Lucent Technologies
Bell Labs Innovations

LambdaUnite™ MultiService Switch (MSS)

Release 2.0

Applications and Planning Guide

365-374-053
CC109192385
Issue a
January 2002

Notice

Every effort has been made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

Mandatory customer information

Trademarks

These trademarks are used in this manual:

Adobe, Acrobat and the Acrobat logo is a registered trademark of Adobe Systems Incorporated.

ANSI is a registered trademark of American National Standards Institute Incorporated.

CompactFlash is a trademark of SanDisk Corporation.

LambdaUnite is a trademark of Lucent Technologies.

Navis is a trademark of Lucent Technologies.

Pentium is a registered trademark of Intel Corporation.

WaveStar is a registered trademark of Lucent Technologies.

Windows, Windows NT and the Windows logo is a registered trademark of Microsoft Corporation.

Ordering information

The order number of this document is 365-374-053 (Issue a).

Support

Technical support

Please contact your Lucent Technologies Local Customer Support Team (LCS) for technical questions about the information in this document.

Information product support

On the following page, we provide a comment form for you to report errors or make suggestions about this document.

Lucent Technologies values your comments!

Lucent Technologies
Bell Labs Innovations

LambdaUnite™ MultiService Switch (MSS)
Release 2.0
Applications and Planning Guide
365-374-053 Issue a January 2002

Lucent Technologies welcomes your comments on this information product. Your opinion is of great value and helps us to improve.

1. Was the information product:

	Yes	*No*	*Not applicable*
In the language of your choice?	☐	☐	☐
In the desired media (paper, CD-ROM, etc.)?	☐	☐	☐
Available when you needed it?	☐	☐	☐

Please provide any additional comments:

____

____

2. Please rate the effectiveness of this information product:

	Excellent	*More than satisfactory*	*Satisfactory*	*Less than satisfactory*	*Unsatisfactory*	*Not applicable*
Ease of use	☐	☐	☐	☐	☐	☐
Level of detail	☐	☐	☐	☐	☐	☐
Readability and clarity	☐	☐	☐	☐	☐	☐
Organization	☐	☐	☐	☐	☐	☐
Completeness	☐	☐	☐	☐	☐	☐
Technical accuracy	☐	☐	☐	☐	☐	☐
Quality of translation	☐	☐	☐	☐	☐	☐
Appearance	☐	☐	☐	☐	☐	☐

If your response to any of the above questions is "*Less than satisfactory*" or "*Unsatisfactory,*" please explain your rating.

____

____

3. If you could change one thing about this information product, what would it be?

____

____

4. Please write any other comments about this information product:

____

____

Please complete the following if we may contact you for clarification or to address your concerns:

Name: ______________________ Date: ______________

Company/organization: ______________ Telephone number: ______________

Address: ______________________________

Email address: ______________ Job function: ______________

If you choose to complete this form online, go to http://www.lucent-info.com/comments
Otherwise fax to 407 767 2760 (U.S.) or +1 407 767 2760 (outside the U.S.) or email comments to ctiphotline@lucent.com

Lucent Technologies values your comments!

LambdaUnite™ MultiService Switch (MSS)
Release 2.0
Applications and Planning Guide
365-374-053 Issue a January 2002

Lucent Technologies welcomes your comments on this information product. Your opinion is of great value and helps us to improve.

1. Was the information product:

	Yes	*No*	*Not applicable*
In the language of your choice?	☐	☐	☐
In the desired media (paper, CD-ROM, etc.)?	☐	☐	☐
Available when you needed it?	☐	☐	☐

Please provide any additional comments:

____

____

2. Please rate the effectiveness of this information product:

	Excellent	*More than satisfactory*	*Satisfactory*	*Less than satisfactory*	*Unsatisfactory*	*Not applicable*
Ease of use	☐	☐	☐	☐	☐	☐
Level of detail	☐	☐	☐	☐	☐	☐
Readability and clarity	☐	☐	☐	☐	☐	☐
Organization	☐	☐	☐	☐	☐	☐
Completeness	☐	☐	☐	☐	☐	☐
Technical accuracy	☐	☐	☐	☐	☐	☐
Quality of translation	☐	☐	☐	☐	☐	☐
Appearance	☐	☐	☐	☐	☐	☐

If your response to any of the above questions is “*Less than satisfactory*” or “*Unsatisfactory,*” please explain your rating.

