Lucent Technologies
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Metropolis® DMX*tend Access Multiplexer*
(Release 1.0 and 2.0)

Applications and Planning Guide

365-372-324
Issue 1.0
July 2002

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DMX Access Multiplexer
Applications and Planning Guide Release 3.0 amd 3.1

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About this information product

Purpose

This applications and planning guide (APG) provides the following information for the Metropolis® DMX*tend Access Multiplexer*:

- Features
- Applications
- Operation
- Engineering
- Support
- Specifications
- Ordering

Safety labels

This document may contain safety labels in the form of **DANGERS**, **WARNINGS**, and **CAUTIONS**.

These admonishments have the following definitions:

- **DANGER** shows the presence of a hazard that *will* cause death or severe personal injury if the hazard is not avoided.
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The alert symbol appears throughout this document to alert the user to these safety labels.

Intended audience

This applications and planning guide is intended for network planners and engineers. However, it is also for anyone who needs specific information regarding the features, applications, operation, engineering, and ordering of the DMX Access Multiplexer.

How to use this information product

The following is a brief description of the contents of each chapter in this document:

- **"About This Document"** describes the purpose, intended audience, reason for reissue, and organization of this document. This section references related documentation and explains how to order, make comments, or recommend changes to this document.
- Chapter 1, **"System Overview,"** describes the DMX Access Multiplexer. This introductory section also lists the features included in the releases covered by this document.
- Chapter 2, **"Features,"** briefly describes the features listed in Chapter 1. These features are described in more detail in Chapter 3, "Network Topologies," Chapter 4, "Product Description," and Chapter 6, "Operations, Administration, Maintenance, and Provisioning."
- Chapter 3, **"Applications and Configurations,"** describes how the DMX Access Multiplexer shelf serves diverse needs such as embedded network evolution, access transport for voice and private line services, interoffice transport, broadband business data access, DSLAM access, IP network infrastructure, enterprise

LAN interconnect and transport, ISP carrier access, and cable access to internet applications through configurations such as path switched ring, linear optical extensions, homing, and hubbing.

- Chapter 4, **"Product Description,"** describes the DMX Access Multiplexer hardware, including the shelf, circuit packs, cables, and power.
- Chapter 5, **"System Planning and Engineering,"** summarizes physical arrangement, cross-connection, and synchronization information to help you plan procurement and deployment of the DMX Access Multiplexer.
- Chapter 6, **"Operations, Administration, Maintenance, and Provisioning,"** defines the "maintenance philosophy," outlining the various features available to monitor and maintain the DMX Access Multiplexer.
- Chapter 7, **"Ordering,"** provides equipment ordering information for the DMX Access Multiplexer.
- Chapter 8, **"Product Support,"** describes how Lucent Technologies supports the DMX Access Multiplexer. This chapter includes information about engineering and installation services, technical support, documentation support, and training available from Lucent Technologies.
- Chapter 9, **"Reliability and Quality,"** provides the Lucent Technologies quality policy and describes the reliability program.
- Chapter 10, **"Technical Specifications,"** lists the technical specifications for the DMX Access Multiplexer.
- Glossary provides definitions for telecommunication acronyms and terms.
- Index supplies users with specific subjects and corresponding page numbers to find necessary information.

Conventions used

Bold typeface signifies emphasis.

Italic typeface denotes a particular product line or information product.

Bold Courier typeface signifies a command.

For the remainder of this information product, "DMX" is used in place of Metropolis® DMX*tend Access Multiplexer* in most cases.

Electronic documentation

Documentation for the DMX Access 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.

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1 System Overview

Overview

Purpose

This chapter introduces the Metropolis® DMX*tend Access Multiplexer* system.

Contents

The following topics are included in this chapter:

Overview of the Metropolis® Portfolio

Purpose

Metropolitan, "metro," networks are the communications networks that link homes and businesses to larger, long-distance core networks. These networks are complex because they are filled with both old and new networking equipment and must carry all types of service traffic, including voice, data and video.

Driven by the exponential growth of the Internet, requirements for metropolitan optical transport networks are changing quickly from pure circuit networks to hybrid networks. This evolution requires metro access networks to aggregate the local loop or last-mile bandwidth in order to integrate with the high-speed core/backbone networks. These requirements are driving metropolitan network evolution from traditional SONET multiplexers into more flexible, higher-speed, data-aware platforms - a necessity for optical edge solutions.

Solution

Lucent Technologies is helping Service Providers to cost-effectively deploy solutions that can accommodate a multitude of services, such as voice, private line, Ethernet, IP, frame relay, and ATM. The Metropolis® portfolio offers a seamless evolution to next-generation metro solutions that can eliminate the bottleneck in the metropolitan network, allowing service providers to deliver new high-speed, revenue-generating services such as gigabit Ethernet, virtual private networks (VPN), storage area networks and digital subscriber lines (DSL).

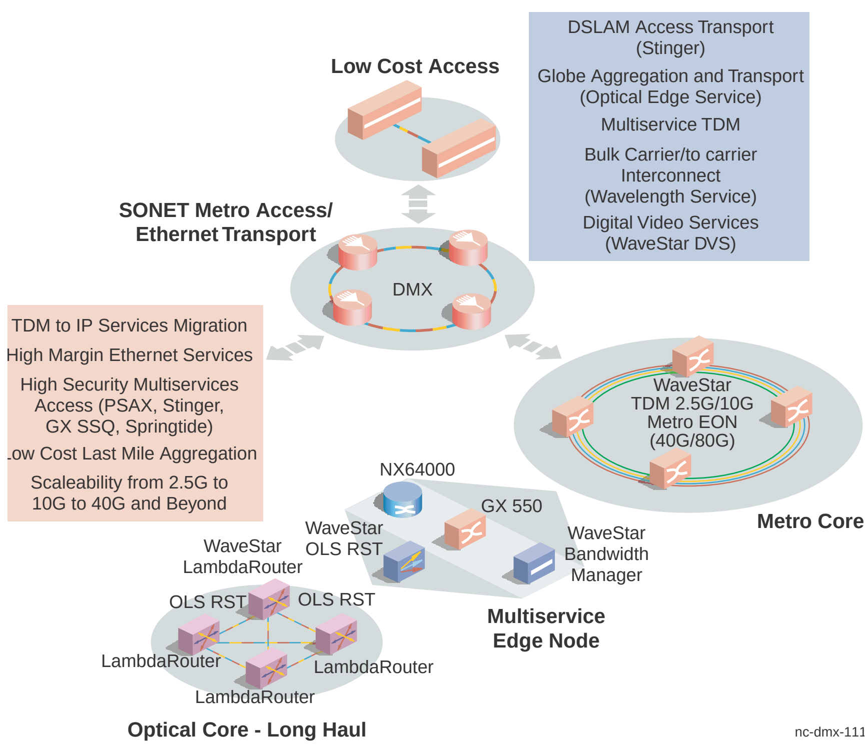
Portfolio

Lucent designed its Metropolis® portfolio so customers can choose the solution that best accommodates their existing networks, allowing them to bring new services to market quickly and cost effectively.

Metropolis® includes two categories of next-generation products based on the most common types of metro networks:

- Next-Generation SONET -- Metropolis® DMX, DMX*press*, and DMX*tend* Access Multiplexers which leverage existing optical equipment while providing a solid foundation for future bandwidth, gigabit Ethernet and IP services growth.
- MetroWDM -- Metropolis EON Enhanced Optical Networking a metro core DWDM solution for regional traffic.

Each of the Metropolis® solutions can fuse with Lucent's new multiservice data switches and existing IP and ATM equipment to provide an end-to-end broadband network that links to long-distance or other metro networks.



Metropolis® Products

Overview

This section provides a brief description of each of the following products which comprise the Metropolis portfolio:

- Metropolis® DMX Access Multiplexer
- Metropolis® DMX*press* Access Multiplexer
- Metropolis® DMX*tend* Access Multiplexer

□

Metropolis® DMX Access Multiplexer

Overview

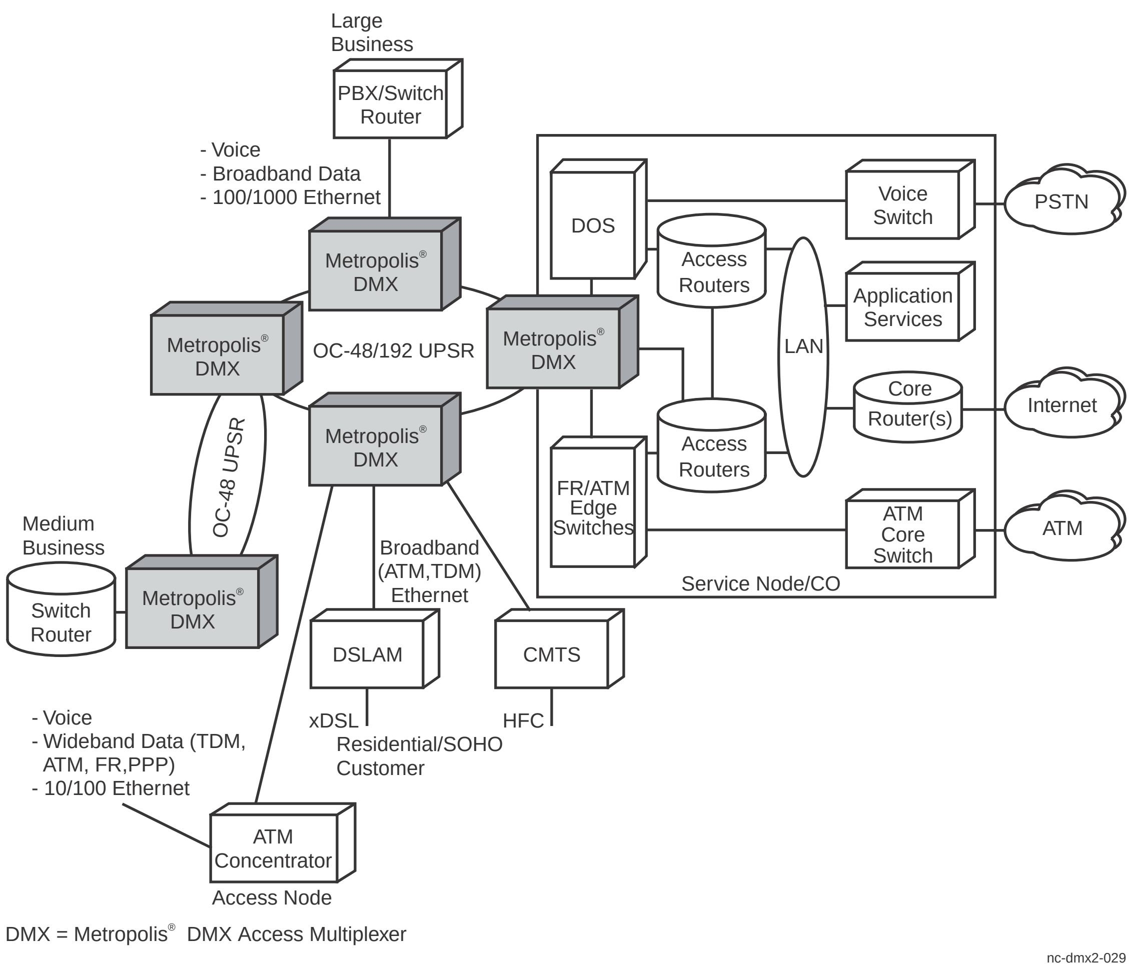
The Metropolis DMX Access Multiplexer product provides a solution for service providers with an embedded SONET base who are seeking to migrate to next generation technology and to new next-generation carriers who are seeking to provide SONET and Ethernet services over the proven reliability of SONET transport from speeds of DS-1 to OC-192. The Metropolis DMX solution helps add revenue opportunities through the addition of new services, and reduces costs through the consolidation of multiple technologies in one network element.

Interfaces

Metropolis DMX supports a wide array of wideband and broadband transport, including traditional SONET transport of DS1, DS3, EC-1, OC-3, OC-12, OC-48, and OC-192 signals, as well as 10/100/1000 Mbps Ethernet LAN transport. This single-shelf product can be equipped to serve many diverse network applications and supports a variety of operations interfaces for current and evolving network operations needs.

Service Applications

The DMX Access Multiplexer provides a wide range of service applications transporting voice and data from the access edge of the network to the core of the network. These applications range from traditional SONET applications to advanced data transport applications.

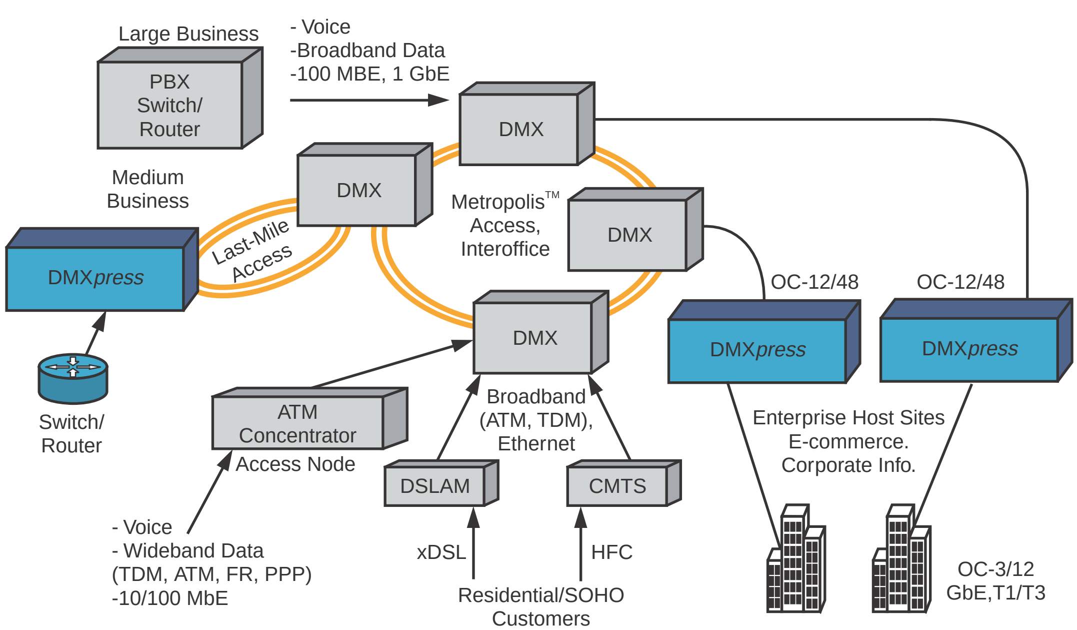


Metropolis® DMXpress Access Multiplexer

Introduction to DMX*press*

The DMX*press* system has been designed to provide a last-mile solution at the lowest-cost possible. In its ability to offer low-cost, high revenue, protected transport for both voice and data, DMX*press* is an ideal solution for fiber-to-the-business applications. DMX*press* eliminates the need for a LAN/WAN boundary and simplifies broadband data service delivery. Plus, the DMX*press* has the transmission capability to send signals directly from a Multi-Tenant Unit (MTU) to a Central Office (CO).

DMX*press* offers an OC-48 and OC-12 UPSR as a standard high-speed interface. DMX*press* can be equipped with a standard TDM card offering either 16 DS1 ports and 1 DS3 port (which can be removed if not needed), or 12 DS3 ports. At the same time, the DMX*press* can be equipped with an Ethernet option pack that provides for a provisionable Gigabit Ethernet (GbE) or Fast Ethernet (10/100 Mbps) packet ring capable of eliminating last-mile bottleneck and accommodating a growing demand for data service. Thus, DMX*press* optimizes last-mile access for internet service growth while maintaining high-revenue voice and private-line capabilities.



The Metropolis™ DMX*press* allow network providers to choose form a variety of access network deployment strategies to meet their service delivery needs

DMX*press* = Metropolis™ DMX*press* Access Multiplexer
DMX = Metropolis™ DMX Access Multiplexer

Introduction to the DMX*tend* Access Multiplexer

Overview

The DMX*tend* Access Multiplexer is a single shelf network multiplexer designed primarily for access transport, business access, and regional interoffice applications transporting voice and data at the OC-3/12 level via a unidirectional path switched ring (UPSR).

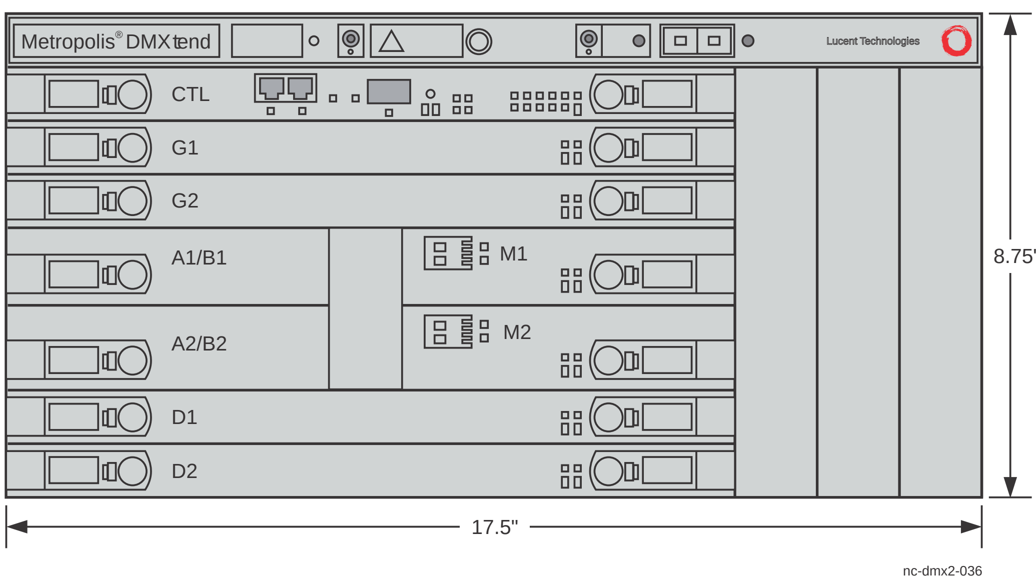
Lucent's rich history of SONET multiplexers provides the foundation for the DMX*tend*. The DMX*tend* builds on that tradition by providing the tools necessary for the new generation of access networks: greater capacity, increased network flexibility, diverse functionality, and reliable service.

DMX*tend* supports a wide array of wideband and broadband transport, including traditional SONET transport of DS1, DS3, EC-1, OC-3, and OC-12, as well as 10/100/1000 Mbps LAN transport. The shelf can be equipped to serve many diverse network applications and supports a variety of operations interfaces for current and evolving network operations needs.

Shelf size

The figure below shows the front view of the DMX*tend* shelf.

Figure 1-1 DMX*tend* Front View and Shelf



Important! The Depth of the DMX*tend* shelf (not shown in the figure above) is 15".

Functionality

There are 9 circuit pack slots in each shelf, consisting of the following:

- 1 Control slot (CTL) for the SYSCTL
- 2 Main slots (M1, M2) for high speed optical line interface units (OC-3 and OC-12)
- 4 multipurpose Function Unit slots (A through D-- there is no C slot and the B slots are virtual slots and share the same physical location as the A slots).

  The A1/B1 and A2/B2 slot pairs support DS1, DS3, EC-1 signals. Again, there is no C slot. The D1 and D2 slots support DS1, DS3, EC-1, and 100BASE-TX signals in Release 1.0. In Release 2.0 additional support of OC-3, OC-12, 1000BASE-SX GbE, and 1000BASE-LX GbE service will be provided.
- 2 multipurpose Growth slots. The G1 and G2 slots support DS1, DS3, EC-1, and 100BASE-TX signals in Release 1.0. In Release 2.0 additional support of OC-3, OC-12, 1000BASE-SX GbE, and 1000BASE-LX GbE service will be provided.

  The Growth slots are regarded as Function Unit slots in Releases 1.0 and 2.0, but in the future may also be used for additional features.

Release 1.0 supports the following circuit packs:

- System Controller (LNW1)
- 28DS1 (LNW6)
- 28DS1PM (LNW7)
- 12DS3/EC1 (LNW16-- supported 3/03)
- 16 DS1, 3 DS3 port combo circuit pack-- 16DS1/3DS3 (LNW??)
- Single OC-3 high-speed OLIU (LNW40)
- Single OC-12 high-speed OLIU (LNW38)
- 10/100Mbps Private Line (100BASE-TX) (LNW71)

Capacity

The DMX*tend* provides a VT1.5 and STS-1 cross-connect fabric for a variety of signals. The DMX*tend*'s main switch fabric is contained in each of the high-speed (network-side interface) circuit packs, located in the MAIN slots of the DMX*tend* shelf. These MAIN slots have the capacity to house OC-3 and OC-12 high-speed interfaces.

Listed below is the number of signals that DMX*tend* can transport if all applicable Function Unit groups are equipped with a particular circuit pack (for example, 136 DS1s if all Function Unit groups are equipped with the DS1 circuit packs-- this capacity would require the use of the 28DS1 packs in slots D and G, and the use of the 16DS1/3DS3 combo pack in slots A and B):

- 72 DS1 (protected)
- 27 DS3 (protected)
- 16 OC-3 (unprotected)
- 8 OC-12 (unprotected)
- 48 10/100BASE-TX
- 8 1000BASE-SX/LX (in Release 2.0)

DMX*tend* also provides STS-1 virtual concatenation. This provides increased flexibility when provisioning Ethernet services. Each 100BASE-TX and 1000BASE-SX/LX Ethernet service can be provisioned to any number of STS-1s (up to 12 STS-1s in Release 1.0).

Operations

The DMX*tend* is representative of ten years of Lucent's innovation and experience in network operations, control, and maintenance. Utilizing Level 1 and Level 2 Target Identifier (TID) Address Resolution (TARP) protocol, a consistent and standard form of address resolution is in place, enabling the DMX*tend* network to be easily monitored and maintained.

DMX*tend* also supports standard interworking using the Open Systems Interconnection (OSI) seven-layer protocol stack over the DCC. The OSI seven-layer protocol stack refers to the OSI reference model, a logical framework for network operations standardized by the ISO. This provides for large networks up to 1000 NEs via level 1 area provisioning and level 2 routing.

The DMX*tend* is designed for easy installation and operation. Centralized operation is supported by a full set of single-ended operations (SEO), control, and maintenance features. Integrated test capabilities and default provisioning simplifies installation.

Basic maintenance tasks can be performed using faceplate LED displays and controls, while a craft interface terminal (CIT) or a remote OS gives access to sophisticated maintenance, provisioning, and reporting features.

Built-in maintenance capabilities support both installation and system operation. A DMX*tend* can be tested and installed without external test equipment.

Feature Release Plan

Overview

This section outlines the major features of Releases 1.0 and 2.0 for the DMX*tend*. The feature release plan will be updated for each future release of the system.

Release 1.0 Features

Listed below are the major features for Release 1.0:

High Speed (network side) Service Interfaces

- **Single OC-3 high-speed optical interface**

  The high-speed OC-3 OLIU is an intermediate reach 1310 nm optical line interface unit supporting UPSR, 1+1, and dual and single homed 0x1 configurations. The OC-3 high-speed interface can cross-connect VTs in any 6 STS-1s in the OC-3 signal.

- **Single OC-12 high-speed optical interface (available 3/03)**

  The high-speed OC-12 OLIU is an intermediate reach 1310 nm optical line interface unit supporting OC-12 add/drop and UPSR configurations, single- and dual-homing, non-revertive protection switching, and VT1.5, STS-1, STS-3(c), and STS-12(c) signal transport. The OC-12 OLIU can cross-connect VTs in any 12 STS-1s in the OC-12 interface.

Low Speed (tributary side) TDM and Ethernet Service Interfaces

- **Port-provisionable 12DS3/EC1 circuit pack (available 3/03)**

  In the 12DS3/EC1 circuit pack DS3 or EC-1 service can be provisioned on a per-**port** basis. The pack provides 12 ports for DS-3 or EC-1 service. 24 DS3/EC1 drop capacity when Function Units D and G are equipped with 12DS3/EC1 circuit packs (12 ports per pack).

- **28DS1 circuit pack**

  The DMX*tend* supports a 28 port DS1 circuit pack (LNW7 or LNW8). 56 DS1 drop capacity when Function Units D and G are equipped with 28DS1 circuit packs (28 ports per pack).

- **16/DS1/3/DS3 circuit pack**

  The DMX*tend* supports a combination DS1/DS3 circuit pack (LNW39) that provides 16 DS1 ports and 3 DS3 ports. These packs fit in Function Units A/B and can provide an additional capacity of 16 DS1 ports and 3 DS3 ports total.

- **24 port 100BASE-TX (10/100Mbps) Private Line Ethernet interface** (LNW71)

  Enhanced 10/100 Mbps Ethernet interface designed to enable Fast Ethernet Private Line services. 48 10/100 Mbps port capacity when 2 Function Unit groups (D and G) are equipped with 10/100 Mbps circuit packs (24 ports per pack).

Network Configurations

- **DS1/DS3 circuit packs 1x1 protected**

  The DMX*tend* offers 1x1 facility protection of all DS1/DS3/EC1 interfaces (ports). This is achieved by filling 2 slots in a function group with the same pack. For example, placing a 12DS3/EC1 circuit pack into D1 and D2. If the pack in D1 fails, the DMX*tend* automatically switches to the circuit pack in slot D2.
- **Facility Loopbacks** for DS1 and DS3 signals.
- **VT1.5 granularity**

  Fully-flexible VT1.5 granularity across 6 or 12 STS-1s in Release 1.0.
- **OC-3/12 high-speed single- and dual-homed Unidirectional Path Switched Ring (UPSR)**

  Single or dual-homed OC-3 or 12 UPSR at VT1.5, STS-1, STS-3c, or STS-12c (STS-12c when using the high-speed OC-12 circuit packs only) level.
- **OC-3 and OC-12 high-speed linear optical extension**

  A 1+1 protected linear extension from the circuit packs in the MAIN slots, offering fully-flexible VT1.5 granularity across 6 pr 12 STS-1s (using the OC-3 or OC-12 high-speed pack respectively).
- **Fast Ethernet** (10/100 Mbps) private line applications
- **Pipe Mode cross-connections**
- **Bridge and Roll cross-connections**
- **1 Mbps Ethernet rate shaping**
- **TCP/IP Gateway Network Element (GNE) functionality**

  DMX*tend* can serve as a TL1 Translation Device (T-TD) by being a gateway network element that allows a Navis EMS and/or PC-CIT to communicate to other network elements (NEs) on an OSI network through an IP access network.

- **FTP over IP transmission capability (IP tunneling)**

  DMX*tend* can functionally encapsulate IP packets within OSI packets to be transmitted through the OSI network to the proper NE. This capability is called IP tunneling.

- **FTP/FTAM Gateway**

  Also referred to as FTTD (File Transfer Translation Device), the FTTD allows DMX*tend* to function as a Gateway Network Element (GNE) that can facilitate the download of files located at FTP servers to remote NEs connected to the DMX*tend*.

- **Ethernet Jumbo Frame Support**

  DMX*tend* supports jumbo-sized Ethernet frames with a maximum capacity of 10, 000 bytes. Jumbo frame support can increase the total throughput of an Ethernet switch by reducing the number of frames that must be processed when switching a high volume of data.

Synchronization

- Internal Stratum 3 timing generator
- Holdover, free running, and OC-3/12 line timing (from high-speed packs in M1 and M2)
- DS1 synchronization output signals and line timing reference switch (S1 Byte)
- Architecturally enabled for an external BITS clock

In-service upgrades

- **In-service upgrade for OC-3 to OC-12 high-speed (available 3/03)**

  DMX*tend* supports in-service upgrades of the high-speed (network interface) circuit packs from OC-3 to OC-12.

Operations

- **DMX*tend* PC-CIT**

  The PC-CIT manages the DMX*tend* system through the LAN/Serial ports, providing TL1 messaging, software download, and full operations, maintenance, and provisioning functions through a Graphic User Interface (GUI). DMX*tend* PC-CIT works on PCs running *Windows™ 2000 and NT4.0.*

- **Navis™ Optical EMS support**

  Navis™ Optical EMS is supported to manage operations on DMX*tend*.

- AITS support
- Level 1 Area Provisioning
- Level 2 Routing
- Operations Interworking with DMX
- Local and Remote Software Download capability
- 19 Miscellaneous Discrete Inputs (MDI) and 4 Miscellaneous Discrete Outputs (MDO)
- Office Alarm support
- Network size of up to 50 Network Elements (256 in R2.0)
- IAO-LAN support (front and rear)
- EIA-RS-232 PC-CIT (serial port front and rear access)
- UPSR protection switching (GR-253 compliance)
- Remote alarm support
- -48 VDC Power supply
- Four levels of security including 7 to 999-day password aging, customized login proprietary messages, and up to 150 users.
- In-service node additions
- **OSI seven-layer protocol stack**

  Provides interworking using the standard Open Systems Interconnection (OSI) seven-layer protocol stack over the data communications channel (DCC).
- **Target ID Address Resolution Protocol (TARP)**

  DMX*tend* is compatible with any other-vendor NEs that support TARP, OSI, IAO LAN, and TL1/X.25 as specified in Telcordia Technologies GR-253.
- **Transmission Control Protocol/Internet Protocol (TCP/IP)**

  Provides access to Navis ™ Optical EMS or PC-CIT over TCP/IP LAN to a DMX and subtending DMX, DDM-2000, and other NEs that support DMX operations interworking.

  TCP/IP also enable software downloads via FTP through the LAN CIT and RS232 CIT ports located at the front of the high-speed (network side) circuit packs in the MAIN slots of the DMX*tend* shelf.

Interwoking Capabilities

- **Product family 2000 and WaveStar product family Operations interworking (OI)**

  OI compatibility with Product Family 2000 (DDM-2000 and FT-2000), and WaveStar Product Family.

- **Metropolis® DMX and DMX*press* Interoperability**

  DMX*tend* supports OI interoperability with the DMX and DMX*press*.

Environmental and Packaging

- **EMC, UL 605950, NEBS Level 3, CSA**

Release 2.0 Features

Listed below are features planned for Release 2.0:

Low Speed (tributary side) TDM and Ethernet Service Interfaces

- **Dual OC-12 low-speed optical interface**

  8 OC-12 ports when all Function Unit groups (including Growth slots) are equipped with OC-12 OLIU circuit packs (2 ports per pack). 4 OC-12 capacity when signals are protected.

- **Quad OC-3 low-speed optical interface**

  16 OC-3 ports when Function Unit groups D&G are equipped with OC-3 OLIU circuit packs (4 ports per pack). 8 OC-3 capacity when signals are protected.

- **56 port DS1 interface (LNW8)**

  112 DS1 drop capacity when Function Units D and G are equipped with LNW8 circuit packs (56 ports per pack, 1x1 hardware protected).

- **48 port DS3/EC1 interface (LNW19)**

  96 DS3/EC1 drop capacity when Function Units D and G are equipped with LNW19 circuit packs (48 ports per pack, 1x1 hardware protected).

- **16 port DS1 interface**

  This 16 port DS1 circuit pack fits in Function Slots A/B. It is a lower-cost alternative to the other DS1 electrical interface packs, is 1x1 hardware protected, and provides 16 DS1 drop capacity when Function Units A/B are equipped with the 16 port DS1 circuit packs (16 ports per pack, 1x1 hardware protected).

- **3 port DS3 interface**

  This 3 port DS3 circuit pack fits in Function Slots A/B. It is a lower-cost alternative to the other DS3 electrical interface packs, is 1x1 hardware protected, and provides 3 DS1 drop capacity when Function Units A/B are equipped with the 3 port DS1 circuit packs (3 ports per pack, 1x1 hardware protected).

- **24 port 100BASE-TX (10/100T) Ethernet interface-- for enhanced GbE packet ring (GPR) (LNW69)**

  LNW69 is an enhanced 10/100 Mbps Ethernet interface designed to enable such features as Committed and Peak Information Rate (CIR and PIR) billing options. 96 10/100 Mbps drop capacity when four Function Unit groups are equipped with 10/100 Mbps circuit packs (24 ports per pack).

- **4 port Gigabit Ethernet (GbE) interface-- for Ethernet enhancements (LNW70)**

  LNW70 is an enhanced 10/100 Mbps Ethernet interface designed to enable such features as Committed and Peak Information Rate (CIR and PIR) billing options. Eight 1000BASE-SX/LX drop capacity when all Function Unit groups (including Growth slots) are equipped with 1G SX and/or 1G LX circuit packs (4 ports per pack, unprotected).

Network Configurations

- **Ethernet Enhancements**

  DMX*tend* Ethernet interfaces are capable of providing CIR and PIR rate shaping, Link Capacity Adjustment Scheme (LCAS), and jumbo frame support in R1.0.

- **4093 Virtual Local Area Networks (VLANs)**
  DMX*tend* allows the provisioning of up to 4093 separate IEEE802.1q VLANs.

- **VLAN Transparency via Stacked VLANs**
  DMX*tend* allows customer traffic to be identified and segregated using “stacked” IEEE 802.1q VLAN tags. VLAN tags enable the formation of Virtual Private Networks (VPNs) by segregating various units of traffic and isolating different end-customers

- Fast spanning tree restoration (per IEEE 802.1w)

- **Link Capacity Adjustment Scheme (LCAS)**

  LCAS is an extension to SONET virtual concatenation that allows a concatenation group to be resized (STS-1 tributaries added or deleted) hitlessly.

- **GbE Private Line**

  Allows the DMX*tend* to provide dedicated bandwidth for individual customers.

- **Low-speed (tributary side) 1+1 protected linear optical extensions (OC-3, OC-12)**
- **Single- and dual-homed 0x1 ring tributaries**: OC-3 and OC-12
- **UPSR bridge and roll cross-connections**
- **Dual Ring Interworking (DRI)**

  ANSI/Bellcore compliant DRI (through drop and continue method) with interconnected rings (OC-3 or OC-12 UPSR interfaces)

- **Performance monitoring (PM) on VLANs**

  DMX can provide PM on VLAN pass-through cross-connections.

- **VT and Ethernet Hairpinning**
- **High-speed Facility Loopbacks**

  DMX*tend* supports facility loopbacks from the transmit port on a high-speed circuit pack (OC-3/12) to the receive port on the same port.

Synchronization

- **Network Time Protocol (NTP)**

  NTP assures accurate time keeping with reference to radio and atomic clocks located on the Internet.

In-service upgrades

- **In-service upgrade from low-density to high-density electrical interface circuit packs.**

  DMX*tend* allows an in-service upgrade from either the LNW16 to the LNW19 or the LNW6 and LNW7 to LNW8.

Operations

- **Navis™ Optical INC support**

Navis™ Optical EMS is supported to manage operations on DMX*tend*.

- **Utilization of Simple Network Management Protocol (SNMP)**

  DMX*tend* allows SNMP to be used in provisioning/monitoring alarms and traps relative to the Ethernet circuit packs.

Interworking Capabilities

- **Multivendor Operations interworking (OI)**

  DMX*tend* supports interoperability with many other vendors. Ask your account representative for more information.

□

2 Features

Overview

Purpose

This chapter briefly highlights the features of the DMX*tend* Access Multiplexer. These features are more thoroughly described in Chapter 3, “Network Topologies,” Chapter 4, “Product Description,” Chapter 5, “System Planning and Engineering”, and Chapter 6, “Operations, Administration, Maintenance, and Provisioning,” as applicable.

Contents

The following topics are included in this chapter:

Hardware Features

Overview

This section briefly describes the major Hardware related features supported through Release 2.0 of the Metropolis® DMX*tend Access Multiplexer*. If a feature does not have “R2.0” next to its title, it is in release 1.0.

Below is a list of the sections included in Hardware Features:

- Network interface circuit packs (those housed in the MAIN slots of the DMX*tend* shelf)
- Optical, tributary interface circuit packs
- Electrical, tributary interface circuit packs
- Ethernet circuit packs

Important! For more detailed information on the capabilities of these circuit packs, refer to the sections entitled “Circuit Packs” in Chapter 4. For technical specifications refer to Chapter 10.

Network Interface Circuit Packs

This section briefly details the network interface circuit packs available through Release 1.0 of the DMX*tend*. “Network Interface” is used to refer to the high-speed circuit packs, housed in the MAIN slots of the DMX*tend* shelf, and used to provide the connection to the core-side of the network.

OC-3 and OC-12 Network Interface (high-speed) Circuit Packs

The DMX*tend* supports the following OC-3 and OC-12 network interface cards:

- LNW38-- OC-12 (1310nm, intermediate-reach, VT mapping across 6 STS-1s, OSP hardened)
- LNW40-- OC-3 (1310nm, intermediate-reach, VT mapping across 12 STS-1s, OSP hardened)

Optical, Tributary Interface Circuit Packs

DMX*tend* supports the following optical, tributary (low-speed) interface circuit packs in Release 1.0 and 2.0:

- LNW36-- OC-3 (1310nm, long-reach, 4 ports, OSP hardened, R2.0)
- LNW46- OC-12 (1310nm, long-reach, 2 ports, OSP hardened, R2.0)

Electrical, Tributary Interface Circuit Packs

DMX*tend* supports the following electrical, tributary interface circuit packs:

- 16DS1 (R2.0)-- LNW?? (16 ports)
- 16/DS1/3/DS3-- LNW39 (16 DS1ports, 3 DS3 ports)
- 28DS1-- LNW6 (28 ports)
- 28DS1PM-- LNW7 (28 ports, enables PM functionality on DS1 interfaces)
- 56DS1PM (R2.0)-- LNW8 (56 ports, enables PM functionality on DS1 interfaces)
- 3DS3 (R2.0)-- LNW?? (3 ports)
- 12DS3/EC1-- LNW16 (12 ports, DS3 or EC-1 service is provisionable on a per-port basis)
- 48DS3/EC1(R2.0)-- LNW19 (48 ports, DS3 or EC-1 service is provisionable on a per-port basis)

Ethernet Interface Circuit Packs

DMX*tend* supports the following Ethernet interface circuit packs in R1.0 and R2.0:

- Fast Ethernet -- LNW71 (24 ports, 10/100 Mbps, enhancements to enable Ethernet private line services)
- Fast Ethernet (R2.0)-- LNW69 (24 ports, 10/100 Mbps, enhancements to enable Ethernet CIR and PIR)
- GbE (R2.0)-- LNW70 (4 ports-- 1 gigabit each, short/long reach--hardware selectable, enhancements to enable Ethernet CIR and PIR)

□

In-service Upgrades

Overview

This section briefly describes the in-services upgrades supported through Release 1.0 of the Metropolis® DMX*tend Access Multiplexer*. All features associated with Release 2.0 display release number next to the feature title. If no release number is specified, the feature was part of the previous release of the DMX*tend*.

In-service electrical upgrade from low to high-density DS1/DS3 circuit packs (R1.0)

DMX*tend* supports an in-service electrical upgrade, enabling you to increase DS1/DS3 capacity without affecting service. Total DS1 capacity can be increased from 56 to 112 DS1 interfaces per shelf. Total DS3/EC1 capacity can be increased from 24 to 96. Electrical in-service upgrades can be preformed on shelves hosting a mix of DS1 and DS3/EC1 circuit packs without affecting service. The DMX*tend* High-Capacity shelf is required when using high-density DS1/DS3 circuit packs.

> **Important!** When Function Slots A/B are populated with 16/DS1/3/DS3 combination circuit packs, an additional 32 DS1s (unprotected may be added to the figure noted above. When Function Slots A/B are populated with 3/DS3 circuit packs, an additional 6 DS3s (unprotected may be added to the figure noted above

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Topologies

Overview

This section briefly describes the major topologies supported through Release 1.0 of the Metropolis® DMX*tend Access Multiplexer*. All features associated with Release 2.0 display release number next to the feature title. If no release number is specified, the feature was part of a previous release of the DMX*tend*.

High-speed (Network interface) OC-3/12 UPSR

DMX*tend* supports UPSR on the STS-3c and STS-12c levels, in addition to STS-1 and VT1.5. When both Main slots are equipped with OC-3/12 OLIUs (LNW40 and LNW38 respectively) circuit packs, an STS-1 switching fabric (STS-1, STS-3c, and STS-12c-- STS-12c only w/ OC-12 OLIU) supports the low-speed interfaces. Each circuit pack establishes both an east-to-west and a west-to-east rotation on the ring. A UPSR ring provides a very valuable and reliable foundation for services protecting against fiber cuts and node failures.

High-speed (Network interface) Linear optical extensions

DMX*tend* supports 1+1 protected linear optical extensions. The high-speed linear optical extension may connect the DMX*tend* shelf, by way of OC-3/12 network interfaces in the MAIN slots, to an OC-48 or OC-192 node with OC-3/12 tributary interfaces or to an OC3/12 node through the network interface. This feature performs true linear switching based on line layer defects.

Low-speed UPSRs (for STS-1 termination and VT Ring Closure-- R2.0)

The DMX*tend* can host multiple OC-3/12 rings on the low-speed interfaces of the DMX*tend* shelf. This is accomplished by intra-function group, pass-through cross-connections. The DMX*tend* can close a low-speed ring by supporting a cross-connection between a receive port on one circuit pack and a transmit port on another circuit pack in the same function or growth group. All protection switching advantages/capabilities of low-speed UPSR configurations still apply in VT Ring Closure applications.

Low-speed (Tributary interface) Linear optical extensions

DMX*tend* supports 1+1 protected linear optical extensions for data transport originating at a data device. The low-speed linear optical extension may connect the DMX*tend* shelf, by way of OC-3/12 tributary interfaces in the Function and/or Growth slots, to an OC-3 or OC-12 node. This feature performs path switching on all paths within a line if that particular line fails.

Single- and dual-homed ring extensions (R2.0)

The DMX*tend* supports low-speed OC-3/12 unswitched UPSR protected broadband tributaries, including single- and dual- homed ring extensions. A DDM-2000 OC-3, OC-12, FiberReach, or *DMXpress* Multiplexer may be the add/drop multiplexer on the lower-speed ring.

Hairpinning (R2.0)

See the section entitled, Hairpinning cross- connections (2-12) in this chapter.

Dual Ring Interworking (R2.0)

DMX*tend* supports UPSR DRI only. DMX*tend* dual node ring interworking (DRI) cross-connection complies with Telcordia GR-1400 (which refers to GR-253-CORE) standards. A service selector exists for each STS-N tributary provisioned for DRI. The service selector selects the better of two received path-level signals in accordance with a given hierarchy of conditions. These conditions include STS Path Signal Fail and PDI-P (Payload Defect Indicator - Path Level). This release supports DRI with the Drop and Continue method to a UPSR.

GbE Packet Rings (R2.0)

DMX*tend* supports Gigabit Ethernet (GbE) packet rings that enable cost-effective internet access and business-to-business LAN services. GbE packet rings allow interworking among 10/100 Mbps and 1000 Mbps (GbE) Ethernet lines while VLAN tagging ensures individual customer privacy. These GbE capabilities allow the DMX*tend* to support various Quality of Service (QoS) features, including fast packet-layer restoration.

4093 VLANs

DMX*tend* allows the provisioning of up to 4093 separate IEEE 802.1q VLANs. VLANs are a way in which LAN users at the enterprise level, located on physically separated LAN networks, are assigned priority access privileges across a WAN backbone. Although they are in different locations, they appear to be on the same physical segment of an enterprise-level LAN. Thus, VLANs are logical groupings of various users, regardless of their physical location on the network.

Stacked VLANs (VLAN Transparency)

DMX*tend* allows customer traffic to be identified and segregated using "stacked" IEEE 802.1q VLAN tags. VLAN tags enable the formation of Virtual Private Networks (VPNs) by segregating various units of traffic and isolating different end-customers. This allows data from different customers to efficiently share common bandwidth while simultaneously ensuring a basic level of security for each customer (hence VPN).

The notion of VLAN "transparency" comes from the fact that individual customer packets are tagged using a second tag, called a customer ID (CID is provided by customer equipment). There is no need to coordinate VLAN tags between the customer and service provider. Therefore, customer packets are transmitted through a service provider's network "transparently".

GbE Private Line (R2.0)

DMX*tend* GbE private lines (1000 Mbps) enable premium data transport services offering GbE transport with optional bandwidth provisioning up to full line-rate. GbE private lines provide the user the ability to transport frames completely transparently between two DMX*tend* NEs. No VLAN knowledge or packet-layer provisioning is required by the user in this application. Simple, SONET cross-connect provisioning is all that is required when using "private line" or "no tag" mode. These GbE capabilities allow the DMX*tend* to provide dedicated bandwidth for individual customers and fast SONET-layer restoration.

Fast Ethernet Private Line (R2.0)

DMX*tend* Fast Ethernet (10/100 Mbps) private lines enable premium data transport services offering 10/100 Mbps transport with optional bandwidth provisioning up to 100Mbps (variable bandwidth provisioning of 1, 2, or 3 STS1s. Fast Ethernet private lines provide the user the ability to transport frames completely transparently between two DMX*tend* NEs. No VLAN knowledge or packet-layer provisioning is required by the user in this application. Simple, SONET cross-connect provisioning is all that is required. These Fast Ethernet capabilities allow the DMX*tend* to provide dedicated bandwidth for individual customers and fast SONET-layer restoration. LNW71 must be used to enable Fast Ethernet private lines.

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Networking Capabilities

Overview

This section briefly describes the major networking capabilities supported through Release 1.0 of the Metropolis® DMX*tend Access Multiplexer*. All features associated with Release 2.0 display release number next to the feature title. If no release number is specified, the feature was part of a previous release of the DMX*tend*.

1 Mbps Rate Limiting

DMX*tend* supports rate shaping at the level of 1 Mbps for Ethernet interfaces. This means that DMX*tend* can automatically establish Ethernet transmission channels to fit the need of the user upon connection. For each connection, the DMX*tend* will create a virtual channel of the appropriate size (in 1 Mbps intervals) to facilitate the desired Service Level Agreement (SLA). Rate limiting at the 1Mbps level provides a transmission ceiling for highly efficient allocation of shared bandwidth for data communications.

VT1.5 granularity

VT1.5 granularity is provided across any 6 or 12 STS-1 signals within the OC-12 and OC-3 high-speed OLIUs (LNW38 and LNW40 respectively).

