15 Minutes
Overload at COT and HDT	at + 3 dBm0 is $\leq$ 0.5 dB compression
See footnotes at end of table.	<b><i>Continued on next page</i></b>

**Table 10-30. Transmission Specifications — AUA45 Dual Ringing Repeater Channel Unit—Continued**

Parameter	Value (Measured at 25° C)
Longitudinal Balance at the HDT (Minimum)¶	200 Hz, 500 Hz, 1,000 Hz: ≥ 58 dB 3,000 Hz: ≥ 53 dB
Equal-Level Cross talk	Better than -65 dB (200 Hz to 3,400 Hz)
<p>* Measured as insertion loss between 900-ohm terminations.</p> <p>† Measured with respect to 900 ohms and 2.16 μF with the opposite end terminated in 900 ohms in series with 2.16 μF.</p> <p>‡ Measured with 900-ohm terminations on both ends.</p> <p>¶ Measured with IEEE method 455-1976.</p>	

**Table 10-31. Transmission Specifications — VF Channel Units with Adjustable Settings**

<b>Parameter</b>	<b>2-Wire E SPOTS® CUs(AUA42, AUA43)</b>	<b>4-Wire CUs (AUA41, AUA44, AUA54)</b>
Loop Resistance (beyond HDT, excluding telset)	CSA loops	0-2800 ohms (loop start, ground-start) 0-5000 ohms (DX)
<b>Gain Range (Granularity)</b>		
Metallic Interface to digital line	-1.0 dB to 6.75 dB (in 0.25-dB steps)	Range depends on function code
Digital line to metallic interface	-8.0 dB to 1.5 dB (in 0.25-dB steps)	Granularity = 0.1 dB
<b>Gain Tracking</b>		
Input -37 to +3 dBm	± 0.25 dB	± 0.25 dB
Input -50 to -37 dBm	± 0.50 dB	± 0.50 dB
Equalization	(Slope type) Equalized CSA cable roll-off at 0.4 kHz varies from 0.0 dB to 1.1 dB; at 2.8 kHz, roll-off varies from 0.3 dB to 1.75 dB	Post-equalization of cable less than 15 dB (H88) or 18 kft (NL) is comparable to D4 4FXS CU (J98726SB). Pre-equalization and post-equalization available by emulating 150-ohm mismatch.
<b>Structural Impedance</b>	600 ohms + 2.16 µF or 900 ohms + 2.16 µF	600 ohms or 1200 ohms
ERL/SRL (2-wire return loss with 4-wire path broken)	28/20 dB	
RL (any Hz) / RL (1 kHz)		23/28 dB
Balance Capability, CSA loops	ERL better than 12 dB at digital line interface of channel unit facing loop	—
<b>Longitudinal Balance (IEEE method)</b>		
	<b>AUA42    AUA43</b>	
200 Hz	63 dB    58 dB	67 dB
500 Hz	63 dB    58 dB	67 dB
1,000 Hz	63 dB    58 dB	67 dB
	<b>Continued on next page</b>	

**Table 10-31. Transmission Specifications — VF Channel Units with Adjustable Settings—Continued**

<b>Parameter</b>	<b>2-Wire E SPOTS® CUs(AUA42, AUA43)</b>	<b>4-Wire CUs (AUA41, AUA44, AUA54)</b>
3,000 Hz	58 dB      58 dB	62 dB
Equal-Level Cross talk, C-message weighted between 0.2 and 3.4 kHz	-65 dB	-65 dB (channel unit) -65 dB (interunit cross talk)
Idle-Channel Noise	23 dBrc0 for AUA42/ AUA43 pair	20 dBrc0 per channel unit, each direction
Impulse Noise, no more than 15 counts in 15 minutes at	59 dBrc0	59 dBrc0
Signal Distortion (at -10 dBm)	> 33 dB	> 33 dB
Single-Frequency distortion 0 dBm0 input tone at any frequency from 0 to 12 kHz	-28 dBm0 for AUA42/ AUA43 pair	-28 dBm0 per channel unit
Intermodulation Distortion (IM) , -13 dBm0 input (IM products)	A-B (R2) < -43 dB 2A-B (R3) < -44 dB	R2 < -49 dB R3 < -51 dB
Pulse Distortion [Peak to Average Ratio (PAR)]	not less than 90	not less than 94

**Table 10-32. SPQ<sup>®</sup> 400 Electrical and Transmission Specifications**

<b>Parameter</b>	<b>Value</b>
Loop Resistance (excluding telset)	0 Ω to 900 Ω
Loop Current	20 mA (900 Ω loop) to 30 mA (0 Ω loop)
VF loss, off-hook, between CO and network interface (NIF) at customer location	4 to 8 dB
Nominal 1,000-Hz loss, <i>SPQ400</i> only: 0 Ω tip-to-ring 900 Ω loop resistance	6.0 dB 1.4 dB
VF loss, on-hook, between CO and NIF at customer location	9 dB to 13 dB
Return loss at COT (reference Z of 900 Ω + 2.16 μF, terminated with 900 Ω + 2.16 μF)	ERL > 18 dB SRL > 10 dB
Return loss at RT (reference Z of 900 Ω + 2.16 μF, CO terminated with 900 Ω + 2.16 μF)	ERL > 18 dB SRL > 10 dB
Structural impedance	900 Ω + 2.16 μF
Minimum longitudinal balance (measured by IEEE Method 455-1976)	200 Hz to 1,000 Hz: ≥ 58 dB 3,000 Hz: ≥ 53 dB
Idle channel noise, end-to-end	≤ 20 dBrnC
Frequency response (loss relative to 1,004 Hz) End-to-end  <i>SPQ400</i> only (1/2 channel)	400 Hz to 2,800 Hz: -0.5 dB to +1 dB 3200 Hz: -0.5 dB to +1.5 dB 300 Hz and 3,400 Hz: -0 dB to +3 dB  400 Hz to 2800 Hz: -0.25dB to + 0.5 dB 3,200 Hz: -0.25 dB to +0.75 dB 300 Hz and 3,400 Hz: -0 dB to +1.5 dB
	<b><i>Continued on next page</i></b>

**Table 10-32. SPQ<sup>®</sup> 400 Electrical and Transmission Specifications — *Continued***

Parameter	Value
60-Hz Rejection	> 20 dB
Cross talk (0-dBm0 input, 200 Hz to 3,400 Hz)	≤ -65 dBm0
Impulse noise at a threshold of 47 dBmCO for 15 minutes	≤ 15 counts
Data pulse distortion (PAR)	
- End-to-end	> 90
- SPQ400 only (1/2 channel)	≥ 94
Single frequency distortion with input of:	
- 0 Hz to 12 kHz, 0 dBm0	< -28 dBm0 at 0 Hz to 12 kHz
- 1,004 Hz to 1020 kHz, 0 dBm0	< -40 dBm0 at 0 Hz to 4,000 Hz
Signal-to-distortion with input of:	
- 0 dBm0 to -30 dBm0	> 33 dB
- -30 dBm0 to -40 dBm0	> 27 dB
- -40 dBm0 to -45 dBm0	> 22 dB
System generated tones 0 Hz < f < 16 kHz	< -50 dBm0
Gain tracking at 1,004 Hz, relative to 0 dBm0	
- -37 dBm0 to +3 dBm0	±0.5 dB maximum (±0.25 dB average)
- -50 dBm0 to -37 dBm0	±1.5 dB maximum (±0.5 dB average)

**Table 10-33. SPQ<sup>®</sup> 400 Environmental Specifications**

<b>Temperature Range (Ambient)</b>	
Operating	-40° to 85°C (-40° to 185°F)
Storage	-40° to 85°C (-40° to 185°F)
<b>Relative Humidity, Noncondensing</b>	
	5% to 95%

**Table 10-34. SPQ<sup>®</sup> 440 Electrical and Transmission Specifications**

<b>Parameter</b>	<b>Value</b>	
	<b>POTS</b>	<b>Special Services</b>
Loop resistance (excluding telset)	0 to 900 Ω	CSA
Loop current	20 mA to 30 mA	25 mA to 30 mA
VF loss, off-hook, between CO and network interface (NIF) at customer location	4 to 8 dB	2 to 5 dB
Nominal 1,000Hz loss, SPQ440 only: 0 Ω tip-to-ring Maximum loop resistance	6.0 dB 1.4 dB	3.4 dB 0 dB
VF loss, on-hook, between CO and NIF at customer location	9 dB to 13 dB	7 dB to 12 dB
Return loss at COT (reference Z of 900 Ω + 2.16 μF, terminated with 900 Ω + 2.16 μF for POTS or TR-57 CSA test loops for special services)	ERL > 18 dB SRL > 10 dB	ERL > 10 dB SRL > 5 dB
Return loss at RT (reference Z of 600 Ω + 2.16 μF, CO terminated with 900 Ω + 2.16 μF)	ERL > 22 dB SRL > 14 dB	ERL > 22 dB SRL > 14 dB

*Continued on next page*

**Table 10-34. SPQ<sup>®</sup> 440 Electrical and Transmission Specifications — *Continued***

<b>Parameter</b>	<b>Value</b>
	POTS and Special Services
Structural Impedance	600 ohms + 2.16 $\mu$ F
Minimum longitudinal balance (measured by IEEE Method 455-1976)	200 Hz to 1,000 Hz: $\geq 58$ dB 3,000 Hz: $\geq 53$ db
Idle channel noise, end-to-end	$\geq 20$ dBmC
<b>Frequency Response (Loss Relative to 1,004 Hz)</b>	
End-to-end	400 Hz to 2,800 Hz: $-0.5$ dB to $+1$ dB
	3,200 Hz: $-0.5$ dB to $+1.5$ dB
	300 Hz and 3,400 Hz: $-0$ dB to $+3$ dB
SPQ440 only (1/2 channel)	400 Hz to 2,800 Hz: $-0.25$ dB to $+0.5$ dB
	3,200 Hz: $-0.25$ dB to $+0.75$ dB
	300 Hz and 3,400 Hz: $-0$ dB to $+1.5$ dB
60 Hz Rejection	$> 20$ dB
Cross talk (0 dBm0 input, 200 Hz to 3,400 Hz)	$\leq -65$ dBm0
Impulse noise at a threshold of 47 dBmCO for 15 minutes	$\leq 15$ counts
Data pulse distortion (PAR)	
End-to-end	$> 90$
SPQ440 only (1/2 channel)	$\geq 94$
Single frequency distortion with input of:	
0 Hz to 12 kHz, 0 dBm0	$< -28$ dBm0 at 0 Hz to 12 kHz