Committed Information Rate (CIR) and Peak Information Rate (PIR) service/billing capabilities (R2.0)

DMX*tend* supports Ethernet CIR and PIR service/billing capabilities in R2.0. The Ethernet circuit packs introduced in R2.0 (LNW70 & LNW69) support enhanced Ethernet features such as CIR, PIR, and LCAS.

CIR refers to the committed information transfer rate guaranteed by the service provider under normal conditions. The Ethernet circuit packs offered in R2.0, therefore, enable the provisioning of particular information rates (translates to bandwidth guarantees) for individual customers.

PIR refers to the peak information transfer rate guaranteed by the service provider during certain time periods that are specified by the customer. The Ethernet circuit packs offered in R2.0, therefore, enable the provisioning of a peak information rate (translates to bandwidth) that an individual customer is guaranteed during a specified time period (for instance, between 8am and 1pm on business days).

Link Capacity Adjustment Scheme (LCAS) (R2.0)

LCAS is an extension to SONET virtual concatenation that allows a concatenation group to be resized (STS-1 tributaries added or deleted) hitlessly.

Jumbo Frame Support (R1.0 and 2.0)

DMX*tend* supports jumbo-sized Ethernet frames with a maximum capacity of 10, 000 bytes. Jumbo frame support can increase the total throughput of an Ethernet switch by reducing the number of frames that must be processed when switching a high volume of data.

In R1.0 jumbo frames are supported with the Fast Ethernet (10/100 Mbps) Private Line circuit pack (LNW71). In R2.0 the Fast Ethernet (LNW69) and GbE/4 (LNW70) will also support jumbo frames.

Multicast Ethernet Packets (R2.0)

DMX*tend* supports multicast Ethernet packets in all releases. A multicast packet is identified by the first bit in the MAC destination address. Such a MAC address will never appear as a source address, and so multicast destination addresses (TIDs) are not learned. Since unknown source addresses are treated as broadcast, multicast packets/frames are sent to ALL ports in the VLAN (IEEE 802.1Q) or Transparent LAN (customer/port tag) for that packet.

Fast Spanning Tree/ IEEE802.1w Rapid Reconfiguration (R2.0)

Ethernet requires a network with a tree structure in order to work effectively. Ethernet bridges and switches build tables that define the paths to specific devices. A MAC bridge, for example, will have a filtering database that defines where to send any packets addressed to a specific MAC within the network. The tables are built based on input from devices within the network. DMX*tend* supports an improved/faster spanning tree algorithm, documented in IEEE 802.1w Rapid Reconfiguration.

If there is a loop in the network, that is, if there is more than one way to get to a destination device, two problems can result:

Frames may be duplicated in the network.

- That is, the same frame may be sent to a node via two different paths.

The address information will be changed as packets from that device are received across different paths. In a meshed network, the reconfiguration of the filtering database can begin to use up all the network resources, so that little bandwidth is left for data traffic.

The spanning tree accomplishes two important functions:

- It removes loops from the bridged network
- It allows Ethernet layer reconfiguration if a link fails.

Important! DMX*tend* has been designed with multi-vendor interoperability in mind. As many vendor's equipment (including legacy equipment) may not be able to use IEEE802.1w, DMX*tend* can automatically fall back on IEEE802.1d in the event that other NEs in the network are running standard spanning tree protocol. However DMX*tend* employs IEEE 802.1w as a default spanning tree protocol.

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Cross-connection Types

All allowable cross-connections

This section details the new types of cross-connections supported by the DMX*tend*. Thus, this represents only a fraction of the total allowable cross-connections. For an in depth look at cross-connections supported by the DMX*tend*, refer to the section entitled "Cross-connections" in Chapter 5 of this document.

Hairpinning cross-connections

In a "hairpinning" topology, low-speed tributary traffic is routed into the system and back out of the system without ever being placed on the high-speed (OC-3/12) UPSR interfaces. The cross-connection capability of connecting any input on a circuit pack in a function or growth slot to any output on a circuit pack in a different function or growth slot in the same shelf, allows you to use a combination of add/drop and hairpinning of compatible payloads through a variety of interfaces. You can bring traffic in from one remote site and cross-connect it at the VT1.5, STS-1, STS-3c, STS-12c or Ethernet (both 100 BASE-TX and 1000 BASE-SX/LX) level back out to other remote sites without consuming any capacity on the high-speed UPSRs.

Bridge and Roll cross-connections (R1.0)

Bridge and roll cross-connections are coordinated activity between two NEs designed to move traffic from one facility to another without affecting service.

By combining the bridge and roll functionalities detailed in the "Cross-connections" section of Chapter 5, the user can change the source of the input tributary of a cross-connection without affecting service.

Bridged Cross-connections

Bridging of an existing cross-connection consists of adding a one-way cross-connection with the same input tributary as that of an existing cross-connection, resulting in a 1x2 multicast from an input tributary to two output tributaries. DMX*tend* supports bridging for each of the supported SONET cross-connection rates. You can bridge any existing cross-connection to a second output port without impairing the existing signal. Conversely, either half of a bridged signal can be taken down without impairing the remaining cross-connected signal.

Rolling cross-connections

The DMX*tend* provides the capability to change the location or source of the input tributary of a given cross-connection, without affecting service (maximum interrupt in service of 2.5 milliseconds). The DMX*tend* supports facility rolling for all supported signal rates as follows:

- Disconnection of the circuit cross-connecting input tributary to output tributary
- Cross-connection of either a new input tributary to the corresponding input tributary

Pipe-mode (adaptive-rate) cross-connections (R2.0)

Path level fault, PM and protection switching automatically adjust to changes in the constituent signal structure of an existing cross-connection. For example, a given STS-3(c) cross-connection may be carrying 3 STS-1s or a single STS-3(c). Fault, PM and protection switching would automatically adjust to changes between the two possible constituent signal structures.

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Operations Features

Overview

This section briefly describes the major Operations related features supported through Release 2.0 of the Metropolis® DMX*tend Access Multiplexer*. If a feature does not have "R2.0" next to its title, it is in release 1.0.

***DMXtend* PC-CIT with GUI**

The PC-CIT manages the DMX*tend* system through the TL1/CIT port, providing TL1 messaging, software download, and full operations and provisioning capability via a Graphic User Interface (GUI) or TL1 command builder. The PC-CIT can run a full-featured GUI or TL1 scripts. Using the GUI, a crafts person can access all DMX*tend* software functions and context-sensitive help. The TL1 command builder, also known as the TL1 Translation Device (T-TD), is a flexible TL1 command instructor that supports full TL1 management through TCP/IP or RS-232 interfaces.

The PC-CIT is not used to download release software to the system (the PC is used, but not the CIT software). Release software can be copied to other NEs remotely, provided the initial download of DMX*tend* release software has occurred on each system.

Performance monitoring

Performance monitoring (PM) data will be reported on the VT1.5, STS-1,STS-3c, STS-12c, DS1, DS3, OC-12 and OC-3 levels.

Support of Simple Network Management Protocol (R2.0)

DMX*tend* makes use of Simple Network Management Protocol (SNMP). SNMP is the most common protocol used by data network management applications to query a management agent using a supported Management Information Base (MIB). SNMP operates at the OSI Application layer. The IP-based SNMP is the basis of most network management software, to the extent that today the phrase "managed device" implies SNMP compliance. The DMX*tend* provides limited SNMP support of certain reports and traps. For more information, see the section entitled "SNMP Parameters and Traps" in Chapter 6 of this document.

TL1 management

TL1 messaging is supported via the Serial, IAO LAN, and X.25 interfaces. The DMX*tend* PC-CIT, when used in conjunction with the TL1 command builder, provides full TL1 management through TCP/IP to OSI interfaces.

TL1 management via TCP/IP

TL1 message exchange is supported over TCP/IP via IAO LAN, OSI LAN, and PC-CIT interfaces. IAO LAN supports TCP/IP protocol and OSI protocol. These provide a communication link from a DMX*tend* to a local node that may serve as a gateway to the network.

Integrated TCP/IP Management Interface

The DMX*tend* supports two types of IP Access. In one case, the DMX*tend* can serve as a TL1 Translation Device (T-TD) by being a gateway network element that allows a Navis EMS and/or PC-CIT to communicate to other network elements (NEs) on an OSI network through an IP access network. In the second instance, the DMX*tend* can functionally encapsulate IP packets within OSI packets to be transmitted through the OSI network to the proper NE. This capability is called IP tunneling.

TL1 Translation

The DMX*tend* can copy the application information within an IP packet into an OSI packet. Thus, all IP protocol information is lost. This translation is performed at the application layer. Separate gateways can be provided by a single DMX*tend*.

IP Tunneling

IP tunneling allows for file transfer through an IP access network. IP tunneling is used to perform end-to-end FTP through the OSI portion of the IP access network. In this instance the DMX*tend* serves as a gateway network element (GNE) that encapsulates an IP packet within an OSI packet. When the final destination of the file is reached, the IP packet is removed from within the OSI packet and processed by the TCP/IP stack. Thus, IP tunneling allows and Navis EMS and/or CIT to reach NEs in an OSI based DCN network with FTP over IP. In this case, the end points of the IP tunnel are the actual terminating points for the IP traffic.

FTP/FTAM Gateway for remote software download

Also referred to as FTTD (File Transfer Translation Device), the FTTD allows DMX*tend* to function as a Gateway Network Element (GNE) that can facilitate the download of files located at FTP servers to remote NEs connected to the DMX*tend*.

Software download over DCC

This feature enables software (upgrade) to be downloaded to remote NEs from a central office site via the data communications channel (DCC).

OSI seven-layer protocol stack

This feature provides interworking using the Open Systems Interconnection (OSI) seven-layer protocol stack over the data communications channel (DCC). The OSI seven-layer protocol stack refers to the OSI reference model, a logical structure for network operations standardized by the International Standards Organization (ISO).

Remote NE Status

This feature partitions a subnetwork into maintenance domains (alarm groups). An Alarm Group is a set of NEs that share status information. Alarm groups can be nodes in a ring or any other logical grouping such as a maintenance or geographical group. Each Level 1 area can be identified as a separate Alarm Group, as long as it does not exceed 50 nodes. You must provision one NE in an Alarm Group as an alarm gateway NE (AGNE) to support office alarms and a summary alarm information of remote NEs in the local alarm report. More than one AGNE can be provisioned per alarm group, but this is not recommended.

Security

Security features include 1-999 day password aging, customized login proprietary messages, and 150 users.

TARP

DMX*tend* is compatible with any other-vendor NEs that support Target ID Address Resolution Protocol (TARP), OSI, IAO LAN, and TL1/X.25 as specified in Telcordia Technologies GR-253.

SONET

Many of the traditional SONET maintenance, provisioning, operations, control, and synchronization features are included in the DMX*tend*. The flexible SONET standard provides a formidable foundation for the DMX*tend* to build upon.

***TIRKS/NMA/Transport* compatibility**

DMX*tend* is supported by Telcordia OSs *TIRKS*, *NMA*, and *Transport*.

Multivendor Operations Interworking

DMX*tend* supports interoperability with many vendors' equipment.

Product Family 2000/WaveStar Product Family Interworking

DMX*tend* supports TARP interoperability with Product Family 2000 nodes such as the FT-2000 OC-48 Lightwave System, the DDM-2000 OC-3/OC-12 Multiplexer, and the DDM-2000 FiberReach Multiplexer.

DMX*tend* also provides interoperability with all *WaveStar* Product Family nodes supporting TARP over UPSR applications (Release 1.0).

Navis™ Operations Support

DMX*tend* supports operations via Lucent's Navis™ Optical EMS and Navis™ Optical INC.

Synchronization

Embedded Stratum 3 timing generator

The OC-12/3 high-speed circuit packs contain an embedded Stratum 3 timing generator. This timing generator is used when the DMX*tend* is configured in a free running mode.

Line timing and external timing are also supported by DMX*tend*. Line timing is derived from an incoming MAIN OC-12/3 line, while external timing is derived from an external timing source.

DS1 timing output

The embedded Stratum 3 timing generator can generate a DS1 timing output to time other externally-timed systems.

S1 byte synchronization messaging

DMX*tend* uses the S1 byte of the SONET overhead to pass timing status information to different nodes in an access transport network.

Network Time Protocol

Network Time Protocol (NTP) assures accurate synchronization of the DMX*tend* with reference to radio and/or atomic clocks located on the Internet.

3 Applications and Configurations

Overview

Purpose

The Metropolis® DMX*tend Access Multiplexer* (DMX*tend*) supports a wide range of service applications and a variety of network applications economically and efficiently.

Contents

The following sections are included in this chapter:

Overview

Overview

The DMX*tend* Access Multiplexer is a single shelf network multiplexer designed primarily for access transport, and business access applications transporting voice and data at the OC-3/12 level via a unidirectional path switched ring (UPSR).

The DMX*tend* offers OC-3/12 UPSR as a standard interface using 1310nm intermediate reach optics. Integrated switching includes VT, STS-1, and Ethernet granularity. The system is line timed. In addition to OC-3/12 equipage, DMX*tend* can support a wide array of wideband and broadband transport, including traditional SONET transport of tributary DS1, DS3, EC-1, OC-3, and OC-12, as well as 10/100/1000 Mbps Ethernet transport. The shelf can be equipped to serve many diverse network applications and supports a variety of operations interfaces for current and evolving network operations needs.

DMX*tend* can be managed by the same operations systems used for DMX, including PC-CIT and Navis™ EMS.

The DMX*tend* is NEBS Level 3 compliant and can be outfitted with a –48 VDC power supply. It can be installed in a outdoor cabinet, or rack/bay mounted.

DMX*tend* brings next-generation SONET to the local loop in a compact, economical, and fully protected platform. Finally, DMX*tend* supports multivendor operations interworking, and is fully compatible with Lucent’s DDM-2000 and FT-2000 systems; allowing you to grow to offer next-generation SONET services while preserving investments in legacy equipment.

□

Loop Access/Cabinet Deployment

Overview

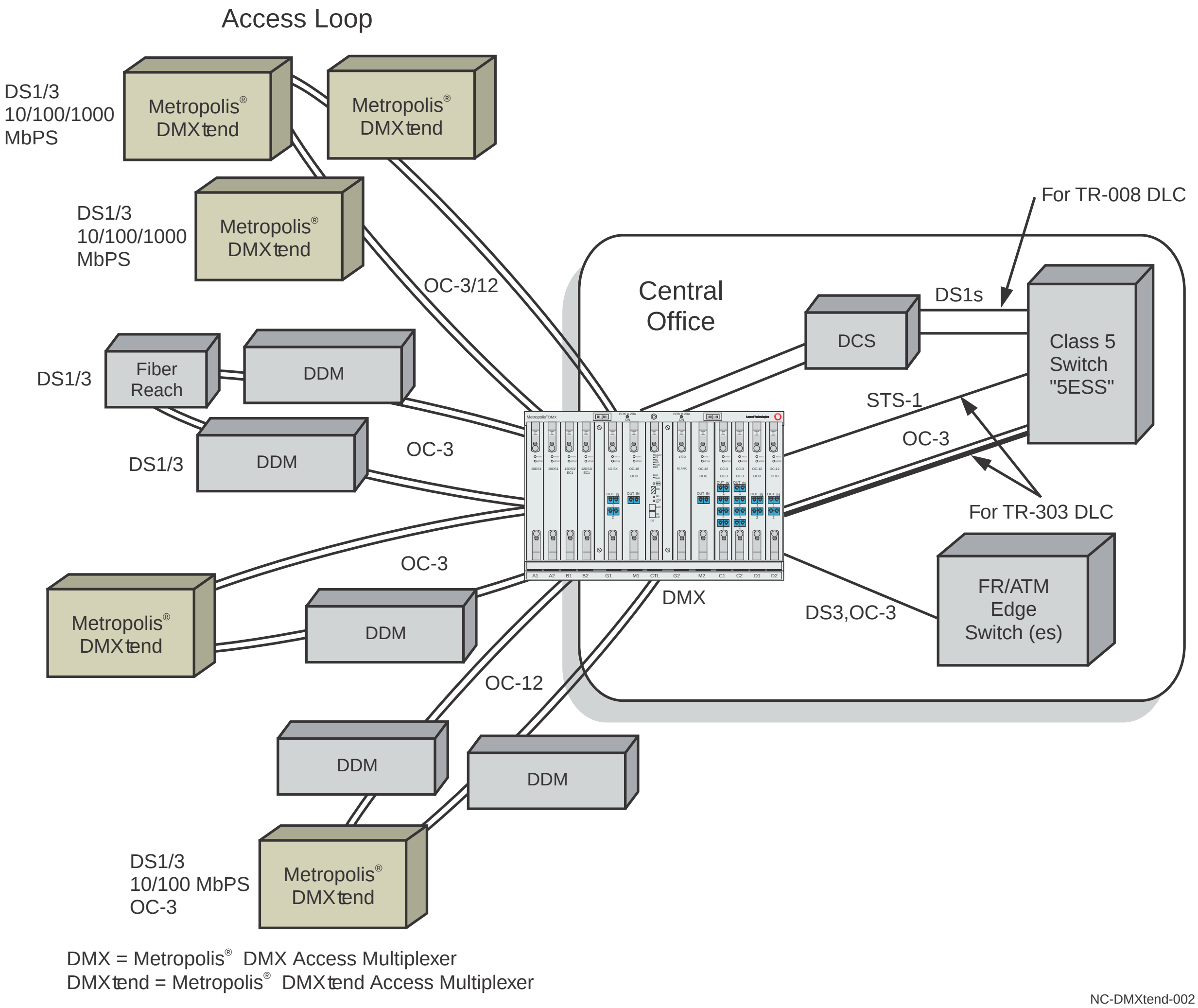
With a modest footprint, TDM and Ethernet over SONET functionality, and standards based architecture, the DMX*tend* is ideal for enabling next-generation loop access and facilitating easy upgrade paths from existing solutions (such as DDM/FT-2000). The DMX*tend* is OSP hardened for outside plant deployment and, with its modest footprint, is well suited for cabinet installations.

Loop Access

Providing intermediate-reach OC-3/12 high-speed optics and a mix of DS1, DS3, EC-1, OC-3, and OC-12 optics, the DMX*tend* can be a collection point for a variety of interfaces, thus enabling next-generation loop access with a smooth upgrade path from legacy equipment.

The figure below shows the DMX*tend* providing loop access for the various interfaces listed above, and interworking with DDM and FT-2000 to enable a network transition to next-generation, higher capacity services, and show how the DMX*tend* can interwork with embedded, legacy equipment. Thus the DMX*tend* can simultaneously foster an upgrade to next-generation, data savvy metro services, while preserving capital investments in legacy equipment where advantageous.

Figure 3-1 Next-generation Loop Access



Cabinet Deployment

DMX*tend* offers a complete set of environmentally hardened TDM circuit packs, enabling OSP hut and cabinet deployments. DMX*tend* can be retro-fitted to fit in the place of previously deployed DDM-2000 systems. It can also fit in standard-sized cabinets, 19”, and 23” bays.

In the future, DMX*tend* may offer unique, cabinet deployment packages for simplified ordering and deployment. More information concerning this possibility will be provided as it becomes available.

For specifications concerning environmentally hardened circuit packs, refer to the appropriate sections of Chapters 4 and 10 of this document.

□

Low-cost Fiber to the Enterprise

Overview

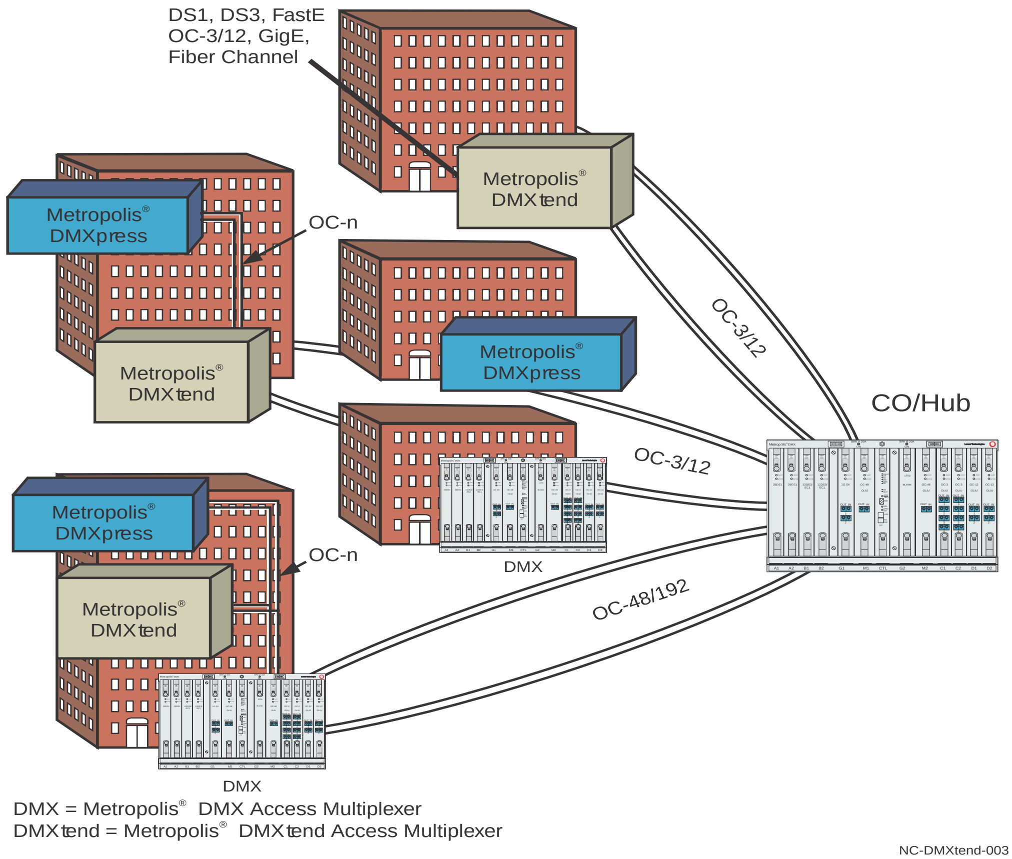
The DMX*tend* provides a compact, equipment protected, multi-service Point of Presence (POP) for Multi Tenant Unit (MTU) collection. This enables cost effective fiber-to-the-enterprise applications, while providing SONET reliability and interoperability.

The DMX*tend* Ethernet capabilities can be used to offer high-speed Internet access, transparent LAN, VLAN, Ethernet private line, and Ethernet rate shaping in combination with high-revenue voice and private line transport applications via DMX*tend*'s TDM capabilities.

Description

With its modest footprint, DMX*tend* can be placed in an office building, office park, corporate campus, medical facility, hotel, or any building housing multiple business units. DMX*tend* is ideal as a collection point for multiple DS1, DS3, EC-1, OC-3/12, 10/100 Mbps, and GbE interfaces. It can also transmit enterprise/edge traffic back to the metro-core over SONET protected OC-3/12 UPSRs or 1+1 linear extensions and supports full facility protection on all DS1, DS3, EC-1, OC-3 and OC-12 interfaces.

Figure 3-2 Fiber to the Enterprise



The figure above shows DMX*tend*s in a few different buildings. With its protected OC-3/12 MAIN optics, the DMX*tend* is perfect for the application pictured below because it can serve as a collection point for various individual business groups colocated in the same building, and transmit their traffic either to a DMX located in the basement or in a wiring closet (as in the bottom left of the figure), or directly to a service provider's site outside of the building. Applications include T1, T3, DSL/DSLAM aggregation, 10/100 Mbps, GbE, and TDM interfaces.

Application advantage

Using the DMX*tend* in this application results in the following advantages:

- Low-cost, facility and SONET protected fiber terminations directly to the business
- Flexible service offerings (DS1, DS3, EC-1, OC-3, OC-12, 10/100 Mbps, GbE)

- Easily managed solution: if the DMX*tend* is connected to the DMX, DMX*press*, Lambda Unite, WaveStar 2.5G/10G, or Lambda Manager the remotely located DMX*tend* can be managed from the central office using the Lucent PC-CIT, Navis™ EMS, or Navis™ INC.
- The DMX*tend* supports service flexibility with a 16 port DS1/ three port DS3 combination circuit pack-- 16, 28, or 56 port DS1-- 3, 12, 48 port DS3-- a 24 port 10/100 Mbps-- and 4 -port GbE circuit packs all of which are meant to facilitate cost-effective and steady growth. With such a variety of TDM and Ethernet interfaces, the need for fork-lift upgrades in order to support new services and increased traffic is nearly eliminated.
- DMX*tend* is designed as an ultra-compact, protected, full-service TDM/Ethernet CPE, eliminating the need for larger NEs or data specific switches and routers within the building. This is extremely advantageous as the cost of renting space in high-rise basements for telecommunications equipment is high.
- Enables next generation Ethernet over SONET services such as VLANs, Transparent LANs, Ethernet private lines, and Ethernet rate shaping.
- The DMX*tend* is one of the few NEs of its size/capabilities to support facility protection on all circuit packs (Ethernet interface packs can not be facility protected).

□

DDM-2000 Ring Upgrade

Overview

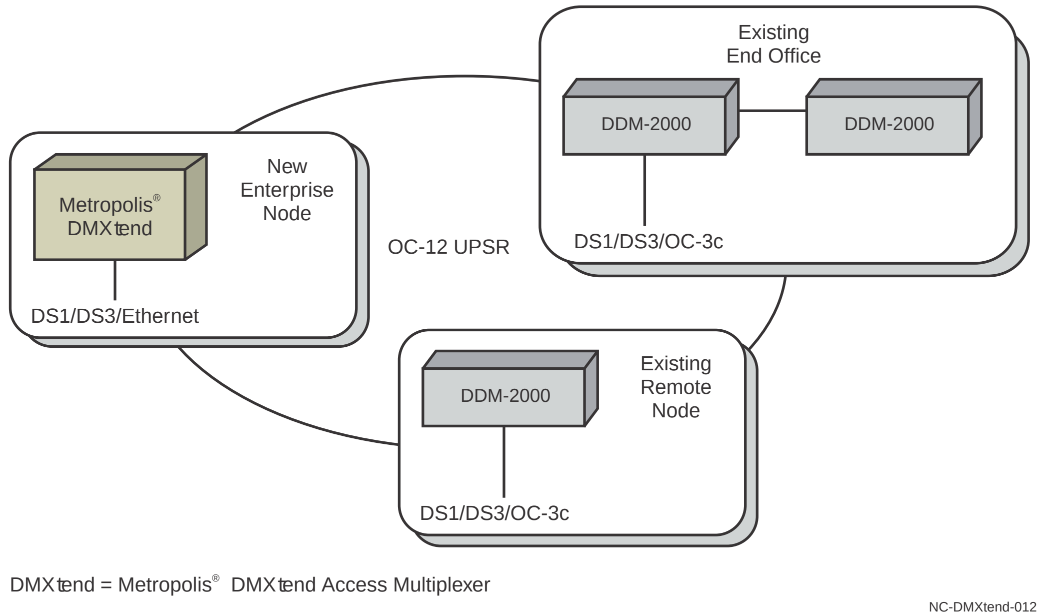
The DMX*tend* provides a low-cost evolution strategy for adding Ethernet services and NG-SONET capabilities to existing DDM-2000 rings.

Description

DMX*tend* and TARP releases of DDM-2000 shelves with OC-3/12 optics connected together have a compatible remote operations capability allowing them to communicate.

Interconnection with other OC-12 rings is possible when the DMX*tend* shelf is equipped with OC-12 MAIN circuit packs.

Figure 3-3 DDM-2000 Ring Upgrade



Application advantage

Using the DMX*tend* in this application results in the following advantages:

- Interoperability with DDM-2000 (TARP Releases) provides investment protection of legacy equipment.
- Cost effective and protected migration of legacy TDM networks to provide multi- service (both TDM and Ethernet) services.
- DMX*tend* (equipped with OC-3/12 pack) can be added to existing SONET rings to enable new Ethernet services on embedded rings.

Campus Network

Overview

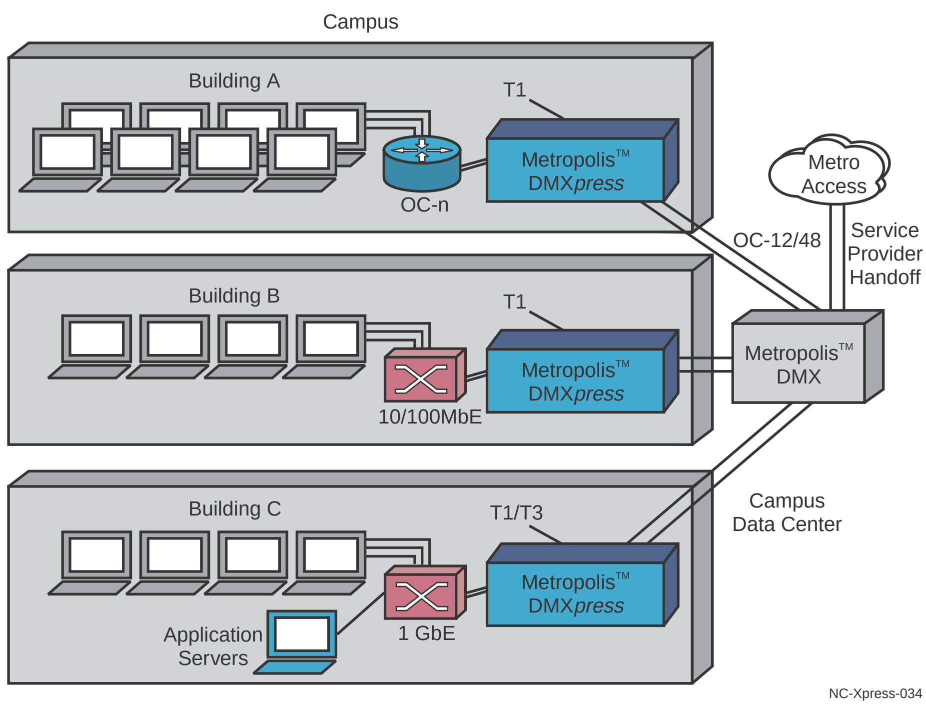
The DMX*tend* provides a highly reliable solution for Campus Networks.

Description

The DMX*tend* can be placed in an office park, corporate campus, college dormitory, or any building housing multiple end users. In its ability to provide a flexible mix of DS1, DS3, OC-3/12, 10/100 Mbps, and GbE tributary interfaces, the DMX*tend* is ideal as a collection point for multiple lines within a diverse MTU providing a variety of both voice and data services.

The figure below shows DMX*tends* in a few different buildings on the same campus. With its OC-3/12 MAIN optics, the DMX*tend* is perfect for the application pictured below because it can serve as a collection point for various individual buildings colocated in the same area, and transmitt their traffic directly to a service provider's site or campus data center over protected OC-3/12 lines.

Figure 3-4 Campus Network



Application Advantage

Using the DMX*tend* in this application results in the following advantages:

- Low-cost, protected, multi-service, optical campus network.
- Reliable, SONET and facility protection of both voice and data services.
- Integrated Ethernet switching and Ethernet compatibility with campus switches.

Multi-service Aggregation

Overview

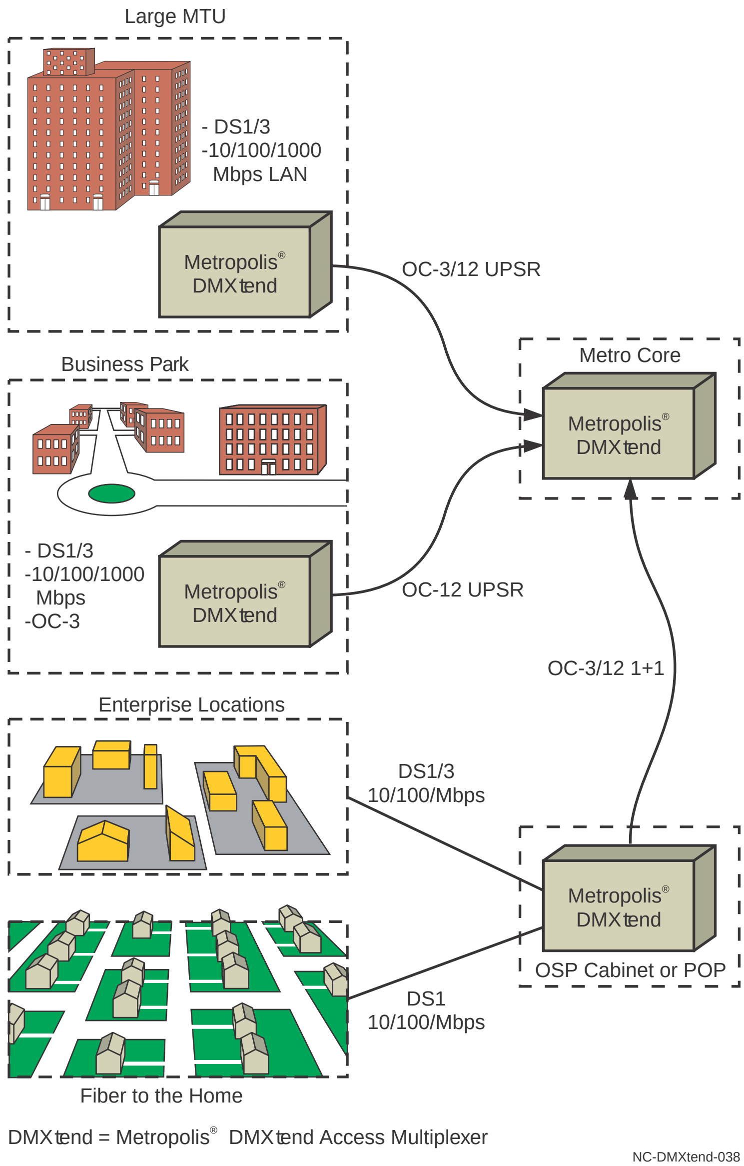
The DMX*tend* offers an affordable, protected solution to multi-service aggregation in the local loop. With it’s compact design, OSP deployment capabilities, and support of a variety of TDM and Ethernet interfaces, DMX*tend* is well equipped to serve as a loop access aggregator for both traditional and next-generation metro services.

Description

Providing intermediate-reach OC-3/12 high-speed optics and a mix of DS1, DS3, EC-1, OC-3, OC-12, 10/100 Mbps and GbE optics, the DMX*tend* can be a collection point for a variety of interfaces providing service to everything from campus networks, enterprise locations and business parks to groupings of private residences and large MTUs.

The figure below shows the DMX*tend* collecting the various services listed above from a variety of small and large establishments and sending them back to a DMX located at the metro core by way of OC-3/12 UPSRs and 1+1 protected linear optical extensions.

Figure 3-5 Multi-service aggregation



Application advantage

Using the DMX*tend* in this application results in the following advantages:

- The DMX*tend*'s small footprint and unique design reduces cost, power consumption, and heat generation at end customer locations and OSP cabinet sites, while at the same time offering facility protection on all optical interfaces.
- Easily managed solution: if the DMX*tend* is connected to the DMX, DMX*press*, Lambda Unite, or WaveStar 2.5G/10G, a remotely located DMX*tend* can be managed from the central office using the Lucent PC-CIT or Navis™ EMS.

- Reliable, SONET network and facility protection of both voice and data services (Ethernet packs are not protected).
- Internet access, VLAN, and Transparent LAN services and applications.
- The ability to mix and match DMX, DMX*tend* and DMX*press* utilizing DMX*tend* where service density/demand is moderate, yet traffic must be protected, allows you to match node size to demand and footprint requirements. DMX*press* on the other hand, offers an ideal NE for sites where service density/demand is low/moderate, but traffic does not need to be protected.

Ethernet Services

Overview

DMX*tend* offers a variety of Ethernet services in Release 1.0 and 2.0. DMX*tend* supports Ethernet packet rings and private lines (private lines in R2.0), providing the options of Committed Information Rate and Peak Information Rate (CIR and PIR) bandwidth provisioning on Ethernet interfaces. Finally, the DMX*tend* supports Link Capacity Adjustment Scheme (LCAS) which provides dynamic bandwidth allocation on Ethernet interfaces.

By offering native Ethernet interfaces on the metro optical network, DMX*tend* helps to simplify your network. This translates into a host of exciting applications that succeed in eliminating discrete customer premise service elements (CPEs) and reducing the number of hub aggregation switches needed for dealing with data service growth. This section provides examples of such applications.

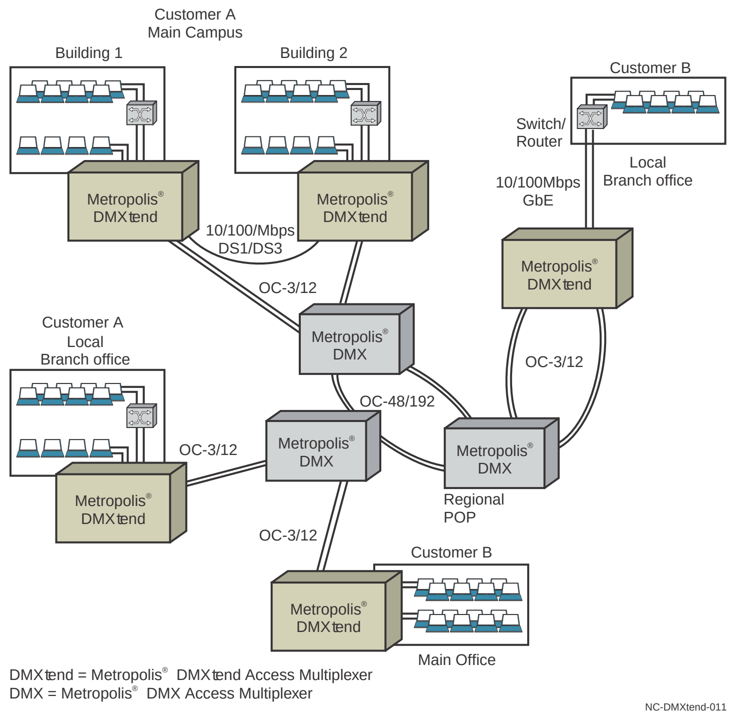
Ethernet Private Line (point-to-point Ethernet) for Enterprise LAN transport

DMX*tend* utilizes standard IEEE 802.1 Ethernet switching in combination with standard STS-1 virtual concatenation (ITU G.707) to transport 10/100 Mbps or 1000 Mbps Ethernet services over a SONET OC-3/12 high-speed (network side) interfaces. DMX*tend* allows you to transport 1, 2, or 3 STS-1s per private line.

In Release 1.0, the DMX*tend* 24 private lines per Ethernet circuit pack. Thus DMX*tend* can support a total of 48 Ethernet private lines.

In this configuration, Ethernet traffic from an end customer may be fed to a core router in the central office (CO), while voice traffic is fed from the same ring to a voice switch in the CO. In private line LAN transport configurations, standard SONET UPSRs can be used to provide restoration within 50 milliseconds.

Figure 3-6 Ethernet Private Line Transport Application



Ethernet private lines provide the user the ability to transport frames completely transparently between two DMX*tend* NEs. No VLAN knowledge or packet-layer provisioning is required by the user in this application. Simple, SONET STS-1 cross-connect provisioning is all that is required. These private line capabilities allow the DMX*tend* to provide dedicated bandwidth for individual customers and fast SONET-layer restoration in the event of a facility-based failure.

Ethernet Private Line Advantages

Ethernet Private Lines provide data transport with absolute QoS. They simplify networks by eliminating intermediate WAN protocols, such as frame relay or ATM while providing service providers an ideal migration path from traditional private line, circuit-based services.

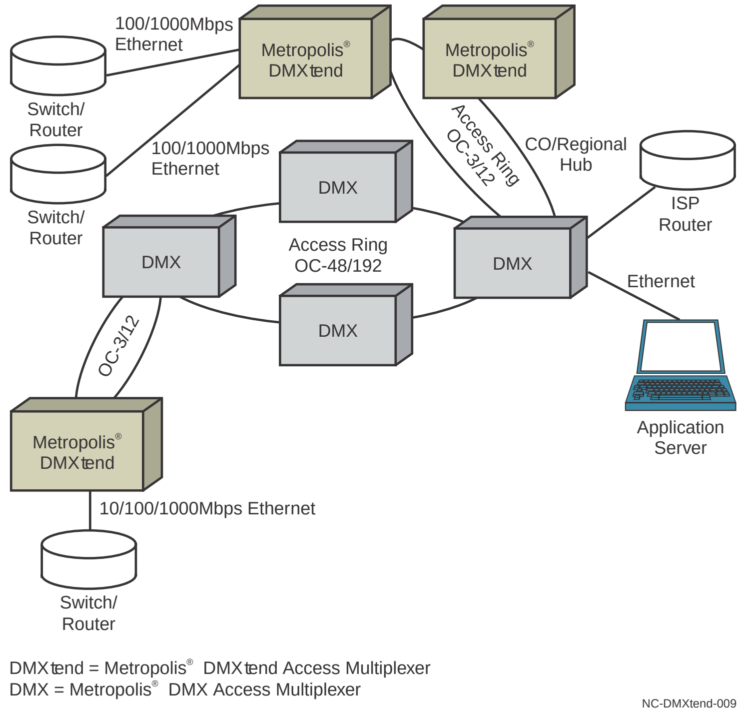
Ethernet Private Lines also provide dedicated bandwidth (with or without protection) and absolute QoS for business critical data transport applications. Private lines are protected by SONET layer protection switching with a guaranteed restoration time of less than 50 milliseconds.

Ethernet Packet Rings

A Packet Ring is a set of packet switches connected in a ring topology that use the inherent redundancy of the ring configuration to provide durability and fast restoration in the event of failures.

Packet rings can be used with or without SONET layer protection. At the packet layer, rapid spanning tree protocol (as defined in IEEE 802.1w) is used to provide protection.

Figure 3-7 Packet Rings



DMX*tend* uses standard Generic Framing Procedure (GFP) encapsulation (ITU G.7041) for Ethernet over SONET mapping. Packet rings provide efficient aggregation and transport for Ethernet traffic. DMX*tend*' virtual concatenation capability (ITU G.707) provides flexible bandwidth granularity in the wide area network (WAN), which can grow with your service demand.

Packet Ring configurations provide business-to-business networking of routers and data switches using Ethernet transport over a reliable, low-cost multi-service network. The DMX*tend* provides the unique capability for a packet ring to span multiple ring topologies. As shown in the figure above, packet rings hosted by the DMX*tend* can span multiple OC-3 or OC-12 ring configurations. Additionally, packet rings hosted by the DMX*tend* can reach into areas serviced by dual/single-homed ring extensions and 1+1 optical extensions (see the figure above).

Port Capacity

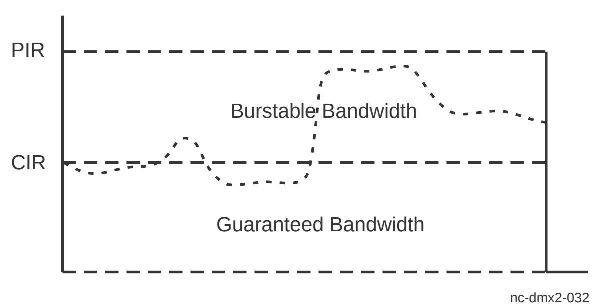
The DMX*tend* currently supports the following number of ports per ethernet circuit pack:

- 24 ports on each 10/100 Mbps Fast Ethernet circuit pack
- 4 ports on each 1000 Mbps GbE circuit pack (depending on the number of ports per pack)

CIR and PIR Rate Shaping

Rate-shaped services offer a statistical multiplexing model that makes efficient use of shared bandwidth. DMX*tend* supports two forms of rate shaping: rate limiting, and committed rate service.

Rate limiting is achieved using Peak Information Rate (PIR) provisioning. Committed rate service is achieved using Committed Information Rate (CIR) provisioning. PIR institutes a limit, or “ceiling”, of maximum bandwidth to be allocated to a particular customer at any time. CIR, on the other hand, provides a guaranteed minimum, or “floor” throughput even during periods of high congestion. Banded and/or burstable services can also be deployed based on CIR and PIR combinations

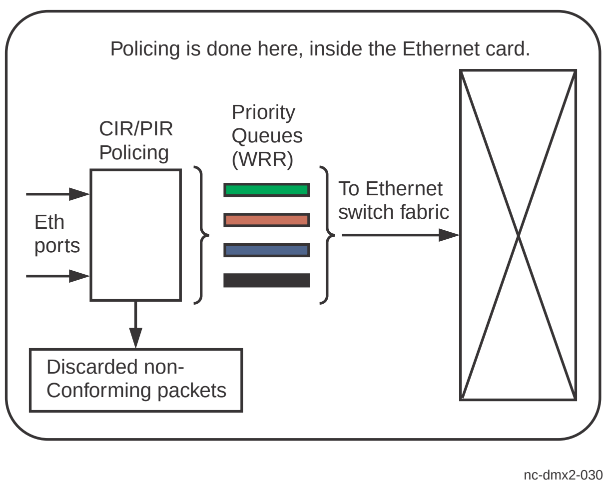


The figure above demonstrates the relationship between CIR and PIR services. Again, PIR represents the maximum bandwidth a particular customer will be allocated at any time, while CIR is guaranteed bandwidth that insures a constant level of service even during periods of high congestion. CIR can be provisioned on a per-port or per-VLAN basis.

As the figure above suggests, if the maximum bandwidth for a customer (PIR) is exceeded, surplus packets may be dropped. On the other hand, if a customer's traffic requires enough bandwidth to exceed their CIR, but remain below their PIR, the packets that exceed the CIR will be marked as discardable. This means that they will not be dropped unless other traffic requires that bandwidth. If the network is not congested when packets exceed the CIR level, the packets will reach their destination. As long as a customer does not exceed their CIR, none of their traffic will ever be dropped.

Policing takes place first in order to ensure that a customer meets the CIP/PIR stipulations of their contract. The priority queing relative to other customer's traffic then occurs; providing another QoS capability.