***Continued on next page***

**Table 10-34. SPQ<sup>®</sup> 440 Electrical and Transmission Specifications — *Continued***

Parameter	Value
1,004 Hz to 1020 kHz, 0 dBm0	< -40 dBm0 at 0 Hz to 4,000 Hz
Signal-to-distortion with input of:	
0 dBm0 to -30 dBm0	> 33 dB
-30 dBm0 to -40 dBm0	> 27 dB
-40 dBm0 to -45 dBm0	> 22 dB
System generated tones 0 Hz < f < 16 kHz	< -50 dBm0
Gain tracking at 1,004 Hz, relative to 0 dBm0:	
-37 dBm0 to +3 dBm0	±0.5 dB maximum (±0.25 dB average)
-50 dBm0 to -37 dBm0	±1.5 dB maximum (±0.5 dB average)

**Table 10-35. SPQ<sup>®</sup> 440 Environmental Specifications**

<b>Temperature Range (Ambient)</b>	
Operating	-40° to 85°C (-40° to 185°F)
Storage	-40° to 85°C (-40° to 185°F)
<b>Relative Humidity, Noncondensing</b>	
5% to 95%	

**Table 10-36. SPQ<sup>®</sup> 909 Electrical and Transmission Specifications**

<b>Parameter</b>	<b>Value</b>
DC Supervisory Range (including telset)	450 $\Omega$
Loop Resistance (up to 500 ft. of AWG 22)	0 $\Omega$ to 20 $\Omega$
Loop Current	20 mA to 25 mA
Nominal 1,000-Hz VF loss off-hook between CO and RT CUs	4 dB
<i>SPQ909</i> alone	4 dB
Nominal 1,000-Hz VF loss off-hook between RT CUs and CO	2 dB
<i>SPQ909</i> alone	2 dB
Nominal 1,000-Hz VF loss on-hook between CO and RT CUs	5.5 dB
<i>SPQ909</i> alone	4 dB
Nominal 1,000-Hz VF loss on-hook between RT CUs and CO	3.5 dB
<i>SPQ909</i> alone	2 dB
Return loss at COT (reference Z of 900 $\Omega$ + 2.16 $\mu$ F, RT terminated with 600 $\Omega$ )	ERL > 18 dB SRL > 10 dB
Return loss at RT (reference Z of 600 $\Omega$ , CO terminated with 900 $\Omega$ + 2.16 $\mu$ F)	ERL > 26 dB SRL > 21 dB
Hybrid Balance of <i>SPQ909</i> (RT terminated with 600 $\Omega$ )	ERL > 26 dB SRL > 21 dB

*Continued on next page*

**Table 10-36. SPQ<sup>®</sup> 909 Electrical and Transmission Specifications — *Continued***

<b>Parameter</b>	<b>Value</b>
Output impedance (structural impedance, hybrid impedance)	600 $\Omega$
Minimum longitudinal balance (measured by IEEE Method 455-1985)	200 Hz to 1,000 Hz: $\geq 45$ dB 3,000 Hz: $\geq 40$ dB
Idle channel noise, end-to-end	$\leq 20$ dBnC
Frequency response (loss relative to 1,004 Hz)	
End-to-end	300 Hz to 3,000 Hz: $-0.5$ dB to $+1$ dB 3,200 Hz: $-0.5$ dB to $+1.5$ dB
SPQ909 alone	300 Hz to 3000 Hz: $-0.25$ dB to $+0.5$ dB 3200 Hz: $-0.25$ dB to $+0.75$ dB
60-Hz Rejection (loss relative to 1,004 Hz)	$> 20$ dB
Cross talk (0 dBm0 input, 200 Hz to 3,400 Hz)	$-65$ dBm0
Impulse noise at a threshold of 47 dBnCO for 15 minutes	$\leq 15$ counts
Data pulse distortion (PAR)	
End-to-end	$> 90$
SPQ909 alone	$\geq 94$
Single frequency distortion with input of:	
0 Hz to 12 kHz, 0 dBm0	$< -28$ dBm0 at 0 Hz to 12 kHz
1,004 Hz to 1,020 kHz, 0 dBm0	$< -40$ dBm0 at 0 Hz to 4000 Hz
Signal-to-distortion with input of:	
0 dBm0 to $-30$ dBm0	$> 33$ dB
$-30$ dBm0 to $-40$ dBm0	$> 27$ dB
$-40$ dBm0 to $-45$ dBm0	$> 22$ dB

***Continued on next page***

**Table 10-36. SPQ<sup>®</sup> 909 Electrical and Transmission Specifications — *Continued***

<b>Parameter</b>	<b>Value</b>
System generated tones 0 Hz < f < 16 kHz	< -50 dBm0
Gain tracking at 1004 Hz, relative to 0 dBm0:	
-37 dBm0 to +3 dBm0	±0.5 dB maximum (±0.25 dB average)
-50 dBm0 to -37 dBm0	±1.5 dB maximum (±0.5 dB average)
-55 dBm0 to -50 dBm0	±3.0 dB maximum (±1.5 dB average)

**Table 10-37. SPQ<sup>®</sup> 909 Environmental Specifications**

<b>Temperature Range (Ambient)</b>	
Operating	-40° to 85°C (-40° to 185°F)
Storage	-40° to 85°C (-40° to 185°F)
<b>Relative Humidity, Noncondensing</b>	
5% to 95%	

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# A SONET Overview



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## Contents

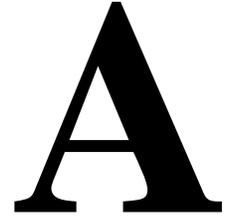
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# A SONET Overview



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## Overview

This section briefly describes the Synchronous Optical Network (SONET).

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## History

In the early 1980's, the American National Standards Institute (ANSI) recognized the need for an optical signal standard for future broadband transmission. The ANSI T1X1 subcommittee began working on optical signal and interface standards in 1984. In 1985, Telcordia Technologies proposed a network approach to fiber system standardization to T1X1. The proposal suggested a hierarchical family of signals whose rates would be **integer multiples** of a basic modular signal. The proposal further suggested a synchronous multiplexing technique, leading to the coining of the term *Synchronous Optical NETWORK* (SONET).

The International Telephone and Telegraph Consultative Committee (CCITT) first showed interest in 1986. Conferences held through 1987 and 1988 resulted in coordinated specifications for both the American National Standard (SONET) and the CCITT-International Standard, Synchronous Digital Hierarchy (SDH). Approval of both sets of standards occurred in late 1988.

## Basic Purpose

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The basic purpose of SONET is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in today's network as well as those planned for the future.

SONET currently defines standard rates and formats and optical interfaces. These and other related issues continue to evolve through the ANSI committees. SONET ultimately will permit an optical midspan meet in a multivendor environment.

The American National Standard defines the following:

- Optical parameters (*ANSI*\* T1.106-1988)
- Electrical parameters (*ANSI*/ T1.102-1993 Draft)
- Multiplexing schemes to map existing digital signals (for example, DS1, DS2, and DS3) into SONET payload signals (*ANSI*/ T1.105-1991)
- Criteria for optical line automatic protection switch (APS) (*ANSI*/ T1.105-1991)
- Overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions (*ANSI*/ T1.105-1991).

## Technical Overview

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### SONET Signal Hierarchy

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The SONET signal hierarchy is based on a basic "building block" frame called the synchronous transport signal - level 1 (STS-1), as shown in Figure A-1 on the following page. The STS-1 frame has a reoccurring rate of 8000 frames per second. Each frame is 125 microseconds.

The STS-1 frame consists of:

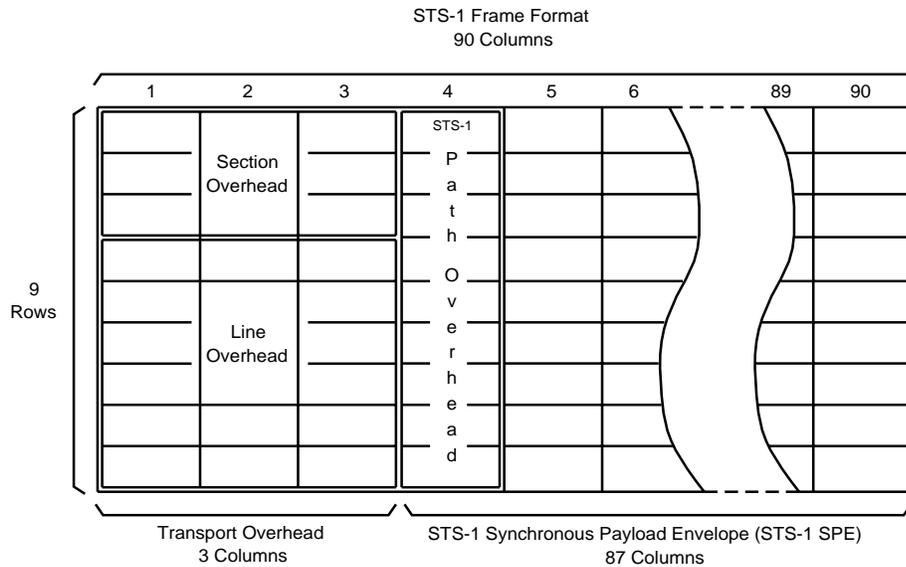
- 90 columns (each column is an 8-bit byte)
- 9 rows.

The STS-1 frame is transmitted serially starting from the left with row 1 column 1 on through column 90, then row 2 column 1 through 90, continuing on, row-by-row, until all 810 bytes (9 X 90) of the STS-1 frame have been transmitted.

Since each STS-1 frame consists of 810 bytes and each byte has 8 bits, the frame contains 6480 bits a frame. There are 8000 STS-1 frames per second, at the STS-1 signal rate of 51,840,000 (6480 X 8000) bits a second.

The first three columns in each of the nine rows carry the SECTION and LINE overhead bytes. Collectively, these 27 bytes are referred to as transport overhead.

The remainder of the frame, columns 4 through 90, is reserved for payload signals (for example, DS1, DS3, and path overhead) and is referred to as the STS-1 synchronous payload envelope (STS-1 SPE). The optical counterpart of the STS-1 is the optical carrier level 1 signal (OC-1), which is the result of a direct optical conversion. The electrical counterpart of the STS-1 is the electrical carrier level 1 signal (EC-1).



**Figure A-1. SONET STS-1 Frame — Simplified Version**

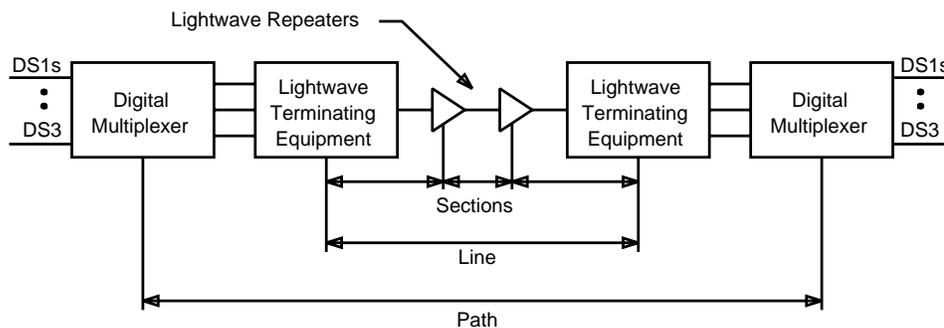
## SONET Layers

---

SONET divides its processing functions into three layers. These three layers are associated with equipment that reflects the natural divisions in network spans.

Figure A-2 shows these defined layers in a signal path. They include:

- **SECTION** and **Section Terminating Equipment** - the transmission spans between lightwave terminating equipment and the regenerators. The spans between the regenerators are also considered sections. Section terminating equipment provides regenerator functions and terminates the section overhead to provide single-ended operations and section performance monitoring.
- **LINE** and **Line Terminating Equipment** - the transmission span between terminating equipment (STS-1 cross-connections) that provides line performance monitoring. If there are no intervening repeaters, the line terminating equipment also functions as section terminating equipment.
- **STS-1 and VT Path** and **Path Terminating Equipment** - the transmission span for an end-to-end tributary (DS1 or DS3) signal that provides functions including signal labeling and path performance monitoring for signals as they are transported through a SONET network. STS-1 path terminating equipment can also provide cross-connections for lower rate (that is, DS1) signals. A virtual tributary (VT) is a sub-DS3 payload and is described later in more detail.

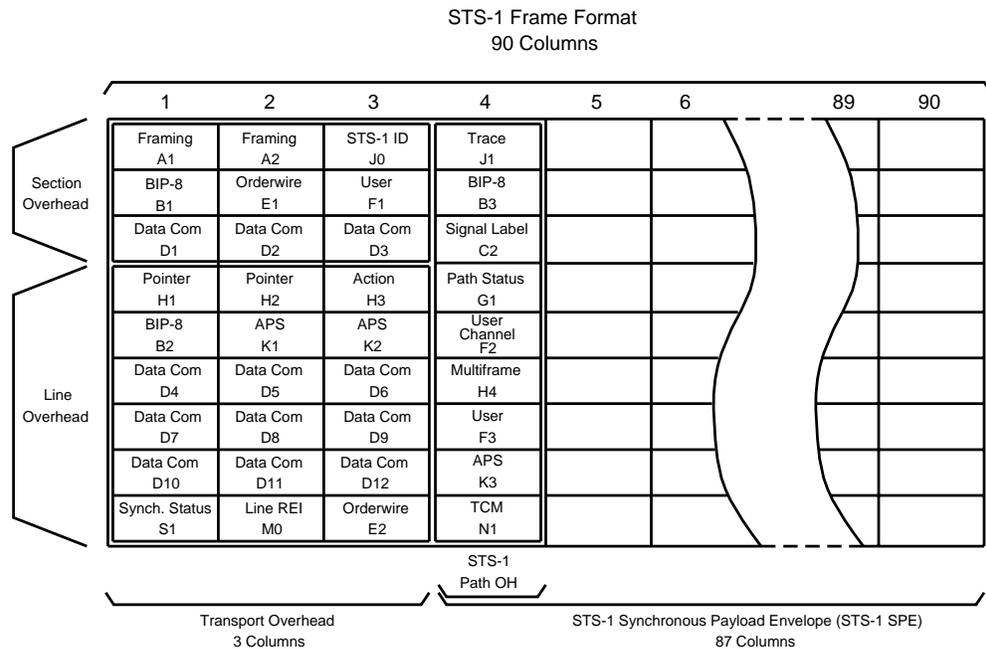


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**Figure A-2. Section, Line, and Path Definitions**

Each SONET layer has a set of overhead bytes as shown in Figure A-3. These bytes carry information used by various network elements.

- **Section Overhead** contains information that is used by all SONET equipment including repeaters.
- **Line Overhead** is used by all SONET equipment except repeaters.
- **Path Overhead** is carried within the payload envelope.
  - **STS-1 path overhead** remains with the STS-1 SPE until its asynchronous signal is extracted (for example, DS-3) or until its individual VT1.5 signals are demultiplexed.
  - **VTN (N= 1.5, 2, 3, or 6) path overhead** remains with the VTN until its asynchronous signal is extracted.



**Figure A-3. SONET Frame Format**

## **SONET Frame Structure**

---

The following pages provide more detailed information on the function of various overhead bytes for each SONET layer.

### **Section Overhead**

---

- Framing (A1, A2)
  - Provides framing for each STS-1.
- STS-1 ID (J0)
  - Provides the order of appearance in a byte-interleaved STS-*N* frame; for example, STS-1 #1, STS-1 #2.....STS-1 #48. In future applications, this byte will provide a section trace function. For information on STS-*N* signals, see the "Higher Rate Transport" part of this section.
- Section Bit-Interleaved Parity (BIP-8) (B1)
  - Provides SECTION performance monitoring and is calculated over all bits of the previous STS-*N* frame. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Orderwire (E1)
  - Provides a local orderwire for voice communication channel between section terminating network elements, such as repeaters. Defined only for STS-1 #1 of an STS-*N* signal.
- Section User Channel (F1)
  - Set aside for the user's purpose. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Data Communications Channel (D1, D2, D3)
  - Is a 192 kb/s message-based channel. Used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment. Defined only for STS-1 #1 of an STS-*N* signal.

## Line Overhead

---

- Line Pointer (H1, H2)
  - Two bytes indicate the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).
- Pointer Action (H3)
  - One byte is allocated for frequency justification.
- Line Bit-Interleaved Parity (BIP-8) (B2)
  - This byte is for line performance monitoring. This byte is provided in all STS-1 signals within an STS-*N* signal.
- Line Automatic Protection Switching (APS) (K1, K2)
  - Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF). Defined only for STS-1 #1 of an STS-*N* signal.
- Line Data Communications Channel (D4 - D12)
  - Is a 576 kb/s message-based channel.
- Synch. Status (S1)
  - In STS-1 #1, the S1 byte is for synchronization status messages, and only bits 5 through 8 are used.
- Line REI (M0)
  - The M0 byte is for STS-1 line far-end block error (FEBE), and only bits 5 through 8 are used.
- Line Orderwire (E2). Defined only for STS-1 #1 of an STS-*N* signal.
  - One byte is allocated to be used as an express orderwire between line terminating equipment.

## Path Overhead

---

There are two types of path overheads:

- STS-1 path overhead
- VT path overhead.

### STS-1 Path Overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is extracted and is used for functions that are necessary to transport all synchronous payload envelopes.

- STS-1 Path Trace (J1)
  - Repetitively transmits a 64 byte, fixed length, string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.
- STS-1 Path Bit-Interleaved Parity (BIP-8) (B3)
  - Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.
- STS-1 Path Signal Labels (C2)
  - Indicates the construction of the STS-1 SPE. A value of 00000000 indicates an unequipped STS-1 SPE. Values for various payload mappings are defined in TR-NWT-000253, Issue 2.
- STS-1 Path Status (G1)
  - Conveys the STS-1 path terminating status, far end block errors (FEBE), and yellow alarm signal conditions back to an originating STS-1 path terminating equipment.
- STS-1 Path User Channel (F2, F3)
  - User communication channel between Path elements.
- VT Multiframe Indicator (H4)
  - Provides a general multiframe indicator for VT-structured payloads.
- STS-1 Path Automatic Protection Switching (K3)
  - Path Automatic Protection Switching
- TCM - Tandem Connection Maintenance (N1)
  - Bits 1-4 used for incoming error monitoring. Bits 5-8 used as communications channel.

## VT Path Overhead

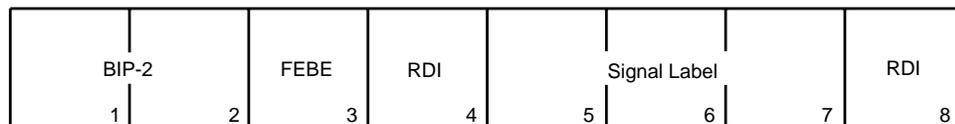
There is one byte of VT path overhead called V5. It occurs on every fourth frame; that is, 2000 times a second.

This byte provides for VT paths the same functions that B3, C2, and G1 provide for STS paths, namely:

- Error checking
- Signal label
- Path status.

The bit assignments of the VT path overhead are specified in the following list and are illustrated in Figure A-4:

- Bits 1 and 2 are used for error performance monitoring (BIP-2).
- Bit 3 is a VT path far-end-block-error (FEBE) indication that is sent back toward an originating VT PTE when errors are detected by the BIP-2.
- Bit 4 and Bit 8 are used for remote defect indication (RDI)
- Bits 5 through 7 provide a VT signal label.



VT Path Signal Label Coding:

0 0 0	Unequipped
0 0 1	Equipped-Nonspecific

---

**Figure A-4. VT Path Overhead Byte**

## **SONET Multiplexing Procedure**

---

SONET has provisions for multiplexing asynchronous DS1s, synchronous DS1s, and asynchronous DS3s. Refer to Figure A-5 and Figure A-6.

The first stage in multiplexing is mapping the input DS1 or DS3 tributary. In the case of DS1 inputs, three time slots (DS0s) are added to the incoming signal thus becoming a VT1.5. An asynchronous DS1 that fully meets the specified rate is mapped into the VT1.5 SPE as clear channel input since no framing is needed.

- Each VT1.5 carries a single DS1 payload.
- Four VT1.5s are bundled into a VT group (VT-G).
- Seven VT-Gs are byte-interleaved into an STS-1 frame.

The VT-G to-STS-1 multiplex is a simple byte-interleaving process, so individual VT signals are easily observable within the STS-1. Thus, cross-connections and add/drop can be accomplished without the back-to-back multiplexing/multiplexing steps required by asynchronous signal formats. The structured VTs are now multiplexed into the STS-1 SPE, and the path, line, and section overhead are added. The final multiplexing, as shown in Figure A-5, provides the scrambled STS-*N* signal to the optical conversion stage.