Figure 3-8 Bandwidth Allocation within Ethernet circuit packs



Rate Shaping Advantages

Rate shaping provides the capability to offer both a guaranteed minimum "floor" throughput during periods of high congestion (CIR), and a maximum "ceiling" throughput in place at all times. Thus, the DMX*tend* enables versatility in QoS for Ethernet applications. With the possibility of burstable services, the DMX*tend* not only provides the possibility of a guaranteed QoS, but also the ability to provide a customer with throughput above and beyond their CIR (when network conditions permit). Finally, all private line services are protected by tried and tested dependability of SONET layer protection.

Municipal Backbone

Overview

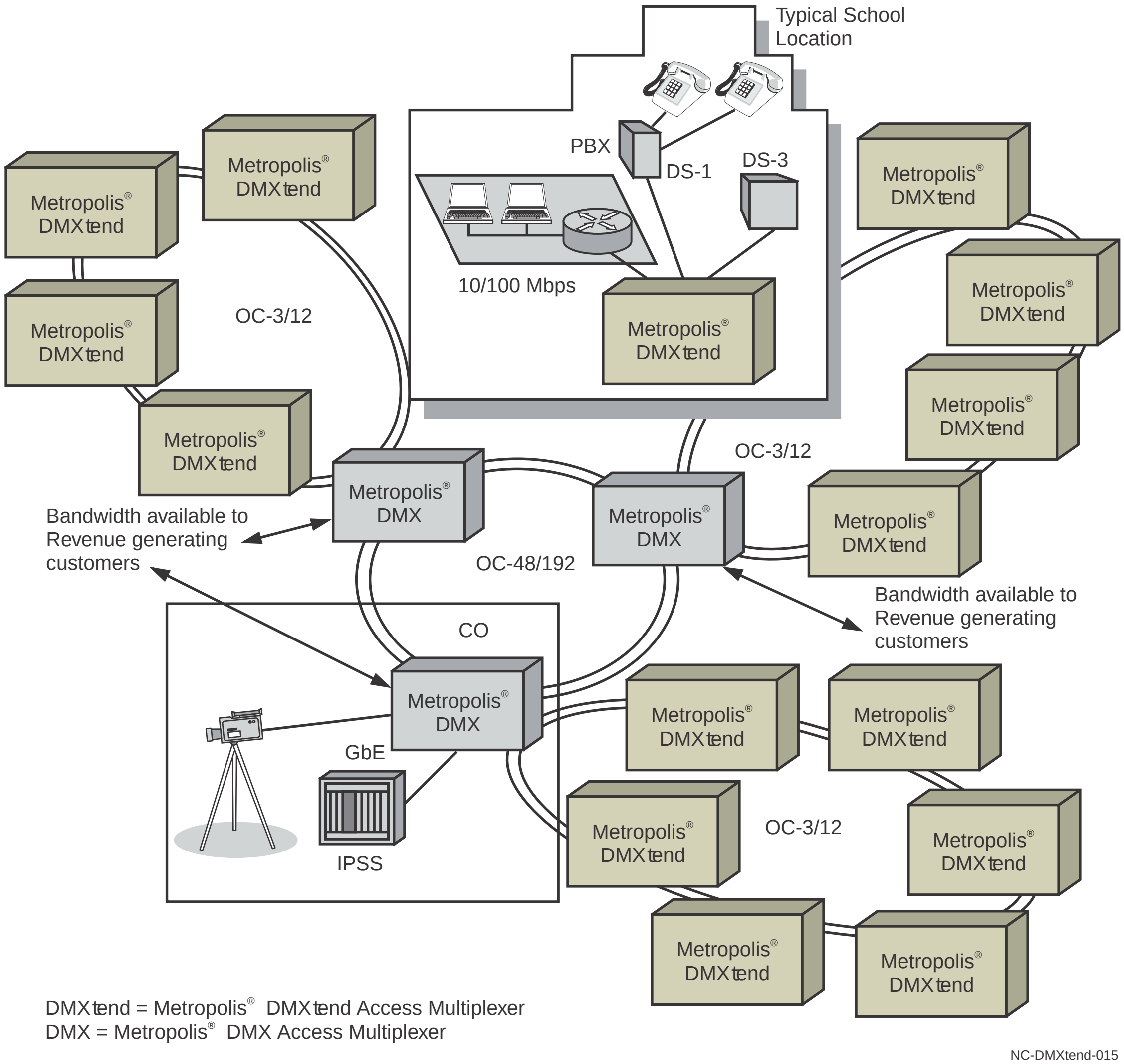
The DMX*tend* provides a low-cost solution for offering high-speed optical connection to community facilities.

Description

The DMX*tend* is ideal for installations on school grounds or in municipal buildings. With the great service capacity the DMX*tend* enables, a single unit is enough to fulfill the needs of most school systems or municipalities. Combine this with affordable pricing and it becomes clear that the DMX*tend* is optimized for low-cost, small footprint entry into smaller environments such as municipalities.

The figure below shows DMX*tends* providing a municipal backbone for combined voice/data service. With it's affordable price, small footprint, and high multi-service port density, the DMX*tend* not only fits such an application, but is capable of providing the additional service capacity to grant bandwidth to revenue generating customers. Furthermore, the DMX units in the figure below are poised to offer great bandwidth to college campuses or large industrial customers over OC-3/12, 10/100 Mbps, and GbE interfaces.

Figure 3-9 Municipal Backbone



Application Advantage

Using the DMX*tend* in this application results in the following advantages:

- Offers low-cost, facility protected, high-speed Ethernet and TDM transport.
- Low-cost multi-service optical network.
- Provide voice, data and video to schools, community buildings, and businesses.
- Offer additional bandwidth to large customer base. The great scalability of the DMX*tend* also allows you to add more customers long into the future without fork-lift equipment upgrades.

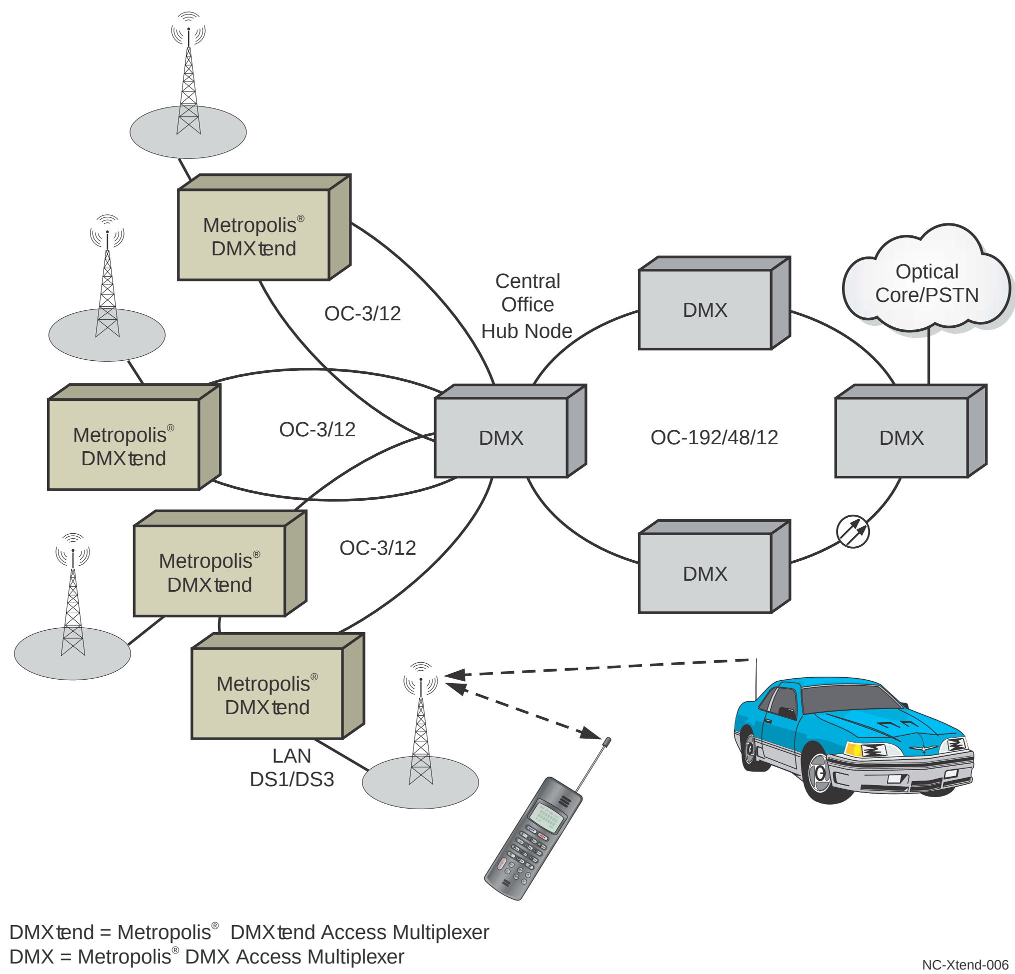
- Reliable, SONET protection of both voice and data services.
- Integrated Ethernet switching and Ethernet compatibility with campus/CPE switches.

Wireless Optical Buildout

Overview The DMX*tend* is environmentally hardened for cell site deployment using OC-3/12 high-speed interfaces.

Description The DMX*tend* can be deployed in outside cabinets at such places as wireless/cellular sites, allowing for cost-effective aggregation of DS1, DS3, and OC-3/12 signals and reliable, SONET protected transport of these services to Hub nodes at the CO in a scalable, compact, and easily managed NE.

Figure 3-10 Wireless Optical Buildout



Application advantage

Using the DMX*tend* in this application results in the following advantages:

- Cost effective, protected transport of wireless service in an environmentally hardened unit designed for outside deployment.
- Compact size of DMX*tend* provides for reduced cost, space, and heat generation at antenna sites, while the extreme scalability offered by the DMX*tend* allows your network to grow without equipment upgrades.
- Easily managed monitoring of equipment at antenna site (such as doors, fire alarms, heating or cooling systems, etc....) through the miscellaneous discrete interfaces on the DMX*tend* (19 MDIs and 4 MDOs).

4 Product Description

Overview

Purpose

This chapter provides a detailed view of the DMX*tend* Access Multiplexer architecture. After introducing the DMX*tend* shelf, this chapter describes the system circuit packs, control, power, and cabling.

Contents

The following hardware is described in this chapter:

Shelf Description

Overview

The DMX*tend* is a single-shelf multiplexer that may house DS1, DS3, DS3/EC-1, OC-3, OC-12, 10/100T, 1G SX/LX circuit packs.

Size and capacity

Each Function Unit slot in the DMX*tend* shelf has a 2.5 Gb/s IO capacity. The Growth slots have 5 Gb/s capacity, and the Main slots have 10 Gb/s. Up to eight systems can fit in a bay (including Fan Unit), and all shelves are individually mounted.

The dimensions of the DMX*tend* shelf are below:

- Width: 17.5 inches
- Height: 8.75 inches
- Depth (front to back): 13.5 inches
- Weight (Max.): 30 pounds.

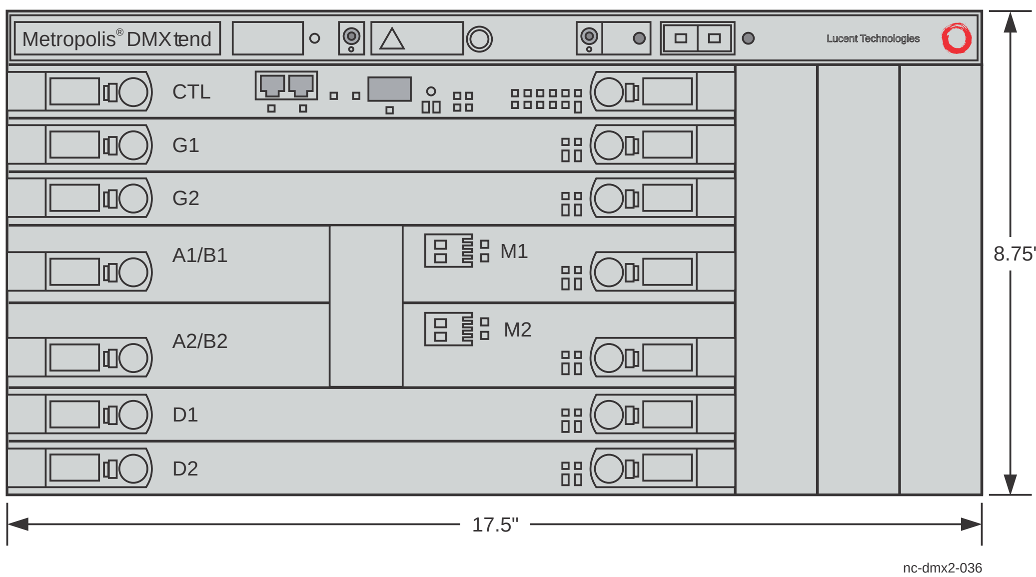
Front view

The figure below shows the front of the DMX*tend* shelf-- which could be equipped with the following:

- 16/DS1/3/DS3 (or 16DS1 or 3DS3) circuit packs in Function Unit group A&B
- 12DS3/EC1 (or LNW6, 7, 8, or 19) or low-speed OC-3/12 circuit packs in Function Unit group D or G
- a 4 port 1GbE SX (or LX) circuit pack in Growth slot G1 and an apparatus blank in Growth slot G2
- OC-3/12 circuit packs in Main slots 1 and 2
- SYSCTL circuit pack in the CTL slot.

10/100T circuit packs are not mentioned, but could populate slot 1 of Function Unit groups D and G

Figure 4-1 Shelf Front View



Front view description

As shown in the figure above, the DMX*tend* shelf contains 6 Function Unit slots (including Growth slots), 2 Main slots, and one CTL slot.

Function Units

There are 2 different types of Function groups: the half-wide slots (A and B) and the full-wide slots (D and G).

Function slots A and B are half-wide slots that share the same physical location on the DMX*tend* shelf. The A1/B1 and A2/B2 slot pairs support DS1, DS3, EC-1 signals (the 16/DS13/DS3, 16DS1, and 3DS3 circuit packs). Function Slots B1 and B2 can be thought of as virtual slots because they share the same physical location as slots A1 and A2. The virtual distinction is made in order to allow the A and B slots to support DS1/DS3 combination circuit packs. When provisioning DS1 service in these slots, service is provisioned for slots A1 and A2. When DS3 service is provisioned on these slots, service is provisioned for slots B1 and B2.

Function Unit D may house OC-3 and OC-12 OLIUs, the 28DS1, 56DS1, 12 DS3/EC-1, 48DS3, as well as the 1G SX and 1G LX GbE and the 10/100 Mbps Fast Ethernet interfaces. All Ethernet circuit packs cannot be protected and must be housed in slot D1. Slot D2 must contain an apparatus blank if an Ethernet circuit pack is housed in slot D1. Protection is available for OC-3, OC-12, DS1, and DS3 circuit packs.

Growth slots

Function Unit G (Growth slots) may house OC-3 and OC-12 OLIUs, the 28DS1, 56DS1, 12 DS3, 48DS3, as well as the 1G SX and 1G LX GbE and the 10/100 Mbps Fast Ethernet interfaces. All Ethernet circuit packs cannot be protected and must be housed in slot G1. Slot G2 must contain an apparatus blank if an ethernet circuit pack is housed in slot G1. Protection is available for OC-3, OC-12, DS1, and DS3 circuit packs.

Main slots

The Main slots are reserved for service and protection main OC-3 or OC-12 circuit packs. The stratum 3 timing generator and main TDM switch fabrics are embedded in both circuit packs.

Control slot

The CTL slot is reserved for the non-redundant System Controller (SYSCTL) circuit pack.

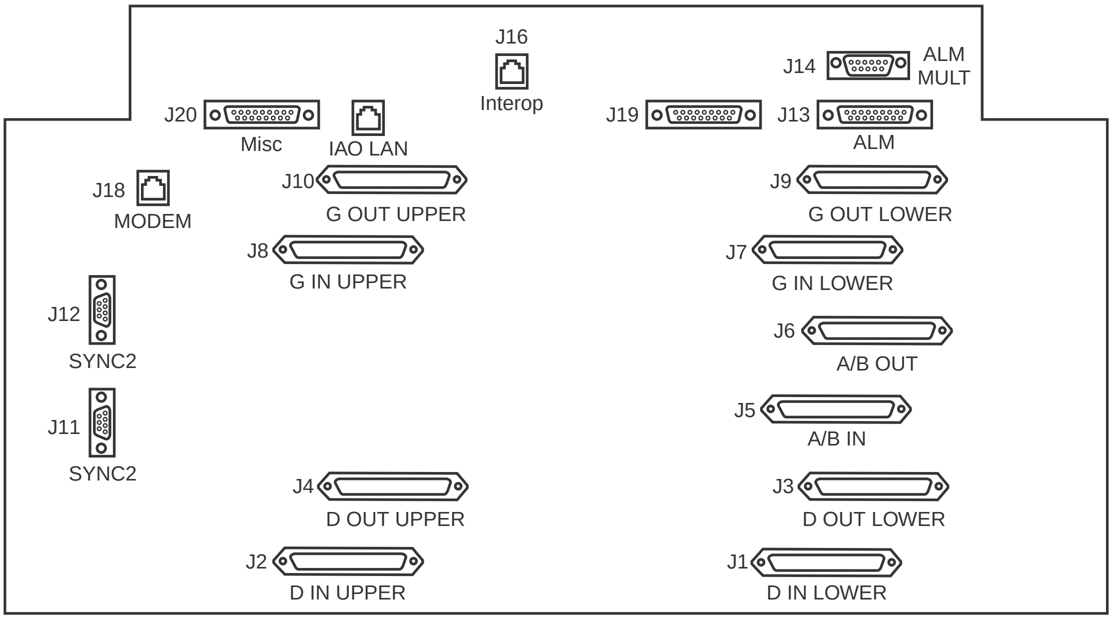
Fan Unit

In the DMX*tend* shelf, the fan unit is included (pictured in the right portion of the shelf).

Rear view (standard shelf)

The figure below shows the various jacks and cable inputs on the backplane of the standard shelf.

Figure 4-2 Standard Shelf Backplane



Backplane description

As shown in the figure above, the DMX*tend* contains jacks for communication with a MODEM and IAO LAN.

The backplane also contains the following cabling inputs:

- two synchronization (SYNC1 and SYNC2)
- two power (P10, P11)
- one miscellaneous discrete (MISC)
- one X.25
- one office alarm (ALM)
- one office alarm mult (ALM MULT)
- five DS1/DS3 inputs (J1, J2, J5, J7, J8)**
- five DS1/DS3 outputs (J3, J4, J6, J9, J10).

The power interfaces (BAT A and BAT B) are located on the side of the shelf.

> **Important!** ** J5 and J6 connectors support a cable that accepts both input and output DS1/DS3 signals.

☐

Circuit Packs

Available circuit packs

The table below contains a list of each circuit pack supported by the DMX*tend*, indicates which slots they are able to be housed in, and in what release each circuit pack is available.

Table 4-1 Circuit Packs in DMX*tend* Shelf

Circuit Pack	Apparatus Code	Slot(s)	Release	Comments
System Controller (SYSCTL)	LNW1	CTL	1.0	extended temp. certification for outside cabinet deployment (OSP Hardened)
OC-12 OLIU (2 ports)	LNW46	D1 & D2, G1 & G2	2.0	Low-speed, long reach. 1310 nm, OSP Hardened
OC-12 OLIU (1 port)	LNW38	M1, M2	1.0	High-speed, Intermediate reach. 1310 nm, OSP Hardened
OC-3 OLIU (4 ports)	LNW36	D1 & D2, G1 & G2	2.0	Low-speed, long reach. 1310 nm, OSP Hardened
OC-3 OLIU (1 port)	LNW40	M1, M2	1.0	High-speed, Intermediate reach. 1310 nm, OSP Hardened
12DS3/EC1	LNW16	D1 & D2, G1 & G2	1.0	12 ports, OSP Hardened
48DS3/EC1	LNW19	D1 & D2, G1 & G2	2.0	48 ports, OSP Hardened
28DS1	LNW6	D1 & D2, G1 & G2	1.0	28 ports, OSP Hardened
28DS1PM	LNW7	D1 & D2, G1 & G2	1.0	28 ports, OSP Hardened
56DS1PM	LNW8	D1 & D2, G1 & G2	2.0	56 ports, OSP Hardened
16/DS1/3/DS3	LNW39	A1 & A2, B1 & B2	1.0	16 DS1 ports, 3 DS3 ports
16DS1	LNW??	A1 & A2, B1 & B2	2.0	12 ports, OSP Hardened

Circuit Pack	**Apparatus Code**	**Slot(s)**	**Release**	**Comments**
3 DS3	LNW??	A1 & A2, B1 & B2	2.0	12 ports, OSP Hardened
10/100T (24 ports) Private Line	LNW71	D1 & D2, G1 & G2	1.0	100 BASE-TX ethernet interface, may occupy only slot 1 of a Function Unit group, supports Ethernet Private Lines
10/100T (24 ports) for Ethernet Enhancements	LNW69	D1 & D2, G1 & G2	2.0	Same specifications as LNW71, but supports Enhanced Ethernet features (CIR, PIR, Spanning Tree per VLAN)
1GbE SX/LX (4 ports) for Ethernet Enhancements	LNW70	D1 & D2, G1 & G2	2.0	Supports Enhanced Ethernet features (CIR, PIR, Spanning Tree per VLAN) and small form factor SX and LX pluggable optics
Apparatus Blank	177D	D1 & D2, G1 & G2	1.0	Filler plates to be used in unpopulated slots of the DMX*tend* shelf
Apparatus Blank	LNW42	M1, M2	1.0	Filler plates to be used in unpopulated slots of the DMX*tend* shelf
Apparatus Blank	LNW43	A1/B1, A2/B2	1.0	Filler plates to be used in unpopulated slots of the DMX*tend* shelf

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Circuit Pack Descriptions

Overview

This section briefly describes DMX*tend* circuit packs.

System Controller (LNW1)

The SYSCTL provides communication with other circuit packs on the DMX*tend* shelf. The SYSCTL supports all DMX*tend* operations interfaces, including IAO LAN (OSI or TCP/IP), TL1/X.25, PC-CIT, office alarms, and miscellaneous discretes. The SYSCTL also supports DCC terminations for each optical line interface, a cross-connect fabric that supports path switching, and timing functions.

The SYSCTL faceplate has push-button switches, alarm/status LEDs, and a 7-segment numeric display to facilitate local operations. The SYSCTL provides redundancy by duplicating all cross-connect information on the OLIU circuit packs. Transmission is not affected if the SYSCTL fails.

The SYSCTL circuit pack provides a microprocessor, nonvolatile memory to store the generic program software and provisioning database, and additional memory for system operation. The SYSCTL circuit pack also has interfaces across the backplane to monitor and control every circuit pack in the shelf.

The SYSCTL supports PC-CIT front access to the DMX*tend* via the IAO LAN (Release 1.1) and a serial RS-232 port located on the back of the DMX*tend* shelf.

16DS1PM (LNW??)

These circuit packs contain 16 DS1 ports that can be cross-connected to VT1.5 timeslots. 16DS1 packs are 1x1 protected, and non-revertive protection switching is supported. Line build-outs and DS1 signal encoding are software provisionable. These packs terminate up to 16 bidirectional DS1 electrical signals and support the transport of DS1 signals coded in either alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) modes. The signals received from the DSX-1 are mapped into SONET VT1.5 signals and then routed to the high-speed OLIU circuit pack.

16DS1PM circuit packs can occupy Function Units A1/B1 and A2/B2. All electric interface circuit packs are 1x1 hardware protected. So, although both half-wide slots can house 16DS1 circuit packs, one slot is always used for hardware protection. Thus the DMX*tend* shelf supports 16 working ports when Function Units A1/B1 and A2/B2 are equipped with the 16 DS1 circuit pack.

In addition to maintenance and provisioning functions, the 16DS1PM circuit pack provides performance monitoring capabilities.

28DS1 (LNW6) and 28DS1PM (LNW7)

These circuit packs contain 28 DS1 ports that can be cross-connected to VT1.5 timeslots when the system is operating with a UPSR or 1+1 Main interface. Both packs are 1x1 protected, and non-revertive protection switching is supported. Line build-outs and DS1 signal encoding are software provisionable. Both circuit packs terminate up to 28 bidirectional DS1 electrical signals and support the transport of DS1 signals coded in either alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) modes. The signals received from the DSX-1 are mapped into SONET VT1.5 signals and then routed to the high-speed OLIU circuit pack.

Both circuit packs can occupy Function Units D and G. All electric interface circuit packs are 1x1 hardware protected. So, although both slots in each function group can house a LNW6 or LNW7 circuit pack, one slot in each function group populated by LNW6 or LNW7 circuit packs is always used for hardware protection. Thus the DMX*tend* shelf supports up to 56 working ports when Function Units D and G are equipped with the LNW6 or LNW7 circuit pack.

In addition to maintenance and provisioning functions, the 28DS1PM circuit pack provides performance monitoring capabilities.

56DS1PM (LNW8)

These circuit packs contain 56 DS1 ports that can be cross-connected to VT1.5 timeslots. 56DS1 packs are 1x1 protected, and non-revertive protection switching is supported. Line build-outs and DS1 signal encoding are software provisionable. These packs terminate up to 56 bidirectional DS1 electrical signals and support the transport of DS1 signals coded in either alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) modes. The signals received from the DSX-1 are mapped into SONET VT1.5 signals and then routed to the high-speed OLIU circuit pack.

56DS1PM circuit packs can occupy Function Units D and G. All electric interface circuit packs are 1x1 hardware protected. So, although both slots in each function group can house a LNW8 circuit packs, one slot in each function group populated by LNW8 circuit packs is always used for hardware protection. Thus the DMX*tend* shelf supports up to 112 working ports when Function Units D and G are equipped with the LNW8 circuit pack.

In addition to maintenance and provisioning functions, the 56DS1PM circuit pack provides performance monitoring capabilities.

3DS3 (LNW??)

These circuit packs contain 3 DS3 ports that can be cross-connected to VT1.5 timeslots. 3DS1 packs are 1x1 protected, and non-revertive protection switching is supported. Line build-outs and DS3 signal encoding are software provisionable. These packs terminate up to 3 bidirectional DS3 electrical signals and support the transport of DS3 signals coded in either alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) modes. The signals received from the DSX-1 are mapped into SONET VT1.5 signals and then routed to the high-speed OLIU circuit pack.

3DS1PM circuit packs can occupy Function Units A1/B1 and A2/B2. All electric interface circuit packs are 1x1 hardware protected. So, although both half-wide slots can house a 3DS1 circuit packs, one slot is always used for hardware protection. Thus the DMX*tend* shelf supports 3 working ports when Function Units A1/B1 and A2/B2 are equipped with the 3DS3 circuit pack.

12DS3/EC-1 (LNW16)

The 12DS3 (LNW16) circuit pack contains 12 ports, is 1x1 protected, and supports non-revertive protection switching. The 12DS3 circuit pack provides bidirectional transport of 12 DS3 signals and maps the DS3 signals into STS-1 signals, and supports transport of DS3 signals coded in bipolar 3-zero substitution (B3ZS). In Release 2.0, DS3 or EC-1 service will be provisionable on a per-port basis within each pack.

The LNW16 may occupy Function Units D and G, on the DMX*tend* shelf. All electric interface circuit packs are 1x1 hardware protected. So, although both slots in each function group can house a LNW16 circuit pack, one slot in each function group populated by LNW16 circuit pack is always used for hardware protection. Thus the DMX*tend* shelf supports up to 24 working ports when Function Units D and G are equipped with the LNW16 circuit packs.

48DS3/EC-1 (LNW19)

The 48DS3 (LNW19) circuit pack contains 48 ports, is 1x1 protected, and supports non-revertive protection switching. The 48DS3 circuit pack provides bidirectional transport of 48 DS3 signals and maps the DS3 signals into corresponding STS-1 signals, and supports transport of DS3 signals coded in bipolar 3-zero substitution (B3ZS). DS3 or EC-1 service is provisionable on a per-port basis within each pack.

The LNW19 may occupy Function Units D and G, on the DMX*tend* shelf. All electric interface circuit packs are 1x1 hardware protected. So, although both slots in each function group can house a LNW19 circuit pack, one slot in each function group populated by LNW19 circuit pack is always used for hardware protection. Thus the DMX*tend* shelf supports up to 96 working ports when Function Units D and G are equipped with the LNW19 circuit packs.

16/DS1/3/DS3 (LNW39)

The 16/DS1/3/DS3 (LNW39) circuit pack contains 16 DS1 ports and 3 DS3 ports, is 1x1 protected, and supports non-revertive protection switching. The DS1/DS3/16/1 circuit pack provides for the bi-directional transport of 16 DS1 (1.544 MHz) signals and 1 DS3 (44.736 MHz) signal and maps them into STS-1 (51.84 MHz) signals. The 16/DS1/3/DS3 also supports transport of DS3 signals coded in bipolar 3-zero substitution (B3ZS).

16/DS1/3/DS3 circuit packs can occupy Function Units A1/B1 and A2/B2. All electric interface circuit packs are 1x1 hardware protected. So, although both half-wide slots can house a 16/DS1/3/DS3 circuit packs, one slot is always used for hardware protection. Thus the DMX*tend* shelf supports 16 DS1 and 3 DS3 working ports when Function Units A1/B1 and A2/B2 are equipped with the 16/DS1/3/DS3 circuit pack.

OC-3 OLIU (LNW36)

The quad OC-3 OLIU (LNW36) low speed circuit pack is a four-port, long-reach, 1310 nm optical line interface unit supporting VT1.5, STS-1 and STS-3(c) path switching. The OC-3 OLIU can interface with other OC-3 rings in the network and can also be used as an interface for OC-3 linear optical extensions, as well as single- and dual- homed ring extensions. Fiber access is provided via four pairs of LC-type connectors on the LNW36 faceplate.

The LNW36 can occupy Function Units D and G on the DMX*tend* shelf, and up to 16 ports are addressable when Function Units D and G are equipped with the LNW36 circuit pack.

OC-3 OLIU (LNW40)

The OC-3 OLIU (LNW40) high speed circuit pack is an intermediate reach 1310 nm circuit pack. The LNW40 supports OC-3 add/drop, UPSR configurations, single- and dual-homing, non-revertive protection switching, and VT1.5, STS-1, and STS-3(c) signal transport. The LNW40 OLIU can cross-connect VTs in 6 STS-1s. The stratum 3 timing generator and central TDM switch fabrics are embedded in the OC-3 OLIU.

The LNW40 may occupy Main slots 1 and 2. Fiber access is provided via a pair of LC-type connectors on the LNW40 faceplate.

The IR-1 (intermediate-reach) OC-3 specifications also meet short-reach (SR) OC-3 requirements.

OC-12 OLIU (LNW46)

The dual OC-12 OLIU (LNW46) low speed circuit pack is a two-port, long-reach, 1310 nm optical line interface unit supporting VT1.5, STS-1, STS-3(c), and STS-12(c) path switching. The LNW46 provides an OC-12 interface to other OC-12 rings, linear optical extensions, and single- and dual-homed ring extensions. Fiber access is provided via two pairs of LC-type connectors on the LNW46 faceplate.

The LNW46 can occupy Function Units D and G on the DMX*tend* shelf, and up to 8 ports are addressable when Function Units D and G are equipped with the LNW46 circuit pack.

OC-12 OLIU (LNW38)

The OC-12 OLIU (LNW38) high speed circuit pack is an intermediate reach 1310 nm circuit pack. The LNW38 supports OC-12 add/drop, UPSR configurations, single- and dual-homing, non-revertive protection switching, and VT1.5, STS-1, STS-3(c), and STS-12(c) signal transport. The LNW38 OLIU can cross-connect VTs in any 12 STS-1s. The stratum 3 timing generator and central TDM switch fabrics are embedded in the OC-12 OLIU.

The LNW38 may occupy Main slots 1 and 2. Fiber access is provided via a pair of LC-type connectors on the LNW38 faceplate.

The IR-1 (intermediate-reach) OC-12 specifications also meet short-reach (SR) OC-12 requirements.

10/100T (LNW71) 100BASE-TX Private Line Ethernet interface

The 10/100T circuit pack has 24 ports and provides data transport at the rate of 10/100 Mbps using standard ethernet switching IEEE 802.1, standard encapsulation according to *ANSI* T1X1.5/2000-024R4 (ITU G.gfp), and standard STS-1 virtual concatenation according to ITU G.707. The LNW71 can transmit signals across spans as long as 100 meters. The LNW71 circuit pack is designed specifically to support Fast Ethernet Private Line applications. Each LNW71 circuit pack can support 24 private lines.

The 10/100T may occupy slot 1 of Function Units D and G, and 48 LNW71 ports are addressable when four Function Units D and G are equipped with LNW71 circuit packs. When the LNW71 circuit packs occupy slot 1 of a Function Unit group, slot 2 must be populated with an apparatus blank.

> **Important!** All Ethernet circuit packs are unprotected interfaces and must occupy slot 1 of a Function Unit group (including Growth slots). When the LNW69, LNW70, and LNW71 circuit packs occupy slot 1 of a Function Unit group, slot 2 must be populated with an apparatus blank.

10/100T (LNW69) for Ethernet Enhancements

The LNW69 circuit pack conforms to the same specifications as the LNW71 described above. Unlike the LNW71, the LNW69 circuit pack contains enhancements that enable it to support enhanced Ethernet rate shaping with CIR and PIR. Each LNW69 circuit pack can support 4 packet rings (network interface) and 24 private lines (tributary interface).

GbE (LNW70) for Enhanced GbE Packet Ring

This 4-port Ethernet interface provides short OR long-reach (1000BASE-SX or -LX) optical data transport at the rate of 1 Gbps using standard Ethernet switching IEEE 802.1, standard encapsulation according to *ANSI* T1X1.5/2000-024R4 (ITU G.gfp), and standard STS-1 virtual concatenation according to ITU G.707. The LNW70 is an unprotected pack. Fiber access is provided by 4 LC-type connector pairs on the LNW70 faceplate. The LNW70 transmits signals at a wavelength of 850nm.

LNW70 contains enhancements that enable it to support enhanced Ethernet services such as CIR and PIR rate shaping. The LNW70 is described as both short-reach (SX) and long-reach (LX) because it supports pluggable optics that allow the user to chose which interface they need (short- or long-reach) and “plug” the appropriate optics module into the circuit pack.

The LNW70 provides space for 4 bidirectional ports. Each LNW70 circuit pack can support 2 packet rings, 2 SONET protected private lines, or 4 unprotected GbE private lines. For more information on LNW70, please refer to the section entitled 1G SX/LX Ethernet (LNW70), in Chapter 10.

> **Important!** Installing any non-approved (non Lucent specified) may cause physical damage to the LNW70. Such things as EMC Regulations, ESD Regulations, laser safety, as well as fundamental optical and electrical performance parameters may all be compromised if non-approved optics are installed in the LNW70 circuit pack. Lucent assumes no responsibility for problems that may occur when non-approved optics are used in the LNW70 circuit pack.

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Control

Overview

DMX*tend* provides extensive control features, accessible through a number of technician and operations system (OS) interfaces. In addition to accessing local DMX*tend* NEs through direct interfaces, technicians and OSs can use the operations features supported via the DCC in the optical signals to access remote NEs. Control functions are supported by the SYSCTL circuit pack.

Three-tiered operations interface

DMX*tend* maintenance procedures are built on three levels of system information and control. The first tier is provided by the LEDs, displays, and push-button switches located on the faceplate of the SYSCTL circuit pack. The second tier uses a *DMXtend* PC-CIT to provision and retrieve detailed reports of performance monitoring, alarm and status, and system configuration for both local and remote NEs. The third tier uses the OS interfaces such as TL1/X.25 and TL1 over IAO LAN (TCP/IP or OSI) or PC-CIT to monitor performance, gather alarm information, and configure the system (R2.0). Also, the IAO LAN interfaces provisioned for TCP/IP support software download and provisionable database backup/restore via FTP.

SYSCTL faceplate

The faceplate of the SYSCTL circuit pack contains indicators that provide system-level information and control functions. The condition of the individual transmission circuit packs can be determined using faceplate LEDs.

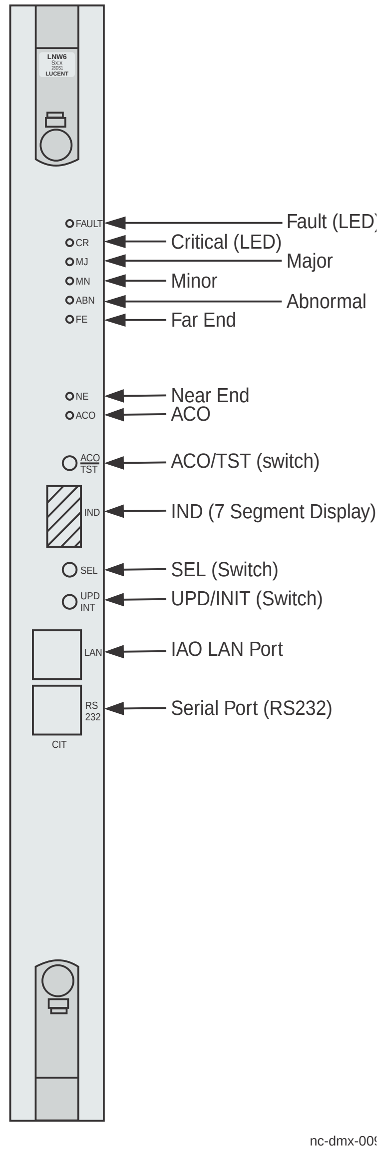
The figure on the following page, shows the SYSCTL faceplate. There is a 7-segment numeric LED display and three push-button switches for Update/Initialize (UPD/INIT), ACO/test (ACO/TEST), and Select (SEL) for local operations.

In addition to the FAULT LED which is lit if the SYSCTL detects its own failure, there are also seven alarm/status LEDs on the SYSCTL faceplate, listed below:

- Critical (CR)
- Major (MJ)
- Minor (MN)
- Abnormal (ABN)
- Far End Activity (FE)

- Near End Activity (NE)
- Alarm Cut-Off (ACO)

Figure 4-3 SYSCTL Circuit Pack



Embedded operations channel

Access and control extends beyond the local DMX*tend* to remote DMX*tend*s via the SONET section DCC. Craft interface dialogs and operations messages are exchanged in the DCC overhead bytes on each OC-3 and OC-12 interface.

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Power Specifications

Power supply

The table below lists DMX*tend* power requirements.

Table 4-2 DMX*tend* Power Supply Requirements

Item	Description
Voltage range, all components	-40.0V to -60V
Power Feeders	two -48V power feeders [BREAKER (A) and BREAKER (B)]
Circuit Breakers (two per shelf)	10.0A

Circuit breakers

DMX*tend* uses on-board power conversion eliminating the need for slots for bulk power converters. Two independent -48V office power feeders (A and B) enter the shelf through connectors and are filtered and distributed to the circuit packs through circuit breakers. Power conversion is performed through modular power converters located on the circuit packs. In each circuit pack, the 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 circuit breaker. The green Power LEDs located next to each circuit breaker (A and B) indicate power is being fed to the breaker.

Current drains

The following table provides the maximum and average current drain requirements for a shelf.

Table 4-3 Shelf Current Drains

Shelf	Current Drains per Feeder in Amperes			
	Average @ –48V	Maximum @ –48V	Average @ –40V	Maximum @ –40V
DMX*tend* Shelf	TBS	10.0	TBS	10.0

The following table provides the maximum and average current drain requirements for a bay equipped with four shelves.

Table 4-4 Bay Current Drains

Bay	Current Drains per Feeder in Amperes			
	Average @ –48V	Maximum @ –48V	Average @ –40V	Maximum @ –40V
Bay equipped with four DMX*tend* Shelves	TBS	40.0	TBS	40.0

The following table provides the maximum and average heat dissipation figures for the DMX*tend* shelf.

Table 4-5 Shelf Heat Dissipation

Shelf	Heat Dissipation in Watts			
	Average @ –48V	Maximum @ –48V	Average @ –40V	Maximum @ –40V
DMX*tend* Standard Shelf	TBS	400	TBS	400

Cabling

Overview This section briefly describes cabling information, including the number of particular cables required. For information regarding available cable lengths and ordering comcodes, refer to the engineering drawing attached to the end of this document.

Cable types The table below lists available cables along with the required number (if any).

Table 4-6 Cables

Connection Type	Cable Assembly Description	Quantity per Shelf	See Note
Interface Cables	Power	1 per shelf	1
	DS1	1 per Function Unit (D or G) housing a 28DS1 circuit pack (as required)	2
	DS3	1 per Function Unit (D or G) housing a 12DS3 circuit pack (as required)	3
	LAN 100 BASE-TX	1 per Function Unit (D or G) housing a 10/100 Mbps Fast Ethernet circuit pack (as required)	
	DS1/DS3 Combination	1 per Function Unit (A/B) housing a DS1/DS3 combination circuit pack (as required)	

Connection Type	Cable Assembly Description	Quantity per Shelf	See Note
Operations Cables	X.25 - X.25	variable	4
	X.25 - Switch	variable	4
	Office Alarm	1 (bottom shelf in bay frame only)	5
	Office Alarm Mult	1 for any adjacent shelves (as required)	6
	Miscellaneous Discrete	1 per shelf (as required)	
	LAN 10/100 BaseT (Crossover)	1 per shelf (as required)	7
	LAN 10/100 BaseT (Straight Through)	1 per shelf (as required)	7
	Sync Timing	1 per shelf (as required)	
	PC-CIT Interface	1 per shelf (as required)	
	Modem Cable Assembly	1 per shelf (as required)	

Table notes

1. One cable assembly supports both the -48VA and -48VB main power feeders on the DMX*tend* shelf. Cable assemblies are available in 6,8, and 10 AWG cable kits including the required Storey connectors for connection a the shelf. The connectors are also available seperately for customers who choose to supply their own cable.
2. One DS1 Cable Assembly is required for each Function Unit group housing a 28DS1 circuit pack. Only One DS1 Cable Assembly is required even when both slots of a Function Unit group are populated with 28DS1 circuit packs. The DS1 Cable Assembly consists of two separate cables, each containing 28 pairs of 24 gauge shielded cable. On each of the 28 pairs of cable, cable 1 is for input and cable 2 is for output.
3. One DS3 Cable Assembly is required for each Function Unit group housing a 12DS3 circuit pack. Only one DS3 Cable Assembly is required even when both slots of a Function Unit group are populated with DS3 circuit packs. The DS3 Cable Assembly consists of two separate cables, each containing 735A cables. Cable 1 consists of 12 inputs and cable 2 consists of 12 outputs. DS3 cable assemblies in a combination of 734 and 735-type cable and available in lengths greater than 450 feet are available for connecting DMX*tend* to other NEs.
4. Either an X.25 - X.25 Cable Assembly (for use when connecting to a

synchronous modem or Packet Assembler/Dissambler [PAD])or an X.25 - Switch Cable Assembly (for X.25 switching applications) may be ordered as needed. Both cable assemblies are equipped with RS-232 connectors on each end of the cable.

5. One Office Alarm Cable Assembly is required for the bottom DMX*tend* shelf in a bay frame. Other DMX*tend* shelves in the bay frame do not require this assembly.
6. One Office Alarm Mult Cable Assembly is required for any adjacent DMX*tend* shelves in a bay frame. For example, if four DMX*tend* shelves are located in a single 7-foot bay frame, three cable assemblies are required. These cables cannot reach any further than an adjacent shelf.
7. The *Crossover* cable is used when connecting to a PC. The *Straight Through* cable is used when connecting with a hub.

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5 System Planning and Engineering

Overview

Purpose

This section summarizes basic system planning and engineering information to plan procurement and deployment of the DMX*tend* Access Multiplexer. There are a number of considerations that should be kept in mind when planning the DMX*tend*'s role in the network. Projected customer requirements will determine initial capacity needed, as well as evolution to higher capacities. The advanced networking capabilities of the DMX*tend* 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.

Contents

The following sections are included in this chapter:

☐

Physical Arrangements

Overview

Purpose This section describes the possible physical arrangements of the DMX*tend* Access Multiplexer.

Contents The following physical arrangement considerations are covered in this section:

☐

Shelf Configurations

Overview

DMX*tend* is designed to provide a vast array of wideband and broadband voice and data services. Therefore, there is great flexibility in the configuration of the shelf. Various combinations of circuit packs may be used for whatever service is desired. The following paragraphs outline the specific packs that may be used in the Function Unit groups for certain applications. For possible circuit pack combinations in every topology covered in this document, see Table 5-2-- Shelf Configurations.

Requirements

The OC-3/12 Main OLIUs must always be located in the M1 and M2 slots on the shelf. The SYSCTL (LNW1) must always be located in the CTL slot.

Important! There are 2 different types of Function groups: the half-wide slots (A and B) and the full-wide slots (D and G).

Function slots A and B are half-wide slots that share the same physical location on the DMX*tend* shelf. The A1/B1 and A2/B2 slot pairs support DS1, DS3, EC-1 signals (the 16/DS13/DS3, 16DS1, and 3DS3 circuit packs). Function Slots B1 and B2 can be thought of as virtual slots because they share the same physical location as slots A1 and A2. The virtual distinction is made in order to allow the A and B slots to support DS1/DS3 combination circuit packs. When provisioning DS1 service in these slots, service is provisioned for slots A1 and A2. When DS3 service is provisioned on these slots, service is provisioned for slots B1 and B2.

Function Unit D and G may house OC-3 and OC-12 OLIUs, the 28DS1, 56DS1, 12 DS3, as well as the 1G SX/LX GbE and the 10/100 Mbps Fast Ethernet interfaces. All Ethernet circuit packs cannot be protected and must be housed in slot D1 or G1. Slot D2 or G2 must contain an apparatus blank if an Ethernet circuit pack is housed in slot D1 or G1. Protection is available for OC-3, OC-12, DS1, and DS3 circuit packs.

Circuit packs The table below contains a list of each circuit pack supported by the DMX*tend*, indicates which slots they are able to be housed in, and in what release each circuit pack is available.