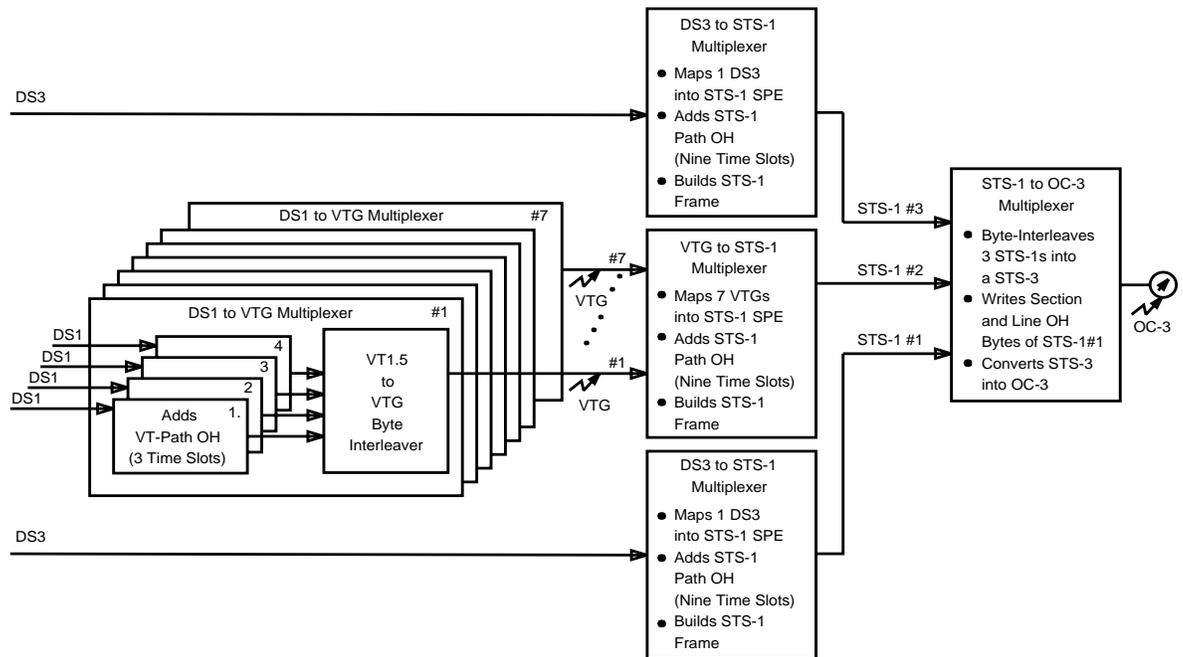


Figure A-5. SONET Multiplexing Procedure

## SONET Demultiplexing Procedure

As shown in Figure A-6, demultiplexing is the inverse of multiplexing. The unscrambled STS-1 signal from the optical conversion stages is processed to extract the section and line overhead and accurately locate the SPE. The next stage processes the path overhead and demultiplexes the VTs. A standard DS3 signal will be provided to the asynchronous network after path overhead processing. For DS1 signals, the individual DS1 VTs are then processed to extract VT overhead and, via the VT pointer, accurately locate the DS1 SPE. Finally, desynchronization of the DS1 SPE provides a standard DS1 signal to the asynchronous network.

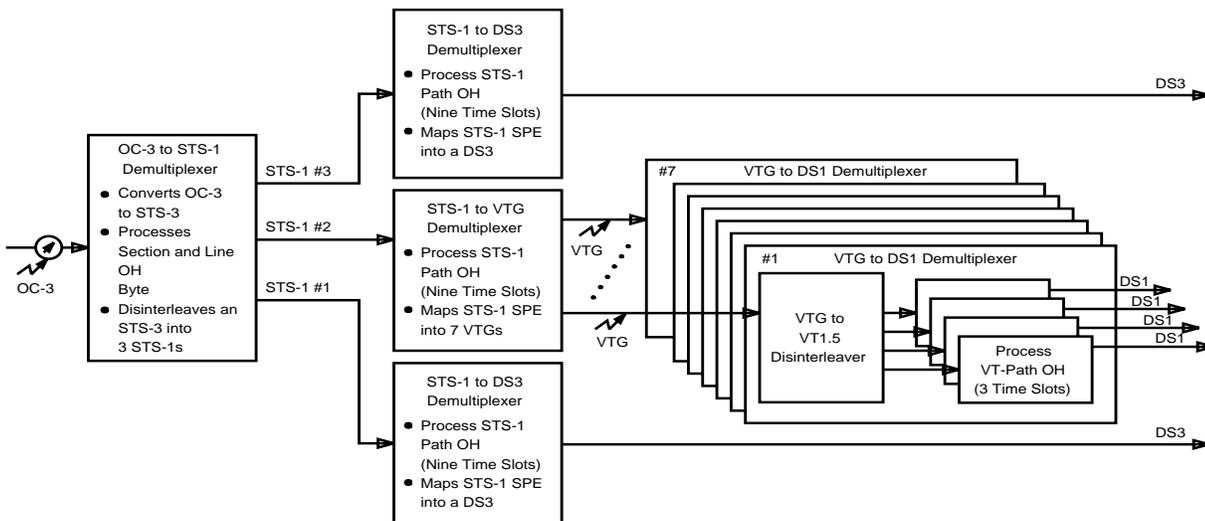
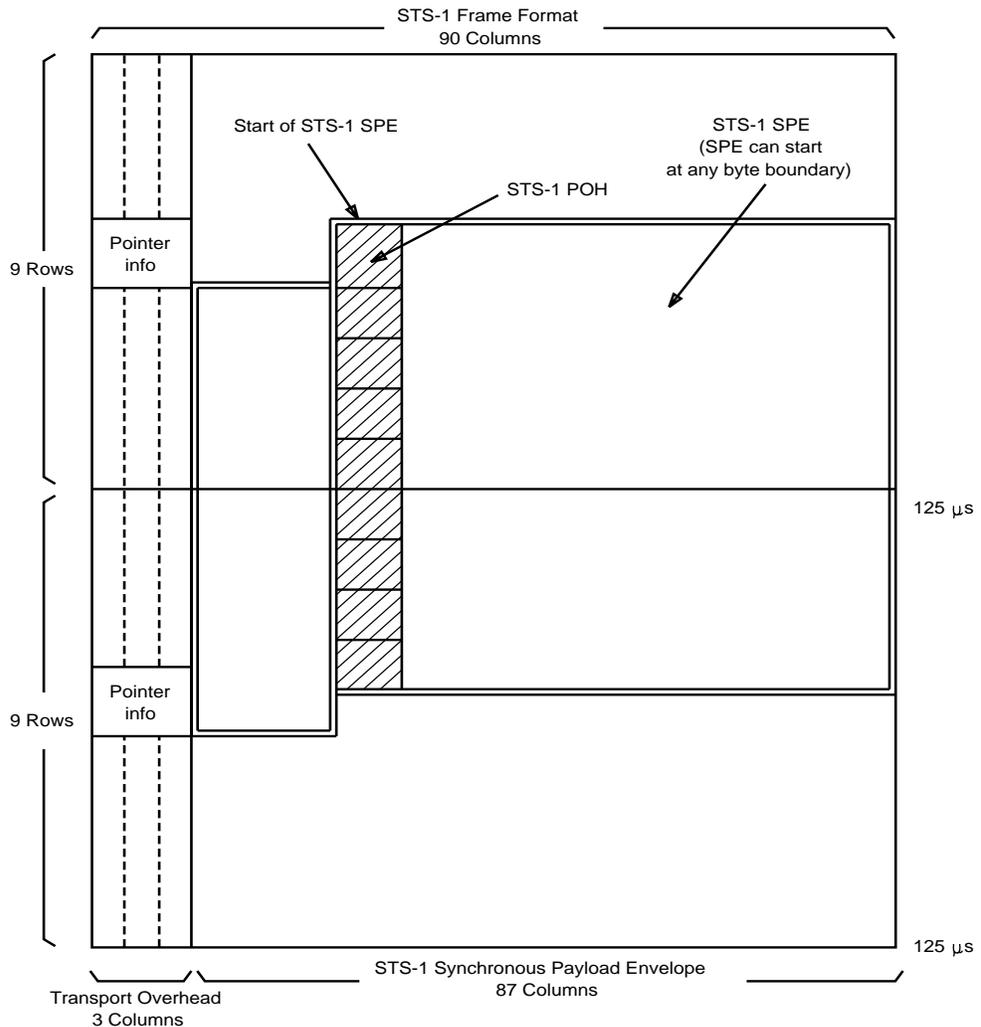


Figure A-6. SONET Demultiplexing Procedure

Two key points should be noted at this time. First, the SONET frame is a fixed time (125  $\mu$ s) and no bit-stuffing is used. Second, as shown in Figure A-7, the synchronous payload envelope can *float* within the frame using byte-stuffing. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing). The SPE can also drift across the 125- $\mu$ s frame boundary. SONET STS pointers are used to locate the SPE relative to the transport overhead.



**Figure A-7. STS-1 Synchronous Payload Envelope in Interior of STS-1 Frame**

## SONET Digital Multiplexing Schemes

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### Asynchronous Multiplexing

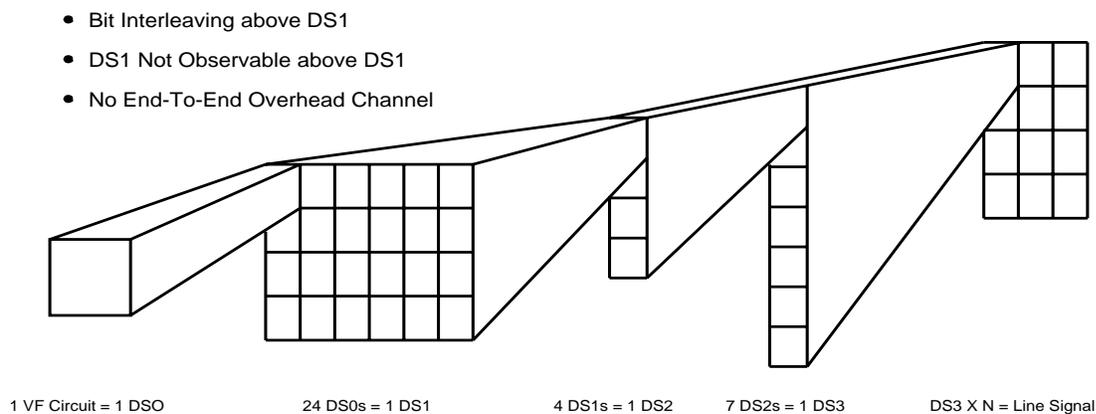
Currently, fiber optic facilities are primarily used to carry DS3 signals. The DS3 signal consists of a combination of the following payload signals:

- 28 DS1s
- 14 DS1Cs
- 7 DS2s.

Typically, 28 DS1 signals are multiplexed into a DS3 signal, using an M13 format. Refer to Figure A-8. M13 format is a process that includes bit-interleaving four DS1 into a DS2 signal and then bit-interleaving seven DS2 signals into a DS3. The DS3 rate is not a direct multiple of the DS1 or the DS2 rates due to the bit-stuffing synchronization technique used in asynchronous multiplexing.

Identification of DS0s contained in any DS-*N* signal, except DS1, is complex and DS0s cannot be directly extracted. Thus, an asynchronous DS3 signal must be demultiplexed down to the DS1 level to access and cross-connect DS0 and DS1 signals.

Another disadvantage of the M13 format is there is no end-to-end overhead channel for use by OAM&P groups.