Table 5-1 Circuit Packs in DMX*tend* Shelf

Circuit Pack	Apparatus Code	Slot(s)	Release	Comments
System Controller (SYSCTL)	LNW1	CTL	1.0	extended temp. certification for outside cabinet deployment (OSP Hardened)
OC-12 OLIU (2 ports)	LNW46	D1 & D2, G1 & G2	2.0	Low-speed, long reach. 1310 nm, OSP Hardened
OC-12 OLIU (2 ports)	LNW38	M1, M2	1.0	High-speed, Intermediate reach. 1310 nm, OSP Hardened
OC-3 OLIU (4 ports)	LNW36	D1 & D2, G1 & G2	2.0	Low-speed, long reach. 1310 nm, OSP Hardened
OC-3 OLIU (2 ports)	LNW40	M1, M2	1.0	High-speed, Intermediate reach. 1310 nm, OSP Hardened
12DS3/EC1	LNW16	D1 & D2, G1 & G2	1.0	12 ports, OSP Hardened
48DS3/EC1	LNW19	D1 & D2, G1 & G2	2.0	48 ports, OSP Hardened
28DS1	LNW6	D1 & D2, G1 & G2	1.0	28 ports, OSP Hardened
28DS1PM	LNW7	D1 & D2, G1 & G2	1.0	28 ports, OSP Hardened
56DS1PM	LNW8	D1 & D2, G1 & G2	2.0	56 ports, OSP Hardened
16/DS1/3/DS3	LNW39	A1 & A2, B1 & B2	1.0	16 DS1 ports, 3 DS3 ports
16DS1	LNW??	A1 & A2, B1 & B2	2.0	12 ports, OSP Hardened
3 DS3	LNW??	A1 & A2, B1 & B2	2.0	12 ports, OSP Hardened
10/100T (24 ports) Private Line	LNW71	D1 & D2, G1 & G2	1.0	100 BASE-TX ethernet interface, may occupy only slot 1 of a Function Unit group, supports Ethernet Private Lines

Circuit Pack	Apparatus Code	Slot(s)	Release	Comments
10/100T (24 ports) for Ethernet Enhancements	LNW69	D1 & D2, G1 & G2	2.0	Same specifications as LNW71, but supports Enhanced Ethernet features (CIR, PIR, Spanning Tree per VLAN)
1GbE SX/LX (4 ports) for Ethernet Enhancements	LNW70	D1 & D2, G1 & G2	2.0	Supports Enhanced Ethernet features (CIR, PIR, Spanning Tree per VLAN) and small form factor SX and LX pluggable optics
Apparatus Blank	177D	D1 & D2, G1 & G2	1.0	Filler plates to be used in unpopulated slots of the DMX*tend* shelf
Apparatus Blank	LNW42	M1, M2	1.0	Filler plates to be used in unpopulated slots of the DMX*tend* shelf
Apparatus Blank	LNW43	A1/B1, A2/B2	1.0	Filler plates to be used in unpopulated slots of the DMX*tend* shelf

Single- and dual-homing shelf

If the DMX*tend* shelf is homing an OC-3 ring, the LNW36 circuit pack must occupy at least one Function Unit group. If the DMX*tend* shelf is homing an OC-12 ring, the LNW46 must occupy at least one Function Unit group. It is possible to single- or dual-home to OC-3 or OC-12 rings on the same shelf. Any other DMX*tend* circuit pack may occupy other Function Unit groups depending on the desired service.

The table below shows the required or optional status of DMX*tend* interfaces for various network configurations.

Table 5-2 Shelf Configurations

Network Configuration	28DS1, 12DS3/ EC1, 56DS1, 48DS3/EC1	10/100T/1G SX/ 1G LX (Note 1)	OC-3/OC-12 (low-speed)	OC-3/12 (high-speed) (Note 2)
OC-3/12 Rings with OC-3/ 12 Ring Transport	Optional	Optional	Required	Required
Single- or Dual-Homing	Optional	Optional	Required	Required
Linear Optical Extensions	Optional	Optional	Required	Required
Hubbing	Optional	Optional	Required	Required

Table Notes

1. Ethernet services can be utilized in any network configuration provided that at least one Function Unit contains an Ethernet circuit pack. If desired, DMX*tend* can be configured as a data transport shelf and house only ethernet circuit packs in the Function Units.
2. An OC-3/12 OLIU is always required in the Main slots.

□

Network Bay Frames

Overview

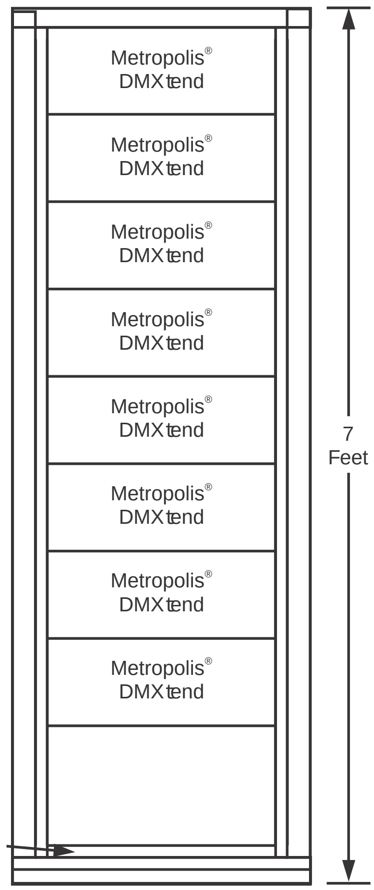
The DMX*tend* can be mounted in frames of both 23-inch and 19-inch widths. 23-inch wide frames available through Lucent include the ED8C800 (for rear mounting) and the ED8C801 (for front mounting). Both of these 7-foot frames may accommodate up to eight DMX*tend* shelves per bay. 19-inch wide EIA310-D bay frames are available through a number of third-party suppliers.

Bay arrangements

A standard 7-foot bay arrangement may contain up to eight DMX*tend* shelves. When a bay frame is fully-equipped with eight DMX*tend* shelves, a 0.515-inch space must remain open at the bottom of the rack to allow for proper air circulation. DMX*tend* shelves should be installed from bottom to top. This arrangement is configured for rear access cabling.

The figure below shows a typical bay arrangement using the DMX*tend* shelf (integral Fan Unit).

Figure 5-1 Typical Bay Frame Arrangement



Important! Note that the Fan Unit is not separate from the DMX*tend* shelf (it is built in), and is mounted at the right of the shelf.

Cabinet Arrangements

Overview

Outside plant (OSP) cabinet configurations are available as the circuit packs are OSP hardened. DMX*tend* can be retro-fit to take the place of previously deployed DDM-2000 systems. DMX*tend* fits in standard cabinets, 19”, and 23” bays.

The DMX*tend* may offer complete cabinet deployment kits in the future. More specific information on this possibility will be included in this section as it becomes available.

□

Cabling

Overview

Lucent offers a full complement of transmission cables and optical jumpers. All interfaces to the DMX*tend* are connectorized. For synchronization interfaces, wire-wrap connections are available. Also, a special 9-pin D-SUB connector (408267722) can be used for synchronization purposes. Rear access cabling is available.

For more information

For more information regarding cable ordering, refer to Chapter 7, “Ordering.” For more information on required cables and cable arrangements, refer to Chapter 4, “Product Description.”

□

Environmental Considerations

Overview

DMX*tend* meets NEBS Level 3 standards for use in central office environments as specified in GR-63-CORE and GR-1089-CORE. DMX*tend* also meets standards for uncontrolled environments as specified in GR-63-CORE and GR-499-CORE. For detailed specifications, refer to Chapter 10, “Technical Specifications.”

□

Cross-connections

Overview

Purpose

This section provides cross-connection information for the DMX*tend* Access Multiplexer. For cross-connect provisioning information, refer to Chapter 6, "Operations, Administration, Maintenance, and Provisioning."

Contents

The following cross-connect information is included in this section:

Cross-Connect Types

Overview

The DMX*tend* has cross-connect capabilities offering users flexibility in directing traffic flow through systems to support a wide variety of customer applications using two-way and mltpt (multi-point [data specific]) cross-connections.

Making cross-connections

Cross-connections are made by specifying the SONET rate (VT1.5 or STS-n), the end point addresses (AIDs), and the cross-connection type (for example, two-way). Each single cross-connection command establishes a one-way or two-way cross-connection.

Bidirectional (two-way) cross-connections

The two-way cross-connection connects a low-speed port or channel to a channel in the high-speed ring interface. This is used in path switched ring applications where VT1.5, STS-1, STS-3(c), STS-12(c) low-speed signals on high-speed channels are cross-connected to low-speed DS1, DS3, EC-1, OC-3, OC-12, 100BASE-TX, or 1000BASE-SX/LX ports. In the transmit direction, all added signals are bridged onto both rotations of the ring. In the receive direction, the better of the two received signals is selected and dropped. Bidirectional cross-connections can be used in Hairpinning and pass-through applications as well.

Unidirectional (one-way) cross-connections

The one-way cross-connection connects a low-speed port or channel to a channel in the high-speed ring interface or connects a channel on the high-speed ring (1-way add) to a low-speed (tributary) port or channel (1-way drop), but not both at the same time and with bidirectional cross-connections. This is used in path switched ring applications where VT1.5, STS-1, STS-3(c), STS-12(c), low-speed signals on high-speed channels are cross-connected to low-speed DS1, DS3, EC-1, OC-3, OC-12, 100BASE-TX, or 1000BASE-SX/LX ports. In the transmit direction, all added signals are bridged onto both rotations of the ring. In the receive direction, the better of the two received signals is selected and dropped. Bidirectional cross-connections can be used in Hairpinning and pass-through applications as well.

Multi-point (data specific) cross-connections

The data specific multi-point (mltpt) cross-connect is a bidirectional cross-connection between two STS-1 Virtual Concatenation Groups (VCGs) on 100BASE-TX or 1000BASE-SX/LX ports to two different ring interfaces. All mltpt cross-connections are done at the STS-1 level. Multi-point cross-connections are used to create packet rings.

Bridged cross-connections

Bridging of an existing cross-connection consists of adding a one-way cross-connection with the same input tributary as that of an existing cross-connection, resulting in a 1x2 multicast from an input tributary to two output tributaries. DMX*tend* supports bridging for each of the supported SONET cross-connection rates. You can bridge any existing cross-connection to a second output port without impairing the existing signal. Conversely, either half of a bridged signal can be taken down without impairing the remaining cross-connected signal.

Manual cross-connect rates

The following lists the signals that can be cross-connected:

- VT1.5
- STS-1
- STS-3c
- STS-12c

□

Allowable Cross-Connects

Overview

In addition to the data specific mltpt (multi-point) cross-connect, the DMX*tend* utilizes several types of two-way SONET and Ethernet cross-connections, including:

- add/drop
  - Unidirectional Path Switched Ring (UPSR)
  - dual 0x1
  - single 0x1
- pass-through
- pass-through hairpin
- SONET hairpinning: inter-function group hairpin
  (hairpin from one low-speed function group to another)
- multi-point (Ethernet only)
- Ethernet hairpinning

Add/Drop

A two-way add/drop cross-connection is a bidirectional cross-connection between a channel on a path protection-switched ring and a port or channel on a ring or non-ring interface. Thus it is most accurately seen as a MAIN to FN (Function Group) cross-connection, as the tributary interface could be supporting a variety of topologies, including low-speed rings. A one-way add/drop cross-connection is a unidirectional cross-connection between a channel on a path protection-switched ring and a port or channel on a ring or non-ring interface.

Unidirectional Path Switched Ring

A Unidirectional Path Switched Ring (UPSR) is self-healing ring configuration in which traffic is sent onto both rotations (both fibers) of the ring in opposite directions. “Path-switched” means that if the working signal fails, the path switches to the protection signal. UPSRs operate in an integrated, single ended fashion-- negating the need for complex network-level coordination in the effort to restore traffic.

Dual 0x1

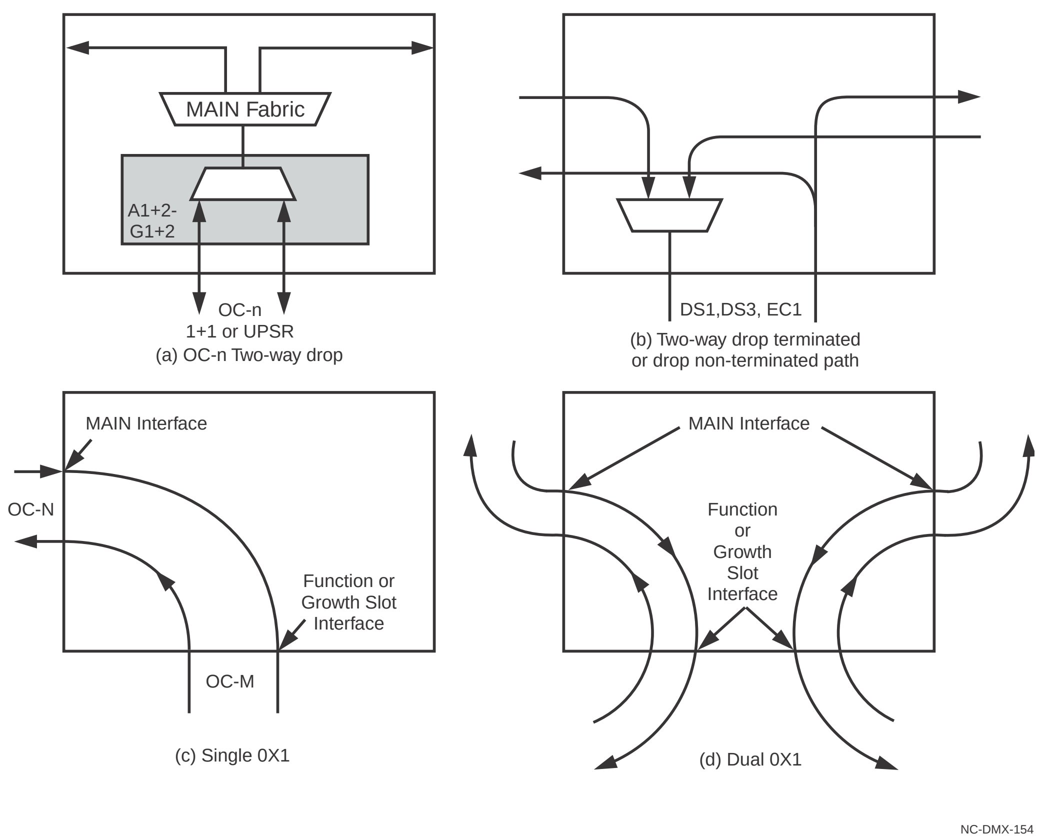
A two-way dual 0x1 cross-connection is a bidirectional cross-connection between channels on both sides of ring interfaces. Dual 0x1 cross-connections do not support path switching or equipment switching.

Single 0x1

A two-way single 0x1 cross-connection is a bidirectional cross-connection between channels on one side of DMX*tend* interfaces (same slot in the FNs on both sides of connection: Slot 1 to Slot 1 or Slot 2 to Slot 2). Single 0x1 cross-connections are primarily used in dual homing applications and do not support path switching or equipment switching.

The figure below shows high-level schematics of two-way add/drop, single 0x1, and dual 0x1 cross-connections.

Figure 5-2 Two-way add/drop, single 0x1, and dual 0x1

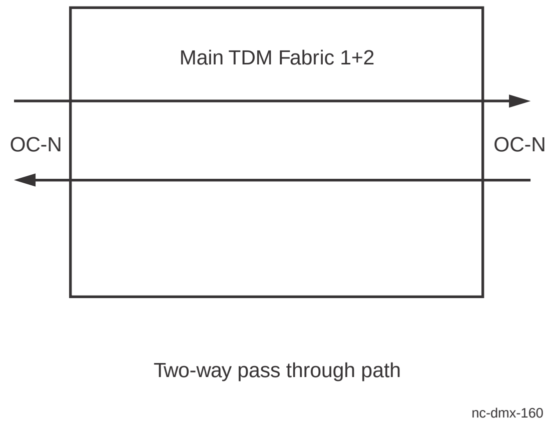


Pass-through

A pass-through cross-connection is made between two ring interfaces in the same MAIN or Function Unit group, allowing the signal to be “passed-through” a ring node on the same timeslot.

The figure below shows a pass-through cross-connection on the high-speed interface (OC-3/12).

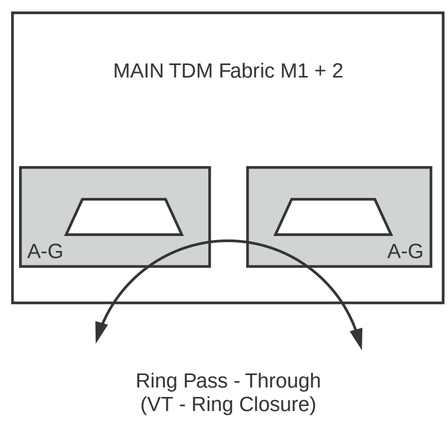
Figure 5-3 Pass-through cross-connection on High-speed interface



Pass-through hairpin

The DMX*tend* can host multiple rings on the low-speed interfaces of the DMX*tend* shelf. This is accomplished by intra-function group, pass-through cross-connections. The DMX*tend* can close a low-speed ring by supporting a cross-connection between a receive port on one circuit pack and a transmit port on another circuit pack in the same function or growth group. All protection switching advantages/ capabilities of UPSR configurations still apply in VT Ring Closure applications.

Figure 5-4 Pass-through hairpin

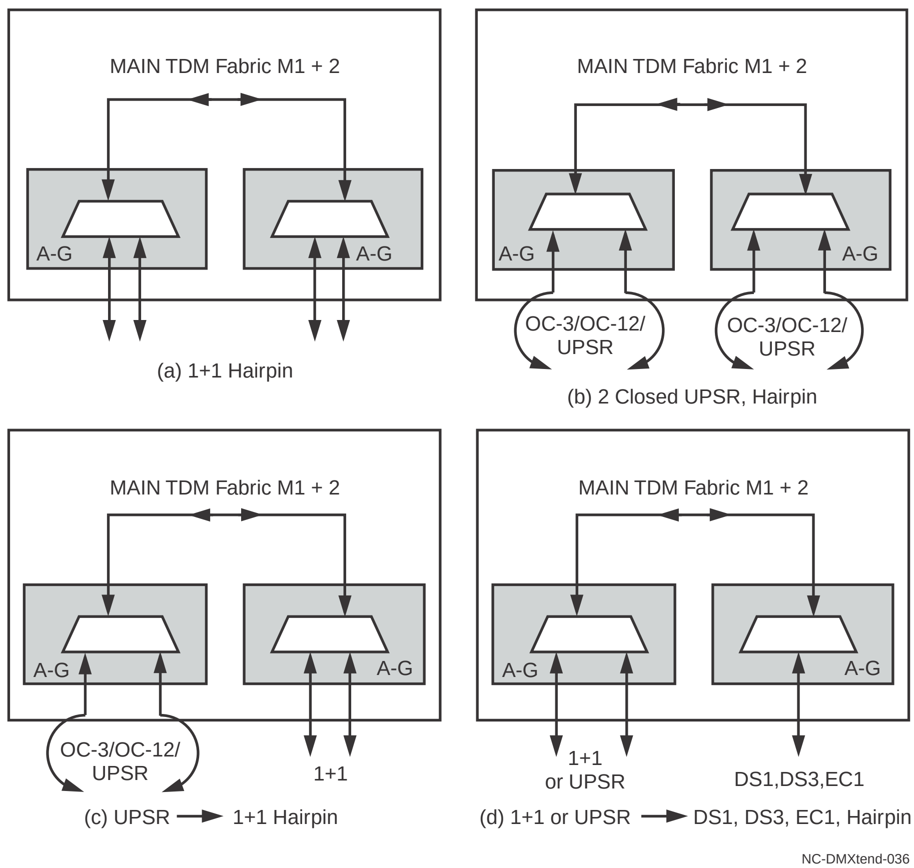


SONET Hairpinning Cross-connections

In a “hairpinning” topology, tributary traffic is routed from one tributary into the system and back out on another tributary without ever being placed on the high-speed (OC-3/12) UPSR interfaces. The cross-connection capability of connecting any input on a circuit pack in a function or growth slot to any output on a circuit pack in a different function or growth slot on the same shelf, allows you to use a combination of add/drop and hairpinning of compatible payloads through a variety of interfaces. You can bring traffic in from one remote site and cross-connect it at the STS-1, STS-3c, STS-12c, or VT 1.5 level back out to other remote sites without consuming any capacity on the high-speed UPSRs.

The figure below shows various SONET hairpinning schematics.

Figure 5-5 SONET Hairpinning

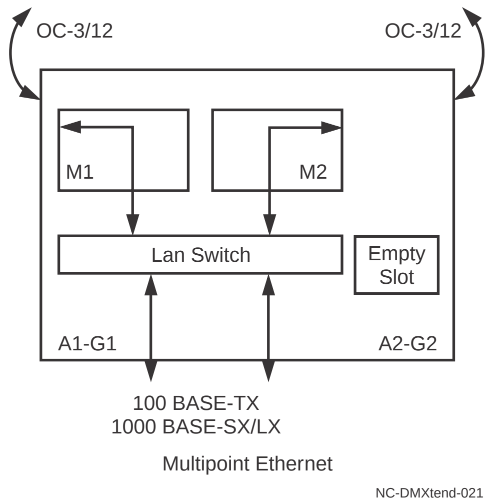


Multi-point (Ethernet only)

The data specific multi-point cross-connect is a bidirectional cross-connection between two STS-1 Virtual Concatenation Groups (VCGs) on 100BASE-TX or 1000BASE-SX/LX ports to two different ring interfaces.

The figure below shows Ethernet Multipoint cross-connection schematic.

Figure 5-6 Ethernet Multi-point cross-connection

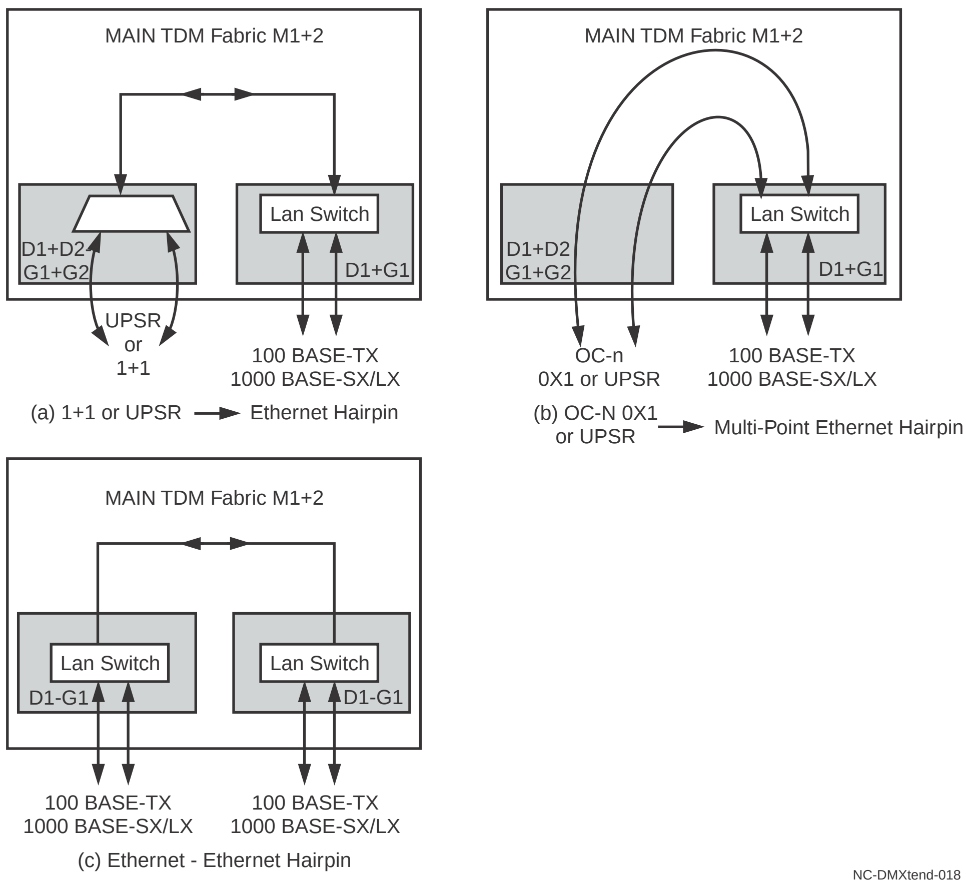


Ethernet Hairpinning Cross-connections

With Ethernet-to-Ethernet hairpinning, traffic may travel from one Ethernet port on a circuit pack in one set of slots, to another port on a circuit pack in a different set of slots (from D1 to G1, for example). From there, the traffic may be multiplexed with other packet traffic before being switched onto another Ethernet or SONET interface.

The figure below shows high-level schematics of Ethernet hairpinning cross connections.

Figure 5-7 Ethernet Hairpinning

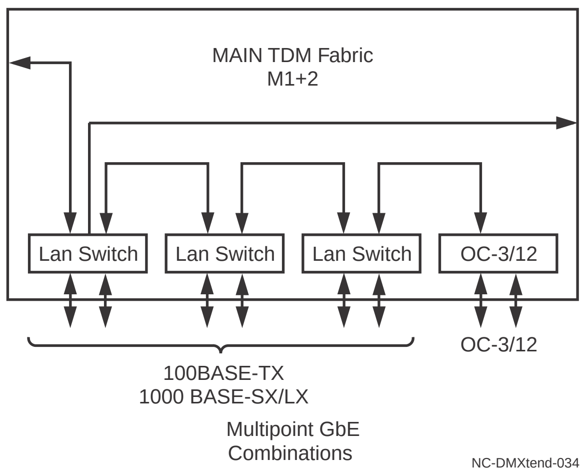


Multi-point Ethernet Combinations

In much the fashion as shown in the figure below, the DMX*tend* supports Multi-point Ethernet cross-connections from one Ethernet interface (D1-G1) to the following combinations of interfaces:

- both OC-3/12 MAIN OLIUs & one 100-TX or GbE-SX/LX(D1-G1)
- two other Ethernet circuit packs: 100-TX and/or GbE-SX/LX packs (D1-G1)
- one OC-3/12 low-speed OLIU (A1-G2) & two 100-TX or GbE-SX/LX interface (D1-G1)
- one OC-3/12 low-speed OLIU (D1-G2) & one 100-TX or GbE-SX/LX (D1-G1)

Figure 5-8 Multi-point Combinations



Ethernet Circuit Pack Capacities and Ring Configurations

The table below details the allowable Ethernet-related ring configurations (Ethernet applications within UPSR topologies) and the number of these configurations that may be supported by each Ethernet circuit pack in the DMX*tend*.

Important! Capacities for each configuration are available in the later of the release numbers shown at the left of the row and the top of the column. For example, consider the first row ("packet Rings on a BLSR"): two packet rings on a UPSR are supported on the LNW69 in R2.0 (which is the later of R1.0 and R2.0), and zero packet rings on a UPSR are supported on the LNW71 in R1.0.

For more information on Packet Rings, Ethernet Private Lines, and Ethernet Rate Shaping, refer to the corresponding section in Chapter 3 of this document.

Table 5-3 Ethernet Circuit Pack Capacities for Ring Configurations

Configurations	Release	Circuit Pack		
		LNW69	LNW70	LNW71
		10/100 Mbps (FE-EPR)	1000Mbps (GbE-EPR)	10/100 Mbps (FE-EPL)
		R2.0	R2.0	R1.0
Packet Rings on UPSRs	1.0	2	2	0
EPL on UPSR w/ UPSR protection	1.0	2	2-4[2]	16-24[1]
EPL on UPSR **w/out** UPSR protection	1.0	2	2	2[1]
BPR= Basic Packet Ring				
EPR= Enhanced Packet Ring (w/ rate shaping)				
EPL= Ethernet Private Line (point-to-point)				
FE= Fast Ethernet (10/100 Mbps) GbE= Gigabit Ethernet (100 Mbps)				

NOTES

1. For LNW71: 16 ports for STS-3c mode, 24 ports otherwise.
2. For LNW70: 2 at full line rate; 4 at subrates totaling 48 STS1s.

All Allowable UPSR Add/ Drop Cross -connections

The table below contains a list of UPSR add/drop cross-connections supported by DMX*tend* in Release 1.0 and 2.0**.** The cross-connections in the table below are all add/drop cross-connections.

Table 5-4 All Allowable UPSR Add/drop Cross-connections

From			**To**	
High-Speed (HS) OC-3/12 OLIU (UPSR)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->		DS1, DS3, FE-PL[7] (Fast Ethernet Private Line)	FE, GbE, OC-3/12 (UPSR, 1+1, unswitched)
	2waypr VT1 --------------------->		DS1	OC-3/12 (UPSR, 1+1, unswitched)
	Multipoint STS1----------------->		FE-PL	FE, GbE
	1waypr STS-n --------------------->			OC-3/12 (UPSR[2,3], 1+1[3], unswitched[2,3])
	1waypr VT1--------------------->			OC-3/12 (UPSR[2,3], unswitched[2,3])
	1 way STS-n --------------------->		DS1[2], DS3[2], FE-PL[2,7]	FE[2], GbE[2], OC-3/12 (1+1[2,3])
	1way VT1--------------------->		DS1[2]	OC-3/12 (1+1[2,3])
HS OC-3/12 OLIU (1+1)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->		DS1, DS3, FE-PL (Fast Ethernet Private Line)	FE, GbE, OC-3/12 (UPSR, 1+1)
	2waypr VT1 --------------------->		DS1	OC-3/12 (UPSR, 1+1)
	1waypr STS-n --------------------->			OC-3/12 (UPSR, 1+1, unswitched)
	1waypr VT1--------------------->			OC-3/12 (UPSR[2,3])
	1 way STS-n --------------------->			OC-3/12 (UPSR[2,3])

From			**To**	
HS OC-3/12 OLIU (Unswitched UPSR)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->			OC-3/12
	2waypr VT1 --------------------->			OC-3/12
	Multipoint STS1----------------->		FE-PL	FE, GbE
	1 way STS-n --------------------->			OC-3/12 [2,3]
	1way VT1--------------------->			OC-3/12 [2,3]

NOTES

1.This could be an intra-function unit connection: the 2 ends of the cross-connection are on different ports/VCGs on the same function units.
2. These connections could be bridge and roll type cross-connections.
3. This could be a dual-ring-interworking (DRI) cross-connection.
4.This could be an inter-function unit connection: the 2 ends of the cross-connection are on ports/VCGs in different function units.
5.This requires identical 0x1 configurations at both ends of the cross-connection (0x1 in slot 1, or 0x1 in slot 2, or dual 0x1).
6.The 2waypr cross-connection type is used for all 2-way cross-connections (excluding multipoint connections). Wether or not the connection is path protected is a function of the provisioned application of the optical ports.
7. STS1 or STS3c connections are supported as a function of equipment mode provisioning.
8. This is a direct pass-through connection: from a paticular timeslot on one side of the ring to the same timeslot on the other side of the same ring.

All Allowable Pass-through Cross -connections

The table below contains a list of UPSR pass through cross-connections supported by DMX*tend* in Release 1.0 and 2.0**.** The cross-connections in the table below are all pass-through cross-connections.

Table 5-5 All Allowable UPSR Pass-through Cross-connections

From			**To**	
High-Speed (HS) OC-3/12 OLIU (UPSR)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->		OC-3/12 (UPSR[1])	
	2waypr VT1 --------------------->		OC-3/12 (UPSR[1])	
	1 way STS-n --------------------->		OC-3/12 (UPS3[2])	
	1way VT1--------------------->		OC-3/12 (UPSR[3])	
Low-Speed (LS) OC-3/12 OLIU (UPSR)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->		OC-3/12 (UPSR[1])	
	2waypr VT1 --------------------->		OC-3/12 (UPSR[1])	
	1 way STS-n --------------------->		OC-3/12 (UPSR[1, 3])	
	1way VT1--------------------->		OC-3/12 (UPSR[1, 3])	

NOTES

1. This is a direct pass-through connection: from a paticular timeslot on one side of the ring to the same timeslot on the other side of the same ring.
2. This could be a dual-ring-interworking (DRI) cross-connection.
3. These connections could be bridge and roll type cross-connections.

Hairpin Cross -connections Involving at Least 1 Optical Port

The table below contains a list of hairpin cross-connections involving at least one optical interface supported by DMX*tend* in Release 1.0 and 2.0**.** The cross-connections in the table below are all hairpin cross-connections.

Table 5-6 Hairpin Cross-connections Involving at Least 1 Optical Port

From			**To**	
Low-Speed (LS) OC-3/12 OLIU (UPSR)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->			DS1, DS3, FE, FE-P[4], GbE, OC-3/12 (UPSR[5], 1+1)
	2waypr VT1 --------------------->			DS1, OC-3/12 (UPSR[5])
	Multipoint STS1----------------->			FE, FE-PL, GbE,
	1waypr STS-n --------------------->			OC-3/12 (UPSR[1,2])
	1waypr VT1--------------------->			OC-3/12 (UPSR[1,2])
	1 way STS-n --------------------->			DS1[1], DS3[1], FE[1], FE-PL[1,4], GbE[1], OC-3/12 (UPSR[2,5], 1+1)
	1way VT1--------------------->			DS1[2]
LS OC-3/12 OLIU (1+1)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->			DS1, DS3, FE-PL [4](Fast Ethernet Private Line), FE, GbE, OC-3/12 (UPSR, 1+1)
	2waypr VT1 --------------------->			DS1, OC-3/12 (UPSR)
	1waypr STS-n --------------------->			OC-3/12 (UPSR[2])
	1 way STS-n --------------------->			OC-3/12 (UPSR[1,2])
	1way VT1 --------------------->			OC-3/12 (UPSR[1,2])

From			**To**	
LS OC-3/12 OLIU (Unswitched UPSR)			**Release 1**	**Release 2**
	2waypr STS-n --------------------->			OC-3/12 [3]
	2waypr VT1 --------------------->			OC-3/12 [3]

NOTES

1. These connections could be bridge and roll type cross-connections.
2. This could be a dual-ring-interworking (DRI) cross-connection.
3. This requires identical 0x1 configurations at both ends of the cross-connection (0x1 in slot 1, or 0x1 in slot 2, or dual 0x1).
4. STS1 or STS3c connections are supported as a function of equipment mode provisioning.
5. This is a direct pass-through connection: from a paticular timeslot on one side of the ring to the same timeslot on the other side of the same ring.

All Electrical/Data Hairpin Cross -connections

The table below contains a list of hairpinn cross-connections supported by DMX*tend* in Release 1.0 and 2.0**.** The cross-connections in the table below are all hairpin cross-connections involving electrical/data interfaces.

Table 5-7 All Electrical/Data Hairpin Cross-connections

From			**To**	
GbE Interface			**Release 1**	**Release 2**
	2waypr STS-n --------------------->			FE, GbE

Synchronization

Overview

Purpose This section describes synchronization features and functions for the DMX*tend* Access Multiplexer.

Contents The following synchronization topics are discussed in this section:

□

Network Synchronization Environment

Overview

Careful consideration should be given to proper design of the SONET network's 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 DMX*tend* are designed to complement the existing and future synchronization network and allow it not only to make use of network timing but also to take on an active role in facilitating network synchronization.

Published sources

A number of published sources give generic recommendations on setting up a synchronization network. The DMX*tend* is designed to operate in a network that complies with recommendations stated in GR-253-CORE and GR-436-CORE.

Recommendations

The following are some key recommendations from the documents listed above. 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 with 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.

Stratum 3 Timing Generator

DMX*tend* supports an embedded Stratum 3 Timing Generator. The timing generator operates with an internal oscillator of +/- 4.6 ppm long-term accuracy in the free running mode, while in holdover the accuracy is +/- .37 ppm over the full -40 to +65^{o} C temperature range. The timing generator should be used according to the recommendations in the documents referenced previously.

□

Synchronization Features

Overview

Synchronization is an important part of all SONET products. DMX*tend* is designed for high performance and reliable synchronization and can be used in a number of synchronization environments. Each DMX*tend* can be provisioned to free run from an internal oscillator, line time from an incoming high-speed interface, or get external timing from the digital synchronization network via DS1 references. DMX*tend* also supports distribution of timing references using DS1 timing outputs.

Synchronization features

DMX*tend* supports three synchronization reference configurations:

- **External Timing** from a Stratum 3 or better office clock (typical CO installations should be synchronized with DS1 timing references from a Stratum 3).
- **Line Timing** from incoming OC-3/12 signal (for small COs or remote sites).
- **Free Running** from the multiplexer's internal Stratum 3 Timing Generator (no synchronization inputs).
- **Network Time Protocol (NTP-- R2.0)** deriving timing reference to radio and/or atomic clocks located on the Internet.

These timing modes are supported by the embedded Stratum 3 Timing Generator in the OC-3 or OC-12 circuit pack. The three basic timing modes can be combined into various network configurations.

Internal timing functions such as reference interfaces, the on-board clock elements, and timing distribution, are provided by the Stratum 3 Timing Generator. The timing generator distributes clock and frame signals, derived from the selected reference source, to the transmission packs.

External timing mode

In external timing mode, the timing generator accepts two DS1 references from an external Stratum 3 or better clock. This Stratum 3 (or better) clock would typically be traceable to a primary reference source (PRS). The DS1 references from the clock synchronize the local DMX*tend* with other network equipment operating under the same primary clock source. A high-stability digital phase-locked loop (DPLL) removes any transient impairments on the DS1 references for improved jitter performance.

The PRS is equipment that provides a timing signal whose long-term accuracy is maintained at 10^{-11} or better with verification to universal coordinated time, and whose timing signal is used as the basis of reference for the control of other clocks in the network. Universal coordinated time is a time and frequency standard maintained by the US National Institute of Standards and Technology.

The DS1 reference inputs are monitored for error-free operation. If the selected reference becomes corrupted or unavailable, the timing generator will switch to the protection reference without causing service degradations. A switch to the protection reference is nonrevertive. If both DS1 inputs are corrupted, the DPLL circuit holds the on-board oscillator frequency at the last good reference sample (holdover). The timing generator will switch back to the external timing mode when a reference is no longer corrupted, but it can be provisioned to require a manual switch. Switching between the two DS1 reference inputs can also be done using a manual command.

Line timing mode

In line timing mode, the timing generator derives local shelf timing from the incoming service OC-3/12 high-speed signal in the Main slot. The DPLL serves to remove any timing transients for improved network jitter performance. If one of the OC-n references is corrupted or unavailable, the timing generator will make a nonrevertive protection switch to the other reference without causing timing degradations. If all OC-n timing signals are lost (for example, due to a cable cut), the timing generator will switch to holdover mode. The timing generator 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.

Free running mode

In free running mode, no mode switching is performed. The timing generator derives timing from a high stability temperature-compensated, voltage-controlled crystal oscillator that has an end of life performance of +/- 4.6 ppm. This oscillator is capable of Stratum 3 accuracy. Only one DMX*tend* in a subnetwork can be provisioned in the free running mode. All other DMX*tend* NEs in the subnetwork must be line timed to this free running system to avoid performance degradation.

DS1 timing output

DMX*tend* also supports a DS1 timing output feature that facilitates network timing distribution. The DS1 timing output is derived from the OC-n line rate, so it is not subjected to multiplexing or pointer processing effects. The result is a DS1 traceable to the far-end source with extremely low jitter and wander. The timing output can follow the protection switching of the OC-n line, be locked to a specific OC-n, or be automatically controlled using synchronization messaging.

The line coding and frame format on the DS1 input is provisionable. Provisioning options include specifying alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) line coding and superframe format (SF) or extended SF (ESF). The output DS1 is a framed all-ones signal under normal conditions or an AIS signal under failure conditions.

Holdover mode

In case of unprotected synchronization reference failure, the Stratum 3 timing generator will switch to “holdover mode” and continue to provide system timing, using the internal oscillator to maintain the last known good reference frequency. If the DS1 (R1.1) timing output is enabled for network synchronization, DS1 AIS will be inserted on detection of unprotected optical reference failure.

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Network Configurations

Overview

The following pages detail the three different network configuration types: free running/line timing, external timing/line timing, and external timing.

Free running/line timing configuration

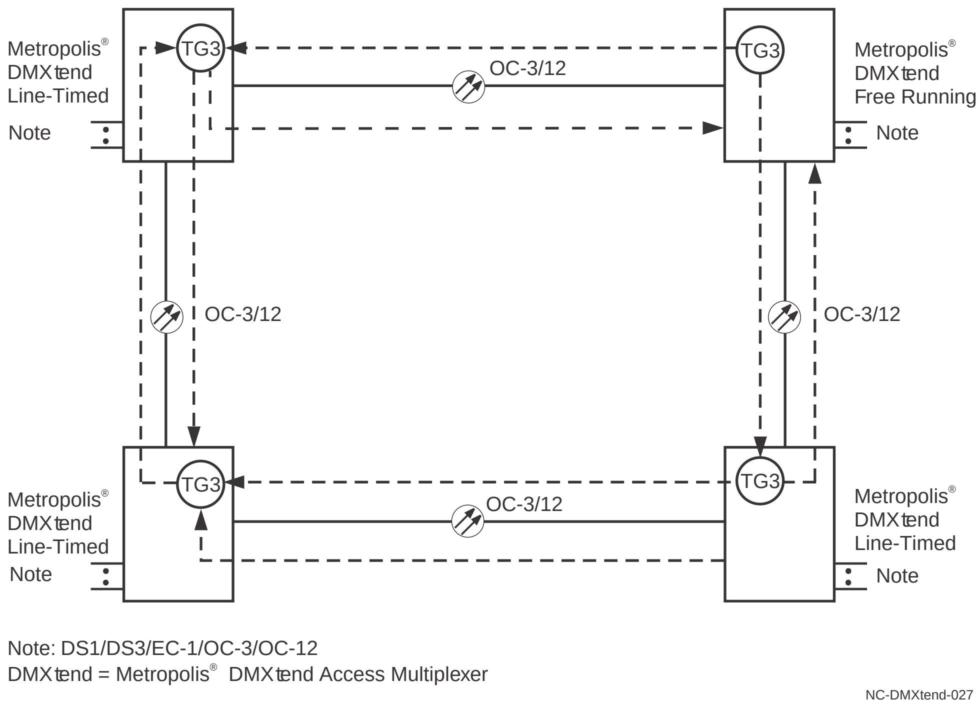
For initial SONET deployment with DS1 and/or DS3 low-speed interfaces, minimum first cost may be a primary concern. The free running/line timing network can operate without an external clock source, so the expense of connecting to one is eliminated. This configuration may be useful for initial access transport and customer location applications, and 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 networks are needed.

The local DMX*tend* times its transmitted signals at the low- and high-speed interfaces from the internal +/- 4.6 ppm of the Stratum 3 timing generator. The remote DMX*tend* recovers timing from the incoming OC-n signal and uses this timing for its transmitted signals.

Because the free running/line timed DMX*tend* network is asynchronous to the DS1/DS3 services carried over it, additional jitter will be experienced on the demultiplexed DS1s/DS3s. 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.

The figure below shows free running/line timed configuration in a ring network.

Figure 5-9 Free Running/Line Timed Configuration - Ring Network



External timing/line timing configuration

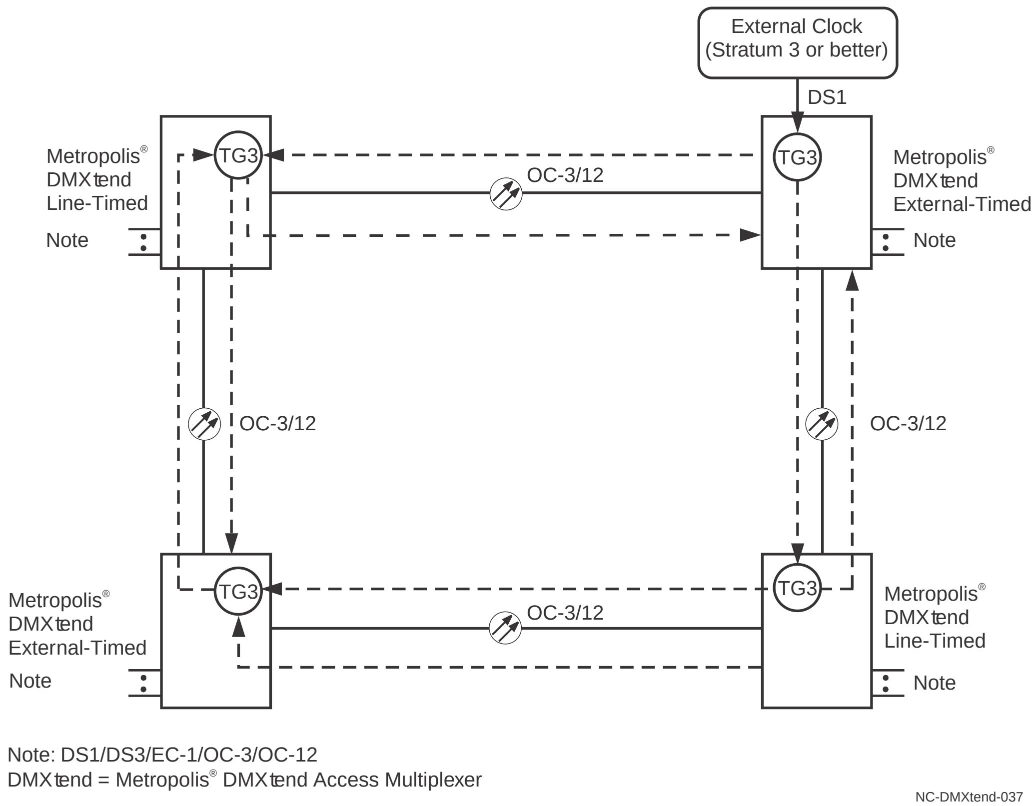
The external timing/line timing configuration integrates access transport and customer location networks into the digital synchronization network as required by the SONET standard. This application is ideal for networks where only one location has a building integrated timing supply (BITS) clock, for example, access transport. 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 DMX*tend* times its transmitted signals at the low- and high- speed interfaces from the internal oscillator that is locked on the external reference. The remote DMX*tend* recovers timing from the incoming OC-n (OC-3/12) signal and uses this timing for its transmitted signals.