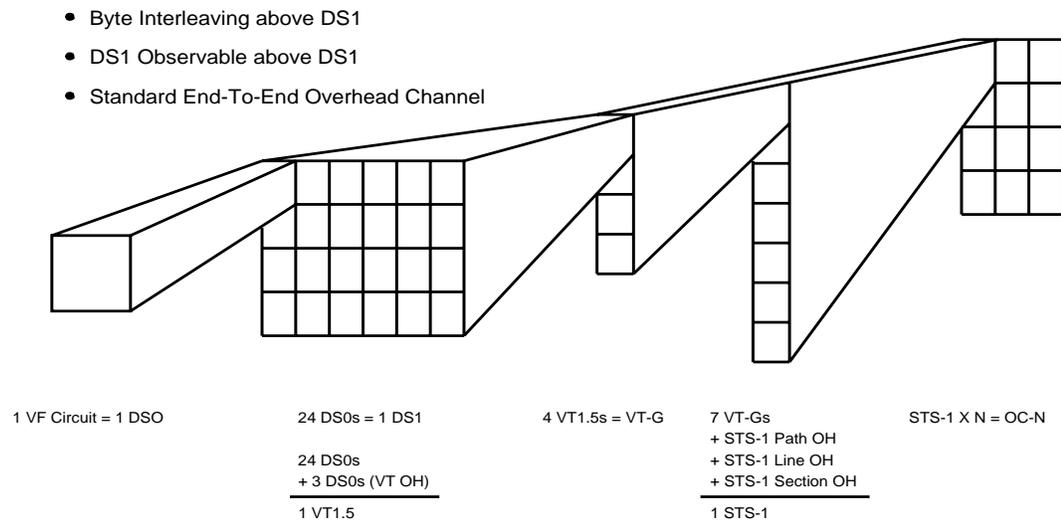
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**Figure A-8. Asynchronous Multiplexing**

## Synchronous Multiplexing

SONET's method of *byte-interleaving* DS1s to a higher signal rate permits economical extraction of a single DS1 without the need to demultiplex the entire STS-1 SPE. In addition, SONET provides overhead channels for use by OAM&P groups.

In SONET, a single asynchronous DS3 signal is mapped into an STS-1 SPE (Figure A-9).



**Figure A-9. Synchronous Multiplexing**

## Virtual Tributary Signals

Sub-DS3 asynchronous signals (DS1, DS1C, DS2 and E1) are *byte-interleaved* into a digital signal called a virtual tributary (VT). The VT is a structure designed for the transport and switching of sub-DS3 payloads. Like the STS-1 signal, the VT signal has a floating pointer that allows each VT SPE to move within the VT structure. There are four sizes of virtual tributaries (VT1.5, VT2, VT3, VT6). Higher rate payloads are transported as one or more concatenated STS-1 signals.

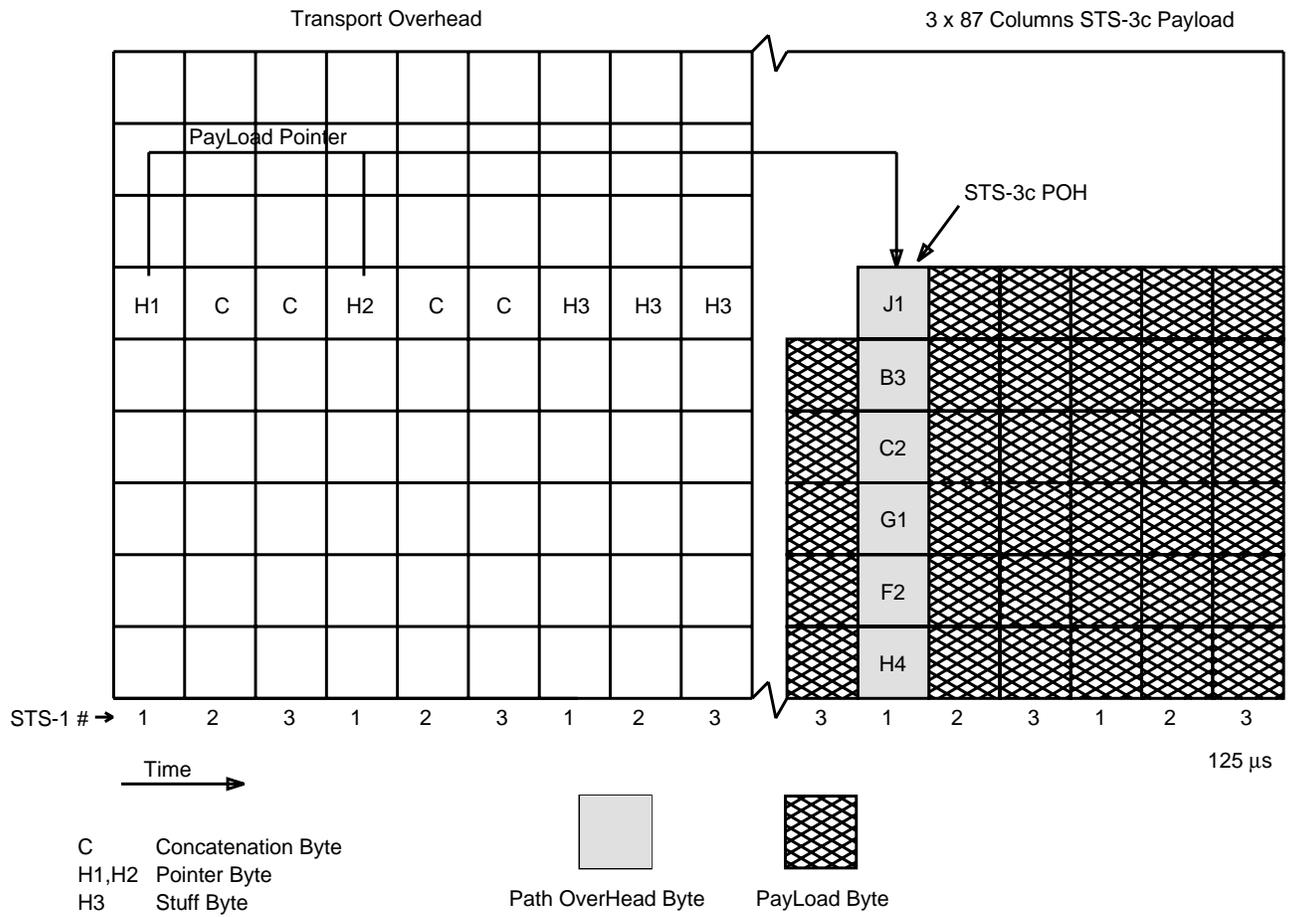
## **Concatenated Mode**

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For services requiring multiples of the STS-1 rate, STS-1 path payloads may be shared to create a single broadband payload called a concatenated STS-*N<sub>c</sub>* (OC-*N<sub>c</sub>*). STS-1 signals are mapped into an STS-*N<sub>c</sub>* SPE and transported as a concatenated STS-*N<sub>c</sub>* signal. This STS-*N<sub>c</sub>* signal can be carried by an STS-*N* or OC-*N* (or higher level) line signal.

The STS-*N* signal is multiplexed, switched, and transported through the network as a single entity. A concatenation indicator, used to show that the STS-1s of the STS-*N<sub>c</sub>* signal are linked together, is contained in the STS-1 payload pointer of all but the first STS-1. The line and section overhead is sent on the first STS-1 and the payload pointer for the first STS-1 is applied to all STS-1 signals in the concatenated signal.

Figure A-10 shows an example of an STS-3c SPE. It consists of 3 x 87 columns and 9 rows of bytes. The order of transmission is row by row, from left to right.



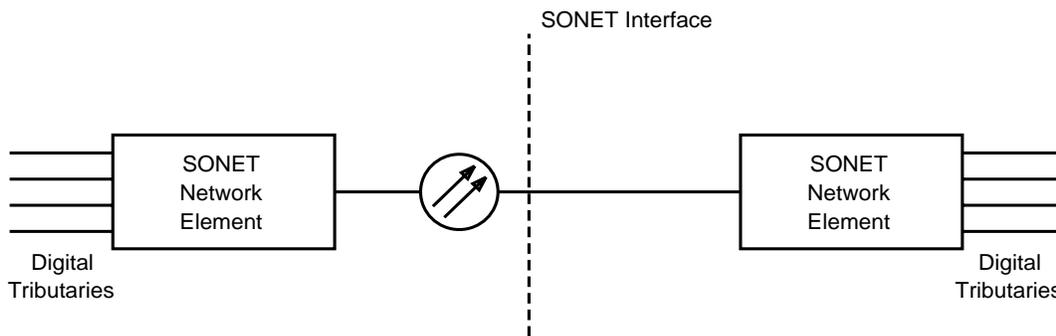
**Figure A-10. STS-3c Concatenated Payload**

## SONET Interface

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The SONET interface (Figure A-11) provides the optical midspan meet between SONET network elements. A SONET network element is the hardware and software that processes one or more layers of the SONET signal.

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Standard optical interconnect at SONET interface

Family of standard rates at  $N \times 51.84$  Mb/s  
[Synchronous Transport Signal (STS-1)]

Overhead channels defined for interoffice operations  
and maintenance functions

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**Figure A-11. SONET Interface**

## SONET Payloads

---

Table A-1 shows the digital signals that can be transported as SONET payloads.

**Table A-1. SONET Payloads**

<b>Input</b>	<b>Equivalent</b>		<b>SONET</b>	
<b>Tributary</b>	<b>Channels</b>	<b>Rate</b>	<b>Signal</b>	<b>Rate</b>
DS1	24 DS0s	1.544 Mb/s	VT1.5	1.728 Mb/s
E1 (CEPT)	32 DS0s	2.048 Mb/s	VT2	2.304 Mb/s
DS1C	48 DS0s	3.152 Mb/s	VT3	3.456 Mb/s
DS2	96 DS0s	6.312 Mb/s	VT6	6.912 Mb/s
DS3	672 DS0s	44.736 Mb/s	STS-1	51.840Mb/s
DS4NA	2016 DS0s	139.624 Mb/s	STS-3c	150.336Mb/s
ATM		149.76 Mb/s	STS-3c	150.336Mb/s
FDDI		125.00 Mb/s	STS-3c	150.336Mb/s
Future payloads		up to 150 Mb/s		
Future broadband payloads		Greater than 150 Mb/s		

DS1 and DS3 signals are the most important of these signals in the current network. Broadband payloads, such as asynchronous transfer mode (ATM) and fiber distributed data interface (FDDI), with rates of 150 Mb/s and higher, are also important. Other payloads may be defined for specific applications.

## Higher Rate Transport

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Higher rate SONET signals are created by byte-interleaving  $N$  STS-1 to form an STS- $N$  signal. The STS- $N$  is then scrambled and converted to an optical carrier - level  $N$  (OC- $N$ ) signal. The OC- $N$  has a line rate of exactly  $N$  times the OC-1 signal (see Table A-2).

**Table A-2. SONET Transport Rates**

OC Level	Line Rate (Mb/s)	Capacity
OC-1	51.84	28 DS1s or 1 DS3
OC-3	155.52	84 DS1s or 3 DS3s
OC-9	466.56	252 DS1s or 9 DS3s
OC-12	622.08	336 DS1s or 12 DS3s
OC-18	933.122	504 DS1s or 18 DS3s
OC-24	1244.16	672 DS1s or 24 DS3s
OC-36	1866.24	1008 DS1s or 36 DS3s
OC-48	2488.32	1344 DS1s or 48 DS3s

## Conclusion

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The intent of this section is to present a short overview of SONET. More detailed expositions can be found in various literature. An excellent description of SONET can be found in Reference 3.

### **REFERENCES**

1. *ANSI T1.106-1988* •American National Standard for Telecommunications - Digital Hierarchy Optical Interface Specifications, Single Mode,• and *ANSI T1.105-1991* •American National Standard for Telecommunications - Digital Hierarchy Optical Rates and Formats Specification.•
2. CCITT Recommendations G.707, G.708, G.709.
3. R. Ballert and Y. C. Ching, •SONET: Now It's the Standard Optical Network,• *IEEE Communications Magazine*, Vol. 27, No. 3 (March 1989): 8-15.
4. *ANSI T1.102-1993 Draft* •American National Standard for Telecommunications - Digital Hierarchy Electrical Interface Specifications.•



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# Glossary

## **0x1**

See Ring (0x1) Low-Speed Interface.

## **1+1**

The 1+1 protection switching architecture protects against failures of the optical transmit/receive equipment and their connecting fiber facility. One bidirectional interface (two fibers plus associated OLIUs on each end) is designated "service," and the other is designated "protection." In each direction, identical signals are transmitted on the service and protection lines ("dual-fed"). The receiving equipment monitors the incoming service and protection lines independently, and selects traffic from one line (the "active" line) based on performance criteria and technician/OS control. In 1+1 both service and protection lines could be active at the same time. Also referred to as linear (1+1) low speed interface.

## **1xN, 1x1**

1xN protection switching pertains to circuit pack protection that provides a redundant signal path through the DDM-2000 (it does not cover protection switching of an optical facility; see "1+1"). In 1xN switching, a group of N service circuit packs share a single spare protection circuit pack. 1x1 is a special case of 1xN, with N=1. In 1x1 only one is active at a time.

## **2B1Q**

2 - Binary, 1 - Quaternary. This means that the input voltage level can be one of 4 distinct levels (**Note:** 0 Volts is not a valid voltage under this scheme). These levels are called Quaternaries. Each quaternary represents 2 data bits, since there are 4 possible ways to represent 2 bits.

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# A

## **ABN**

Abnormal (status condition)

## **ACO**

Alarm Cutoff — A pushbutton switch available on the user panel that can be used to retire an audible office alarm.

## **ACO/TST**

Alarm Cutoff and Test — The name of a pushbutton on the user panel.

## **Active**

Active identifies a 1+1 protected OC-N line which is currently selected by the receiver at either end as the payload carrying signal or a 1x1 or 1xn protected circuit pack that is currently carrying service. (See Standby.)

## **ADM**

Add/Drop Multiplexer

**AGNE**

Alarm Gateway Network Element — A defined NE in an alarm group through which members of the alarm group exchange information.

**AIS**

Alarm Indication Signal — A code transmitted downstream in a digital network that shows that an upstream failure has been detected and alarmed.

**AMI**

Alternate Mark Inversion — A line code that employs a ternary signal to convey binary digits, in which successive binary ones are represented by signal elements that are normally of alternating, positive and negative polarity but equal in amplitude, and in which binary zeros are represented by signal elements that have zero amplitude.

**ANSI**

American National Standards Institute

**APS**

Automatic Protection Switch

**ARM**

Access Resource Module

**AS&C**

Alarm, Status, and Control

**ASCII**

American Standard Code for Information Interchange — A standard 8-bit code used for exchanging information among data processing systems and associated equipment.

**ASN.1**

Abstract Syntax Notation 1

**ASNE**

Alarm Server Network Element

**ATM**

Asynchronous Transfer Mode

**Auto**

Automatic — One possible state of a DS1 or DS3 port. In this state, the port will automatically be put "in service" if a good signal is detected coming from the DSX panel.

**Automatic Protection Switch**

A protection switch that occurs automatically in response to an automatically detected fault condition.

**Automatic Synchronization Reconfiguration**

A feature that allows another synchronization source to be automatically selected and the synchronization source provisioning to be automatically reconfigured in the event of a synchronization source failure or network synchronization change, for example, a fiber cut.

**AUXCTL**

Auxiliary Control — The name of the slot to the left of the SYSCTL slot on the DDM-2000 OC-3 and FiberReach wideband shelves and to the right of the SYSCTL slot on the DDM-2000 OC-12 shelf.

**Available Time**

In performance monitoring, the 1-second intervals.

---

**B**

**B3ZS**

Bipolar 3-Zero Substitution — A line coding method that replaces a string of three zeros with a sequence of symbols having some special characteristic.

**B8ZS**

Bipolar 8-Zero Substitution — A line coding method that replaces a string of eight zeros with a sequence of symbols having some special characteristic.

**Backbone Ring**

A host ring

**BDFB**

Battery Distribution and Fuse Bay

**BER**

Bit Error Ratio — The ratio of bits received in error to the total bits sent.

**BIP**

Bit Interleaved Parity — A method of error monitoring over a specified number of bits, that is, BIP-3 or BIP-8.

**BITS**

Building Integrated Timing Supply — A single clock that provides all the DS1 and DS0 synchronization references required by clocks in a building.

**BRI**

Basic Rate Interface

**Broadband**

Any communications channel with greater bandwidth than a voice channel; sometimes used synonymously with wideband.

---

**C**

**CC**

Clear Channel — A provisionable mode for the DS3 output that causes parity violations not to be monitored or corrected before the DS3 signal is encoded.

**CCITT**

International Telephone and Telegraph Consultative Committee — An international advisory committee under United Nations' sponsorship that has composed and recommended for adoption worldwide standards for international communications. Recently changed to the International Telecommunications Union Telecommunications Standards Sector (ITU-TSS).

**CD-ROM**

Compact Disk, Read Only Memory

**CDTU**

Channel and Drop Test Unit

**CEV**

Controlled Environment Vault

**Channel**

A logical signal within a port. For example, for an EC-1 port, there is one STS-1 channel and sometimes 28 VT1.5 channels. See Port.

**Channel State Provisioning**

A feature that allows a user to suppress reporting of alarms and events during provisioning by supporting multiple states (automatic, in-service and not monitored) for VT1.5 and STS-1 channels. See Port State Provisioning.

**CIT**

Craft Interface Terminal

**CLF**

Carrier Line Failure Status

**CLK**

Clock

**CMISE**

Common Management Information Service Element

**CMOS**

Complementary Metal Oxide Semiconductor

**CO**

Central Office

**COACH**

A system of on-line support tools aimed at providing product news and bulletins, diagnostic services, compatibility information, and on-line documents.

**COT**

Central Office Terminal

**CP**

Circuit Pack

**CPE**

Customer Premises Equipment

**CR**

Critical (alarm status)

**CSA**

Carrier Serving Area

**CSU**

Channel Service Unit

**CS&O**

Customer Support and Operations

**CV**

Coding Violation (a performance-monitoring parameter)

**CVFE**

Coding Violation Far-End — An indication returned to the transmitting terminal that an errored block has been detected at the receiving terminal.

---

**D**

**DACS III-2000**

Digital Access and Cross-Connect System that provides clear channel switching at either the DS3 or the STS-1 rates, eliminating the need for manual DSXs.

**DACS IV-2000**

Digital Access and Cross-Connect System that provides electronic DS3/STS-1 or DS1/VT1.5 cross-connect capability, eliminating the need for manual DSXs.

**DCC**

Data Communications Channel — The embedded overhead communications channel in the SONET line. It is used for end-to-end communications and maintenance. It carries alarm, control, and status information between network elements in a SONET network.

**DCE**

Data Communications Equipment — In a data station, the equipment that provides the signal conversion and coding between the data terminal equipment (DTE) and the line. The DCE may be separate equipment or an integral part of the DTE or of intermediate equipment. A DCE may perform other functions usually performed at the network end of the line.

**DDM-Plus**

Lucent's optical and electrical DS1 transport system. DDM-Plus transports up to four DS1s per pair of optical fiber and can provide T1 extension over existing copper wires.

**DDM-1000**

Lucent's Dual DS3 Multiplexer — A digital multiplexer that multiplexes DS1, DS1C, or DS2 signals into a DS3 signal or a 90 Mb/s or 180 Mb/s optical signal.

**DDM-2000**

Lucent's next generation network multiplexers that multiplex DS1, DS3, or EC-1 inputs into EC-1, OC-1, OC-3, or OC-12 outputs.

**Default Provisioning**

The parameter values that are preprogrammed as shipped from the factory.

**Demultiplexing**

A process applied to a multiplexed signal for recovering signals combined within it and for restoring the distinct individual channels of these signals.

**DEMUX**

Demultiplexer - "The DEMUX direction" is from the fiber toward the DSX.

**Digital Multiplexer**

Equipment that combines by time-division multiplexing several digital signals into a single composite digital signal.

**DLC**

Digital Loop Carrier

**DPLL**

Digital Phase-Locked Loop

**DRI**

Dual Ring Interworking. Two ring networks interconnected at two common nodes.

**Drop and Continue**

A technique that allows redundant signal appearances at two central offices in a DRI network, allowing protection against central office failures.

**DS1**

Digital Signal Level 1 (1.544 M/bs)

**DS1 Circuit Pack**

The DS1 interface circuit pack interfaces to the DSX-1 panel.

**DS3**

Digital Signal Level 3 (44.736 M/bs)

**DS3 Circuit Pack**

The DS3 circuit pack interfaces to the DSX-3 panel.

**DSn**

Digital Signal Rate n — One of the possible digital signal rates at DDM-2000 OC-3 and OC-12 interfaces: DS1 (1.544 Mb/s) or DS3 (44.736 Mb/s).

**DSNE**

Directory Services Network Element — A designated network element that is responsible for administering a database that maps network element names (TIDs) to addresses [NSAPs (network service access points)] in an OSI subnetwork. There can be one DSNE per ring. Can also be a GNE.

**DSX**

Digital Cross-Connect Panel — A panel designed to interconnect equipment that operates at a designated rate. For example, a DSX-3 interconnects equipment operating at the DS3 rate.

**DSXBIU**

Digital Signal Cross-Connect Backplane Interface Unit

**DT**

Distant Terminal

**DTE**

Data Terminating Equipment — That part of a data station that serves as a data source (originates data for transmission), a data sink (accepts transmitted data), or both.

**Dual 0x1 Cross-Connection**

In a single-homed application, the DDM-2000 OC-3/OC-12 Multiplexer uses a dual 0x1 cross-connection to map the VT1.5 channels between the DDM-2000 FiberReach OC-3 and the DDM-2000

OC-12 rings. This dual 0x1 architecture means that the VT1.5 path switching is one in the DDM-2000 FiberReach and not in the host DDM-2000. Individual DS1 signals within an STS-1 can therefore be dropped to DDM-2000 OC-3 shelves at several nodes around the ring. See Single 0x1.