External timing is required when EC-1 low-speed interfaces are used to interconnect the local DMX*tend* with other SONET equipment. Thus, the external timing/line timing configuration should be the long-term goal for all access transport and customer location applications.

In a ring topology, synchronization messaging allows automatic synchronization reconfiguration in the event of a fiber or equipment failure.

The figure below, shows external timing/line timing in a ring configuration.

Figure 5-10 External Timing/Line Timing - Ring Network

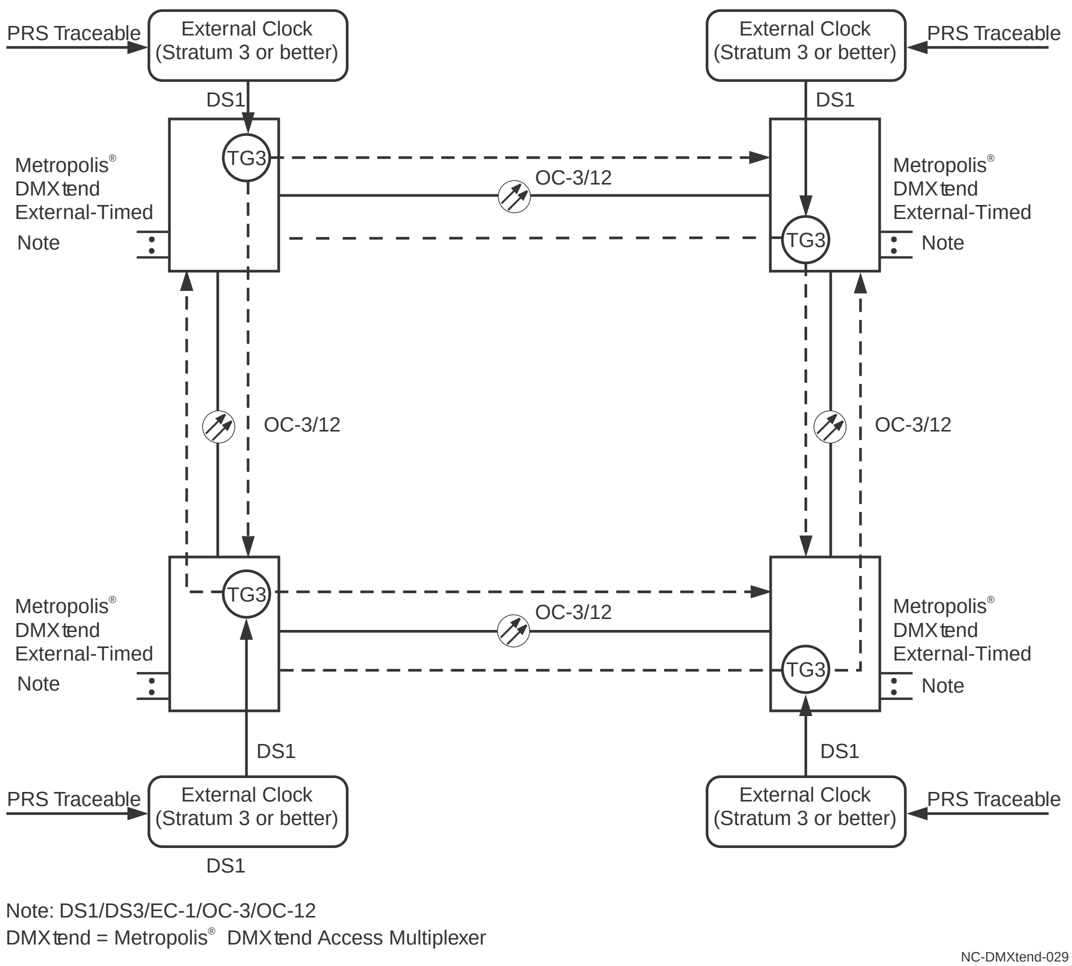


External timing configuration

The external timing configuration uses external DS1 timing to each DMX*tend* in the network. Since it requires local office clocks at each site, it is most suited to interoffice applications. A DMX*tend* network may have all DS1 references traceable to a common primary reference source (for example, outstate trunking) referred to as synchronous, or to multiple primary reference sources (for example, a carrier-to-carrier interface). The multiple primary reference source is referred to as plesiochronous operation. The figure on the following page shows an external timing configuration.

A tributary signal (for example, DS1) that traverses several plesiochronous regions may encounter increased STS-1 and VT pointer adjustments compared to that encountered in a synchronous environment. These pointer adjustments may increase jitter on the tributary when dropped from the SONET network. While standard jitter generation limits are perfectly acceptable for most service needs, some data services or other equipment may be particularly sensitive to jitter-induced degradations. Therefore, it is generally desirable to minimize the number of plesiochronous regions within a network, through Stratum 1 clock traceability and line timing of remote SONET elements.

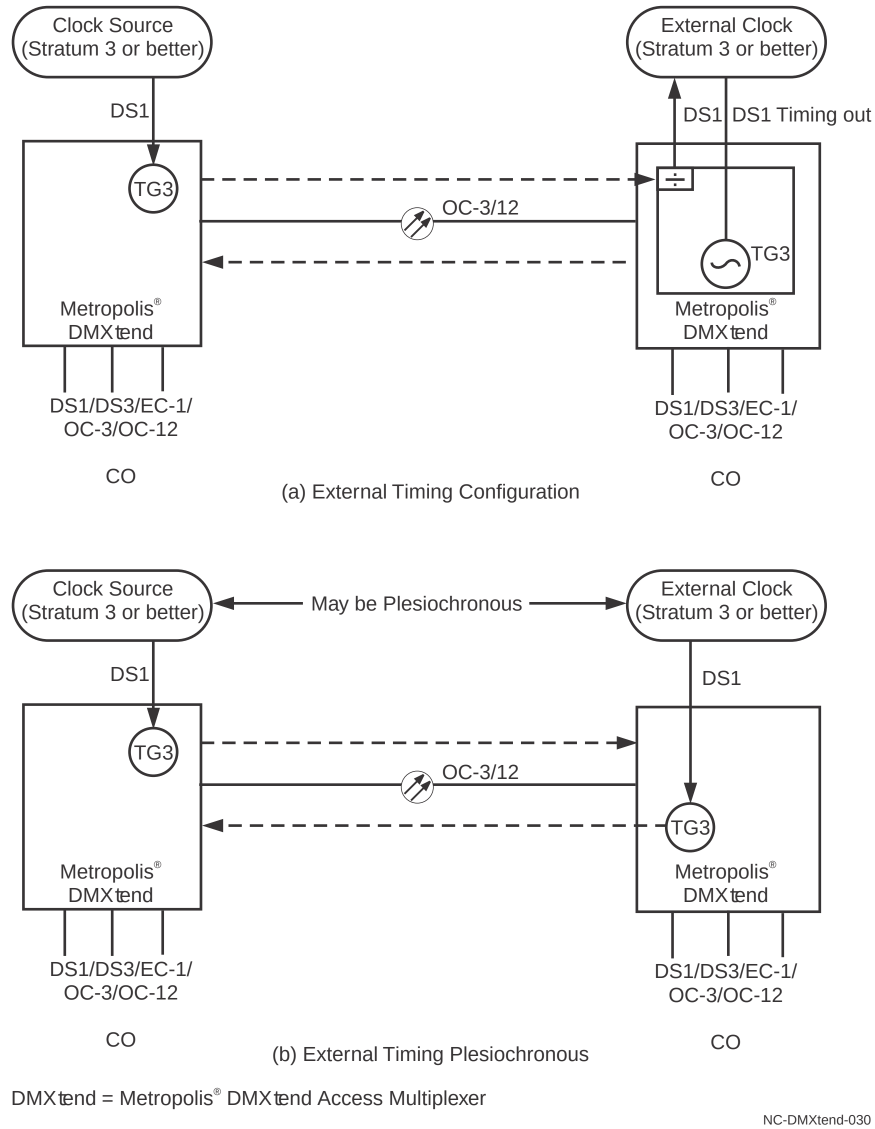
Figure 5-11 External Timing Configuration - Ring Network



External timing with DS1 timing output

External timing may be combined with the DS1 timing output feature as shown in the figure below. Note that the DS1 timing output feature and plesiochronous operation are mutually exclusive. Each of the network topologies (hubbing, ring) can use external timing.

Figure 5-12 DS1 Timing Output and Plesiochronous Timing Configurations



Timing Distribution

Network timing distribution

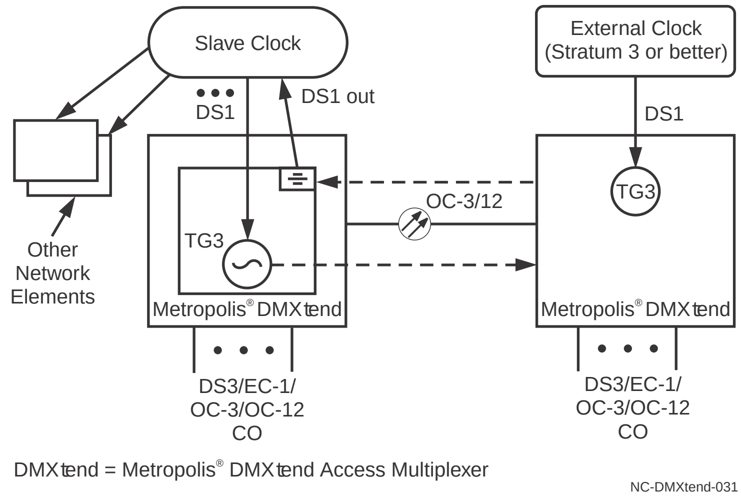
DS1 signals have long been used to pass timing information through the network synchronization hierarchy. These DS1 timing references should be transmitted between master and slave clock sources over the most reliable facilities available. In some cases, these DS1 signals also carry traffic. The facility of choice has evolved from T-carrier through asynchronous lightwave systems to SONET lightwave systems. As these systems are upgraded to SONET systems, timing distribution plans should be revisited to ensure the quality of the timing signals are not degraded. With proper planning, SONET can be used to improve the overall quality of the network timing.

Interoffice timing distribution

One way SONET can be used to improve the quality of interoffice network timing is through the use of OC-n (OC-3/12) timing distribution. DMX*tend* supports the evolution to interoffice OC-n timing distribution by providing a DS1 timing output derived from the incoming OC-n signal. The DS1 timing output is traceable to the clock source that times the DMX*tend* subnetwork and has extremely low jitter and wander. This is true regardless of the number of DMX*tend* systems connected in the network. This DS1 can be fed to the local BITS clock which subsequently times the local DMX*tend* and the other equipment in the office. If a BITS clock is not available in the office, the DS1 timing output can be used to time other equipment (including another DMX*tend*) directly. DMX*tend* can provide DS1 timing outputs in all supported topologies (for example, add/drop and ring).

With OC-n timing distribution, the OC-n line signal, rather than a DS1 multiplexed into the SONET payload, will provide a timing transport mechanism better suited to a complex, heavily interconnected SONET network. In this configuration, a DS1 reference from the CO BITS clock still times the OC-n transmitted to the remote site. At the remote site, a DS1 output reference is created directly from the received OC-n signal, as shown in the figure below.

Figure 5-13 OC-n (OC-3/12) Derived DS1 Timing Reference



Potential advantages

OC-n (OC-3/12) timing distribution has several potential advantages. It preserves transport bandwidth for customer services and guarantees a high-quality timing signal. Also, as the CO architecture evolves to replace DSX interconnects with SONET EC-1 interconnects and direct OC-n interfaces, OC-n distribution becomes more efficient than multiplexing DS1 references into an access facility in the CO.

A previous drawback to using OC-n timing distribution was that the network timing failures could not be communicated to downstream clocks via DS1 AIS, since the DS1 signal does not pass over the OC-n interface. A standard SONET synchronization messaging scheme to convey synchronization failures is now in place. The DMX*tend* multiplexer supports this synchronization messaging scheme. With this option, clock Stratum levels can be passed from NE to NE, allowing downstream clocks to switch timing references without creating timing loops, if a network synchronization failure occurs. If a quality timing reference is no longer available, the DMX*tend* sends AIS over the DS1 interface. If the local OC-n lines fail, DMX*tend* outputs AIS on the DS1 output or an upstream DMX*tend* enters holdover.

Access network timing distribution

OC-n (OC-3/12) timing distribution can also be used in access networks or to small COs. In this configuration, a DS1 reference from the CO BITS clock still times the OC-n transmitted to the remote site. The line timing capability of DMX*tend* provides the ability to recover OC-n timing. The DS1 timing output feature can be used to also extend timing to customer networks or remote sites. In this case, the DS1 timing output may be used to time switch remotes, DMX*tend* shelves, or other local equipment directly. Ideally, the equipment can provide an external timing reference. Otherwise, the signal must be input to a traffic DS1 port on the external equipment which will tie up some of this equipment's bandwidth. In this configuration, it is important that the DS1 reference to the DMX*tend* in the CO be traceable to the same clock used to source the DS1s being carried to the customer site or small CO. If it is not, slips may occur.

Alternate timing sources

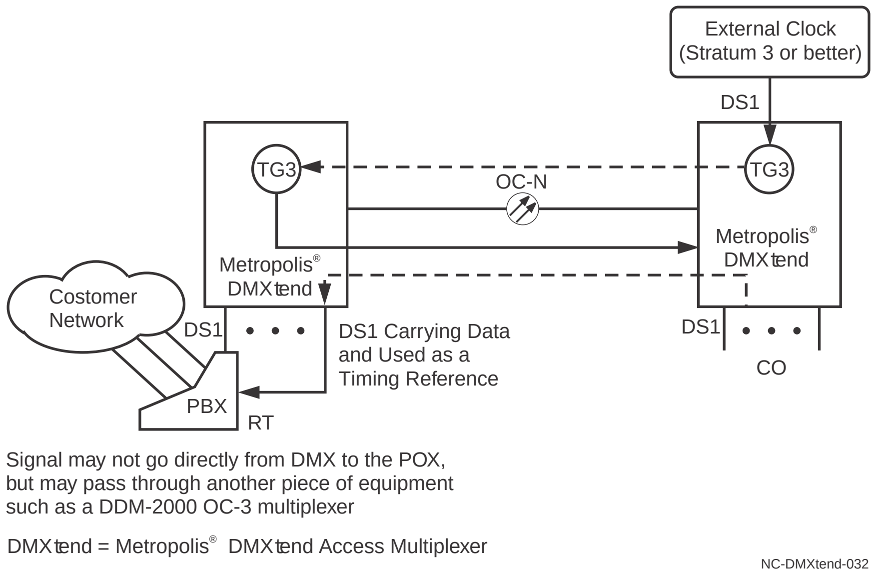
Although an ideal source of timing, OC-n timing distribution, via a DS1 timing output, cannot be used to provide timing in all applications. In cases where the local equipment is not provided with an external timing reference input, or in some private networks where the timing is to be distributed from another private network location, timing may be distributed via traffic-carrying DS1s. In these applications, a stable DS1 timing source can be achieved by ensuring that all elements in the SONET network are directly traceable to a single master clock via line timing. In this environment, the high-performance desynchronizer design of the DMX*tend* allows a DS1 timing reference to be carried as a multiplexed DS1 payload.

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 DMX*tend* 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 (see figure on following page) and synchronizing an end-office remote switch to a larger office's host switch.

Note:

Synchronous operation via line timing eliminates the generation of VT pointer adjustments, thus maintaining the phase stability needed for a high-quality DS1 timing reference. Cross-connecting at the STS-1 level also eliminates the VT pointer adjustments. While the design of the DMX*tend* maintains jitter/wander within standard DS1 interface requirements, even in the presence of VT pointer adjustments, and while the DS1 is likely to be stable enough for most equipment to use as a timing reference, some equipment may have more stringent stability requirements for its timing references.

Figure 5-14 Timing from Multiplexed DS1



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Synchronization Messaging

Overview

DMX*tend* provides 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 DMX*tend* Multiplexer to the next. This capability allows the DMX*tend* to automatically change their timing reference in order to always maintain the highest quality timing available. The capability also allows the DMX*tend* to inform a local BITS clock when the DS1 timing output has been degraded and should no longer be used as a reference. This synchronization messaging feature is compliant with the scheme developed in the *ANSI* T1X1 standards committee.

Applications

The applications that are currently supported with the synchronization messaging feature can be divided into three categories:

- DS1 timing output integrity
- Automatic synchronization reconfiguration
- Synchronization provisioning integrity.

DS1 timing output integrity

The derived DS1 timing outputs are typically used as a synchronization reference to a BITS clock which provides the timing reference to an externally-timed DMX*tend* Multiplexer. The synchronization reference is derived from the SONET transmission facility which is synchronized from an upstream timing reference. In this way, the timing from the BITS clock in one office (master) is distributed to the next office (slave) using the SONET transmission facilities between them as the synchronization vehicle.

The BITS are typically capable of synchronizing to a Stratum 3 or better accuracy. The DMX*tend* equipped with the embedded Stratum 3 timing generator is capable of synchronizing to a +/- 4.6 ppm clock or better. The Stratum timing hierarchy requires that clocks of equal or better Stratum level be used to synchronize other clocks. In this way, the Stratum timing hierarchy is preserved under all failure conditions. Under non-failure conditions, the DMX*tend* does not introduce its own internal timing source onto the SONET facility, but merely transfers the quality of its timing reference. A failure of all derived DS1 timing references to the BITS at the master office will cause the BITS to enter holdover mode, whose minimum accuracy is dependent on its internal clock. If the BITS internal clock is of equal or better Stratum level than the DMX*tend*, the externally-timed DMX*tend* will use this reference to synchronize all outgoing SONET transmission facilities. This preserves the required hierarchical structure of the timing network and should be maintained at all times.

If the externally-timed DMX*tend* at the master office enters holdover due to a disconnected reference cable or a local BITS failure, the quality of the derived DS1 timing output at the slave office will now be traceable directly to the DMX*tend*. The Stratum timing hierarchy will be violated if the slave office BITS requires timing accuracy of better Stratum level than that provided by the master DMX*tend*'s internal clock. Because the DMX*tend* contains the embedded Stratum 3 Timing Generator, Stratum 3 accuracy will be maintained indefinitely. This provides acceptable timing for Stratum 3 NEs at slave offices.

Another scenario that will cause the Stratum timing rules to be violated is when at least one line-timed DMX*tend* exists at a site between the master and slave offices. In this scenario, a fiber cut between the master office and the line-timed site will cause the line-timed DMX*tend* to enter holdover (with accuracy dependent upon its internal clock). If the BITS at the slave office requires a higher accuracy clock than that generated by the DMX*tend* in holdover, the Stratum timing hierarchy will be violated.

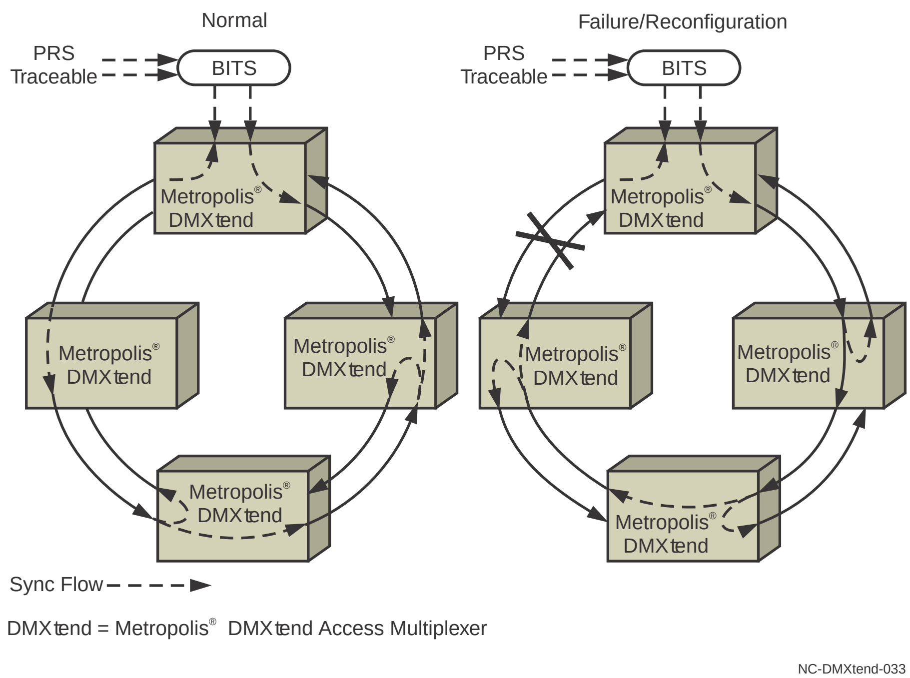
Automatic synchronization reconfiguration

SONET was designed to operate optimally in a synchronous environment. Although plesiochronous 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 DMX*tend* NE. The DMX*tend* shelf can be optioned to determine the best timing reference available 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.

Access ring network

Under normal operation in the access ring network pictured in the figure below, the ring has one DMX*tend* externally timed and the others line timed in the counterclockwise direction. If a fiber failure occurs between the first two DMX*tend*s, the synchronization autoreconfiguration feature will cause the DMX*tend*s 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.

Figure 5-15 Synchronization Reconfiguration - Access Ring



Synchronization provisioning integrity

A welcome side feature of synchronization messaging is that it helps prevent provisioning errors. Provisioned timing loops on DMX*tend*s will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

Frequently Asked Network Timing Distribution Questions

Overview The following are some frequently asked questions about network timing distribution.

1 *How do I time DMXtend shelves in a central office environment?*

Each DMX*tend* should be externally referenced to the BITS clock in the office. If a BITS clock is not available in the office, a traffic-carrying DS1 from the local switch may be bridged (for example, using a bridging repeater) as the reference to the DMX*tend*. Line timing the DMX*tend* may also be used, but at least one DMX*tend* in the network must be externally timed.

2 *Where do I use the DS1 timing output feature?*

The primary application is for supplying a timing reference to the office BITS clock. This allows the BITS clock to be slaved to a BITS clock in another office that is, in turn, traceable to the primary reference source (PRS). Typically, the DMX*tend* supplying the DS1 timing output will, in turn, be externally timed by the BITS clock. If there is no BITS clock, the DS1 timing output can be used to time a switch or switch remote (if the switch remote is equipped for that option) directly or even another DMX*tend* Multiplexer.

3 *How do I prevent my BITS clock from using a DS1 timing output when a failure in the network results in this DS1 being timed from a SONET NE in holdover?*

SONET sync messaging informs the local DMX*tend* of this condition, and AIS is inserted on the DS1 timing output.

4 *What is the advantage of using the DS1 timing output instead of a multiplexed DS1 as the timing reference?*

The DS1 timing output is derived from the optical line rate and is superior because:

- The DS1 is virtually jitter-free
- Sync messages guarantee the traceability of the timing
- Administration of traffic DS1s for timing is eliminated.

5 *Can I ever use the DMXtend in the free running timing mode?*

If a PRS traceable external reference is available, it is the recommended timing mode for any/all CO applications. The free running timing mode can be used but a slight increase in jitter will result. If one DMX*tend* is provisioned for free running, all other DMX*tend* NEs in the network must be line timed and SONET interfaces to other equipment are not allowed. The DS1 timing output is not allowed with a free running network.

6 *How do I provide timing to a central office host switch that does not have the option for an external reference?*

A DS1 carried over SONET may contain significant jitter/wander and be unacceptable to the switch as a timing reference. If the central office has a BITS clock, the recommendation is to use the output from the BITS clock into an unused DS1 traffic port on the switch. If the central office does not have a BITS clock, the recommendation is to use the DS1 timing output from the DMX*tend* as the line timing reference into an unused DS1 traffic port on the switch.

7 *Can a DS1 carried over SONET ever be used as a timing reference?*

YES! In many applications there is no other choice. Most switch remotes, for instance, obtain their timing from a specific DS1 signal generated by their host switch, so these remotes must line time from the DS1 signal. In addition, DLC equipment, channel banks, and PBXs will not likely have external references and may be allowed to line time from a DS1 carried over SONET.

8 *Are there any specific concerns when using a DS1 carried over SONET to time equipment such as a switch remote or DLC?*

Yes. The major concern is to make sure all the equipment is synchronous. The DMX*tend* NEs should be synchronous to each other to prevent pointer adjustments. This can be accomplished by having one source DMX*tend* that is externally timed. The other DMX*tend* NEs in the network should be line timed, or they should be externally timed to a clock to which they provide a DS1 timing output. The DMX*tend* NEs should also be synchronous to the switch to prevent excessive mapping jitter. This can be done by synchronizing the host switch to the BITS clock used to reference the DMX*tend*.

9 *Will I have any problems providing timing to a customer that has a high quality PBX or switch?*

If the network is completely synchronous, as described in the previous answer, there should be no problems. If the PBX is sensitive to the jitter produced, even under the synchronous conditions, the DS1 timing output of DMX*tend* may be required to be used as a timing reference to this equipment.

10 *Why does Bellcore say that DS1s carried over SONET should not be used for timing?*

Bellcore has provided this recommendation because there are several limitations. Bellcore says that DS1s carried over SONET must be used in applications such as switch remotes and will be acceptable, provided pointer adjustments are not created.

11 *Can pointer adjustments be prevented?*

Neither random nor periodic pointer adjustments will occur if the DMX*tend* shelf is provisioned for line timing.

12 *How do I time DMXtend at a remote site?*

Line time.

13 *How many DMXtend NEs can I chain together in an add/drop configuration before the timing becomes degraded?*

The Stratum level traceability of the nth node in an add/drop chain is the same as that in the first node. Also, while timing jitter will theoretically increase as the number of nodes is increased, the high quality timing recovery and filtering on the DMX*tend* allows add/drop chains to be extended to any practical network limit without detectable increases in jitter levels. In practice, the only effects on timing at the nth node will occur whenever high-speed protection switches occur in any of the previous n-1 nodes. These effects should be rare.

14 *How do I time a DMXtend ring network?*

An interoffice ring should have each node externally timed if BITS clocks are available. All other rings should have one node externally timed (two in some dual homing architectures) and the rest of the nodes line timed. Synchronization reconfiguration is automatic.

15 *Why are there more issues related to timing with SONET equipment than there are with asynchronous equipment?*

SONET equipment was designed to work ideally in a synchronous network. When the network is not synchronous, mechanisms such as pointer processing and bit-stuffing must be used and jitter/wander increases.

16 *Can DS3 signals be used to carry DS1 timing signals without the worry of having the network synchronous?*

Yes, although this option is more expensive.

17 *What are the limitations on automatic synchronization reconfiguration?*

Automatic synchronization reconfiguration is only available when the DMX*tend* is provisioned for line timing mode. This allows the timing direction of an OC-n (OC-3/12) ring network to change automatically in response to a failure. When the DMX*tend* is provisioned for external timing, automatic synchronization reconfiguration is not available. When an OC-n fault is detected in the timing direction, AIS is inserted on the derived DS1s which forces the BITS into holdover preventing timing loops.

18 *How do I synchronize a BITS clock and maintain automatic synchronization reconfiguration on a DMXtend ring?*

Provision all but the host node (node with co-located PRS) for line timing. Provide each non-host BITS clock with a pair of derived DS1s. The DMX*tend* will detect faults and provide the BITS clocks with good inputs if available. Timing loops will be prevented. The host node should be set for external timing and get its timing from an externally timed BITS clock. To prevent a timing loop, the host BITS clock should get its timing from a PRS traceable source. The non-host nodes should not be timed from the co-located BITS clock since this would disable the automatic synchronization reconfiguration feature.

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6 Operations, Administration, Maintenance, and Provisioning

Overview

Purpose

This chapter describes the operations, administration, maintenance, and provisioning (OAM&P) functions for the DMX*tend* Access Multiplexer.

Contents

The following sections are included in this chapter:

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Maintenance

Overview

Purpose

This section describes the maintenance philosophy of the DMX*tend* Access Multiplexer.

Contents

The following maintenance topics are discussed in this section:

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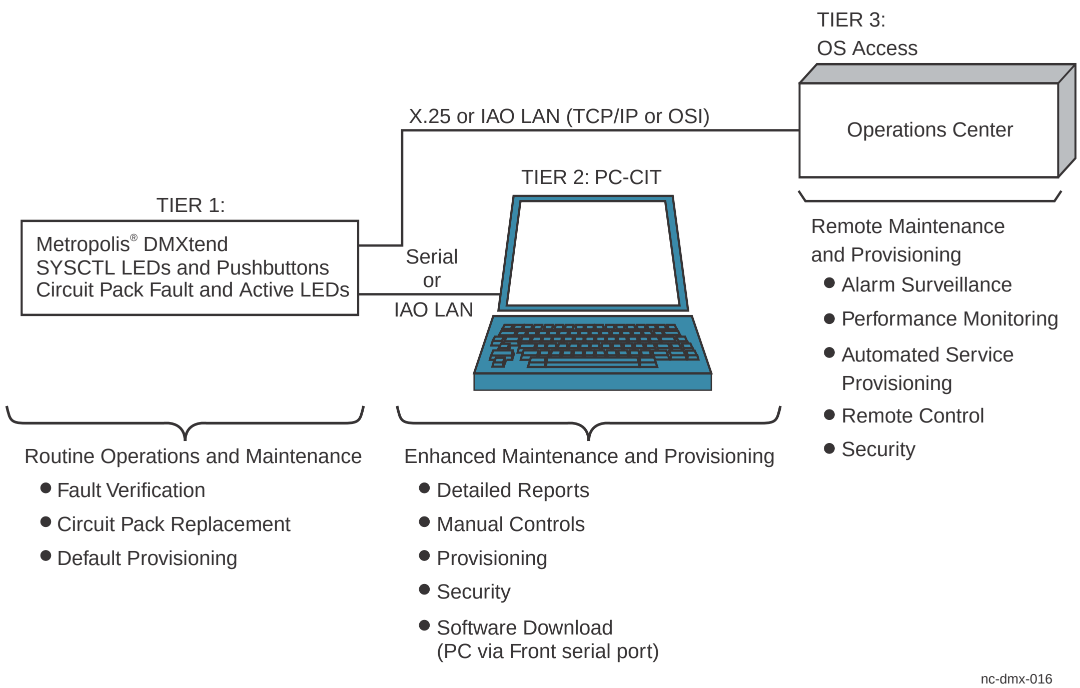
Three-tiered Operations

Overview The figure below, shows the three-tiered operations procedures for DMX*tend*. The DMX*tend* operations procedures are built on three levels of system information and control, spanning operations needs from summary-level status to detailed reporting.

Figure 6-1 Three-Tiered Operations



SYSCTL faceplate (Operations Tier 1)

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 and reported as office major, if desired.

The light-emitting diodes (LEDs) and push buttons on the SYSCTL faceplate allow routine tasks to be performed without a PC-CIT or any test equipment. The SYSCTL faceplate LEDs provide system-level alarm and status information for the local NEs and a summary for all remote NEs in the alarm group. The circuit pack faceplate FAULT LEDs allow fast and easy fault isolation to a particular circuit pack.

The SYSCTL faceplate 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 alarms. A green ACO button 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 LED shows that the power is on and the terminal is receiving a -48V source. Three yellow status LEDs show abnormal (ABN) conditions, near-end activity (NE), and far-end activity (FE). The yellow ABN LED is lighted when a temporary condition, potentially affecting transmission, exists. For example, this condition could be a manual protection switch or lockout, loopback, or system test in progress.

The Update/Initialize (UPD/INIT) button addresses the local system. The recessed UPD/INIT 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.

The SYSCTL faceplate's remote display functions serve the single-ended maintenance needs of access transport applications. When any alarm or status condition exists at a remote DMX*tend* shelf in the same alarm group, the FE LED on the faceplate is lighted.

Table 6-1, SYSCTL Faceplate Indicators and Functions (6-5), details the various LEDs and push-button switches and describes their functions.

Table 6-1 SYSCTL Faceplate Indicators and Functions

LED/Push-button	Indicator name	Function
FAULT	Fault	Indicates isolated circuit pack failure.
CR	Critical	Indicates critical alarm for local system.
MJ	Major	Indicates major alarm for local system.
MN	Minor	Indicates minor alarm for local system.
ABN	Abnormal	Indicates temporary transmission-affecting condition.
FE	Far-End Activity	Indicates remote alarm or status condition.
NE	Near-End Activity	Indicates local alarm or status condition.
ACO	Alarm Cut-Off	Activates alarm cut-off (will also display software version information when depressed for 3 seconds).
ACO/TEST	Alarm Cut-Off/Test	Performs LED tests.
SEL	Select	When the SEL and the UPD/INIT buttons are simultaneously depressed for a period of 5 seconds, you will receive a **P.** on the display. This lets you know that you can now force a software download.
UPD/INIT	Update/Initialize	Updates the local system.

Circuit pack LEDs

To supplement the SYSCTL faceplate's system-level view, each circuit pack provides a red FAULT LED on its faceplate. A lighted FAULT LED shows that the DMX*tend* has isolated a failure to that circuit pack. On transmission circuit packs, a flashing FAULT LED shows that an incoming signal to that circuit pack has failed.

Local craft interfaces (Operations Tier 2)

The local craft interfaces include the PC-CIT, which may be utilized in a variety of ways.

Craft Interface Terminal (PC-CIT) (software download-- front serial port only)

DMX*tend* supports a front serial port over an RJ45 interface. This port is configured as data communications equipment (DCE) for direct terminal access, and it provides data rates of up to 115,000 baud. Local and remote software download operations can only be performed through the front serial port (a PC must be connected directly to the front serial interface).

DMX*tend* also supports TL1 over PC-CIT through the serial port, allowing TL1 messages to be exchanged over PC-CIT asynchronous ports.

PC-CIT (TL1 over TCP/IP)

The PC-CIT is a small CIT interface that provides a flexible TL1 command instructor. The PC-CIT connects to a DMX*tend* using either the front or rear serial ports, the front IAO LAN port, or the rear IAO LAN port. The PC-CIT supports TCP/IP (or OSI) connections through both the front and rear IAO LAN interfaces.

The PC-CIT is used for report generation, as well as command and system response. Access to the system is provided via serial or IAO LAN interfaces.

Operations System (OS) TL1/LAN interfaces (Operations Tier 3)

The third operations tier consists of OS access. DMX*tend* OS interfaces include X.25 and IAO LAN TCP/IP or OSI.

TL1/X.25

The TL1 message-based OS interface provides remote OS access, as well as detailed reporting and control capabilities. The interface uses standard X.25 protocol and needs no mediation device (i.e., 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 DMX*tend* 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 DMX*tend* NEs with Telcordia OSs.

The DMX*tend* supports TL1 alarm surveillance and performance monitoring with OSs such as Telcordia's Network Monitoring and Analysis (NMA). The DMX*tend* supports service provisioning with memory administration OSs such as Lucent's Navis ™ EMS or Telcordia's TEMS. The DMX*tend* 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 capabilities.

The OS can use more than one DMX*tend* 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. Lucent's Navis ™ EMS, as well as other-vendor NEs that adhere to GR-253-CORE, can serve as the TL1/X.25 GNE for the DMX*tend*.

Front LAN CIT (IAO LAN) and RS232 CIT (Serial)

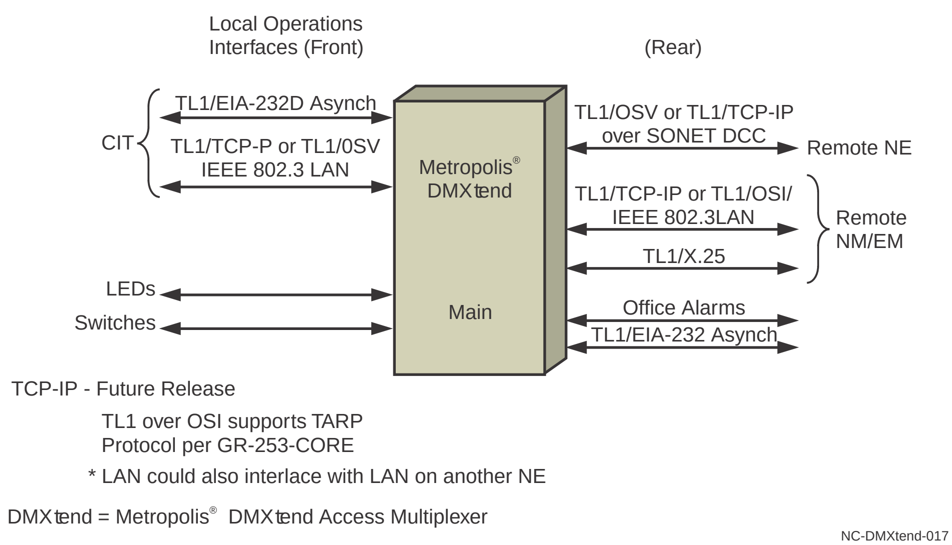
The front LAN CIT and RS232 CIT interfaces provide a connection to the PC-CIT and are intended for OSI LAN or TCP/IP based communications. OAM&P activities such as loopbacks and testing, protection switching, provisioning, PM, retrieving reports, and security on any and all DMX*tend* NEs in a subnetwork are provided by the front IAO LAN interface. These interfaces are located on the circuit pack housed in the MAIN SLOT of the DMX*tend* shelf.

Rear IAO LAN

The primary purpose of the rear IAO LAN interface is to provide remote OS access, such as OS TL1 access over TCP/IP Gateway. It also supports a faster software download from Navis® EMS (or any FTP server) using file transfer protocol (FTP) to Lucent DMX*tend* systems when software is being upgraded. This rear IAO LAN port can also be used for PC-CIT OSI-based interfaces and TCP/IP support.

The figure below, shows how with the various DMX*tend* operations interfaces.

Figure 6-2 Operations Interfaces



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Operations Philosophy

Overview

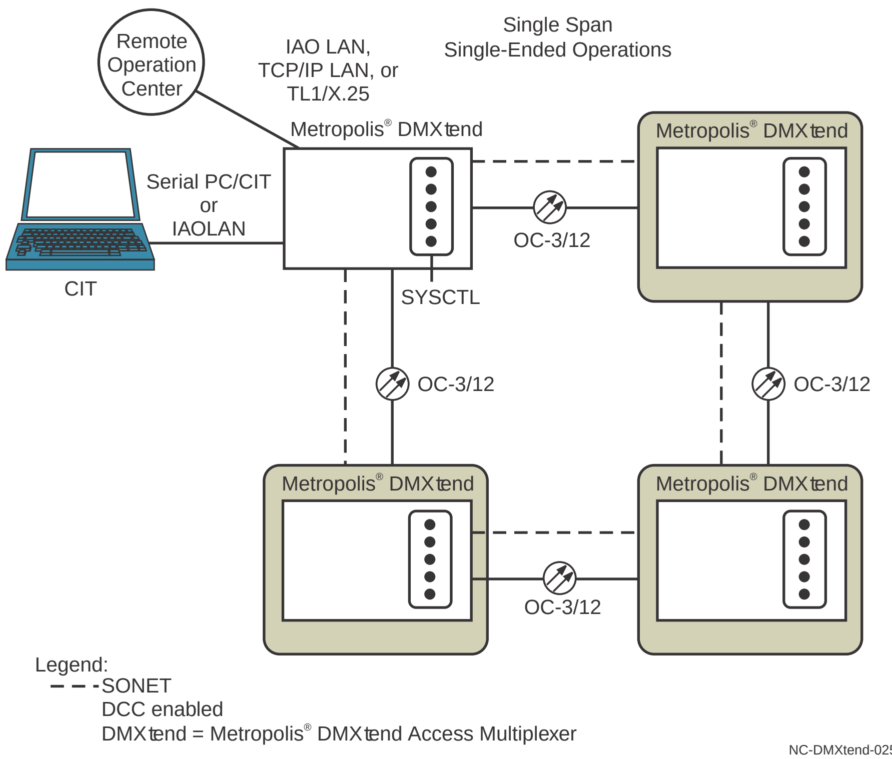
The DMX*tend* has incorporated an operations philosophy that is optimized for operations in the access transport environment. This allows operation and maintenance of remote NEs from a single location. Similarly, a technician working at a remote site can gain access to other NEs. In addition, OSs are available to allow operation of the DMX*tend* NEs from a centralized operations center.

The DMX*tend* uses the SONET data communications channel (DCC) to provide remote PC-CIT access, remote CO alarms, remote alarm reports, and remote OS access. The terms remote operations, single-ended operations (SEO), and Operations Interworking (OI) are synonymous.

SEO capability

The figure below, shows the SEO capability that provides remote access to all DMX*tend* systems in a subnetwork from a single DMX*tend* location. This minimizes the need for technician travel because most maintenance, provisioning, and administration can be performed on all NEs with DCC connectivity by accessing any one NE. The SEO capability can be disabled between NEs to create maintenance boundaries (for example, interoffice applications) or for security reasons.

Figure 6-3 Remote Operations Philosophy



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Lucent Operations Interworking

Overview

Operations interworking (OI) provides the capability to access, operate, administer, maintain, and provision remote Lucent NEs from any Lucent NE with DCC connectivity in a network or from a centralized OS.

OI support

Lucent OI is available among NEs that are connected through the SONET DCC or IAO LAN. With this feature, users can perform OAM&P activities on a centralized basis, saving travel time and money.

OI features including the following:

- Remote OS access via TL1 over TCP/IP (or OSI) or TL1/X.25
- Remote PC-CIT access
- Remote NE status
- Remote software download and copy
- Remote time and date synchronization

For more information on OI, refer to *Lucent Technologies WaveStar Product Family Operations Interworking Guide*, 365-372-303.

The table below provides a list of the products the DMX*tend* supports OI with. The table also indicates which release of the DMX*tend* each product is supported by.

Table 6-2 DMX*tend* OI Support

Product	DMX*tend* Release	
	Release 1.0	**Release 2.0**
DMXpress Release 1.0	 **X**	 **X**
DDM-2000 OC-3 Release 15.0	 **X**	 **X**
DDM-2000 OC-12 Release 7.0	 **X**	 **X**
FiberReach Release 4.0	 **X**	 **X**
FT-2000 Release 9.1	 **X**	 **X**
WaveStar 2.5G/10G (2-Fiber) Release 4.0 Release 5.0 Release 6.0	 **X** **X** **X**	 **X** **X** **X**
WaveStar BandWidth Manager Release 4.0 Release 4.1	 **X** **X**	 **X** **X**
NCC Release 3.2	 **X**	 **X**
Lambda Unite Release 2.0		 **X**
PC-CIT Release 5.2 - GUI Release ? Release ?	 **X** **X** **X**	 **X** **X** **X**

Product	DMX*tend* Release	
	Release 1.0	Release 2.0
EMS (formerly "SNMS")		
Release 5.1	X	X
Release 7.0	X	X
Release 8.0	X	X
Release 9.0	X	X
NMS		
Release 6.0	X	X
Lucent (Ascend) GX550[(b)]	*	*
Lucent (Ascend) CBX500	*	*
ETEK	X	X
Avanex	X	X
TIRKS		
Release 19.4	X	X
Release 19.5	X	X
Release 19.6	X	X
Release 19.7	X	X
NMA		
Release 10.1	X	X
Release 11.0	X	X
Release 11.1	X	X
Release 12.0	X	X
Transport (TEMS)		
Release 2.0	X	X
Release 2.2	X	X
Release 2.4	X	X
Release 2.5	X	X

NOTES

(*) Transmission interworking only

Alarm groups

An alarm group is a set of NEs that share status information between themselves, such as alarms, LEDs, and ACO status. The set of remote NEs that an NE can exchange status information which 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 SONET subnetwork. In DMX*tend*, all NEs are defaulted into the same alarm group (number 255).

Alarm groups can be nodes in a ring, nodes of a linear extension, or any other logical grouping such as a maintenance group or geographical group. For example, 24 NEs could be provisioned into three alarm groups with eight NEs that share a community of interest such as the same OC-3 low-speed optical interface.

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

Alarm group functions

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 the highest alarm level among other member NEs in the same alarm group.

Alarm Gateway Network Element (AGNE)

Members of an alarm group exchange information through one or more alarm gateway NEs (AGNEs) that are defined in the same alarm group. All DMX*tend* NEs use the DCC to receive and report alarm and status information to the AGNE(s). 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 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, but it is recommended that only one AGNE be provisioned for each alarm group. Considerations for choosing an NE as an AGNE include being central to the group to make communications links easily accessible for maintenance purposes.

The AGNE and TL1/X.25 GNE should be separate NEs. Furthermore, the AGNE is a “collection point” and does not have to be a NE in a CO.

Multi-Vendor Operations Interworking

TARP

To support multi-vendor OI, the DMX*tend* supports Target ID Address Resolution Protocol (TARP).

TARP provides NSAP-TID translations and is the established multi-vendor standard for SONET NEs that support TL1 OS interfaces. DMX*tend* supports the TARP Data Cache (TDC) function to reduce the frequency of TARP propagation throughout the subnetwork and to improve performance.

Compatibility

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

DMX*tend*'s compatibility with other-vendor NEs could be tested by customers or independent third parties such as Telcordia Technologies.

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Software Download and Copy

Overview

DMX*tend* can upgrade the system software while in-service. Yet, initial software installation must be done locally using a PC connected to the DMX*tend* via the front serial port. It uses flash erasable programmable read-only memory (flash EPROM) chips to store the system software. System software can be downloaded using a PC (see specifications in Section 10) through the RS-232 interface on the SYSCTL faceplate into the local system, or to another system connected to the local system via the SONET DCC. In addition, system software can be copied between DMX*tend* systems connected by the SONET DCC. The remote software download and copy capabilities enable the network service providers to avoid costly craft dispatches for software upgrade.

Downloads

DMX*tend* systems accept downloads without disrupting transmission and with minimal impact on operation functions. This enables the software downloads to be transparent to the transmission services and to the network operations. While the current software version is still running, DMX*tend* accepts the downloading of compressed, dormant software copies without affecting the operation of the system. An “apply” command can be scheduled to be applied at any time the user specifies.