**Dual Homing**

In DDM-2000 FiberReach, a network topology in which two OC-3 shelves serve as DDM-2000 FiberReach Multiplexer hosts supporting up to twelve OC-1 rings. Each DDM-2000 FiberReach Multiplexer ring is interconnected between the two separate hosts. Two SLC-2000 Access Systems serving as DDM-2000 FiberReach hosts can support up to four OC-1 rings. See Single Homing.

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**E**

**EC-1, EC-n**

Electrical Carrier — The basic logical building block signal with a rate of 51.840 Mb/s for an EC-1 signal and a rate of n times 51.840 Mb/s for an EC-n signal. An EC-1 signal can be built in two ways: A DS1 can be mapped into a VT1.5 signal and 28 VT1.5 signals multiplexed into an EC-1 (VT1.5 based EC-1), or a DS3 can be mapped directly into an EC-1 (DS3 based EC-1).

**ECI**

Equipment Catalog Item — The bar code number on the faceplate of each circuit pack used by some inventory systems.

**EEPROM**

Electrically Erasable Programmable Read-Only Memory

**EIA**

Electronic Industries Association

**EMC**

Electromagnetic Compatibility

**EMI**

Electromagnetic Interference

**EOOF**

Excessive Out of Frame

**EPRM**

Erasable Programmable Read-Only Memory

**EQ**

Equipped (memory administrative state)

**ES**

Errored Seconds — A performance monitoring parameter. ES "type A" is a second with exactly one error; ES "type B" is a second with more than one and less than the number of errors in a severely errored second for the given signal. ES by itself means the sum of the type A and type B ESs.

**ESD**

Electrostatic Discharge

**ESF**

Extended Super Frame (format for DS1 signal)

**EST**

Environmental Stress Testing

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**F**

**FCC**

Federal Communications Commission

**FDDI**

Fiber Distribution Data Interface

**FE**

Far-End. Any other network element in a maintenance subnetwork other than the one the user is at or working on. Also called remote.

**FE-ACTY**

Far End Activity — An LED on the user panel.

**FEBE**

Far End Block Error — An indication returned to near-end transmitting node that an errored block has been detected at the far end.

**FE ID**

Far End Identification — The 7-segment display on the faceplate of the SYSCTL circuit pack.

**FEPROM**

Flash EPROM — A new technology that combines the non-volatility of EPROM with the in-circuit reprogrammability of EEPROM (electrically-erasable PROM.)

**FERF**

Far-End Receive Failure — An indication returned to a transmitting terminal that the receiving terminal has detected an incoming section failure.

**FE SEL**

Far End Select — An LED on the user panel.

**FIT**

Failures in  $/10^9$  hours of operation.

**Free Running**

An operating condition of a clock in which its local oscillator is not locked to an internal synchronization reference and is using no storage techniques to sustain its accuracy.

**FT-2000**

Lucent's SONET OC-48 Lightwave System

**Function Unit**

Refers to any one of a number of different circuit packs that can reside in the A, B, or C function unit slots on the DDM-2000 OC-3 Multiplexer, or in the A, B, C, or D function unit slots of the DDM-2000 OC-12 Multiplexer.

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## G

### **GCNS-2000**

Lucent's Gigabit Cell Network Switch

### **GNE**

Gateway Network Element — A network element that has an active X.25 link. Can also be a DSNE.

### **GR**

Telcordia Technologies General Requirement

### **Group**

The eight slots that may be equipped.

### **GTP**

General Telemetry Processor

### **GUI**

Graphical User Interface

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## H

### **Hairpin Routing**

A cross-connection between Function Units; for example, Function Unit C to Function Units A or B. Cross-connections go through Main, but no bandwidth or time slots are taken from the backbone ring. Eliminates need for another shelf.

### **HDSL**

High Data Rate Digital Subscriber Line

### **HECI**

Humans Equipment Catalog Item

### **Holdover**

An operating condition of a network element in which its local oscillator is not locked to any synchronization reference but is using storage techniques to maintain its accuracy with respect to the last known frequency comparison with a synchronization reference.

---

## I

### **IC**

Internal Clock. Used in synchronization messaging.

### **ID**

Identifier. See Shelf ID and Site ID.

**IEC**

International Electrotechnology Commission

**IMF**

Infant Mortality Factor

**INC**

Incoming Status

**INCM**

A parallel telemetry point used to indicate incoming low-speed failures.

**I/O**

Input/Output

**IP**

Internetwork Protocol

**IR**

Intermediate Reach. A term used to describe distances of from 15 to 40 km between optical transmitter and receiver without regeneration. See long reach.

**IS**

In Service — One possible state of a DS1, DS3, or EC-1 port. Other possible states are "auto" (automatic) and "nmon" (not monitored).

**ISCI**

Intershelf Control Interface

**ISI**

Intershelf Interface

**ISDN**

Integrated Services Digital Network

**IS-3**

An intraoffice short reach proprietary interface provided by the 21D/21D-U and 22D-U optical line interface units.

**ISO**

International Standards Organization. See OSI.

**IVHS**

Intelligent Vehicle Highway System

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**J**

**Jitter**

Timing jitter is defined as short-term variations of the significant instants of a digital signal from their ideal positions in time.

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## **L**

### **LAN**

Local Area Network

### **LAPD**

Link Access Procedure "D"

### **LBO**

Line Build Out — An equalizer network between the DDM-2000 OC-3 and OC-12 Multiplexers and the DSX panel. It guarantees the proper signal level and shape at the DSX panel.

### **LCN**

Local Communications Network

### **LEC**

Local Exchange Carrier

### **LED**

Light Emitting Diode — Used on a circuit pack faceplate to show failure (red) or service state. It is also used to show the alarm and status condition of the system.

### **Line Timing**

The capability to directly derive clock timing from an incoming OC-N signal while providing the user the capability to provision whether switching to an alternate OC-N from a different source (as opposed to entering holdover) will occur if the OC-N currently used as the timing reference for that NE becomes unsuitable as a reference. For example, intermediate nodes in a linear network are line timed. See Loop Timing.

### **Local**

See Near-End.

### **Locked Cross-Connection**

This is a variation of the ring cross-connection that allows the user to lock the path selector to a specified rotation of the ring. Any signal received from the other rotation of the ring is ignored.

### **LOF**

Loss of Frame — A failure to synchronize to an incoming signal.

### **Loop Timing**

Loop timing is a special case of line timing. It applies to NEs that have only one OC-N interface. For example, terminating nodes in a linear network are loop timed. See Line Timing.

### **LOP**

Loss of Pointer — A failure to extract good data from an STS-1 payload.

### **LOS**

Loss of Signal — The complete absence of an incoming signal.

### **LR**

Long Reach. A term used to describe distances of 40 km or more between optical transmitter and receiver without regeneration. See intermediate reach.

**LS**

Low Speed

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**M**

**Main**

Slots on the DDM-2000 shelf in which the OLIU circuit packs are installed.

**Midspan Meet**

The capability to interface between two lightwave terminals of different vendors. This applies to high-speed optical interfaces.

**MD**

Mediation Device

**MJ**

Major Alarm

**MM**

Multimode

**MML**

huMan-Machine Language defined by ITU-TSS, formerly CCITT.

**MN**

Minor Alarm

**MPEG**

Moving Picture Experts Group

**MSDT**

Multi-Services Distant Terminal

**MTBF**

Mean Time Between Failures

**MTBMA**

Mean Time Between Maintenance Activities

**Multiplexing**

The process of combining several distinct digital signals into a single composite digital signal.

**Mult**

Multiplying. The cascading of signals in a bay. In the MULT mode, the DS1 external reference can be cascaded to other shelves in a bay using Mult cables. Normally starting with the bottom shelf (Number 1) and working towards the top of the bay.

**MUX**

Multiplex

**MXBIU**

Multiplexer and Backplane Interface Unit

**MXRVO Circuit Pack**

The MXRVO circuit pack multiplexes seven VT-G signals from the DS1 circuit packs to an STS-1 signal for connection to the OLIU circuit packs.

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**N**

**NE**

Near-End. The network element the user is at or working on. Also called local.

**NE**

Network Element — The basic building block of a telecommunications equipment within a telecommunication network that meets SONET standards. Typical internal attributes of a network element include: one or more high- and low-speed transmission ports, built-in intelligence, synchronization and timing capability, access interfaces for use by technicians and/or operation systems. In addition, a network element may also include a time slot interchanger.

**NE-ACTY**

Near End Activity — An LED on the user panel.

**NEBS**

Network Equipment-Building System

**nm**

Nanometer ( $10^{-9}$  meters)

**NMA**

Network Monitoring and Analysis — An operations system designed by Telcordia Technologies which is used to monitor network facilities.

**NMON**

Not Monitored — A provisioning state for equipment that is not monitored or alarmed.

**NMLI** — Native Mode LAN Interface external to the DDM-2000 FiberReach multiplexer.

**Node**

In SONET a node is a line terminating element.

**Non-Revertive**

A protection switching mode in which, after a protection switch occurs, the equipment remains in its current configuration after any failure conditions that caused a protection switch to occur clear or after any external switch commands are reset. (See Revertive.)

**NRZ**

Nonreturn to Zero

**NSA**

Not Service Affecting

**NSAP**

Network Services Access Point — An address that identifies a network element. Used for maintenance subnetwork communication using the OSI protocol.

**NTF**

No Trouble Found

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**O**

**OAM&P**

Operations, Administration, Maintenance, and Provisioning

**OC, OC-n**

Optical Carrier — The optical signal that results from an optical conversion of an STS signal; that is, OC-1 from STS-1 and OC-n from STS-n.

**OC-1**

Optical Carrier Level 1 Signal (51.84 Mb/s)

**OC-3**

Optical Carrier Level 3 Signal (155 Mb/s)

**OC-3c (STS-3c)**

Optical Carrier Level 3 Concatenated Signal — Low-speed broadband signal equivalent to three STS-1s linked together with a single path overhead.

**OC-12**

Optical Carrier Level 12 Signal (622 Mb/s)

**OHCTL**

The overhead controller circuit pack provides user access to the SONET overhead channels.

**OLIU**

Optical Line Interface Unit

**OOF**

Out of Frame

**OOL**

Out of Lock

**Operations Interface**

Any interface that provides information on the system performance or control. These include the equipment LEDs, user panel, CIT, office alarms, and all telemetry interfaces.

**OPS/INE**

Operations System/Intelligent Network Element

**OS**

Operations System — A central computer-based system used to provide operations, administration, and maintenance functions.

**OS-GNE**

Operations System - Gateway Network Element

**OSMINE**

Operations Systems Modifications for the Integration of Network Elements

**OSI**

Open Systems Interconnection — Referring to the OSI reference model, a logical structure for network operations standardized by the International Standards Organization (ISO).

**OSGNE**

Operations System Gateway Network Element — An OSGNE serves as a single interface to the OS for NEs in the same subnetwork using X.25 interfaces.