An OS(s) will lose communications while the network is being upgraded for a half an hour or less.

The DMX*tend* can also accept software downloads from Lucent’s SNMS and PC-CIT when upgrading to subsequent releases (R2.0 and higher).

Maintenance Signaling

Alarm indication signals

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 and notify upstream equipment to initiate trunk conditioning because of a downstream detected failure (remote defect indicator [RDI]).

Compliance

Maintenance signaling is compliant with SONET (Telcordia Technologies GR-253) 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. Remote defect indication signals include STS-1 path RDI and VT path RDI. Other maintenance signals include STS-1 path unequipped, and VT path unequipped.

Fault Detection, Isolation, and Reporting

Overview

DMX*tend* continuously monitors incoming signals and internal system conditions. Incoming SONET signals are monitored for loss of signal (LOS), loss of frame (LOF), loss of pointer (LOP), line AIS, path AIS, bit error ratio (BER) thresholds and unequipped signals. The BER threshold crossings are detected for DS1, DS3, EC-1, OC-3, OC-12, STS-1, STS-3c, and STS-12c signals.

Fault detection

When an internal fault is detected, automatic diagnostics isolate the faulty circuit pack. Faults are reported to local technician and OSs so that technician dispatch and repair decisions can be made. If desired, OS personnel and local technicians can use the PC-CIT to gain more detailed information on the fault condition.

Fault isolation

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

Fault reporting

The system can also report all detected alarm and status conditions through the appropriate office alarm relays, SYSCTL faceplate LEDs, transmission circuit pack LEDs, and TL1 interfaces.

Loopbacks and Tests

Overview

The DMX*tend* allows technicians to perform loopback tests on all low- and high-speed interfaces. Low-speed DS1, DS3, and EC-1 electronic loopbacks, directed toward the high-speed line (terminal loopback), are individually controllable from the CIT or the OS interface. Active electronic loopbacks are shown by the ABN LED on the SYSCTL faceplate and in the alarm and status report. EC-1, DS1, and DS3 facility loopbacks toward the DSX are also available.

Manual optical loopbacks

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. In some cases a lightguide buildout assembly is required to prevent receiver overload when performing loopbacks.

Internal testing capabilities

Technicians can use the internal testing capabilities for installation and manual troubleshooting. The DS1 and DS3 test signal generators and detectors are integrated into the system, eliminating the need for external test equipment to perform transmission tests.

Specific testing

DMX*tend* also allows technicians to test specific system components. In addition to the automatic diagnostics, DMX*tend* provides tests for LEDs, office alarms, and the SYSCTL circuit pack.

Protection Switching

Overview

Purpose This section describes the types and functions of protection switching in the DMX*tend* Access Multiplexer.

Contents The following protection switching topics are discussed in this section:

□

Line Protection Switching

Overview

Line protection switching (1+1) occurs automatically in response to detected faults, as well as in response to external commands from technicians at a local or remote CIT or OS. DMX*tend* provides SONET standard line protection switching on low-speed optical interfaces as a user-provisionable option.

Protection switching priorities

DMX*tend* uses standard protection switching priorities as follows:

- Inhibit automatic protection switch
- Lockout of protection
- Forced switch
- Automatic switch: signal fail
- Automatic switch: signal degrade
- Manual switch.

DMX*tend* uses unidirectional 1+1 nonrevertive line switching. Automatic protection switch procedures as specified by the SONET standard are used.

To support 1+1 compatibility on the OC-n interface, the interface must be provisioned for the “identical” application mode.

Automatic line switching

Automatic line switches are initiated by signal fail and signal degrade conditions on the received OC-n signal. This signal’s BER is calculated from violations in the SONET line overhead B2 parity byte. Signal fail is declared for incoming loss of signal, loss of frame, line AIS, or a BER exceeding 10^{-3}, while a BER exceeding a provisionable 10^{-5} to 10^{-9} threshold causes the signal degrade condition. A line protection switch is completed within 50 milliseconds of the onset of a hard failure such as a fiber cut.

In multispan applications (for example, hubbing), each OC-n span switches independently. For example, in hubbing applications, a switch on the central office-to-hub span will not cause switches on any of the hub-to-remote spans. Similarly, a line switch on a hub-to-remote span will not propagate to other hub-to-remote or central office-to-hub spans.

Path Protection Switching (Path Switched Rings)

Overview

DMX*tend* supports path switched ring applications using the path protection switching schemes described in Telcordia Technologies GR-1400. 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 input is bridged 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.

Application modes

There are three types of protection application modes, listed below:

- distinct (UPSR)
- identical (1+1-- linear)
- 0x1

The identical application mode is functionally equivalent to a 1+1 protected configuration, providing path switching on all paths within a high-speed line if that particular line fails.

The distinct application mode (UPSR) provides ring path protection switching on low-speed OC-3 and OC-12 interfaces.

The 0x1 application mode is an unprotected mode used on low-speed OC-3 or OC-12 low-speed interfaces.

UPSR configurations

DMX*tend* supports the following OC-3/12/48 path switched ring configurations:

- VT1.5/STS-1
- VT1.5/STS-1/STS-3c/STS-12c

Path protection switching is non-revertive. A manual path protection switching command allows switching to the other path for ease of ring maintenance. STS-n path switching is triggered by incoming line LOS, LOF, LOP, AIS, and unequipped or STS-1 path BER exceeding a signal fail (10^{-3}) or signal degrade threshold. The system also supports VT path protection switching based on VT AIS, LOP, unequipped, and signal degrade.

DMX*tend* also supports STS-1/STS-3(c) non-revertive path protection switching on low-speed (OC-3/OC-12) optical interfaces, as well as STS-12(c) path switching on OC-12 low-speed interfaces. Path protection is user-provisionable on a per-port basis.

Unprotected paths (0x1)

DMX*tend* provides an unprotected or locked cross-connect mode, referred to as 0x1, on OC-3 and OC-12 low-speed ports. This option is user-provisionable on a per-port basis and supports single- and dual-homed ring on ring topologies.

Mixed protection modes

DMX*tend* supports mixed protection modes (identical, distinct, and 0x1) on different ports on the same OLIU. In Release 3.0, DMX*tend* supports mixed protection modes (identical, distinct, and 0x1) on different channels on the same line or port.

Ethernet interface protection

On the WAN (SONET) side of the network, DMX*tend* utilizes standard IEEE 802.1D spanning tree protection for multipoint applications and/ or STS-1 UPSR protection (for point-to-point applications). See the section beginning on the following page for more detailed information on Spanning Tree Protection.

Spanning Tree

Overview

This section provides information on the spanning tree protocol and spanning tree groups. The DMX*tend* now supports a faster spanning tree algorithm documented in IEEE 802.1w.

> **Important!** DMX*tend* has been designed with multi-vendor interoperobility in mind. As many vendor's equipment (including legacy equipment) may not be able to use IEEE802.1w, DMX*tend* can automatically fall back on IEEE802.1d in the event that other NEs in the network are running standard spanning tree protocol. However DMX*tend* employs IEEE 802.1w as a default spanning tree protocol.

Function of spanning tree

Ethernet requires a network with a tree structure in order to work effectively. Ethernet bridges and switches build tables that define the paths to specific devices. A MAC bridge, for example, will have a filtering database that defines where to send any packets addressed to a specific MAC within the network. The tables are built based on input from devices within the network.

If there is a loop in the network, that is, if there is more than one way to get to a destination device, two problems can result:

- Frames may be duplicated in the network. That is, the same frame may be sent to a node via two different paths.
- The address information will be changed as packets from that device are received across different paths. In a meshed network, the reconfiguration of the filtering database can begin to use up all the network resources, so that little bandwidth is left for data traffic.

The spanning tree accomplishes two important functions:

- It removes loops from the bridged network
- It allows reconfiguration if a link fails.

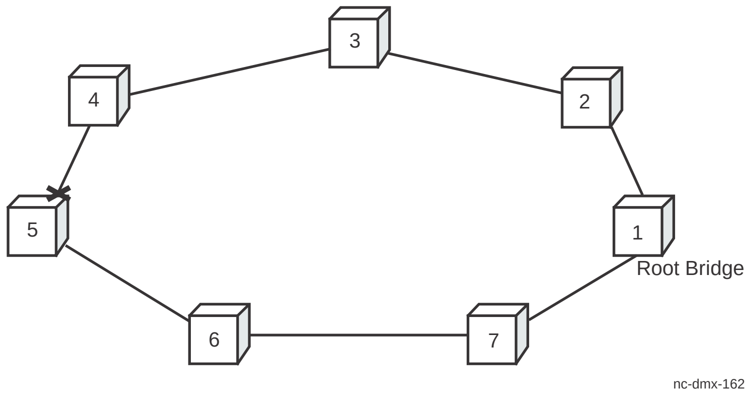
How it works

The spanning tree works as follows:

1. Initially, every node in the group thinks it is the root node.
2. As information about the network becomes clear, one node is designated the root node.
   It is from this node that the distance to any point in the network may be measured.

3. Configuration BPDUs are sent from each node to determine the most economical route from each node to the root node.
4. Some ports are blocked so that there are no loops in the network and so that the network provides the most efficient paths from the root to the nodes.
   This effectively creates a tree structure for the network.
5. If an active link fails, the network is reconfigured so that previously blocked links can be used for traffic.

The following figure illustrates the spanning tree:



Legend:

Active Links	1- 2; 2- 3; 3 -4 ; 5-6; 6-7; 7-1
Inactive Links	4-5
X	Indicates a blocked port (no packets sent or received on this port).

Note that the configuration provides the shortest (most efficient) path from each node to the root. The configuration also provides only one path from the root node to any other node.

Reconfiguration

If one of the active links were broken, the network would reconfigure to allow traffic to get to the nodes. For example, if the link between 3 and 4 were broken, the link between 5 and 4 would be enabled. When the failure/break is repaired, the network will revert to the original configuration.

□

Equipment Protection

Overview

All transmission circuit packs are optionally 1x1 protected (not including ethernet interfaces) and use non-revertive switching. The ACTIVE LEDs on the 1x1 protected circuit pack faceplates show which circuit packs are carrying service. This aids technicians in circuit pack replacement procedures.

Protection switching priorities

The following protection switching priorities on equipment are user-controllable through TL1 commands:

- inhibit switch
- forced switch
- manual switch.

Protection switching is available for all traditional SONET interfaces when provisioned for path and/or line protection switching.

If protection is not desired, SONET interfaces can be provisioned for no protection by not equipping the adjacent Function Unit slot. For example, if Function Unit slot A1 is equipped with an OC-3 circuit pack, then slot A2 would remain unpopulated.

Performance Monitoring

Overview

Purpose

This section lists and describes performance monitoring parameters, SNMP traps and parameters, data storage, thresholds, and TCA transmission.

Contents

The following performance monitoring information is included in this section:

Performance Monitoring Parameters

Overview

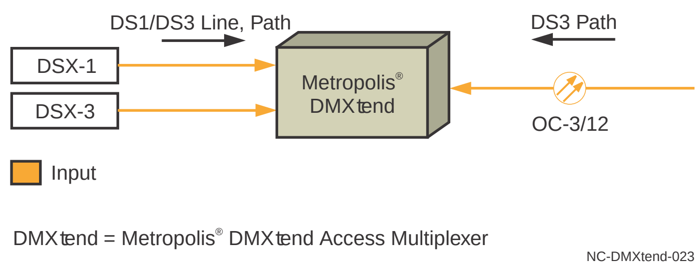
DMX*tend* uses performance monitoring (PM) to support proactive maintenance of the network and tariffed service performance verification. Proactive maintenance refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming but indicative of an impending hard or soft failure. Hard and soft failures result in reactive maintenance. PM conditions are reported on both SONET and ethernet interfaces.

Proactive maintenance

Proactive maintenance consists of monitoring performance parameters associated with the SONET sections, lines and paths within the SONET network, as well as incoming and outgoing bytes and frames on ethernet ports. Table 6-2, SONET PM Parameters (6-32), lists the SONET performance parameters monitored by DMX*tend*. 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. Ethernet performance monitoring parameters are listed later in this section.

Figure 6-4, DS1/DS3 Line/Path Performance Monitoring (6-29), shows DS1/DS3 line and path and DS3 path performance monitoring. DMX*tend* monitors DS3 line and path parameters from the DSX-3 and DS3 path parameters from the optical path.

Figure 6-4 DS1/DS3 Line/Path Performance Monitoring



Line parameter

A line is a physical transport vehicle that provides the means of moving digital information between two points in a network. The line is characterized by a metallic transmission medium and its specific coding type. A line is bounded by its two end points, known as line terminations. A line termination is the point where the electrical, bipolar line signal is generated and transmitted, or received and decoded.

Path parameter

A path is a framed digital stream between two points in a network and represents digital signal transport at a specified rate, independent of the equipment and media providing the physical means of transporting the signal. A path is defined by its two end points, called path terminations, where its frame structure is generated and decoded. A path may be carried wholly within one transport segment (line), or it may span a sequential arrangement of two or more transport segments.

DS1 performance monitoring

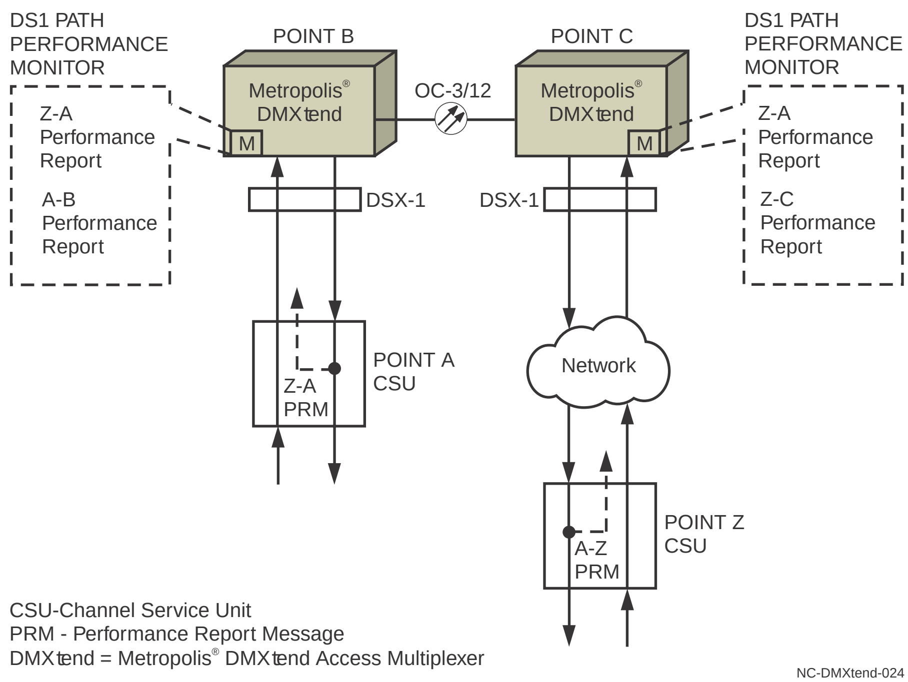
Tariffed service verification consists of monitoring performance parameters that can be associated with the customer's end-to-end service. The DMX*tend* system provides this capability for DS1 services with the DS1 performance monitoring feature. Based on *ANSI* T1.403 extended superframe format (ESF), this capability retrieves performance messages written into the ESF data link by the customer's terminal equipment. From these messages, the DMX*tend* can determine and report the end-to-end error performance of the entire DS1 link *as seen by the customer*. These parameters, listed in Table 6-2, SONET PM Parameters (6-32), 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.

Application of the DS1 performance monitoring feature for tariffed service verification is shown in Figure 6-5, DS1 Path Performance Monitoring (6-31). This shows an *ANSI* T1.403 ESF format DS1 service carried between points A and Z, using an OC-3/12 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 CSU onto the outgoing (A - Z) ESF data link as a performance report message (PRM). The DS1 PM 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 OC-3/OC-12 system interfacing the Z end reports the A - Z performance by reading the PRM from the customer's "Z" CSU. By reviewing data from each OC-3/12 system, the service provider can determine the complete end-to-end performance (A - Z and Z - A) of the customer's service.

DS1PM circuit pack

Additionally, each 28DS1PM 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 28DS1PM circuit pack can also provide this same near-end information for super frame (SF) formatted (sometimes 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.

Figure 6-5 DS1 Path Performance Monitoring



SONET PM parameters The table below, lists the performance monitoring parameters for the SONET interfaces.

Table 6-3 SONET PM Parameters

Facility	Measured parameter
OC-3 Section	Severely Errored Frame Seconds (SEFS)
OC-12 Section	Severely Errored Frame Seconds (SEFS)
DS1 Line	Errored Seconds, Line (ESL) Enhanced Line Signal Threshold (BERL)
DS3 Line	Line Coding Violations (CVL) Errored Seconds (ES) Severely Errored Seconds (SES)
EC-1 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) STS Pointer Justifications Counts (PJC)
OC-3 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) Line Protection Switch Counts (PSC-L) STS Pointer Justification Counts (PJC)

Facility	Measured parameter
OC-12 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) Line Protection Switch Counts (PSC-L) STS Pointer Justification Counts (PJC)
STS-1, STS-3c, STS-12c, Path	B3 Coding Violations (CV) B3 Errored Seconds (ES) B3 Errored Seconds Type A (ESA) B3 Errored Seconds Type B (ESB) B3 Severely Errored Seconds (SES) B3 Unavailable Seconds (UAS)
VT1.5 Path	V5 Errored Seconds (ES) V5 Severely Errored Seconds (SES) V5 Unavailable Seconds (UAS)
DS1 Path	Coding Violations, Path (CVP) Coding Violations, Path Far-End (CVPFE) Errored Seconds, Path (ESP) Errored Seconds, Path Far-End (ESPFE) Severely Errored Seconds, Path (SESP) Severely Errored Seconds, Path Far-End (SESPFE) Unavailable Seconds, Path (UASP) Unavailable Seconds, Path Far-End (UASPFE)
DS3 Path	P-bit Coding Violations Severely Errored Frame Seconds (SEFS)
DS3 Path for both P-bit and F&M bits (from fiber only)	CP-V Coding Violations Severely Errored Frame Seconds (SEFS) ES-P Errored Seconds SES-P Errored Seconds UAS-P Unavailable Seconds

Facility	Measured parameter
DS3 Path for P-bit, F&M bits, and C-bit (from fiber and DSX)	CV-P Coding Violations Severely Errored Frame Seconds (SEFS) ES-P Errored Seconds SES-P Errored Seconds UAS-P Errored Seconds

DS3 performance monitoring

DMX*tend* provides DS3 performance monitoring with three DS3 path PM options: P-bit (parity bit), adjusted F&M bit (frame and multiframe bit), and C-bit. The options are selected using a command that also sets the PM mode to “on” (default) or “off,” which enables or disables the monitoring and reporting of DS3 path PM data.

P-Bit

When provisioned for P-bit, the system calculates and provides counts of DS3 P-bit coding violations (CV), errored seconds (ES), and unavailable seconds (UAS) incoming from the fiber. Quarter-hour and day registers are provided with provisionable threshold crossing alerts (TCAs) on a per shelf basis. Severely errored frame seconds (SEFS) are also monitored.

Because P-bits can be corrected at nodes provisioned for VMR along a DS3 path, the DS3 P-bit PM data may not provide a complete report of the end-to-end DS3 path errors.

Adjusted F&M Bit

Adjusted F&M bit performance monitoring provides an alternative method for determining and accumulating DS3 path performance data based on an error estimation technique using errors on the F&M framing bits to approximate the actual error counts in the DS3 path payload. F&M bits are not corrected at nodes provisioned for VMR along a DS3 path. When provisioned for adjusted F&M bit, the system calculates and provides estimated counts of DS3 adjusted F&M bit coding violations (CV), errored seconds (ES), severely errored seconds (SES), and unavailable seconds (UAS) incoming from the fiber.

Quarter-hour and current day registers are provided with provisionable threshold crossing alerts (TCAs) on a per shelf basis. Severely errored frame seconds (SEFS) are also monitored.

C-Bit

DMX*tend* also provides DS3 path PM using the C-bit option. When the C-bit option is selected, both near-end and far-end (far-end block errors) PM data are monitored and displayed.

The system provides counts of DS3 C-bit parity coding violations (CV-P), errored seconds (ES-P), severely errored seconds (SES-P), and unavailable seconds (UAS-P) incoming from the DSX-3 and the fiber. The type of performance monitoring is provisioned per DS3 service by a CIT command.

For C-bit PM, the DS3 service can be provisioned in violation monitor (VM) or violation monitor and removal (VMR) modes. In VM mode, the C-bit errors are not corrected as in the P-bit option.

Quarter-hour and day registers are provided with provisionable threshold crossing alerts (TCAs). The TCAs are provisionable on a per-shelf basis. Severely errored frame seconds (SEFS) counts are also provided.

Ethernet performance monitoring

DMX*tend* provides PM capabilities for the 10/100Mbps, GbE SX/LX Ethernet interfaces. PM data is collected at each LAN and WAN interface in the network for both incoming and outgoing directions. The WAN interface provides a connection to a SONET Virtual Concatenation Group (VCG).

Listed below are the six PM parameters that provide PM data on all ethernet interfaces:

- **Dropped Frames (congestion)**

  This parameter counts the number of incoming ethernet frames dropped at a specific LAN/WAN port due to buffer overflow. Buffer overflow occurs when the network is congested.

- **Dropped Frames (errors)**

  This parameter counts the number incoming ethernet frames dropped at a LAN/WAN port due to a frame check sequence (FCS) error or another defect in the frame.

- **Incoming Number of Bytes**

  This parameter counts the total number of bytes incoming to a LAN/WAN port.

- **Incoming Number of Frames**

  This parameter counts the total number of ethernet frames incoming to a LAN/WAN port.

- **Outgoing Number of Bytes**

  This parameter counts the total number of outgoing bytes transmitted by a specified LAN/WAN port.

- **Outgoing Number of Frames**

  This parameters counts the total number of outgoing frames transmitted by a specified LAN/WAN port.

SNMP Parameters and Traps

Support of Simple Network Management Protocol (R2.0)

DMX*tend* makes use of Simple Network Management Protocol (SNMP). SNMP is the most common protocol used by data network management applications to query a management agent using a supported Management Information Base (MIB). SNMP operates at the OSI Application layer. The IP-based SNMP is the basis of most network management software, to the extent that today the phrase “managed device” implies SNMP compliance.

Parameters Supported

The DMX*tend* supports all of the following SNMP parameters.

Table 6-4 SNMP Parameters supported

SNMP Parameters
Administration Status (RFC2863)
Operational Status (RFC2863)
Total Bytes Received (RFC2863)
Frames Received (RFC2863)
Multicast Frames Received (RFC2863)
Broadcast Frames Received (RFC2863)
Received Frames Dropped (RFC2863)
Received Error Frames (RFC2863)
Bytes Sent (RFC2863)
Unicast Frames Sent (RFC2863)
Multicast Frames Sent (RFC2863)
Broadcast Frames Sent (RFC2863)
Traps Enabled or Disabled (RFC2863)
Time of Last Counter Discontinuity (RFC2863)
Fragments (RFC2358/RFC2665)
CRC Errors (RFC2358/RFC2665)
Collision (RFC2358/RFC2665)
Late Collision (RFC2358/RFC2665)

SNMP Parameters
Oversize Frames (RFC2358/RFC2665)
MAC Receive Errors (RFC2358/RFC2665)
Duplex Status (RFC2358/RFC2665)
Flow Control Default Mode (RFC2358/RFC2665)
Flow Control Operational Mode (RFC2358/RFC2665)

Traps Supported

The DMX*tend* supports all of the following SNMP traps.

Table 6-5 SNMP Traps supported

SNMP Traps
Link Up (RFC2863)
Link Down (RFC2863)
Loss of Signal on GbE or FE LAN Port (Ethernet Private MIB)
Incoming VCG Fail (VCG Private MIB)
Incoming VCG Loss of Alignment (VCG Private MIB)
Incoming VCG Loss of Frame Delineation (VCG Private MIB)
Incoming VCG Data Type Mismatch (VCG Private MIB)
Incoming STS -1 Loss of Frame (VCG Private MIB)
Incoming STS-1 Sequence Number Mismatch (VCG Private MIB)
Circuit Pack Not Allowed (Equipment Private MIB)
Illegal Circuit Pack Type (Equipment Private MIB)
FE-LAN Circuit Pack Failed (Equipment Private MIB)
GbE-LAN Circuit Pack Failed (Equipment Private MIB)
Circuit Pack Removed (Equipment Private MIB)
Circuit pack Inserted (Equipment Private MIB)

Performance Monitoring Data Storage

Quarter-hour and current day registers

DMX*tend* provides current quarter-hour and current day registers for all accumulated performance parameters. The previous 8 hours of quarter-hour and previous day registers are also provided.

Access

The DMX*tend* system can initialize these registers through the TL1 interfaces at any time, as well as retrieve and report their contents.

Performance Parameter Thresholds

Provisioning

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.

Threshold crossing alerts (TCAs)

Whenever the current quarter-hour or the current day threshold for a given parameter is exceeded, DMX*tend* generates a threshold-crossing alert (TCA) that is entered into the performance monitoring exception report and reported to the OS through the TL1 interface.

TCA Transmission to OS

Overview

The TCA information can be reported to the OS using any of the TL1 OS interfaces. TCAs can be used to trigger proactive maintenance activity.

TL1 access

The TL1/X.25 or TL1 over TCP/IP OS interfaces should be used to derive full benefit from DMX*tend*'s performance monitoring capabilities. The full set of PM data stored by DMX*tend* (TCAs and the contents of PM registers) is provided through any of the TL1 interfaces.

Provisioning

Overview

Purpose This section describes the many types of provisionable parameters available in DMX*tend*.

General DMX*tend* allows the user to customize many system characteristics through provisioning features. Provisioning parameters are set by software controls.

Contents The provisionable parameters described in this section include:

□

Default Provisioning

Default values

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 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

Overview

Software control allows remote provisioning of DMX*tend* NEs. This feature is provided especially for provisioning parameters likely to change in service, in support of centralized operations practices.

Cross-Connect Provisioning

Overview

The DMX*tend* can be provisioned for signal routing. Depending on the application, VT1.5, STS-1, STS-3(c), or STS-12(c) signal cross-connections may be established to route traffic in a specific manner. Cross-connections may be bidirectional or unidirectional.

Typical cross-connections

Any VT1.5 or STS-n signal may be provisioned for the following signal routes:

- Main to Main
- Main to Function Unit.
- Hairpin (Function Unit to Function Unit).

VT1.5 and STS-n signals may be cross-connected in several ways. For bidirectional drop services, the “two-way” cross-connection is used to connect a like signal in the high-speed Main slot to any available time slot in any Function Unit slot equipped with low-speed OC-3, OC-12, 10/100 Mbps, or GbE, DS1, or DS3/EC-1 circuit packs. For unidirectional drop services, the “one-way” cross-connection is used to connect a like signal in the high-speed Main slot to any available time slot in any Function Unit slot equipped with low-speed OC-3, OC-12, DS1, DS3/EC-1, 10/100 Mbps, or GbE circuit packs.

STS-1 cross-connections to ethernet interfaces are also available. The “two-way” or “one-way” cross-connection is used for UPSR point-to-point ethernet applications. A mltpt (data specific) cross-connect is used for multipoint Ethernet applications.

The bidirectional or unidirectional pass-through cross-connect is used to pass VT1.5 or STS-n signals through the NE all on the same timeslot.

For more info

For more information on cross-connections, refer to Chapter 5, “System Planning and Engineering.”

Automatic Provisioning on Circuit Pack Replacement

Overview

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 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

Overview

Port state provisioning is a feature provided on DMX*tend* NEs that can help suppress alarm reporting and performance monitoring by supporting multiple states for DS1, DS3, EC-1, and Ethernet LAN ports.

The states supported are as follows:

- automatic (AUTO)
- in-service (IS)
- not monitored (NMON).

Port states

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

Overview

Automatic channel state provisioning is a capability provided on DMX*tend* NEs that suppresses reporting of transient alarms and events during provisioning by supporting multiple states (AUTO, IS, NMON) for VT1.5, STS-1, STS-3(c), or STS-12(c) channels.

Automatic channel state provisioning

While an end-to-end circuit is being set up, particularly during VT1.5 and STS-n 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, DMX*tend* provides automatic channel state provisioning.

Channel states

A VT1.5 or STS-n channel is kept in the default automatic (AUTO) state until the reception of a valid signal (a framed non-AIS or non-LOP) in that channel. While in AUTO state, no alarms or events are reported on the channel. On receiving a valid signal, which occurs when the end-to-end circuit is completely provisioned, the channel automatically changes to the in-service (IS) state, where it resumes normal alarm and event reporting. An additional state, not-monitored (NMON), is also supported in which alarm and event reporting is suppressed regardless of the validity of the signal being received on the channel. Like the port state provisioning capabilities already provided for physical ports like DS1, DS3, and EC-1, the user can submit commands to manually change a channel from IS or AUTO to NMON, and from NMON to AUTO. A user cannot manually change from AUTO or NMON to IS.

Line State Provisioning

Overview The state of the low-speed OC-3, and OC-12 interfaces can be set manually to NMON or IS. On OLIUs with multiple ports (OC-3 and OC-12), the line state default is IS and alarms are suppressed. Users must manually set unused ports to NMON or those ports will be alarmed.

Reports

Overview

Purpose This section describes reports generated by DMX*tend*.

Contents Reports described in this section include:

□

Alarm and Status Reports

Overview

The system provides alarm reports that list the active alarm and status conditions, including a remote alarm/status feature that summarizes alarms in other NEs in an alarm group. A description of the condition (for example, controller failure, incoming high-speed signal failure, synchronization hardware or reference failure, etc.) is included in the reports 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

Status conditions include:

- Manually initiated abnormal conditions (for example, forced switch, manual lockouts, loopbacks, system testing)
- Incoming AIS detected
- ACO active.

A description of the status condition (for example, DS1 loopback active, DS3 facility loopback active, etc.) is included in the report along with a time stamp indicating when the condition began.

Performance Monitoring Reports

TCA summary report

DMX*tend* provides a report that lists the number of SONET performance-monitoring parameters that have crossed their thresholds. This report provides a snapshot of the system performance level. If there is signal degradation, it is quickly pinpointed so that corrective action may be taken before customers are affected, thus supporting proactive maintenance. Threshold-crossing alerts (TCAs) are not reported on ethernet interfaces.

This report provides separate parameter summaries for each signal level in the system, including SONET section, line, and path, as well as dropped/incoming/outgoing ethernet bytes and frames. The parameter summaries show the user which performance status to request if they want further information.

Performance status reports

These reports provide detailed information on the current and previous 8 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 section, line, and path parameters, as well as ethernet parameters.

Maintenance History Reports

Overview

A maintenance history report contains the following past conditions:

- alarms
- status
- protection switching
- user interface commands (e.g., provisioning, loopback request, manual protection, etc.)

Summary

The maintenance history report contains time stamps indicating when each condition was detected and when it cleared, as well as when the command was entered. Note that any system controller reset clears all records in the log.

Reference

See the *DMXtend Access Multiplexer User Operations Guide*, 365-372-325, for details on the history log.

State Reports

Overview

The state report shows the protection state of all circuit packs installed in the system and the state of the individual low/high-speed channels.

Circuit pack states

The circuit pack state is reported as “active” or “standby.”

Path states

The state of the individual VT1.5 /STS-n channels and paths may be one of the following:

- not monitored (NMON)
- in service (IS)
- auto (AUTO).

The system reports this information on all interfaces. AUTO refers to a slot that is available for automatic provisioning. For VT1.5/STS-n channels and paths, the AUTO state would transition to the IS state if a good signal is detected.

Port states

The state of individual ports, including those contained in multiport circuit packs (28DS1, 12DS3/EC1, Ethernet interface packs, quad OC-3, or dual OC-12), may be NMON, IS, or AUTO.

Line states

The state of individual lines may be IS or NMON (quad OC-3 or dual OC-12).

Provisioning Reports

Overview

The DMX*tend* provides a variety of provisioning reports that contain the current values of all electronically-provisionable parameters and hardware-selectable parameters (12DS3/EC1). For more information on the provisioning reports generated, refer to the *DMXtend Access Multiplexer User Operations Guide*, 365-372-301.

Version/Equipment List

Overview

The DMX*tend* system provides a full inventory report on all hardware and software currently installed.

Information provided

The version/equipment list provides the following information:

- Circuit pack name
- 10-character *CLEI* code
- 6-digit equipment catalog item (ECI)
- 10-character apparatus code
- 6-character series number
- 12-character serial number (includes date and location of manufacture)
- Program version (software generic) code
- Program versions in dormant area.

Administration

Overview

Purpose This section provides information on system administration.

Contents System administration considerations included in this section are:

Software Upgrades

Overview

DMX*tend* provides an in-service software installation capability to update the generic program in local and remote systems. Upgrades are distributed on CD-ROMs containing the new software and an installation program. These software upgrades are the primary mechanism to add new feature enhancements to the in-service DMX*tend* 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.

Software download

In the DMX*tend* system, software download takes place in two stages. In the first stage, the new generic software is downloaded into a dormant "flash" area as a compressed file. In the second stage, the new generic is uncompressed and moved into an active "flash" space. During this process, the old release continues to run from random access memory (RAM). Installation is not service-affecting, so down time is limited to the reboot time.

Local installation procedure

The procedure is straightforward. The technician connects a personal computer (PC) to the RS-232 front serial port on the local DMX*tend*, starts the installation program, and is prompted with a few warnings before the upgrade installation actually begins. After the technician confirms to proceed, the PC takes over the process and completes the installation.

Beginning in Release 2.0, installation may be performed via Lucent's SNMS or PC-CIT over the IAO LAN interface using FTP. For more information on software download and upgrade via SNMS, refer to the *Subnetwork Management System (SNMS) User Guide*, 190-224-100.

IP Access for network management

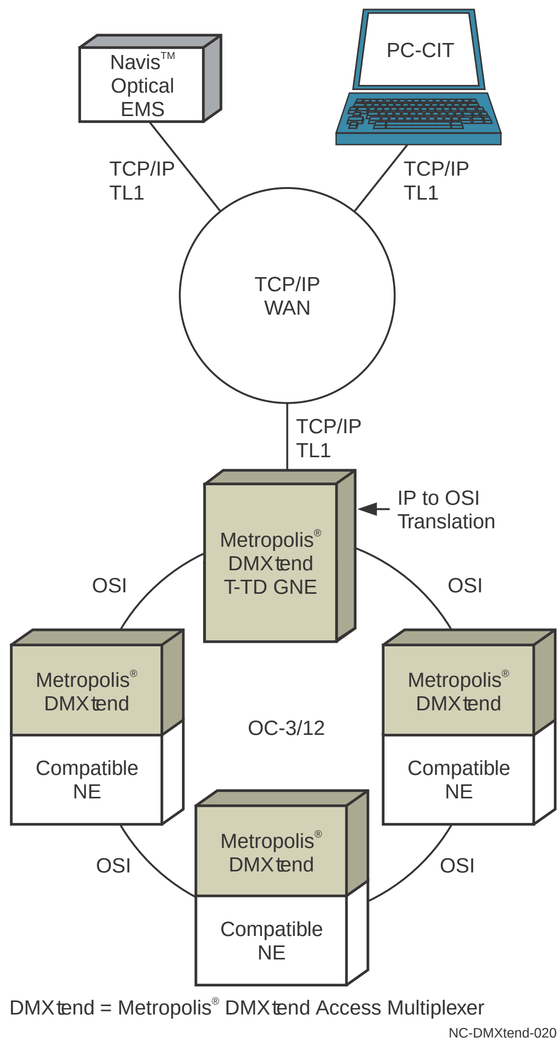
Overview

For the purpose of network management, the DMX*tend* supports two types of IP Access. In one case, the DMX*tend* can serve as a TL1 Translation Device (T-TD) by acting as a gateway network element that allows an SNMS and/or PC-CIT to communicate to other network elements (NEs) through an IP access network. This capability allows you to send TL1 commands from an SNMS or PC-CIT located on a TCP/IP based network to various NEs connected on an OSI network. In the second instance, the DMX*tend* can functionally encapsulate IP packets within OSI packets to be transmitted through the OSI network to the proper NE. Thus the DMX*tend* supports IP based protocols such as FTP by providing end-to-end IP connectivity between OS and NE. This capability is called IP tunneling.

TL1 Translation

The DMX*tend* can copy the application information within an IP packet into an OSI packet. This translation is performed at the application layer. When acting as a TL1 translation device, the DMX*tend* system must be provisioned with a list of possible OSs. If an OS is not on the list residing within the system, a connection from that OS will not be accepted. When the DMX*tend* is used as a TL1 translation device it is referred to as the T-TD GNE (Gateway Network Element). The T-TD GNE provides the same functionality as the NCC TL1 TCP/IP gateway.

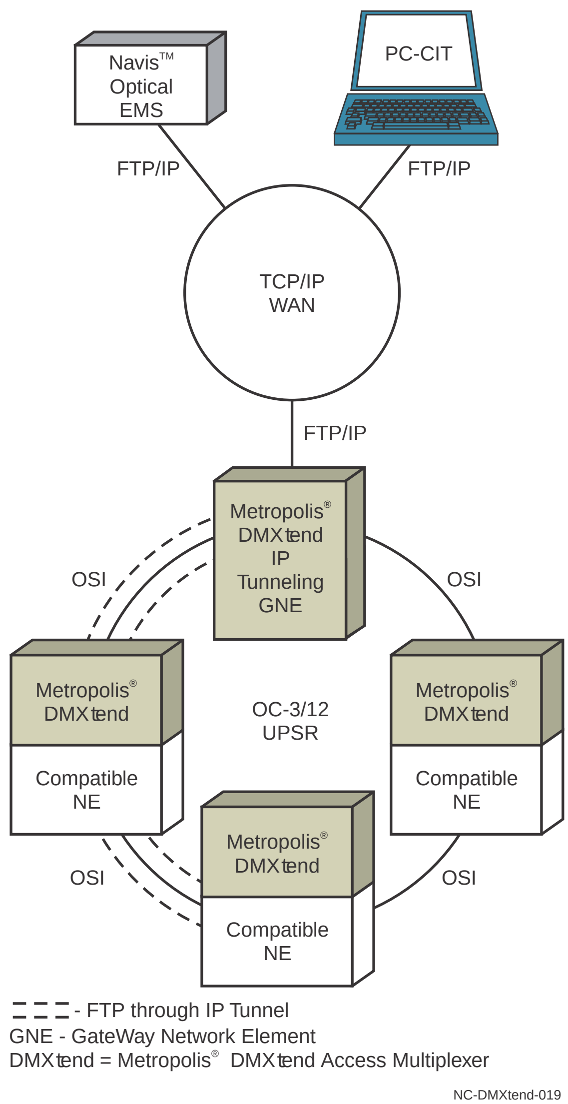
Figure 6-6 TL1 Translation Device



IP Tunneling

IP tunneling is used to perform end-to-end FTP through the IP and OSI portion of the network. In this instance the DMX*tend* serves as a GNE that encapsulates an IP packet within an OSI packet. When the final destination of the packet is reached, the IP packet is taken from within the OSI packet and processed by the TCP/IP stack. Thus, IP tunneling allows an SNMS and/or PC-CIT to reach NEs in an OSI based DCN network with FTP over IP. In this case, the end point of the IP tunnel is the actual end for the IP traffic. IP tunneling can be used for any IP based protocol, but the use will be limited to FTP for this release.

Figure 6-7 IP Tunneling



Network Size

Overview

The maximum number of DMX*tend* NEs that Release 1.0 can support in a single subnetwork is 50 in R1.0 and 256 in R2.0 (50 per Level 1 area). Through IS-IS Level 2 Routing, larger networks may be supported for particular applications. There is no limitation on the size of networks formed by splitting a large network into a number of smaller maintenance networks by disabling the DCC between the networks. IS-IS Level 2 Routing can be done in-service without affecting transmission traffic.

Security

Overview

DMX*tend* offers security against unauthorized access to the system functions. The use of security is provisionable for the front CIT port, the rear CIT (modem) port, the X.25 port, the IAO LAN port, and the DCC. In addition to this, the DCC can be disabled, thus securely isolating the DMX*tend* system from possible remote intrusion. A provisionable timeout is available for each access port that enables automatic termination of inactive or unattended sessions.

User types

There are four types of users:

- Three **privileged user** accounts are reserved for system security administration.
- **General** users can select and maintain their own password.
- **Maintenance users** are allowed to perform basic maintenance functions. These users can select and maintain their own passwords.
- **Reports-only users** can display certain system information but cannot change provisioning or maintenance parameters.

Security features

DMX*tend* provides security features such as 7-999 day password aging, customized login proprietary messages, and 150 user login IDs.

30-day password aging

This feature allows the customer to enable or disable the aging of a user's password. The maximum interval before a password must be changed is 999 days.

Customized login proprietary notice

This feature affords privileged users the opportunity to provision a proprietary banner, to be displayed upon login, to improve the system's security. The banner is displayed in conjunction with the Lucent Proprietary banner.

By default this feature is "disabled." When the banner is disabled, only the Lucent Proprietary notice appears upon login. If the banner is "enabled", the Lucent Proprietary notice is displayed first, followed by the customer-provisioned banner.

The banner has a maximum line number of 9 and a maximum character number of 450 (9 lines x 60 characters = 450).

150 users

DMX*tend* supports 150 user login IDs: 3 privileged users and 147 other user IDs with the general, maintenance, or reports-only privileges.

7 Ordering

Overview

Purpose

This chapter contains information on ordering Metropolis DMX*tend* Access Multiplexer equipment and software. The information in this chapter tells you where to go for ordering information, and provides important sparing information and FIT rates relative to both circuit packs and other equipment.

Contents

Ordering topics included in this chapter are:

Introduction

Overview

Lucent has created a set of engineering drawings to facilitate the ordering of all products in the future. These drawings are updated for each planned Release, and contain all of the information needed to order DMX*tend* equipment. The information contained in the engineering drawings will not be duplicated anywhere in the interest of keeping all information current and consistent at all times. This chapter will explain how to make sure you are using the most current version of the engineering drawing and where to order it.

Software and Documentation ordering information is not included in the engineering drawings and is therefore included in this chapter. This chapter also contains important information regarding sparing information and FIT rates for all DMX*tend* equipment. Any information about particular pieces of equipment (i.e. the uses of various cables versus other) is meant to convey useful information that may/may not be contained in the engineering drawings. This information is meant to be used in conjunction with engineering drawings, but not to replace them.

How to order

Equipment and software orders may be placed via Lucent's online ordering process. For more information, contact your Account Executive.

Engineering Drawings

Overview

In the interest of ensuring that ordering information is always consistent and up-to-date, Lucent has created a set of engineering drawing meant to contain all information needed to order a DMX*tend* system.

Where to Obtain Engineering Drawings

The engineering drawing is included as an Appendix with each release of the Metropolis® DMX*tend* Access Multiplexer Applications and Planning Guide (refer to Appendix C of this document). However, the engineering drawing is likely to be updated more frequently than the Applications and Planning Guide. Therefore, it is possible to order the most current version of the engineering drawing individually from CIC.

Whenever ordering equipment, first ensure that you have the most current version of ED8C951-10. You may do so by contacting CIC through one of the mediums detailed below.

How to order Engineering Drawings

The most up-to-date version of the Engineering drawing (ED8C951-10) may be obtained through CIC. There are 2 ways to obtain material from CIC:

□

- Got to www.lucentdocs.com and follow the link for Drawings. Enter the drawing number in the proper field (ED8C951-10).
  - Verify that the drawing you have is the same Issue number as the drawing on the site.
  - If it is not the same issue, follow the steps on the CIC website for ordering a new drawing.
  - If it is the same issue, the drawing is sufficient to help you configure an order.
- Contact CIC by phone: 1-800-582-3688

□

Software and Documentation

Overview

This section provides software ordering information.

Software releases included in this section are:

- Release 1.0 Software
- Release 2.0 Software

Software ordering information

Listed below are some need-to-know items before ordering DMX*tend* software:

- DMX*tend* software is shipped separately from the hardware.
- Order one set of software for each shelf ordered. Software orders must be placed in addition to the hardware order to receive software.
- All system controller (SYSCTL) circuit packs are shipped without software loaded on them. Therefore, software loading must occur at or before installation.
- It may be desirable to have backup CD-ROMs for all releases on hand for backup or initial downloading.
- The software ordering table includes a cross-reference to comcodes where available.
- DMX*tend* software includes PC/CIT software.
- Initial Release software includes a CD containing the current documentation to accompany the DMX*tend*. Hardcopies of the most current documentation are available through CIC.

Available software The table below, lists the DMX*tend* software that may currently be ordered.

Table 7-1 Orderable Software

Comcode	Product Release	Description
TBS	R1.0	Initial Installation Software (CD-ROM and SRD)
TBS	R1.0	R3.1 Spare Software
TBS	R2.0	Initial Installation Software (CD-ROM and SRD)
TBS	R2.0	Upgrade Software (from R1.0 to R2.0) (CD-ROM and SRD)
TBS	R2.0	R2.0 Spare Software

Available documentation

The table below, lists documentation that may currently be ordered. Documents that come with a shelf assembly order or a software order are noted.

Table 7-2 Orderable Documentation

Document Number	Title
365-372-325	*DMXtend Access Multiplexer User Operations Guide* **(Note 1)**
365-372-326	*DMXtend Access Multiplexer Alarm Messages and Trouble Clearing Guide*
TBS	*DMXtend Access Multiplexer Software Release Description* **(Note 2)**
365-372-327	*DMXtend Access Multiplexer Installation Manual*
365-372-328	*DMXtend Access Multiplexer Command Manual*
365-372-303	*WaveStar Product Family Operations Interworking Guide*
TBS (comcode)	*DMXtend User Documentation CD, Release 3* **(Note 2)**

Important! The comcodes for these documents is not supplied so as to limit confusion. This book, the Applications and Planning Guide, is not updated concurrently with the other documents listed in this table, but before them. As such, if comcodes were supplied here, it could result in confusion and the ordering of the wrong version of a document. Use the telephone number for CIC, provided on page 3 of this Chapter, to obtain the correct comcodes for the desired documents. The comcode for the User Documentation CD is supplied, but it is recommended that CIC be called to verify that the correct version of the CD is being ordered.