**OSP**

Outside Plant

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**P**

**Pass Through**

Paths that are cross-connected directly across an intermediate node in a ring network.

**P-bit**

Performance Bit

**PC**

Personal Computer

**PCU**

Power Converter Unit

**PID**

Program Identification

**PINFET**

Positive Intrinsic Negative Field Effect Transistor

**PJC**

Pointer Justification Count

**Plesiochronous Network**

A network that contains multiple maintenance subnetworks, each internally synchronous and all operating at the same nominal frequency, but whose timing may be slightly different at any particular instant. For example in SONET networks, each timing traceable to their own Stratum 1 clock are considered plesiochronous with respect to each other.

**PLL**

Phased-Locked Loop

**PM**

Performance Monitoring — Measures the quality of service and identifies degrading or marginally operating systems (before an alarm would be generated).

**PMN**

Power Minor Alarm

**POH**

Path Overhead

**POP**

Points of Presence

**Port**

The physical, electrical, or optical interface on a system. For example, DS1, DS3, EC-1, OC-3, and OC-12. See Channel.

**Port State Provisioning**

A feature that allows a user to suppress alarm reporting and performance monitoring during provisioning by supporting multiple states (automatic, in-service and not monitored) for low speed ports. See Channel State Provisioning.

**POTS**

Plain Old Telephone Service

**Proactive Maintenance**

Refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming, but indicative of an impending signal fail or signal degrade defect (for example, performance monitoring).

**Protection Line**

As defined by the SONET standard, the protection line is the pair of fibers (one transmit and one receive) that carry the SONET APS channel (K1 and K2 bytes in the SONET line overhead). On a DDM-2000 FiberReach system, a *protection* line is a pair of fibers that terminate on an OLIU circuit pack in the `main` slot. (See Service Line.)

**PRM**

Performance Report Message

**PROTN**

Protection

**Product Family 2000**

Lucent's line of SONET standard network products providing total network solutions.

**PRS**

Primary Reference Source

**PSU**

Power Supply Unit

**PVC**

Permanent Virtual Circuit

**PWR**

Power

---

**R**

**RAM**

Random Access Memory

**Reactive Maintenance**

Refers to detecting defects/failures and clearing them.

**Remote**

See Far-End.

**REN**

Ringer Equivalent Number

**Revertive**

A protection switching mode in which, after a protection switch occurs, the equipment returns to the nominal configuration (that is, the service equipment is active, and the protection equipment is standby) after any failure conditions that caused a protection switch to occur clear or after any external switch commands are reset. (See Non-Revertive.)

**RGU**

Ring Generator Unit

**Ring**

A configuration of nodes comprised of network elements connected in a circular fashion. Under normal conditions, each node is interconnected with its neighbor and includes capacity for transmission in either direction between adjacent nodes. Path switched rings use a head-end bridge and tail-end switch. Line switched rings actively reroute traffic over a protection line.

**Ring (0x1) Low Speed Interface**

Formerly referred to as dual 0x1 or single 0x1. In ring applications, the DDM-2000 OC-3 and OC-12 Multiplexers use a 0x1 interface meaning both fibers carry service as opposed to a linear (1+1) low speed interface where one fiber is used for service and the other for protection. See 1+1.

**RPP**

Reliability Prediction Procedure — Described in Telcordia Technologies TR-NWT-00032.

**RT**

Remote Terminal — An unstaffed equipment enclosure that may have a controlled or uncontrolled environment.

**RTAC**

Lucent's Regional Technical Assistance Center (1-800-225-RTAC)

**RZ**

Return to Zero

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**S**

**SA**

Service Affecting

**SCADA**

Supervisory Control and Data Acquisition

**SD**

Signal Degrade

**SDH**

Synchronous Digital Hierarchy

**Self-Healing**

Ring architecture in which two or more fibers are used to provide route diversity. Node failures only affect traffic dropped at the failed node.

**SEFS**

Severely Errored Frame Seconds

**SEO**

Single-Ended Operations — The maintenance capability that provides remote access to all DDM-2000 systems from a single location over the DCC.

**Service Line**

On a DDM-2000 FiberReach system, a service (or "working") line is a pair of fibers (one transmit and one receive) that terminate on an OLIU circuit pack in the **main** slot. As defined by the SONET standard, the SONET APS channel is not defined on a service (or "working") line. (See Protection Line.)

**SES**

Severely Errored Seconds — This performance monitoring parameter is a second in which a signal failure occurs, or more than a preset amount of coding violations (dependent on the type of signal) occurs.

**SF**

Super Frame (format for DS1 signal)

**Shelf ID**

A switch settable parameter with values of from 1 to 8. Used to log into a selected shelf in a bay using the CIT.

**SID**

System Identification

**Single 0x1 Cross-Connection**

In a dual-homed application, the DDM-2000 OC-3/OC-12 Multiplexer uses a single 0x1 cross-connection to map the VT1.5 channels between the DDM-2000 FiberReach OC-1 and the DDM-2000 OC-3/OC-12 rings. This single 0x1 architecture maps low speed to high speed on a specified ring rotation. The high speed to low speed drop is made on the same specified ring with no path switching. Protection is provided at the VT1.5 end points. See Dual 0x1.

**Single Homing**

In DDM-2000 FiberReach, a network topology in which a single OC-3 shelf serves as a DDM-2000 FiberReach Multiplexer host supporting up to six OC-1 rings. A SLC-2000 Access System serving as a host can support up to two OC-1 rings. See Dual Homing.

**Site ID**

A switch settable parameter with values of from 1 to 8. Displayed on SYSCTL circuit pack to indicate to which site the user panel alarms and LEDs apply.

**SLIM**

Subscriber Loop Interface Module

**SM**

Single Mode

**SONET**

Synchronous Optical Network

**SPE**

Synchronous Payload Envelope

**SPOTS**

Super POTS

**SQU**

Sync Quality Unknown. Used in synchronization messaging.

**SRD**

Software Release Description

**Standby**

Standby identifies a 1+1 protected OC-N line which is not currently selected by the receiver at either end as the payload carrying signal, or a 1x1 or 1xn protected circuit pack that is not currently carrying service. (See Active.)

**Star Topology**

For DDM-2000 FiberReach, this refers to a configuration of multiple point-to-point OC-1 extensions from a single DDM-2000 OC-3/OC-12 Multiplexer.

**Status**

The indication of a short-term change in the system.

**STS, STS-n**

Synchronous Transport Signal — The basic logical building block signal with a rate of 51.840 Mb/s for an STS-1 signal and a rate of n times 51.840 Mb/s for an STS-n signal.

**STS-1 SPE**

STS-1 Synchronous Payload Envelope — A 125-microsecond frame structure composed of STS path overhead and the STS-1 payload.

**STS-3c**

Synchronous Transport Level 3 Concatenated Signal. See OC-3c.

**Subnetwork**

Group of SONET network elements that share a SONET data communications channel.

**Synchronization Messaging**

SONET synchronization messaging is used to communicate the quality of network timing, internal timing status, and timing states throughout a subnetwork.

**SYSCTL**

The system controller circuit pack that provides overall administrative control of the terminal.

---

**T**

**T1EXT**

T1 Carrier Extension Circuit Pack

**T1X1 and T1M1**

The *ANSI* committees responsible for telecommunications standards.

**TA**

Telcordia Technologies Technical Advisory

**TABS**

Telemetry Asynchronous Byte Serial (Protocol)

**TARP**

Target Address Resolution Protocol

**TBOS**

Telemetry Byte-Oriented Serial (Protocol) — Defines one physical interface for direct connection between the telemetry remote and the monitored equipment. An RS-422 port is used to provide the operations system with sufficient alarm and status information to localize a problem to a given DDM-2000 and to determine the severity of the problem.

**TCA**

Threshold-Crossing Alert — A condition set when a performance-monitoring counter exceeds a user-selected threshold. A TCA does not generate an alarm but is available on demand through the CIT and is shown by TBOS and causes a message to be sent to NMA via the X.25/TL1 interface.

**TCVCXO**

Temperature-Compensated Voltage-Controlled Crystal Oscillator — A highly stable and accurate clock source used in the DDM-2000 TGS circuit pack.

**TGS**

The timing generator circuit pack generates clock signals for distribution to the transmit circuits. It operates in the free-running, loop-timing, phase-lock, and holdover modes.

**TID**

Target Identifier — The Telcordia Technologies name for the system name.

**TL1**

Transaction Language 1 — A Telcordia Technologies machine-to-machine communications language that is a subset of ITU-TSS, formerly CCITT's, human-machine language.

**TLB**

Timing Looped Back. Used in synchronization messaging.

**TOP**

Task Oriented Practice

**TR**

Telcordia Technologies Technical Requirement

**TSA**

Time Slot Assignment

**TSI**

Time Slot Interchange

**TSO**

Technical Support Organization — Supports RTAC and the customers.

---

## U

### UAS

Unavailable Seconds. In performance monitoring, the count of seconds in which a signal is declared failed or, in which, 10 consecutively severely errored seconds (SES) occurred, until the time when 10 consecutive non-SES occur.

### Unidirectional

A protection switching mode in which the system at each end of an optical span monitors both service and protection lines and independently chooses the best signal (unless overridden by an equipment failure or by an external request, such as a forced switch or lockout). In a system that uses unidirectional line switching, both the *service* and *protection* lines may be *active* simultaneously, with one line carrying traffic in one direction and the other line carrying traffic in the other direction. The K1 and K2 bytes in the SONET line overhead are used to convey to the far end which line the near end receiver has chosen, so that an "active" indication may be made at the far end.

### UOC

Universal Optical Connector — Receptacles on the faceplate of some OLIUs that accept ST<sup>®</sup>, SC, or FC connectors.

### UPD/INIT

A pushbutton on the user panel.

---

## V

### VF

Voice Frequency

### VLSI

Very Large Scale Integration — Refers to very complex state of the art integrated circuits.

### VM

Violation Monitor — A mode of the DS3 circuit pack in which it will monitor but not remove P-bit parity violations on the DS3 signal received from the fiber.

### VMR

Violation, Monitor, and Removal — A mode of the DS3 circuit pack in which it will monitor and remove P-bit parity violations on the DS3 signal received from the fiber.

### VONU

Virtual Optical Network Unit

### VT

Virtual Tributary — A structure designed for transport and switching of a sub-DS3 payload.

### VT1.5

A 1.728 Mb/s virtual tributary

**VT-G**

Virtual Tributary Group — A 9-row by 12-column SONET structure (108 bytes) that carries one or more VTs of the same size. Seven VT groups (756 bytes) are byte-interleaved within the VT-organized STS-1 synchronous payload envelope.

---

**W**

**WAN**

Wide Area Network

---

**Z**

**Zero Code Suppression**

A technique used to reduce the number of consecutive zeros in a line-codes signal (B3ZS for DS3 signals and B8ZS for DS1 signals).

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