Table notes

1. The DMX*tend* Access Multiplexer User Operations Guide (in CD-ROM form) is shipped with the shelf assembly. The document may be ordered separately as well.
2. The DMX*tend* Access Multiplexer Software Release Description and User Documentation CD-ROM are shipped with a software order. The

document and CD-ROM may not be ordered separately.

Miscellaneous Equipment and Tools

Lightguide build-outs

DMX*tend* utilizes Lucent's state-of-the-art *AllWave ADVANTAGE*™ Fiber Optic Attenuators. These attenuators reduce optical power from the transmitter that can result in over-saturation of the receiver, have low reflection to meet stringent system requirements, and are backward-compatible with existing transmission systems. Unique to the AllWave ADVANTAGE optical connectivity solution (OCS), the new *LC*™ optic attenuators are designed to provide flat spectral loss across the full spectrum, allowing the attenuators to be used in the 1300 nm, 1400 nm, and 1500 nm bands. LC optical attenuators are ideal for networks deploying AllWave fiber, metropolitan or regional networks, applications supported by conventional single-mode optical fiber, multiservice network protocols, and DWDM networks.

The table below, lists the available LC-type lightguide build-out attenuators for the DMX*tend*.

Table 7-3 Lightguide Build-outs and Accessories

Description	Comcode	See note
LC Build-Out Attenuators		1
5 dB	108279381	
10 dB	108279431	
15 dB	108279480	
20 dB	108279530	
Allwave ADVANTAGE™ Fiber Optic Identification Kit	108622929	2

Table notes

1. The LC build-out attenuators listed are connector style PC (polished connectors) at the fiber end. These attenuators must be used on the receive side in all cases. For the LNW36 OC-3 and LNW46 OC-12 circuit packs, the specified attenuation may not be achieved if a SM-MM (single-mode-multi-mode) fiber signal is incoming to the LC SM-SM attenuator. In this case, a 15 dB attenuator, for example, may achieve an attenuation value less than the specified 15 dB.
2. The AllWave ADVANTAGE Fiber Optic Identification Kit includes labels for fiber optic apparatus products to identify Lucent AllWave Fiber paths. An instruction sheet is included with recommendations on

how to install and use the labels.

Accessories The table below shows the miscellaneous accessories available for DMX*tend*.

Table 7-4 Miscellaneous Accessories

Product	Model/Description	Comcode	ITE#	Installation Order #
Optical Fiber Scope	Noyes OFS 300-200X	408197028	ITE-7129	33712900
2.5mm Universal Adapter Cap	For use with the Noyes OFS 300-200X	408197044	ITE-7129D1	33712901
1.25mm Universal Adapter Cap	For use with the Noyes OFS 300-200X	408197069	ITE-7129D2	33712902
Video Fiber Scope[1]	Noyes VFS-1	TBD	TBD	TBD
Individual, presaturated alcohol wipes	99% pure isopropyl alcohol	901375147	ITE-7136	33713600
CLETOP Cleaning Cassette	Type A Reel	901375154	ITE-7137	33713700
CLETOP Cleaning Cassette Replacement Reel	Type A Reel	901375014	ITE-7137 D1	33713701
Luminex Stick port cleaners	1.25 mm	901375030	ITE-7134	33713400
Luminex Stick port cleaners	2.5 mm	901375022	ITE-7135	33713500
Luminex Stick port cleaners	5.5” x 5.5”	408201226	R6033	23603300

Table notes

1. This equipment may not be necessary at all locations. It is to be used when the ports need to be verified for cleanliness. If care is exercised when cleaning fibers, the video scope may not be needed.
2. The equipment and material listed above has been tested and is proven effective. Substitution of equipment or materials is at the discretion of the user and is not recommended.

□

Sparing Information for a Metropolis® DMX*tend Access Multiplexer* System

Overview

This section provides circuit pack sparing information for DMX*tend*.

> **Important!** The number of spares for each code must be determined and maintained separately, based on the in-service population of the code at each location.

Lead time

Lead time (turnaround time) the elapsed time between a known circuit pack/port unit failure at a given service location and the arrival of a repaired (or new) circuit pack/port unit at the location where spare circuit packs are stocked to maintain a spare circuit pack level consistent with the circuit pack population in service.

> **Important!** Lead time should not be confused with mean time to repair (≤2 hours), which is the elapsed time between a known in-service circuit pack failure and when a spare circuit pack replacement is put into service.

□

Failure Rates

Circuit pack failure rates

The table below provides the steady-state circuit pack failure rates for DMX*tend*.

Table 7-5 Circuit Pack Failure Rates

Circuit Pack	Apparatus Code	Slot(s)	Release	FIT Rate
System Controller (SYSCTL)	LNW1	CTL	1.0	5098 (7646 in OSP)
OC-48 OLIU	LNW41	M1, M2	2.0	8375
OC-12 OLIU (2 ports)	LNW46	D1 & D2, G1 & G2	2.0	3111 (4667 in OSP)
OC-12 OLIU (2 ports)	LNW38	M1, M2	1.0	TBD
OC-3 OLIU (4 ports)	LNW36	D1 & D2, G1 & G2	2.0	4076 (6114 in OSP)
OC-3 OLIU (2 ports)	LNW40	M1, M2	1.0	TBD
12DS3/EC1	LNW16	D1 & D2, G1 & G2	1.0	4520 (6780 in OSP)
48DS3/EC1	LNW19	D1 & D2, G1 & G2	2.0	TBD
28DS1	LNW6	D1 & D2, G1 & G2	1.0	6379 (9569 in OSP)
28DS1PM	LNW7	D1 & D2, G1 & G2	1.0	6379 (9569 in OSP)
56DS1PM	LNW8	D1 & D2, G1 & G2	2.0	TBD
16/DS1/3/DS3	LNW39	A1 & A2, B1 & B2	1.0	TBD
16DS1	LNW??	A1 & A2, B1 & B2	2.0	TBD
3 DS3	LNW??	A1 & A2, B1 & B2	2.0	TBD

Circuit Pack	Apparatus Code	Slot(s)	Release	FIT Rate
10/100T (24 ports) Private Line	LNW71	D1 & D2, G1 & G2	1.0	TBD
10/100T (24 ports) for Ethernet Enhancements	LNW69	D1 & D2, G1 & G2	2.0	10513
1GbE (4 ports) for Ethernet Enhancements	LNW70	D1 & D2, G1 & G2	2.0	NA

Notes

These FIT rates are subject to change.

Equipment failure rates

The table below provides the steady-state equipment failure rates for DMX*tend*.

Table 7-6 Equipment Failure Rates

Equipment	Failure Rate (FIT)
Circuit Breaker	10
Fan Unit	1500

Important! Figure 7-1 applies to the equipment listed in the table above, as well as to the circuit packs and port units.

☐

Sparing Graph

Overview

This section provides guidelines and a procedure to determine the number of spares needed at each location. The number of spares for each circuit pack or port unit code must be determined and maintained separately, based on that code's in-service population at each given location.

Using the sparing graph

Use the following procedure to determine how many spare circuit packs, port units, or other pieces of equipment are required for each code at each location to maintain 99.9% service continuity, given a 10-day lead time.

1 Locate the failure rate for the unit under consideration using Table 7-5 on page 7-12, or Table 7-6 on page 7-14.

2 Refer to the figure on the following page and select the curve that represents the nearest failure rate.

3 Follow the curve until it intersects the vertical line that represents the number of units in service at the given location.

4 Refer to the horizontal line immediately above the intersection. The number associated with this line is the minimum number of spares recommended for that location.

5 Repeat steps 1-4 for each circuit pack, port unit, and type of equipment listed in Table 7-5 on page 7-12, or Table 7-6 on page 7-14.

END OF STEPS

Example of using the graph

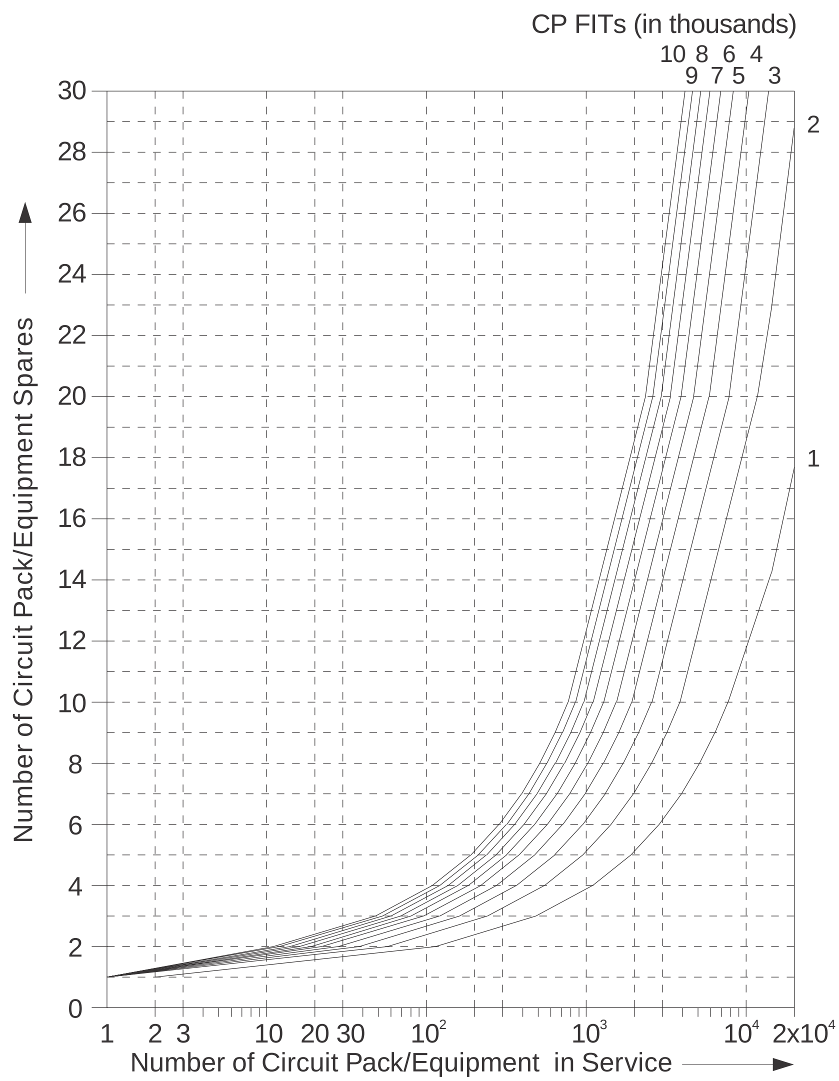
If there are 100 OC-12 OLIUs (failure rate of 3282) in service at a given location and your lead time is 10 days, then you should order and stock 3 spare OC-12 OLIUs port units for that location.

□

Sparing graph for 10-day lead time

Use the graph below to plan the number of spares necessary for the circuit packs, port units and pieces of common equipment used in DMX*tend*.

Figure 7-1 Sparing Graph for a 10-Day Lead Time



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8 Product Support

Overview

Purpose

This chapter describes the support services available to Lucent Technologies' customers.

Lucent Technologies offers a number of services to assist customers with Engineering, Installation and Technical Support of their networks. Additionally, Lucent Technologies offers product-specific training courses.

Contents

The following topics are discussed in this chapter:

Worldwide Services

Overview

Lucent Worldwide Services provides a full life-cycle of services and solutions to help you plan, design, implement, and operate your network in today's rapidly changing and complex environment.

Engineering Services

Engineering Services provide information and technical support to customers during the planning, implementation, and placement of equipment into new or existing networks. We determine the best, most economical equipment solution for a customer and help ensure equipment is configured correctly for the customer’s network needs, works as specified, and is ready for installation on delivery. These services consist of the following:

- Equipment engineering
- Software engineering
- Site records
- Engineering consulting
- Additional engineering services (Network Realignment, System Capacity Planning, System Health Assessment, etc...)

Installation Services

Lucent Technologies offers Installation Services focused on providing the technical support and resources customers need to efficiently and cost-effectively install their network equipment. We offer a variety of options that provide extensive support and deliver superior execution to help ensure the system hardware is installed, tested, and functioning as engineered and specified. Installation Services provides a complete flexible solution tailored to meet customers' specific needs. These services consist of the following:

- Equipment installation
- Specialized equipment installation
- Network connectivity services
- Installation support services

Technical Support

Lucent Technologies provides the following Technical Support Services:

- Remote Technical Support (RTS) - remote technical support to troubleshoot and resolve system problems.
- On-site Technical Support (OTS) - on-site assistance with operational issues and remedial maintenance.
- Repair and Replacement (R&R) - technical support services for equipment repair/return or parts replacement.
- Lucent OnLine Customer Support - online access to information and services that can help resolve technical support requests.

Important! Technical Support Services are available 24 hours a day, 7 days a week.

Customers inside the United States and Canada

Technical Support Services can be reached at **1-866-LUCENT8** (866-582-3688): *Prompt 1*.

Customers outside the United States

Technical Support Services can be reached at **+1-630-224-4672**: *Prompt 2*.

Web-Site

For additional information regarding Worldwide Services, refer to the Lucent Technologies' web-site at **http://www.lucent.com/products**

1. Click on **Browse the catalog**
2. Click on **Worldwide Services Solutions**
3. Select the desired service to display:
   - Engineering and Installation
   - Technical Support Services

Training

Overview

Lucent Technologies offers a formal training curriculum to complement your product needs.

Registering for a course

To review the available courses or to enroll in a training course at one of Lucent's corporate training centers,

- Within the United States,
  - Visit **https://www.lucent-product-training.com**
  - Call **1-888-LUCENT8** (888-582-3688): *Prompt 2*.
- Outside the continental United States,
  - Visit **https://www.lucent-product-training.com**
  - Contact your in-country training representative
  - Call: **+1-407-767-2798**
  - Fax: **+1-407-767-2677**

Suitcasing

To arrange for a suitcase session at your facility,

- Within the United States, call **1-888-LUCENT8** (888-582-3688): *Prompt 2*.
- Outside the continental United States,
  - Contact your in-country training representative
  - Call: **+1-407-767-2798**
  - Fax: **+1-407-767-2677**

9 Reliability and Quality

Overview

Purpose

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.

Contents

The following reliability and quality information is included in this chapter:

Lucent's Commitment to Quality and Reliability

Statement

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.*

Quality plan

This Lucent Technologies Quality Policy guided the development of the DMX Access Multiplexer and will continue affecting this product throughout its life cycle. The primary tool ensuring product quality is the Quality Plan, used with the Lucent Technologies Transmission Systems Reliability Program.

Reliability Specifications

Overview

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 modeling system reliability, 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.

Design and development

During the design and development 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.

Manufacturing and field deployment

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 improvement efforts on the DMX Access Multiplexer.

Reliability requirements

The DMX Access Multiplexer meets all applicable Telcordia Technologies reliability requirements that cover transmission availability. The applicable Telcordia Technologies requirements and objectives were clarified through interactions with Telcordia Technologies during their audit of DMX. The basis for these requirements comes from GR-TSY-000418, “Generic Reliability Assurance Requirements for Fiber Optic Transport Systems.” The methods and assumptions used to calculate the DMX 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 (GR-NWT-000418, Issue 1, December 1997). 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 (GR-NWT-000418, Issue 1, December 1997).

The outage requirements and objectives apply to any part of the product needed to process an incoming high-speed (OC-48) or low-speed (DS1, DS3, EC1, OC-3, OC-12) signal. 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 (GR-499-CORE, Issue 2, December 1998, Section 2.1.2).

Markov modeling was used to calculate the predicted system outage. The analysis assumes a mean time to repair of 2 hours for the CO environment and 4 hours for the RT environment. Individual circuit pack failure rates used in the model were calculated using the method described in GR-TSY-000332, "*Reliability Prediction Procedure for Electronic Equipment (RPP)*."

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Infant Mortality and Design Life

Environmental stress testing

DMX 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 subject to EST. However, based on field return data, when the early life failures for any circuit pack codes have been minimized and the infant mortality factor is below 2.5, these circuit pack codes may be subjected only to sampling EST.

International Standards Organization (ISO) Certification

Overview

Lucent Technologies' 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

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.

Warranty

Hardware warranty

Lucent Technologies provides a one year hardware warranty on the DMX Access Multiplexer, effective from the date the unit is shipped.

Lucent Technologies provides two contacts for hardware failure emergencies. The Repair and Return line is to be used when ever a piece of equipment has failed to the point that it requires repairs, or must be replaced. The only times the Hotline is to be used is in the event of a service outage or during the initial installation and turn-up of the DMX*tend*.

- Repair and Return: 1-800-255-1402
- Emergency Hotline: 1-800-869-6757

Software warranty

Lucent Technologies provides a one year software warranty on the DMX Access Multiplexer, effective when one of the following actions occurs (whichever comes first):

- date of customer’s first service installation
- date of customer’s acceptance as identified in the purchase agreement
- 30 days after shipment of the software generic.

Lucent’s warranty on any software release will not exceed 24 months after general availability (GA) of that release. All warranties pertain to the deployment of a release and do not apply to individual software licenses. For more warranty information, contact your local Lucent Technologies Account Executive.

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10 Technical Specifications

Overview

Purpose

This section contains the technical specifications for the DMX*tend* Access Multiplexer.

Transmission interface standards

The table below, lists the transmission interface standards for electrical, optical, and ethernet interfaces.

Table 10-1 Transmission Interface Standards

Interface	**Standard**	**Comments**
DS1/DS3/EC-1	*ANSI* T1.231-1997 GR-499-CORE, Issue 2, 1998	B8ZS/AMI option, SF/ESF (DS1) VMR, VM, or clear channel (DS3)
OC-3/OC-12	GR-253-CORE, Issue 3, 2000 GR-496-CORE, Issue 1, 1998 GR-1400-CORE, Issue 3, 2001 *ANSI* T1.231-1997	
10/100T, 1G SX/LX	IEEE 802.3 IEEE 802.3 *ANSI* T1X1.5/2001-024R5 ITU G.7041	

Contents This chapter contains the following sections:

Electrical Interfaces

Overview

Purpose This section contains the technical specifications for the low-speed electrical interfaces.

Contents This section provides information on the following interfaces:

16DS1 (LNW??) 28DS1 (LNW6), 28DS1PM (LNW7), and 56 DS1PM (LNW8)

Electrical specification

The DS1 low-speed interface transmits and receives a standard electrical DS1 signal as specified in GR-499-CORE (1.544 Mb/s nominal rate, DSX-1 interconnect specification). Line coding is provisionable per DS1 port to alternate mark inversion (AMI) or AMI with bipolar 8-zero substitution (B8ZS).

Format specification

The LNW6 provides clear channel transport of any DSX-1 compatible signal. There are no format constraints on the LNW6. The LNW7 and LNW8 circuit packs can be provisioned for the following DS1 formats: clear channel (default), superframe (SF), or extended superframe (ESF) as specified in GR-499-CORE, Section 10. In the case of SF or ESF format selections, DS1 performance monitoring information is collected by monitoring the associated DS1 framing format per *ANSI* T1.231-1997.

Alarm thresholding

The following parameters are monitored on the LNW7 and LNW8 interfaces:

- Loss of signal (LOS): 28DS1 + 28DS1PM + 56DS1PM
- Bit error rate threshold (BER) based on line coding violations (CV-L): 28DS1PM and 56DS1PM only

The alarm level for the monitored parameters can be provisioned to critical (CR), major (MJ), minor (MN), or status. B8ZS and AMI coding violation failure thresholds are user setable to 10^{-3} through 10^{-8}.

DS1 Transmission Length

When transmitting DS1 signals to a DSX panel, the Approximate Span Length is 655 feet.

When transmitting DS1 signals to another DS1 terminating device (such as a DMX*tend*) the Approximate Span Length is 1110 feet.

Loopbacks

The following loopbacks are supported on the LNW7 and LNW8 interfaces:

- Per-port DS1 facility loopback
- Per-port DS1 terminal loopback.

Line build-outs (LBOs)

Line build-outs are software-provisionable. The maximum distance depends on the cable type (maximum 665 feet).

Performance monitoring

PM data is reported for DS1 signals when DMX*tend* is equipped with the 2 LNW7 or LNW8 circuit packs. For a detailed list of PM parameters and thresholds, refer to Table 10-15, SONET PM Parameters (10-41).

3DS3 (LNW??), 12DS3/EC1 (LNW16), and 48DS3/EC1 (LNW19)

Electrical specification (DS3)

The low-speed DS3 interfaces transmit/receive a standard electrical DS3 signal as specified in GR-499-CORE, Section 9 (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.

Electrical specification (EC-1)

The EC-1 low-speed interfaces provide clear channel transport of any STS-1 signal compatible with the electrical STS-1 interface specification in GR-253-CORE, Issue 3. The EC-1 low-speed port can be provisioned to provide STS-1 path termination functions for a VT1.5 structured STS-1 with an asynchronous DS1 mapping.

The low-speed EC-1 interfaces transmit/receive a standard electrical EC-1 signal as specified in GR-253-CORE, Issue 3 (51.844 Mb/s rate, STSX-1 interconnect specification, bipolar 3-zero substitution (B3ZS) encoded and scrambled). No EC-1 service available on 3DS3 circuit pack.

DS3/EC-1 Port Provisioning

The LNW16 and LNW19 circuit packs enable you to provision DS3 or EC-1 service on a per-port basis. Thus, one of these circuit packs can host a variety of DS3 or EC-1 traffic.

DS3/EC-1 Transmission Length

When transmitting DS3/EC1 signals to a DSX panel, the Approximate Span Length is 450 feet.

When transmitting DS3/EC1 signals to another DS3 terminating device (such as a DMX*tend*) the Approximate Span Length is 900 feet.

□

10/100T (10/100 Mbps) Ethernet (LNW69, and LNW71)

Electrical specification

The 10/100T circuit packs provides a 24-port, 100BASE-TX, IEEE 802.3-compliant interface that is capable of spanning distances of 100 meters. The 10/100T port performs protocol transparent filtering and bridging of incoming media access control (MAC) frames. MAC frames with a destination address on the local bus are filtered by the 10/100T circuit packs to prevent unnecessary transmission of frames over the wide area network (WAN). The 10/100T interface auto-negotiates mode (full/half duplex) and speed (10/100 Mbps) when interfacing with other 802.3-compliant devices over twisted pair media. The 10/100T circuit packs must be housed in slot 1 of a Function Unit group and is not equipment protected. However, facility protection is provided through the WAN via SONET UPSR or through the IEEE 802.1D spanning tree algorithm.

The 10/100T ethernet interfaces comply with the following transmission standards:

- standard IEEE 802.1D for transparent bridging and spanning tree protection
- standard IEEE 802.3, Section 25 for 10/100 Mb autonegotiation (including flow control, full-duplex transmission, and half-duplex transmission).

Format specification

The 10/100T circuit packs comply with the following formatting standards:

- standard IEEE 802.1Q VLANs
- standard *ANSI* T1X1.5/2001-024R5 generic framing procedure (encapsulating ethernet frames and mapping them into a SONET payload.
- standard ITU G.7041 STS-1 virtual concatenation.

Performance monitoring

Performance monitoring capabilities are available on the 10/100T circuit packs, however Threshold Crossing Alerts (TCAs) are not supported. Monitored parameters include:

- Dropped Frames (congestion)
- Dropped Frames (errors)
- Incoming Number of Bytes
- Outgoing Number of Bytes
- Incoming Number of Frames
- Outgoing Number of Frames.

Optical Interfaces

Overview

Purpose This section contains technical specifications for the low- and high-speed DMX*tend* optical interfaces.

Contents The following optical interfaces are discussed in this section:

□

Quad OC-3 Low-speed OLIU (LNW36)

Optical specification

The LNW36 OLIU photonics meet or exceed SONET OC-3, long-reach specifications (SONET LR-1 DFB). The distributed feedback (DFB) laser transmitter supplies a 1310 nm, scrambled non-return-to-zero (NRZ) coded signal (155.52 Mb/s).

The LNW36 OLIU long reach OC-3 interface supports span lengths up to 55 km and is OSP hardened. Refer to the SONET Optical Specifications: OC-3 and OC-12 OLIUs (10-14) section in this chapter for detailed system, transmitter, receiver, and link budget specifications.

Alarm thresholding

The following parameters are monitored on the OC-3 interface:

- LOS
- LOF
- LOP
- AIS-L
- RDI-L (FERF)
- Path AIS
- Path Unequipped
- Signal degrade (BER)
- Signal fail (BER).

Performance monitoring

SONET line and path performance monitoring complies with the standards outlined in GR-253-CORE. For detailed PM parameter thresholds on the OC-3 interface, refer to Table 10-15, SONET PM Parameters (10-41).

Single-port OC-3 High-speed OLIU (LNW40)

Optical specification

The LNW40 photonics meet or exceed SONET OC-3 intermediate-reach specifications (SONET OC-3 IR-1 Fabry Perot [FP] category). The FP laser (FP is a Multi-Longitudinal Mode laser) supplies a 1310 nm, scrambled NRZ-coded signal (622.08 Mb/s).

The LNW40 high-speed interface supports span lengths up to 20 km and is OSP hardened. Refer to the SONET Optical Specifications: OC-3 and OC-12 OLIUs (10-14) section in this chapter for detailed system, transmitter, receiver, and link budget specifications.

Important! The IR-1, OC-3 optical specifications meet Short Reach (SR) OC-3 requirements as well.

Alarm thresholding

The following parameters are monitored at the OC-3 high-speed (Network-side) interface.

- LOF
- LOS
- LOP
- AIS-L
- RDI-L (FERF)
- Path AIS
- Path Unequipped
- Signal Degrade (BER)
- Signal Fail (BER).

Performance monitoring

SONET line and path performance monitoring complies with the standards outlined in GR-253-CORE. For detailed PM parameter thresholds on the OC-3 high-speed interface, refer to Table 10-15, SONET PM Parameters (10-41).

Dual-port OC-12 Low-speed OLIU (LNW46)

Optical specification

The LNW46 photonics meet or exceed SONET OC-12, long-reach specifications (SONET LR-1 DFB category). The distributed feedback laser (DFB) supplies a 1310 nm, scrambled NRZ-coded signal (622.08 Mb/s). For direct optical loopbacks, at least 10 dB of optical attenuation is needed for the LNW46.

The LNW46 low-speed interface supports span lengths up to 53 km and is OSP hardened. Refer to the SONET Optical Specifications: OC-3 and OC-12 OLIUs (10-14) section in this chapter for detailed system, transmitter, receiver, and link budget specifications.

Alarm thresholding

The following parameters are monitored at the low-speed OC-12 interface.

- LOF
- LOS
- LOP
- AIS-L
- RDI-L (FERF)
- Path AIS
- Path Unequipped
- Signal Degrade (BER)
- Signal Fail (BER).

Performance monitoring

SONET line and path performance monitoring complies with the standards outlined in GR-253-CORE. For detailed PM parameter thresholds on the OC-12 interface, refer to Table 10-15, SONET PM Parameters (10-41).

Single-port OC-12 High-speed OLIU (LNW38)

Optical specification

The LNW38 photonics meet or exceed SONET OC-12 intermediate-reach specifications (SONET OC-12 IR-1 Fabry Perot [FP] category). The FP laser (FP is a Multi-Longitudinal Mode laser) supplies a 1310 nm, scrambled NRZ-coded signal (622.08 Mb/s).

The LNW38 high-speed interface supports span lengths up to 20 km and is OSP hardened. Refer to the SONET Optical Specifications: OC-3 and OC-12 OLIUs (10-14) section in this chapter for detailed system, transmitter, receiver, and link budget specifications.

> **Important!** The IR-1, OC-12 optical specifications meet SR OC-12 requirements as well.

Alarm thresholding

The following parameters are monitored at the OC-12 high-speed (Network-side) interface.

- LOF
- LOS
- LOP
- AIS-L
- RDI-L (FERF)
- Path AIS
- Path Unequipped
- Signal Degrade (BER)
- Signal Fail (BER).

Performance monitoring

SONET line and path performance monitoring complies with the standards outlined in GR-253-CORE. For detailed PM parameter thresholds on the OC-12 high-speed interface, refer to Table 10-15, SONET PM Parameters (10-41).

SONET Optical Specifications: OC-3 and OC-12 OLIUs

Overview

The following tables present the optical specifications for the OC-3 LNW36 and LNW40, and OC-12 LNW46 and LNW38 OLIUs.

System specifications

The table below lists the LNW36, LNW40, LNW46, and LNW38 OLIU system specifications.

Table 10-2 SONET Optical System Specifications

System Information	LNW36	LNW46	LNW38	LNW40
Optical Line Rate	155.52 Mb/s	622.08 Mb/s	622.08 Mb/s	155.52 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ	Scrambled NRZ	Scrambled NRZ
Optical Wavelength	1310nm	1310 nm	1310 nm	1310 nm
Performance	SONET LR-1 (Long Reach)	SONET LR-1 (Long Reach)	SONET IR-1 (Intermediate Reach)	SONET IR-1 (Intermediate Reach)
Temperature Range	OSP Hardened	OSP Hardened	OSP Hardened	OSP Hardened

Transmitter specifications

The table below lists the LNW36, LNW40, LNW46, and LNW38 OLIU transmitter information.

Table 10-3 SONET Optical Transmitter Information

Transmitter Info.	LNW36	LNW46	LNW38	LNW40
Optical Device Temperature Controller	None	None	None	None
FDA Classification	Class I	Class I	Class I	Class I
Optical Source	Distributed Feed-Back (DFB) Laser / Fabry Perot (FP)	Distributed Feed-Back (DFB) Laser	Fabry Perot (FP) Laser	Fabry Perot (FP) Laser
Faceplate Optical Connector	LC connector	LC connector	LC connector	LC connector

Receiver specifications

The table below lists the LNW36, LNW40, LNW46, and LNW38 OLIU receiver information.

Table 10-4 SONET Optical Receiver Information

Receiver Information	LNW36	LNW46	LNW38	LNW40
Optical Detector	InGaAsP PIN	InGaAsP PIN	InGaAsP PIN	InGaAsP PIN
Faceplate Optical Connector	LC connector	LC connector	LC connector	LC connector

Link budgets The table below lists the LNW36, LNW40, LNW46, and LNW38 OLIU link budgets.

Table 10-5 SONET Optical Specifications and Link Budgets

Parameter	**LNW36 (Note1) OC-3 LR-1**	**LNW46 (Note 1) OC-12 LR-1**	**LNW38 (Note 1) OC-12 IR-1**	**LNW40 (Note1) OC-3 IR-1**
Minimum Wavelength	1280 nm	1280 nm	1274 nm (1293 nm)	1280 nm (1261 nm)
Maximum Wavelength	1335 nm	1335 nm	1356 nm (1334 nm)	1335 nm (1360 nm)
Maximum Spectral Width ($\Delta\lambda_{20}$)	1.0 nm	1.0 nm	NA	NA
Maximum RMS Spectral Width (σ)	NA	NA	2.5 nm (4.0 nm)	7.7 nm (4.0 nm)
Maximum Transmitter Power	0.0 dBm	+2.0 dBm	-8.0 dBm	-8.0 dBm
Minimum Transmitter Power	-5.0 dBm	-2.5 dBm	-15.0 dBm	-15.0 dBm
Maximum Received Power ($1x10^{-12}$ BER)	0.0 dBm	-7.0 dBm	-8.0 dBm	-8.0 dBm
Minimum Received Power ($1x10^{-12}$ BER)	-34.0 dBm	-30.5 dBm	-28.0 dBm	-28.0 dBm
Minimum System Gain (see Note 2)	29.0 dB	28.0 dB	13.0 dB	13.0 dB
Optical Path Penalty (see Note 3)	1.0 dB	1.0 dB	1.0 dB	1.0 dB
Connector Loss (see Note 4)	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Unallocated Margin (see Note 5)	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Minimum Loss Budget (see Note 6)	0.0 dB	9.0 dB	0.0 dB	0.0 dB

Parameter	LNW36 (Note1) OC-3 LR-1	LNW46 (Note 1) OC-12 LR-1	LNW38 (Note 1) OC-12 IR-1	LNW40 (Note1) OC-3 IR-1
Maximum Loss Budget (see Note 7)	25.0 dB	24.0 dB	9.0 dB	9.0 dB
Approximate Span Length (see Note 8)	55 km	53 km	20 km	20 km

Notes

1. All terminology consistent with GR-253-CORE, Issue 3. All values given are worst-case end-of-life (EOL)
2. The System Gain includes connector loss at the transmitter and receiver points S and R in GR-253-CORE, Issue 3.
3. Optical path penalty includes effects of dispersion, reflection, and jitter that occur on the optical path. The optical path penalty for 1310 nm optics is 1.0 dB maximum.
4. One additional connector (0.75 dB) on each end is assumed to connect station cable to outside plant.
5. Additional unallocated margin, or safety margin, can be 0-3 dB. Typically, a 1.5 dB value is assumed.
6. The LNW46 requires an external lightguide build-out (optical attenuator) as part of the connector assembly for optical loopbacks and for loss budgets less than 10 dB to avoid overloading the optical receiver.
7. The stated maximum loss budget equals the System Gain, less the Optical Path Penalty, the Additional Connector Loss Margin, and the Additional Unallocated Margin. The resultant Maximum Loss Budget is available for station cable loss, transmission cable loss, and splice loss.
8. The approximate Approximate Span Length values are calculated per an attenuation assumption. As a general rule, for attenuation-limited systems, an attenuation of 0.45 dB/km is used for 1310 nm optics. This estimate includes typical cable loss (0.40 dB/km) and up to 11 splice losses (0.2 dB per splice). For 1310 nm OC-3 and OC-12 systems, dispersion is not a limiting factor, and the applications are attenuation-limited. Approximate Span Lengths can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

□

1G SX/LX Ethernet (LNW70)

Optical specification

The 1G SX/LX circuit pack provides a short- or long-reach, 4-port, 1000BASE-SX/LX, IEEE 802.3-compliant interface.

Pluggable Optics

The LNW70 features pluggable optics which enable it to function as both an SX (short-reach) and LX (long-reach) interface. The card is shipped with no optics modules installed. Depending on the customer's order, a set of either Small-Form-Pluggable (SFP) optical transceivers, SX or LX capable, will be supplied by Lucent for use with the LNW70 circuit pack. The customer then simply installs these pluggable optical transceivers into the desired ports on the LNW70 circuit pack.

In order to guarantee fundamental optical and electrical performance parameters and in order to ensure compliance with industry regulations, only SFP optical transceivers supplied by Lucent Technologies shall be used in the LNW70 circuit pack.

These optics conform to the standards specified in the following two sections for 1000BASE-SX and 1000BASE-LX interfaces respectively. Therefore, please refer to the following two sections of this Chapter to obtain the specifications for the SX and LX interfaces supported on the LNW70 circuit pack.

> **Important!** Installing any non-approved (non Lucent specified) may cause physical damage to the LNW70. Such things as EMC Regulations, ESD Regulations, laser safety, as well as fundamental optical and electrical performance parameters may all be compromised if non-approved optics are installed in the LNW70 circuit pack. Lucent assumes no responsibility for problems that may occur when non-approved optics are used in the LNW70 circuit pack.

1G SX (1000BASE-SX Optics) Ethernet (for LNW70)

Optical specification

The LNW70 circuit pack provides the option of a long-reach or short-reach, 4-port, 1000BASE-SX, IEEE 802.3-compliant interface. This section will detail the specifications of the short-reach optics, while the following section will detail those of the long-reach optics. The LNW70 circuit pack performs protocol transparent filtering and bridging of incoming media access control (MAC) frames. MAC frames with a destination address on the local bus are filtered by the LNW70 to prevent unnecessary transmission of frames over the wide area network (WAN). The LNW70 must be housed in slot 1 of a Function Unit group and is not equipment protected. However, protection is provided via SONET UPSR or through the IEEE 802.1w spanning tree algorithm.

The LNW70 1G SX ethernet interface complies with the following transmission standards:

- standard IEEE 802.1w for transparent bridging and spanning tree protection
- standard IEEE 802.3 autonegotiation (for flow control).

System specifications

The following are the 1G SX system specifications:

- Optical Line Rate: 1.25 Gb/s +/- 100 ppm
- Optical Line Coding: 8B/10B
- Performance: Short-reach.

Operating range

The table below shows the operating range for the 1G SX optical ethernet interface. A 1000BASE-SX compliant transceiver supports both 50 µm and 62.5 µm fiber media types. A transceiver that exceeds the operational range requirement while meeting all other optical specifications is considered compliant (e.g., a 50 µm solution operating at 600 m meets the minimum range requirement of 2 to 550 m).

Table 10-6 1G SX Operating Range Over Each Optical Fiber Type

Fiber Type	Modal Bandwidth @ 850 nm (minimum overfilled launch) (MHz-km)	Minimum Range (meters)
62.5 µm MMF	160	2 to 220
62.5 µm MMF	200	2 to 275
50 µm MMF	400	2 to 500
50 µm MMF	500	2 to 550
10 µm SMF	Not supported	Not supported

Transmitter specifications

The table below shows 1G SX optical transmitter specifications. The 1000BASE-SX transmitter meets these specifications per measurement techniques define in IEEE 802.3, Section 38, Clause 6.

Table 10-7 1G SX Transmit Specifications

Description	**62.5/50 µm MMF**	**Unit**
Transmitter type	Shortwave Laser	
Signaling speed (range)	1.25 +/- 100 ppm	GBd
Wavelength (l, range)	770 to 860	nm
T_{rise}/T_{fall} (max; 20%-80%; l > 830 nm)	0.26	ns
T_{rise}/T_{fall} (max; 20%-80%; l £ 830 nm)	0.21	ns
RMS spectral width (max)	0.85	nm
Average launch power (max)	**Note 1**	dBm
Average launch power (min)	-9.5	dBm
Average launch power of OFF transmitter (max) **(Note 2)**	-30	dBm
Extinction ratio (min)	9	dB
RIN (max)	-117	dB/Hz
Coupled Power Ratio (CPR) (min) **(Note 3)**	9 < CPR	dB

Table notes

1. The 1000BASE-SX launch power shall be the lesser of the class 1 safety limit as defined by IEEE 802.3, Section 38, Clause 7.2 or the average receiver power (maximum) defined by Table 10-8.
2. Examples of an OFF transmitter are as follows: no power supplied to the Physical Medium Dependent (PMD), laser shutdown for safety conditions, and activation of a “transmit disable” or other optional module laser shut-down conditions. During all conditions when the Physical Medium Attachment (PMA) is powered, the ac signal (data) into the transmit port will be valid encoded 8B/10B patterns (this is a requirement of the Physical Coding Sublayer [PCS]) except for short durations during system power-on-reset or diagnostics when the PMA is placed in a loopback mode.
3. Radial overfilled launches (described in IEEE 802.3, Section 38A, Clause 2) should be avoided even if they meet CPR ranges.

Receiver specifications

The 1000BASE-SX receiver meets the specifications defined in the table below, per measurement techniques defined in IEEE 802.3, Section 38, Clause 6. The sampling instant is defined to occur at the eye center. The receive sensitivity includes the extinction ratio penalty.

Table 10-8 1G SX Receive Specifications

Description	62.5 µm MMF	50 µm MMF	Unit
Signaling speed (range)	1.25 +/- 100 ppm	1.25 +/- 100 ppm	GBd
Wavelength (range)	770 to 860	770 to 860	nm
Average receive power (max)	0	0	dBm
Receive sensitivity	-17	-17	dBm
Return loss (min)	12	12	dB
Stressed receive sensitivity **(Notes 1 and 2)**	-12.5	-13.5	dBm
Vertical eye-closure penalty **(Note 3)**	2.60	2.20	dB
Receive electrical 3 dB upper cutoff frequency (max)	1500	1500	MHz

Table notes

1. Measured with conformance test signal at TP3 (see IEEE 802.3, Section 38.6.11) for BER at the eye center.
2. Measured with a transmit signal having a 9 dB extinction ratio. If another extinction ratio is used, the stressed receive sensitivity should be corrected for the extinction ratio penalty.
3. Vertical eye-closure penalty is a test condition for measureing stressed receive sensitivity. It is not a required characteristic of the receiver.

Link budgets The worst-case power budget and link penalties for a 1000BASE-SX channel are shown in the table below.

Table 10-9 1G SX Link Budgets and Penalties

Parameter	**62.5 µm MMF**		**50 µm MMF**		**Unit**
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	160	200	400	500	MHz-km
Link power budget	7.5	7.5	7.5	7.5	dB
Operating distance	220	275	500	550	m
Channel insertion loss **(Notes 1 and 2)**	2.38	2.60	3.37	3.56	dB
Link power penalties **(Note 2)**	4.27	4.29	4.07	3.57	dB
Unallocated margin in link power budget **(Note 2)**	0.84	0.60	0.05	0.37	dB

Table notes

1. Operating distances used to calculate the channel insertion loss are the maximum values specified in Table 10-6.
2. A wavelength of 830 nm is used to calculate the channel insertion loss, link power penalties, and unallocated margin.

Format specification

The LNW70’s 1G SX ethernet interface complies with the following formatting standards:

- standard IEEE 802.1Q VLAN encapsulation (user assigned or network assigned)
- standard ANSI T1X1.5/2001-024R5 generic framing procedure (encapsulating ethernet frames mapping them into a SONET payload)
- standard ITU G.704.1 STS-1 virtual concatenation.

Performance monitoring

Performance monitoring capabilities are available on the 1G SX interface, however Threshold Crossing Alerts (TCAs) are not supported. Monitored parameters include:

- Dropped Frames (congestion)
- Dropped Frames (errors)
- Incoming Number of Bytes
- Outgoing Number of Bytes
- Incoming Number of Frames
- Outgoing Number of Frames.

1G LX (1000BASE-LX Optics) Ethernet (for LNW70)

Optical specification

The LNW70 circuit pack provides the option of a long-reach or short-reach, 4-port, 1000BASE-SX, IEEE 802.3-compliant interface. This section will detail the specifications of the long-reach optics, while the preceding section detailed those of the short-reach optics. The LNW70 circuit pack performs protocol transparent filtering and bridging of incoming media access control (MAC) frames. MAC frames with a destination address on the local bus are filtered by the LNW70 to prevent unnecessary transmission of frames over the wide area network (WAN). The LNW70 must be housed in slot 1 of a Function Unit group and is not equipment protected. However, protection is provided via SONET UPSR or through the IEEE 802.1w spanning tree algorithm.

The LNW70 1G LX Ethernet interface complies with the following transmission standards:

- standard IEEE 802.1w for transparent bridging and spanning tree protection
- standard IEEE 802.3 autonegotiation (for flow control).

System specifications

The following are the 1G LX system specifications:

- Optical Line Rate: 1.25 Gb/s +/- 100 ppm
- Optical Line Coding: 8B/10B
- Performance: Long-reach.

Operating range

The table below shows the operating range for the 1G LX optical Ethernet interface. A 1000BASE-LX compliant transceiver supports 50 µm, 62.5 µm, 10 µm fiber media types. A transceiver that exceeds the operational range requirement while meeting all other optical specifications is considered compliant (e.g., a 50 µm solution operating at 5500 m meets the minimum range requirement of 2 to 5000 m).

Table 10-10 1G LX Operating Range Over Each Optical Fiber Type

Fiber Type	Modal Bandwidth @ 1300 nm (minimum overfilled launch) (MHz-km)	Minimum Range (meters)
62.5 µm MMF	500	2 to 550
50 µm MMF	400	2 to 550
50 µm MMF	500	2 to 550
10 µm SMF	N/A	2 to 10,000

Transmitter specifications

The table below describes the transmit specifications for 1G LX interface. The 1000BASE-LX transmitter meets these specifications per measurement techniques define in IEEE 802.3, Section 38, Clause 6.

Table 10-11 1G LX Transmit Specifications

Description	**62.5 µm MMF**	**50 µm MMF**	**10 µm SMF**	**Unit**
Transmitter type	Longwave Laser			
Signaling speed (range)	1.25 +/- 100 ppm			GBd
Wavelength (l, range)	1270 to 1335			nm
T_{rise}/T_{fall} (max; 20%-80% response time)	0.26			ns
RMS spectral width (max)	4			nm
Average launch power (max)	-3			dBm
Average launch power (min)	-11.5	-11.5	-11.0	dBm
Average launch power of OFF transmitter (max)	-30			dBm
Extinction ratio (min)	9			dB
RIN (max)	-120			dB/Hz
Coupled Power Ratio (CPR) (min) **(Note 1)**	28 < CPR < 40	12 < CPR < 20	N/A	dB

Table notes

1. Due to dual media (single-mode and multimode) support of the 1G LX transmitter, fulfillment of this specification requires a single-mode fiber offset-launch mode-conditioning patch cord (as described in IEEE 802.3, Section 38.11.4) for MMF and SMF operation. This patch cord is not used for single-mode operation.

Receiver specifications

The 1000BASE-LX receiver meets the specifications defined in the table below, per measurement techniques defined in IEEE 802.3, Section 38.6. The sampling instant is defined to occur at the eye center. The receive sensitivity includes the extinction ratio penalty.

Table 10-12 1G LX Receive Specifications

Description	62.5 µm MMF	Unit
Signaling speed (range)	1.25 +/- 100 ppm	GBd
Wavelength (range)	1270 to 1355	nm
Average receive power (max)	-3	dBm
Receive sensitivity	-19	dBm
Return loss (min)	12	dB
Stressed receive sensitivity **(Notes 1 and 2)**	-14.4	dBm
Vertical eye-closure penalty **(Note 3)**	2.60	dB
Receive electrical 3 dB upper cutoff frequency (max)	1500	MHz

Table notes

1. Measured with conformance test signal at TP3 (see IEEE 802.3, Section 38.6.11) for BER at the eye center.
2. Measured with a transmit signal having a 9 dB extinction ratio. If another extinction ratio is used, the stressed receive sensitivity should be corrected for the extinction ratio penalty.
3. Vertical eye-closure penalty is a test condition for measureing stressed receive sensitivity. It is not a required characteristic of the receiver.

Link budgets The worst-case power budget and link penalties for a 1000BASE-LX channel are shown in the table below.

Table 10-13 1G LX Link Budgets and Penalties

Parameter	**62.5 μm MMF**	**50 μm MMF**	**50 μm SMF**	**10 μm SMF**	**Unit**
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	500	400	500	N/A	MHz-km
Link power budget	7.5	7.5	7.5	8.0	dB
Operating distance	550	550	550	10,000	m
Channel insertion loss **(Notes 1, 2, and 3)**	2.35	2.35	2.35	4.57	dB
Link power penalties **(Notes 2 and 3)**	3.48	5.08	3.96	3.27	dB
Unallocated margin in link power budget **(Note 2 and 3)**	1.67	0.07	1.19	0.16	dB

Table notes

1. Operating distances used to calculate the channel insertion loss are the maximum values specified in Table 10-10.
2. A wavelength of 1270 nm is used to calculate the channel insertion loss, link power penalties, and unallocated margin.
2. These figures are actually better than specified here, and will be updated in a future release.

Format specification

The LNW70 1G LX ethernet interface complies with the following formatting standards:

- standard IEEE 802.1Q VLAN encapsulation (user assigned or network assigned)
- standard ANSI T1X1.5/2001-024R5 generic framing procedure (encapsulating ethernet frames and mapping them into SONET format)
- standard ITU G.7041 STS-1 virtual concatenation.

Performance monitoring

Threshold Crossing Alerts (TCAs) are not supported on the 1G LX interface, however PM capabilities are available including:

- Dropped Frames (congestion)
- Dropped Frames (errors)
- Incoming Number of Bytes
- Outgoing Number of Bytes
- Incoming Number of Frames
- Outgoing Number of Frames.

Lightguide Jumpers and Buildouts

Overview

The DMX*tend* provides standard LC-type connectors on all optical interfaces. 5 dB, 10 dB, 15 dB, and 20 dB attenuating build-outs are supported.

Single-mode jumpers

The OC-3, OC-12, and 1G LX lightguide interfaces use single-mode jumpers for connecting to and from the outside plant *LGX* panel and the DMX*tend*.

Multi-mode jumpers

The 1G SX interface must use multi-mode jumpers.

Build-outs

DMX*tend* supports the use of single-mode to single-mode (SM-SM) fiber exclusively, except on the 1G SX interface.

Reference

For more information, including a complete list of available jumpers and build-outs, refer to the Miscellaneous Equipment and Tools section in Chapter 7, Ordering.

System Peformance

Overview

Purpose This section provides performance specifications for the DMX*tend* Access Multiplexer.

Contents The following performance specifications are discussed in this section:

□

SONET Overhead Bytes

Overview

DMX*tend* uses SONET transport and path overhead bytes as specified in GR-253-CORE.

V4 byte

The reserved V4 byte in the VT1.5 superframe is sometimes used for internal error detection in a DMX*tend* shelf. This internal usage of the V4 byte may cause the value of a transmitted V4 byte to vary. The DMX*tend* always ignores the value of the V4 byte received from another network element as required by GR-253-CORE.

Wander/Jitter

Maximum time interval error (MTIE)
For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference.

Wander requirements
Wander transfer, tolerance, and generation requirements are met as specified in GR-253-CORE.

Jitter requirements
Jitter transfer, tolerance, and generation requirements are met as specified in GR-253-CORE and GR-499-CORE.

Short-term stability
The SONET interfaces meet the T1.101 OC-N output short-term stability mask as specified in GR-253-CORE, Section 5.

Signal Performance

Overview The following specifications apply to the standard networks defined in GR-499-CORE, Issue 3.

DS1 rate For systems interfacing at the DS1 rate, the number of errored seconds during a 7-hour, one-way loopback test, is less than 10.

DS3 rate For systems interfacing at the DS3 rate, the number of errored seconds during a 2-hour, one-way loopback test, is less than 29.

BER The BER is less than $2x10^{-10}$ for both the DS1 and DS3 rates. Burst-errored seconds are excluded.

Burst-errored seconds The frequency of burst-errored seconds, other than those caused by protection switching induced by hard equipment failures, averages less than 4 per day.

Synchronization

Overview

The embedded Stratum 3 Timing Generator meets the specifications of GR-253-CORE, SONET Transport Systems Generic Criteria. The timing generator function is embedded in the 1x1 protected optical interface circuit packs in the main slot pair.

Timing modes

The timing generator supports four timing modes:

- **External timing**

  Locked to an external Stratum 3 (+/- 4.6 ppm) or better DS1 reference.

- **Line timing**

  Locked to recovered clock from an OC-N signal (from Main OC-3/OC-12 only).

- **Free running**

  Timing derived from high-stability temperature-compensated voltage-controlled crystal oscillator (TCVCXO) with a long-term accuracy of +/- 4.6 ppm and temperature stability of -40^{o} C to +65^{o} C.

- **Holdover**

  Timing derived from the internal oscillator in the case of an unprotected synchronization reference failure. In this instance, the Stratum Timing Generator switches to “holdover mode” and continues to provide system timing, using the internal oscillator to maintain the last known good reference frequency. If the DS1 timing output is enabled for network synchronization, DS1 AIS will be inserted on detection of unprotected optical reference failure. In holdover mode, the accuracy is +/-.37 ppm over the full -40 to +65^{o} C temperature range.

- **DS1 timing outputs**

  In addition, each timing generator (main circuit pack) provides a single DS1 sync output derived from a received optical interface signal (OC-N). These DS1 timing outputs may be used to provide a timing reference signal to a local BITS clock (see Chapter 4 of this document).

DS1 timing functions

The DS1 timing reference inputs and outputs meet the specifications of GR-499-CORE for DS1 interfaces and GR-253-CORE for timing references. The following are the DS1 timing functions:

- Two DS1 timing reference inputs
- Two DS1 timing reference outputs
- Software-provisionable line build-outs for DS1 timing outputs (up to 655 feet depending on cable type)
- Alarms (Out of Frame, AIS, BER).

Protection Switching

1+1 networks

DMX*tend* complies with SONET 1+1 unidirectional nonrevertive protection switching requirements as specified in GR-253-CORE. Automatic line switches are initiated by signal fail and signal degrade conditions on the received OC-3/OC-12 low-speed optical signal and are completed within 50 milliseconds of a signal failure. The signal's BER is calculated from violations of the SONET line overhead B2 parity bytes. Signal fail is declared for incoming LOS, LOF, line AIS, or a BER exceeding 10^{-3}, while a BER exceeding a provisionable threshold between 10^{-5} and 10^{-9} causes a signal degrade to be declared. Manual switch commands are available through the local and remote operations interfaces.

High-speed UPSR networks

Path protection rings feed a SONET payload (STS or virtual tributary [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 LOS, LOF, LOP, path unequipped, path AIS, and path BER performance. On pass-through paths, all detected hard failures (LOS, LOF, LOP, line AIS, or STS-1 path AIS) 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.

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 transmission degradation on one of the rings requires that the other ring path be selected. The DMX*tend* 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.

Low-speed UPSR networks

On low-speed SONET optical interfaces (OC-3/12), UPSR is optional and protection switching is provisionable (UPSR or 1+1) on a per-line basis.

Transient Performance

Power loss restart

After system shutdown due to power loss, the system will exhibit a 2-second error free transmission interval which begins within 1 minute of restoration of power.

Transmission start-up on signal application

The system, after having no signal applied for greater than 1 minute at the DSX-n interface, will exhibit a 2-second error free transmission interval which begins within 5 seconds of the reapplication of a signal.

Transmission Delay

One-way transmission delay

The table below, lists the worst-case measured one-way transmission delay (microseconds) between DMX*tend* interfaces.

Table 10-14 Transmission Delay in Microseconds (µm)

Interface	**OC-n**		**EC1**		**DS1**		**DS3**
Cross-Connect	VT	STS-n	VT	STS-1	VT	STS-1	STS-1
OC-n	50	25	50	25	100	100	25
EC-1	50	25	-	-	-	-	-
DS1	100	100	-	-	-	-	-
DS3	N/A	25	-	-	-	-	-

□

Performance Monitoring

Overview

DMX*tend* performance monitoring complies with GR-253-CORE and *ANSI* T1.231-1997 specifications for SONET and asynchronous networks.

SONET PM parameters

The table below lists the provisionable threshold range for monitored parameters and, in brackets, the default thresholds. Thresholding of any parameter(s) can be disabled.

Table 10-15 SONET PM Parameters

Parameter Definition		**Threshold Range (Default)**	
Facility	**Measure**	**Current Quarter Hour**	**Current Day**
OC-12 Section	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]
OC-3 Section	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]
OC-12 Line	Coding Violations (CV)	1-55365 [5537]	1-5315040 [132874]
	Errored Seconds (ES)	1-900 [40]	1-65535 [900]
	Errored Seconds Type A (ESA)	1-900 [30]	1-65535 [90]
	Errored Seconds Type B (ESB)	1-900 [30]	1-65535 [90]
	Severely Errored Seconds (SES)	1-63 [20]	1-4095 [60]
	Unavailable Seconds (UAS)	1-63 [30]	1-4095 [90]
	STS Pointer Justification Counts (PJC)	1-65535 [60]	1-9999999 [5760]

Parameter Definition		Threshold Range (Default)	
Facility	**Measure**	**Current Quarter Hour**	**Current Day**
OC-3 Line	Coding Violations (CV)	1-13841 [1384]	1-1328736 [132874]
	Errored Seconds (ES)	1-900 [40]	1-65535 [900]
	Errored Seconds Type A (ESA)	1-900 [30]	1-65535 [90]
	Errored Seconds Type B (ESB)	1-900 [30]	1-65535 [90]
	Severely Errored Seconds (SES)	1-63 [20]	1-4095[60]
	Unavailable Seconds (UAS)	1-63 [30]	1-4095 [90]
	Line Protection Switch Counts (PSC-L)	1-63 [2]	1-255 [4]
	STS Pointer Justification Counts (PJC)	1-65535 [60]	1-9999999 [5760]
EC-1 Line	Coding Violations (CV)	1-4613 [461]	1-442848 [44285]
	Errored Seconds (ES)	1-900 [40]	1-65535 [900]
	Errored Seconds Type A (ESA)	1-900 [30]	1-65535 [90]
	Errored Seconds Type B (ESB)	1-900 [30]	1-65535 [90]
	Severely Errored Seconds (SES)	1-63 [20]	1-4095 [60]
	Unavailable Seconds	1-63 [30]	1-4095 [90]
	STS Pointer Justification Counts (PJC)	1-65535 [60]	1-9999999 [5760]
DS3 Line	CV-L Coding Violations	1-16383 [40]	1-1048575 [3820]
	Errored Seconds, Line (ES-L)	1-900 [25]	1-65535 [250]
	Severely Errored Seconds, Line (SES-L)	1-63 [4]	1-4095 [40]
DS1 Line	ES-L Line Errored Seconds	1-900 [65]	1-65535 [648]

Parameter Definition		**Threshold Range (Default)**	
Facility	**Measure**	**Current Quarter Hour**	**Current Day**
STS-1 Path	Coding Violations (CV)	1-4510 [451]	1-432960 [43296]
	Errored Seconds (ES)	1-900 [40]	1-65535 [900]
	Errored Seconds Type A (ESA)	1-900 [30]	1-65535 [90]
	Errored Seconds Type B (ESB)	1-900 [30]	1-65535 [90]
	Severely Errored Seconds (SES)	1-63 [20]	1-4095 [60]
	Unavailable Seconds	1-63 [30]	1-4095 [90]
DS3 Path	P-Bit Error Counts	1-4026 [403]	1-386500 [38650]
	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]
Enhanced DS3 Path for P-Bits, F&M Bits, and C-Bits from Fiber and DSX	Coding Violations (CV)	1-16383 [40]	1-1048575 [3820]
	ES-P Errored Seconds	1-900 [25]	1-65535 [250]
	SES-P Severely Errored Seconds	1-63 [4]	1-4095 [40]
	UAS-P Unavailable Seconds	1-63 [10]	1-4095 [10]
	SE Frame Seconds	1-63 [2]	1-4095 [8]
DS1 Path	ES-P Errored Seconds	1-900 [65]	1-65535 [648]
	SES-P Severely Errored Seconds	1-63 [10]	1-4095 [100]
	UAS-P Unavailable Seconds	1-63 [10]	1-4095 [10]
	ES-PFE Errored Seconds	1-900 [65]	1-65535 [648]
	SES-PFE Severely Errored Seconds	1-63 [10]	1-4095 [100]
	UAS-PFE Unavailable Seconds	1-63 [10]	1-4095 [10]
	CV-P (SF) Coding Violations	1-16383 [72]	1-1048575 [691]
	CV-P (ESF) Coding Violations	1-16383 [13296]	1-1048575 [132960]
	CV-PFE Coding Violations	1-16383 [13196]	1-1048575 [132960]
VT1.5 Path	Errored Seconds (ES)	1-900 [40]	1-65535 [900]
	Severely Errored Seconds (SES)	1-63 [20]	1-4095 [60]
	Unavailable Seconds (UAS)	1-63 [30]	1-4095 [90]

Ethernet parameters

DMX*tend* provides PM capabilities for the 10/100T, 1G SX, and 1G LX ethernet interfaces. PM data is collected at each LAN and WAN interface in the network for both incoming and outgoing directions and is stored in quarter-hour and day bins. The WAN interface provides a connection to a SONET Virtual Concatenation Group (VCG).

Provisionable threshold crossing alerts (TCAs) are not supported on the ethernet interfaces. Listed below are the six PM parameters that provide PM data on all ethernet interfaces:

- **Dropped Frames (congestion)**

  Counts the number of incoming ethernet frames dropped at a specific LAN/WAN port due to buffer overflow. Buffer overflow occurs when the network is congested.

- **Dropped Frames (errors)**

  Counts the number of incoming ethernet frames dropped at a LAN/WAN port due to a frame check sequence (FCS) error or another defect in the frame.

- **Incoming Number of Bytes**

  Counts the total number of bytes incoming to a LAN/WAN port.

- **Incoming Number of Frames**

  Counts the total number of ethernet frames incoming to a LAN/WAN port.

- **Outgoing Number of Bytes**

  Counts the total number of outgoing bytes transmitted by a specified LAN/WAN port.

- **Outgoing Number of Frames**

  Counts the total number of outgoing frames transmitted by a specified LAN/WAN port.

Operations Interfaces

Overview

Purpose 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 operation interfaces include the CIT interface, IAO LAN (via OSI or TCP/IP), SYSCTL faceplate LEDs, and equipment indicators. DMX*tend* supports office alarms, user-definable miscellaneous discretes, and TL1/X.25.

Contents The following operation interfaces are discussed in this section:

Craft Interface Terminal (PC-CIT)

Overview

The DMX*tend* PC-CIT is the primary tool used to interface with the DMX*tend*. It is a personal computer (PC) with the DMX*tend* user-interface software installed. The DMX*tend* PC-CIT is compatible with PCs running Microsoft Windows NT and Windows 2000. The PC-CIT also provides a user-friendly TL1 command builder interface.

Minimum requirements

It is anticipated that most customers will dedicate a lap-top PC to run the DMX*tend* PC-CIT applications software. However, a properly configured desktop PC will also suffice.

The following list shows the minimum requirements for the customer-provided PC with recommended Windows operating system.

- Microsoft Windows 2000 or NT 4.0 Operating System with service pack 4. The customer is responsible for ensuring that the PC remains virus -free.
- Pentium 266 MHz processor; Pentium III 500 MHz processor is recommended for optimum performance
- 128 MB RAM minimum, 256 recommended
- One-gigabyte hard-disk drive with at least 150 megabytes of free space. The DMX*tend* PC-CIT application requires 50 MB, and the installation requires 30MB. In addition, each copy of the NE generic requires an additional 60 MB.
- CD-ROM drive
- SVGA monitor 800x 600 resolution (1024 x 768 recommended)
- 10 BASE-T LAN interface
  Pin Designations/signals are:
  - -1 TD+
  - -2 TD-
  - -3 RD+
  - -6 RD-

PC-CIT and Windows requirements

The following table illustrates the Windows operating system requirements for DMX*tend* PC-CITs.

DMX*tend* port/ Windows Guidelines	**Serial Port**	**OSI/TCP-IP LAN Port**
Windows NT	X	X
Windows and 2000	X	--

TL1/LAN

Overview

DMX*tend* supports a TL1 over TCP/IP interface or TL1 over OSI LAN interface for communication between a DMX*tend* NE and an Element Management System (EMS) of a Network Management System (NMS). TL1 over TCP/IP LAN complies with requirements specified in IEEE 802.3 and NSIF-AR-9806-088R11.

TL1 translation device (T-TD Gateway)

The T-TD is a device that translates TL1 messages over a TCP/IP connection to a TL1 over OSI association, providing a TL1 TCP-OSI gateway. The T-TD, when used in conjunction with the PC-CIT, is an open system interconnection (OSI) proxy that accepts TCP/IP connections and sets up matching OSI connections. This requires the support of the TCP/IP stack and the seven-layer OSI stack.

Front IAO LAN interface

The DMX*tend* provides an RJ45-compatible front IAO LAN interface that is intended for use with a local PC. This interface will support a TL1/TCP gateway via an IEEE 802.3-compliant interface with a graphical user interface (GUI) in future releases.

Rear IAO LAN interface

TL1 over TCP/IP or TL1 over OSI LAN is supported via an RJ45-compatible IAO LAN rear interface (R1.1) on the DMX*tend*, enabling the DMX*tend* to connect with any NMS possessing a compatible TCP/IP or OSI interface (such as the SNMS or the PC-CIT). This allows TL1 communication over a data network between several different NEs. For instance, Lucent's Subnetwork Management System (SNMS) can communicate with a DDM-2000 that is on the same network as the DMX*tend* connected to the SNMS via the rear IAO LAN interface. The IAO LAN complies with OSI requirements as specified in GR-253-CORE, Section 8.

SONET DCC

The SONET DCC provides TL1 over OSI connections with remote NEs in a subnetwork.

□

Personal Computer Specifications for Software Download

Specifications

The PC used for software download should have:

- Windows NT or 2000
- CD-ROM drive for CD-ROM download.

Compatible modems

A compatible modem must meet the following minimum requirements:

- 300, 1200, 2400, 4800, 9600, 19,200 or 115,000 baud
- Full duplex
- 8 data bits
- No parity bits
- 1 start bit
- 1 stop bit
- No flow control.

LEDs, Indicators, and Office Alarms

SYSCTL Faceplate

The LNW1 SYSCTL circuit pack faceplate contains the following push-button switches and LEDs:

- FAULT LED
- Critical (CR) LED
- Major (MJ) LED
- Minor (MN) LED
- Abnormal (ABN) LED
- Far End Activity (FE) LED
- Near End Activity (NE) LED
- Alarm Cut-Off/Test (ACO) LED
- ACO/TEST (ACO SW) button
- Select (SEL) button
- Update/Initialize (UPD INIT) button
- 7-segment numeric display

The seven segment numeric display is used to identify the remote system presently displayed on the local user panel.

A green PWR ON LED is lighted when the shelf is receiving -48 V power. A green ACO LED is lighted when the ACO function is active.

The SEL, ACO SW, and UPD INIT push-buttons are provided to control system operation.

Equipment indicators

A red LED FAULT indicator is provided on all circuit packs. 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 control office audible and visual alarms. Separate relays handle CR, MJ, and MN alarms. Each contact closure is rated at 1 A, 60 V maximum. The CR and MJ alarms can be wire-ORed. The CR alarm relays are fail safe against unprotected power failures.

TL1/X.25 Interface

Overview

DMX*tend* supports a TL1/X.25 interface via a rear-access, synchronous, **EIA-232-D (V.24)** port capable of speeds up to 115,000 baud (at least 9600 baud is recommended to avoid TL1/X.25 output buffer overflow).

The DMX*tend* automatically assumes the role of a TL1/X.25 GNE when its X.25 interface is connected. TL1 commands *RTRV-SYS* and *RTRV-STATE-X25* indicate if DMX*tend* is an active TL1/X.25 GNE.

A TL1 *RTRV-STATE-X25* command addressed to a DMX*tend* TL1/X.25 GNE retrieves the status of the X.25 communications, including the X.25 packet size and an X.25 event history. TL1 command *ENT-SYS* can be used to provision the X.25 packet size.

TL1 Messages Reference

The *Metropolis®* DMX*tend Access Multiplexer Operations Systems Engineering Guide (TL1 Message Guide)*, 365-372-328, specifies the supported TL1 messages in detail.

X.25 Virtual Circuits (VCs)

The X.25 circuits between a DMX*tend* TL1/X.25 GNE and the OSs may be transported via an X.25 packet network, dedicated private line, or circuit-switched network at the user's option. Multiple DMX*tend* X.25 Physical links may be combined through an external X.25 concentrator, but that would be independent of the DMX*tend* shelf or bay.

A DMX*tend* TL1/X.25 GNE supports up to 9 permanent virtual circuits (PVCs) or up to 9 switched virtual circuits (SVCs). Any combination of PVCs and SVCs is supported, but no more than a total of 9 VC are allowed. The DMX*tend* TL1/X.25 GNE default VC assignments are shown in the table below.

Table 10-16 TL1/X.25 Interface Default VC Assignments

PVC ID*	SVC ID*	Logical Group #	Logical Channel #	Default TL1 Messages (ACID)
1		0	1	Command/Responses (tl1peercomm)
2		0	2	Autonomous Maintenance Messages and Command/Responses (tl1maintenance)
3		0	3	Autonomous Provisioning Messages (REPT DBCHG) and Command/Responses (tl1memoryadminstration)
	1	0	16	Command/Responses (tl1peercomm)
	2	0	17	Command/Responses (tl1peercomm)
	3	0	18	Command/Responses (tl1peercomm)
	4	0	19	Command/Responses (tl1peercomm)
	5	0	20	Command/Responses (tl1peercomm)
	6	0	21	Command/Responses (tl1peercomm)
*** Default Values**				

X.25 Packet Layer

At the packet layer, DMX*tend* is configured as a passive data-terminating equipment (DTE) with the following parameters as shown in the table below.

Table 10-17 X.25 Packet Layer Parameters

Parameter	Value
Packet Size	128 bytes or 256 bytes
Window Size	2 packets
D bit support	NO
M bit support*	YES

***** DMX*tend* uses the M bit when more than one packet is required to output a TL1 message.

For SVC facilities, the parameters listed in the following table should be set to the specified values for communication to take place.

Table 10-18 X.25 Packet Layer Parameters for SVC Facilities

Parameter	Value
Window negotiation	2
Packet size negotiation	7 (128 bytes), 8 (256 bytes)[a]
Modulo	8
Reverse charging	Don’t care[b]
Closed user group	Don’t care

Notes

(a) DMX*tend* accepts this facility only if it matches DMX*tend*’s provisioned X.25 packet size. Otherwise, the call will be cleared.

(b) The DMX*tend* always accepts the call request packet should these facilities be present, but it does not attempt to validate the information.

X.25 Link layer

At the link layer, DMX*tend* uses the standard link access procedure “B” (LAPB) protocol with the following parameters as shown in the table below.

Table 10-19 LAPB Link Layer Parameters

Parameter	**Value**
Maximum Frame Size	2104 bits
Modulo	8
Window Size	7 frames
n2	7 retries
T1	3 seconds
T3*	20 seconds
***** DMX*tend* uses synchronous, full duplex, continuos carrier communication.	

X.25 Pin connections

DMX*tend* uses synchronous, full duplex, continuous carrier communication. Data rates of up to 115,000 baud are supported, and at least 9600 baud are recommended (to avoid TL1/X.25 output buffer overflow). The rear X.25 port is configured as DTE, using the pin connections specified in the table below.

Table 10-20 EIA-232-D (V-24) Pin Connections

Pin	Description
2	Transmitted Data (TD)
3	Received Data (RD)
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	DCE Ready (DSR)
7	Signal Ground (SG)
8	Received Line Signal Detector (DCD)
15	Transmitter Signal Element Timing (DCE to DTE) (TC)
17	Receiver Signal Element Timing (DCE to DTE) (RC)
20	DTE Ready (DTR) (always on when DMX*tend* is powered)

User-Setable Miscellaneous Discrete Interface

Overview

The user-setable miscellaneous discrete interface allows an operations system (OS) to control and monitor equipment collocated with the DMX*tend* through a set of input and output contact closures. Miscellaneous discrete environmental inputs can monitor conditions like open doors or high temperature, miscellaneous discrete outputs control equipment such as fans and generators. The status of the miscellaneous discrete environmental inputs can be queried on demand via the DMX*tend* PC-CIT. DMX*tend* collects miscellaneous discrete alarms and automatically sends them to the operations system (OS).

External customer equipment

Any external customer equipment to be monitored by DMX*tend* must provide the electrical equivalent of a contact closure across the corresponding environmental input wiring pairs. The contact closure must be capable of passing at least 10 mA of drive current.

Power source

The power source to enable the control of external customer equipment may have a voltage range from a minimum of 3 V to a maximum of 72 V. DMX*tend* provides a unidirectional opto-isolator connection across each corresponding control output wiring pair. The load current across each control output wiring pair must be limited by the external customer equipment and must not exceed 35 mA.

Reference

For detailed wiring information, refer to the *Metropolis*® DMX*tend Access Multiplexer Installation Manual*, 365-372-327 and *Metropolis*® DMX*tend Access Multiplexer Application Schematic*, ED8C951-10.

□

Physical Specifications

Overview

Purpose

This section provides DMX*tend* physical characteristics, including environmental and power specifications.

Contents

The following specifications are included in this section:

□

Physical Specifications

Shelf physical characteristics

The standard DMX*tend* shelf has the following characteristics (dimensions including Fan Unit in parentheses):

- Width: 17.5 inches
- Height: 8.75 inches
- Depth (front to back): 13.5 inches
- Weight (Max.): 30 pounds.

Environmental Specifications

Temperature and humidity

The DMX*tend* shelf meets Telcordia Technologies' Network Equipment Building System ("*NEBS Generic Equipment Requirements*," GR-63-CORE) requirements for use in CO environments.

The DMX*tend* shelf has a fan unit built into the shelf.

The DMX*tend* is environmentally hardened and will function at temperatures of -40^{o}C to +65^{o}C and humidity of 5 to 95 percent (noncondensing) in all TDM applications when equipped with the OC-3 or OC-12 high-speed circuit pack. In all other applications the DMX*tend* functions at temperatures of 0^{o}C to +50^{o}C.

EMC requirements

The DMX*tend* 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.

Earthquake requirements

DMX*tend* meets the earthquake requirements defined in Telcordia Technologies GR-63-CORE and Pacific Bell Standard PBS-000-102PT.

Fire resistance

DMX*tend* meets ignitability requirements specified in *ANSI* T1.307-1997. In addition, the DMX*tend* meets the fire resistance requirements of *UL* 60950, 3rd Edition.

Underwriters Laboratories

The DMX*tend* is *UL* recognized 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*, *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 DMX*tend* has been certified by the Canadian Standards Association per standard CAN/CSA-C22.2 Number 60950-00.

□

Power Specifications

Power supply

The table below lists DMX*tend* power requirements.

Table 10-21 DMX*tend* Power Supply Requirements

Item	Description
Voltage range, all components	–40.0V to –60V
Power Feeders	two –48V power feeders [BREAKER (A) and BREAKER (B)]
Circuit Breakers (two per shelf)	10.0A

Circuit breakers

DMX*tend* uses on-board power conversion eliminating the need for slots for bulk power converters. Two independent -48V office power feeders (A and B) enter the shelf through connectors and are filtered and distributed to the circuit packs through circuit breakers. Power conversion is performed through modular power converters located on the circuit packs. In each circuit pack, the 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 circuit breaker. The green Power LEDs located next to each circuit breaker (A and B) indicate power is being fed to the breaker.

Current drains The following table provides the maximum and average current drain requirements for a shelf.

Table 10-22 Shelf Current Drains

Shelf	**Current Drains per Feeder in Amperes**			
	Average @ –48V	**Maximum @ –48V**	**Average @ –40V**	**Maximum @ –40V**
DMX*tend* Shelf	TBS	10.0	TBS	10.0

The following table provides the maximum and average current drain requirements for a bay equipped with four shelves.

Table 10-23 Bay Current Drains

Bay	**Current Drains per Feeder in Amperes**			
	Average @ –48V	**Maximum @ –48V**	**Average @ –40V**	**Maximum @ –40V**
Bay equipped with four DMX*tend* Shelves	TBS	40.0	TBS	40.0

Lucent Technologies
Bell Labs Innovations

Glossary

Acronyms and Abbreviations

1G
Gigabit

A

ABN
Abnormal (status condition)

ACO
Alarm Cutoff

ACO/SW
Alarm Cutoff and Test

ADM
Add/Drop Multiplexer

AGNE
Alarm Gateway Network Element

AIS
Alarm Indication Signal

AMI
Alternate Mark Inversion

ANSI
American National Standards Institute

APS
Automatic Protection Switch

ARM
Access Resource Manager

AS&C
Alarm, Status, and Control

ASCII
American Standard Code for Information Interchange

ASN.1
Abstract Syntax Notation 1

ASNE
Alarm Server Network Element

ATM
Asynchronous Transfer Mode

Auto
Automatic

AUXCTL
Auxiliary Control

B

B3ZS
Bipolar 3-Zero Substitution

B8ZS
Bipolar 8-Zero Substitution

BDFB
Battery Distribution and Fuse Bay

BER
Bit Error Ratio

BIP
Bit Interleaved Parity

BITS
Building Integrated Timing Supply

BRI
Basic Rate Interface

C

CC
Clear Channel

CCITT
International Telephone and Telegraph Consultative Committee

CEV
Controlled Environment Vault

CD-ROM
Compact Disk, Read-Only Memory

CDTU
Channel and Drop Test Unit

CIT
Craft Interface Terminal

CLEC
Competitive Local Exchange Carrier

CLF
Carrier Line Failure Status

CMISE
Common Management Information Service Element

CMOS
Complementary Metal Oxide Semiconductor

CMTS
Cable Modem Termination System

CO
Central Office

CP
Circuit Pack

CPE
Customer Premises Equipment

CR
Critical (alarm status)

CSA
Carrier Serving Area

CSU
Channel Service Unit

CTL
Control

CTS
Customer Technical Support

CV
Coding Violation

CVFE
Coding Violation Far End

D

DCC
Data Communications Channel

DCE
Data Communications Equipment

DCS
Data Collection System

DEMUX
Demultiplexer

DLC
Digital Loop Carrier

DNS
Data Networking Services

DPLL
Digital Phase-Locked Loop

DRI
Dual Ring Interworking

DS1
Digital Signal Level 1

DS3
Digital Signal Level 3

DSL
Digital Subscriber Line

DSLAM
Digital Subscriber Line Access Multiplexer

DSNE
Directory Services Network Element

DSX
Digital Cross-Connect Panel

DT
Distant Terminal

DTE
Data Terminating Equipment

E

EC-1
Electrical Carrier Level 1

ECI
Equipment Catalog Item

EEPROM
Electrically-Erasable Programmable Read-Only Memory

EIA
Electronic Industries Association

EMC
Electromagnetic Compatibility

EMI
Electromagnetic Interference

EOOF
Excessive Out of Frame

EPROM
Erasable Programmable Read-Only Memory

EQ
Equipped (memory administrative state)

ES
Errored Seconds

ESD
Electrostatic Discharge

ESF
Extended Super Frame

EST
Environmental Stress Testing

F

FCC
Federal Communications Commission

FDDI
Fiber Distribution Data Interface

FE
Far End

FE ACTY
Far End Activity

FEBE
Far End Block Error

FE ID
Far End Identification

FEPROM
Flash EPROM

FERF
Far End Receive Failure

FE SEL
Far End Select

FIT
Failures in 10^{-9} hours of operation.

G

GbE
Gigabit Ethernet

GNE
Gateway Network Element

GR
Telcordia Technologies General Requirement

GTP
General Telemetry Processor

GUI
Graphical User Interface

H

HECI
Humans Equipment Catalog Item

HFC
Hybrid Fiber Coaxial

I

IAO LAN
Intra-Office Local Area Network

IC
Internal Clock

ID
Identifier

IEC
International Electrotechnology Commission

IMF
Infant Mortality Factor

INC
Incoming Status

I/O
Input/Output

IP
Internet Protocol

IR
Intermediate Reach

IS
In Service

ISCI
Intershelf control Interface

ISI
Intershelf Interface

ISDN
Integrated Services Digital Network

ISO
International Standards Organization

ISP
Internet Service Provider

IVHS
Intelligent Vehicle Highway System

L **LAN**
Local Area Network

LAPD
Link Access Procedure "D"

LBO
Line Build Out

LCN
Local Communications Network

LEC
Local Exchange Carrier

LED
Light-Emitting Diode

LOF
Loss of Frame

LOP
Loss of Pointer

LOS
Loss of Signal

LR
Long Reach

LS
Low Speed

M **MD**
Mediation Device

MJ
Major Alarm

MM
Multimode

MML
huMan-Machine Language

MN
Minor Alarm

MPEG
Moving Picture Experts Group

MSDT
Multi-Services Distant Terminal

MSO
Metropolitan Serving Office

MTBF
Mean Time Between Failures

MTBMA
Mean Time Between Maintenance Activities

Mult
Multipling

MUX
Multiplex

MXBIU
Multiplexer and Backplane Interface Unit

N

NAP
Network Access Point

NE
Near End

NE
Network Element

NE ACTY
Near-End Activity

NEBS
Network Equipment-Building System

nm
Nanometer (10^{-9} meters)

NMA
Network Monitoring and Analysis

NMON
Not Monitored (provisioning state)

NRZ
Nonreturn to Zero

NNI
Network-Network Interface

NSA
Not Service Affecting

NSAP
Network Services Access Point

NTF
No Trouble Found

O **OAM&P**
Operations, Administration, Maintenance, and Provisioning

OC-1
Optical Carrier Level 1 Signal (51.84 Mb/s)

OC-3
Optical Carrier Level 3 Signal (155 Mb/s)

OC-12
Optical Carrier Level 12 Signal (622 Mb/s)

OC-48
Optical Carrier Level 48 Signal

OLIU
Optical Line Interface Unit

OOF
Out of Frame

OOL
Out of Lock

OPS/INE
Operations System/Intelligent Network Element

OS
Operations System

OSGNE
Operations System Gateway Network Element

OSI
Open Systems Interconnection

OSMINE
Operations Systems Modifications for the Integration of Network Elements

OSP
Outside Plant

P

P-bit
Performance Bit

PC
Personal Computer

PCU
Power Conversion Unit

PID
Program Identification

PINFET
Positive Intrinsic Negative Field Effect Transistor

PJC
Pointer Justification Count

PLL
Phase-Locked Loop

PM
Performance Monitoring

PMN
Power Minor Alarm

POH
Path Overhead

POP
Points of Presence

POTS
Plain Old Telephone Service

PRM
Performance Report Message

PROTN
Protection

PRS
Primary Reference Source

PSU
Power Supply Unit

PVC
Permanent Virtual Circuit

PWR
Power

R **RAM**
Random Access Memory

RDC
Regional Data Center

RPP
Reliability Prediction Procedure (described in Telcordia Technologies TR-NWT-00032)

RT
Remote Terminal

RTAC
Lucent Regional Technical Assistance Center (1-800-225-RTAC)

RZ
Return to Zero

S

SA
Service Affecting

SCADA
Supervisory Control and Data Acquisition

SD
Signal Degrade

SDH
Synchronous Digital Hierarchy

SEFS
Severely Errored Frame Seconds

SEO
Single-Ended Operations

SES
Severely Errored Seconds

SF
Super Frame (format for DS1 signal)

SID
System Identification

SLA
Service Level Agreements

SLIM
Subscriber Loop Interface Module

SM
Single Mode

SONET
Synchronous Optical NETwork

SPE
Synchronous Payload Envelope

SQU
Sync Quality Unknown

SRD
Software Release Description

STS, STS-n
Synchronous Transport Signal

STM
Synchronous Transfer Mode

STS-1 SPE
STS-1 Synchronous Payload Envelope

STS-3c
Synchronous Transport Level 3 Concatenated Signal

STS-12c
Synchronous Transport Level 12 Concatenated Signal

SYSCTL
System Controller (circuit pack)

T

T1X1 and T1M1
The ANSI committees responsible for telecommunications standards

TA
Telcordia Technologies Technical Advisory

TABS
Telemetry Asynchronous Byte Serial (Protocol)

TARP
Target ID Address Resolution Protocol

TCA
Threshold-Crossing Alert

TCP/IP
Transmission Control Protocol/Internet Protocol

TCVCXO
Termperature-Compensated Voltage-Controlled Crystal Oscillator

TDM
Time Division Multiplexing

TID
Target Identifier

TIRKS
Trunk Integrated Record Keeping System

TG3
Stratum 3 Timing Generator

TL1
Transaction Language 1

TLB
Timing Looped Back

TOP
Task Oriented Practice

TR
Telcordia Technologies Technical Requirement

TSA
Time Slot Assignment

TSI
Time Slot Interchange

TSO
Technical Support Organization

U **UAS**
Unavailable Seconds

UNI
User Network Interface

UOC
Universal Optical Connector

UPD/INIT
Update/Intialize

UPSR
Unidirectional Path Switched Rings

V **VF**
Voice Frequency

VLAN
Virtual Local Area Network

VLSI
Very Large Scale Integration

VM
Violation Monitor

VMR
Violation Monitor and Removal

VoIP
Voice over Internet Protocol

VONU
Virtual Optical Network Unit

VPN
Virtual Private Network

VT
Virtual Tributary

VT1.5
Virtual Tributary 1.5 (1.728 Mb/s)

VT-G
Virtual Tributary Group

W

WAN
Wide Area Network

Glossary

Terms and Definitions

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 (service in one direction, protection in the other).

1xN, 1x1
1xN protection switching pertains to circuit pack protection that provides a redundant signal path through the DMX 2.5G Multiplexer (it does not cover protection switching of an optical facility; se "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.

A

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).

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.

ASCII - American Standard Code for Information Interchange
A standard 8-bit code used for exchanging information among data processing systems and associated equipment.

Auto
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 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.

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.

BER - Bit Error Rate
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.

Broadband
Any communications channel with greater bandwidth than a voice channel; sometimes used synonomously 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).

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.

CLEC - Competitive Local Exchange Carrier
Company that provides local phone services in competition with RBOCs.

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-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 time-division multiplexing several digital signals into a single composite digital signal.

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 Mb/s

DS1(28) Circuit Pack

The DS1(28) circuit pack interfaces to the DSX-1 panel.

DS3

Digital Signal Level 3 (44.736 Mb/s).

DS3/EC-1 Circuit Pack

The DS3/EC-1 circuit pack interfaces to the DSX-3 panel.

DSn - Digital Signal Rate n

One of the possible digital signal rates at DMX 2.5G Multiplexer 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 to equipment that operates at a designated rate. For example, a DSX-3 interconnects equipment operating at the DS3 rate.

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 Homing

A network topology in which two OC-3 or OC-12 shelves serve as DMX 2.5G Multiplexer hosts supporting up to 16 OC-3 rings or 4 OC-12 rings. Each DMX 2.5G Multiplexer ring is interconnected between the two separate hosts.

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.

ES - Errored Seconds
A performance monitoring parameter.

ESF - Extended Super Frame
The format for a DS1 signal.

F **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 SYSCTL circuit pack faceplate.

FEBE - Far End Block Error
An indication returned to the 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 nonvolatility of EPROM with the in-circuit reprogrammability of EEPROM (electrically-erasable PROM).

FERF - Far End Receive Failure
An indication returned to the transmitting terminal that the receiving terminal has detected an incoming section failure.

FE SEL - Far End Select
An LED on the faceplate of the SYSCTL circuit pack.

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, C, or D function unit slots on the DMX 2.5G Multiplexer.

G

GNE - Gateway Network Element

A network element that has an active X.25 link. Can also be a DSNE.

H

Hairpin Routing

A cross-connection between function units (inter-function unit). For example, function unit C to function untis A, B, or D. Also, a cross-connection within the same function unit (intra-function unit). Cross-connections go through Main, but no bandwidth or time slots are taken from the backbone ring. Eliminates need for another shelf.

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.

HFC - Hybrid Fiber Coaxial

Technology using coaxial and fiber cable to transport data services in addition to television channels.

I

IC - Internal Clock

Used in synchronization messaging.

ID

See shelf ID and site ID.

IR - Intermediate Reach

A term used to describe distances of 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).

J

Jitter

Timing jitter is defined as short-term variations of the significant instants of a digital signal from their ideal positions in time.

L

LBO - Line Build Out
An equalizer network between the DMX 2.5G Multiplexer and the DSX panel. It guarantees the proper signal level and shape at the DSX panel.

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 theuser 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 reciever without regeneration. See Intermediate Reach.

M **Main**

The two slots (M-1 and M-2) on the DMX 2.5G Multiplexer shelf in which the OC-48 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.

Multiplexing

The process of combining several distinct digital signals into a single composite digital signal.

Mult - Multipling

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.

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: onr or more high- and low-speed transmission ports, built-in intelligence, synchronization and timing capability, and 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 faceplate of the SYSCTL circuit pack.

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.

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.

NSAP - Network Services Access Point
An address that identifies a network element. Used for maintenance subnetwork communication using the OSI protocol.

O

OC, OC-n - Optical Carrier
The optical signal that results from an optical inversion of an STS signal; that is, OC-1 from STS-1 and OC-n from STS-n.

OC-1
Optical Carrier Level 1 Signal (51.844 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 equivalent to three STS-1s linked together with a single path overhead.

OC-12
Optical Carrier Level 12 Signal (622 Mb/s).

OC-12c (STS-12c)
Optical Carrier Level 12 Concatenated Signal. High-speed broadband equivalent to twelve STS-1s linked together with a single path overhead.

OC-48
Optical Carrier Level 48 Signal.

Operations Interface
Any interface that provides information on the system performance or control. These include the equipment LEDs, SYSCTL faceplate, and office alarms.

OS - Operations System
A central computer-based system used to provide operations, administration, and maintenance functions.

OSI - Open Systems Interconnection

Referring to the OSI reference model, a logical structure for network operations standardized by the Internation 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.

P

Pass Through

Paths that are cross-connected directly across an intermediate node in a ring network.

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.

PM - Performance Monitoring

Measures the quality of service and identifies degrading or marginally operating systems (before an alarm would be generated).

Port

The physical, electrical, or optical interface on a system. For example, DS1, DS3, EC-1, OC-3, OC-12, and OC-48. *See Channel*.

Port State Provisioning

A feature that allows a user to supress 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*.

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 DMX 2.5G Multiplexer, a protection line is a pair of fibers that terminate an OLIU circuit pack in the Main-2, A-2, B-2, C-2, or D-2 slots. *See Service Line*.

Product Family 2000
Lucent's line of SONET standard network products providing total network solutions.

PSTN - Public Switched Telephone Network
The network that provides public telephone service.

R **Reactive Maintenance**
Refers to decting defects/failures and clearing them.

Remote
See Far-End (FE).

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 the clearing of any failure conditions that caused a protection switch to occur or after any external switch commands are reset. *See Non-Revertive*.

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 DMX 2.5G Multiplexer may 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 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.

S **S3-TG - Stratum 3 Timing Generator**

The timing generator circuit pack, located in the OC-48 OLIU circuit pack, generates clock signals for distribution to the transmit circuits. It operates in the free-running, loop-timing, phase-lock, and holdover modes.

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.

SEO - Single-Ended Operations

The maintenance capability that provides remote access to all DMX 2.5G Multiplexer systems from a single location over the DCC.

Service Line

On a DMX 2.5G Multiplexer 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-1, A-1, B-1, C-1, or D-1 slots. As defined by the SONET standard, the SONET APS channel is not defined on a service line. *See Protection Line*.

SES - Severely Errored Seconds

This performance monitoring parameter is a second in which a signal fail occurs, or more than a preset amount of coding violations (dependent on the type of signal) occurs.

SF - Super Frame

The format for DS1 signals.

Shelf ID

A switch-settable parameter with values from 1 to 8. Used to log into a selected shelf in a by using the CIT.

Single 0x1 Cross-Connection

In a dual-homed application, the DMX 2.5G Multiplexer uses a single 0x1 cross-connection to map the VT1.5 channels between the DDM-2000 FiberReach, OC-3 Multiplexer, or OC-12 Multiplexer and the DMX 2.5G Multiplexer 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.

Single Homing

A network topoly in which a single DDM-2000 FiberReach, OC-3 Multiplexer, or OC-12 Multiplexer serves as a DMX 2.5G Multiplexer host supporting up to six

OC-3 or OC-12 rings.

Site ID
A switch-settable parameter with values from 1 to 8. Displayed on the SYSCTL circuit pack to indicate to which site the faceplate alarms and LEDs apply.

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 1x1 or 1xN protected circuit pack that is not currently carrying service. *See Active*.

Status
The indication of a short-term change in the system.

STS, STS-n - Synchronous Transport Signal
The basic 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 - System Controller
The system controller circuit pack that provides overall administrative control of the terminal.

T

T1X1 and T1M1
The ANSI committees responsible for telecommunications standards.

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 causes a message to be sent to NMA via the X.25/TL1 interface.

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.

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 other line carrying traffic in the other direction. For a 1+1 protection scheme 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 - Univeral Optical Connector
Receptacles on the faceplate of some OLIUs that accept *ST*, SC, or FC connectors.

UPD/INIT
A push-button on the SYSCTL faceplate.

V **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 from the received 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.

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

WaveStar Product Family

Lucent's next generation line of network products.

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).

Lucent Technologies
Bell Labs Innovations

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T