____

____

3. If you could change one thing about this information product, what would it be?

____

____

4. Please write any other comments about this information product:

____

____

Please complete the following if we may contact you for clarification or to address your concerns:

Name: ____________________ Date: ______________

Company/organization: ______________ Telephone number: ______________

Address: ______________________________

Email address: ______________ Job function: ______________

If you choose to complete this form online, go to http://www.lucent-info.com/comments
Otherwise fax to 407 767 2760 (U.S.) or +1 407 767 2760 (outside the U.S.) or email comments to ctiphotline@lucent.com

Contents

2 Features

7 Ordering

8 Product support

9 Quality and reliability

Lucent Technologies
Bell Labs Innovations

About this information product

Purpose

This Applications and Planning Guide (APG) provides the following information about *LambdaUnite*™ MultiService Switch (MSS):

- Features
- Applications
- Product description
- Operations and maintenance
- System engineering
- Product support
- Technical and reliability specifications

Reason for reissue

This is the initial version of this guide for *LambdaUnite* MSS Release 2.0.

Safety labels

Safety labels are not used in this guide.

Intended audience

The *LambdaUnite* MultiService Switch (MSS) Applications and Planning Guide is primarily intended for network planners and engineers. In addition, others who need specific information about the features, applications, operation, and engineering of *LambdaUnite* MSS may find the information in this manual useful.

How to use this information product

Each chapter of this manual treats a specific aspect of the system and can be regarded as an independent description. This ensures that readers can inform themselves according to their special needs. This also means that the manual provides more information than needed by many of the readers. Before you start reading the manual, it is therefore necessary to assess which aspects or chapters will cover the individual area of interest.

The following table briefly describes the type of information found in each chapter.

Chapter	Title	Description
Preface	About This Document	This chapter • describes the guide's purpose, intended audience, and organization • lists related documentation • explains how to comment on this document
1	Introduction	This chapter • presents network application solutions • provides a high-level product overview • describes the product family • lists features
2	Features	Describes the features of *LambdaUnite* MSS
3	Network Topologies	Describes some of the main network topologies possible with *LambdaUnite* MSS

Chapter	Title	Description
4	Product Description	This chapter • provides a functional overview of the system • describes the hardware and configurations available for the product
5	Operations, Administration, Maintenance, and Provisioning	Describes OAM&P features (such as alarms, operation interfaces, security, and performance monitoring)
6	System Planning and Engineering	Provides planning information necessary to deploy the system
7	Ordering	Describes how to order *LambdaUnite* MultiService Switch (MSS).
8	Product Support	This chapter • describes engineering and installation services • explains documentation and technical support • lists training courses
9	Quality and Reliability	This chapter • provides the Lucent Technologies quality policy • lists the reliability specifications
10	Technical Specifications	Lists the technical specifications
Appendix A	SDH Overview	Describes the standards for optical signal rates and formats (SDH)
Appendix B	SONET Overview	Describes the standards for optical signal rates and formats (SONET)

Chapter	Title	Description
	Abbreviations and Acronyms	Expands common telecommunication abbreviations and acronyms
	Glossary	Defines telecommunication terms
	Index	Lists specific subjects and their corresponding page numbers

Conventions used

The following conventions are used throughout the manual:

Numbering

Each fascicle can be identified by its number (see above) and contains a chapter which is numbered accordingly (e.g. Chapter 2 is contained in Fascicle 2). The page numbering begins with "1" in every chapter. To be able to identify them easily, these numbers are prefixed with the fascicle number.

Related documentation

This section briefly describes the documents that are included in the *LambdaUnite* MultiService Switch (MSS) documentation set.

- Installation Guide
  The *LambdaUnite* MSS Installation Guide is a step-by-step guide to system installation and setup. It also includes information needed for pre-installation site planning and post-installation acceptance testing.
- Applications and Planning Guide
  The *LambdaUnite* MSS Applications and Planning Guide (APG) is for use by network planners, analysts and managers. It is also for use by the Lucent Account Team. It presents a detailed overview of the system, describes its applications, gives planning requirements, engineering rules, ordering information, and technical specifications.
- User Operations Guide
  The *LambdaUnite* MSS User Operations Guide provides step-by-step information for use in daily system operations. The manual demonstrates how to perform system provisioning, operations, and administrative tasks by use of *WaveStar*® CIT.
- Alarm Messages and Trouble Clearing Guide

The *LambdaUnite* MSS Alarm Messages and Trouble Clearing Guide gives detailed information on each possible alarm message. Furthermore, it provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement.

- Operations System Engineering Guide
  The *LambdaUnite* MSS Operations System Engineering Guide serves as a reference for all TL1 commands which can be used to operate the network element. The manual gives an introduction to the concept of the TL1 commands and instructs how to use them.
- *Navis*™ Optical EMS Provisioning Guide (Application *LambdaUnite* MSS)
  The *Navis* Optical EMS Provisioning Guide (Application *LambdaUnite* MSS) gives instructions on how to perform system provisioning, operations, and administrative tasks by use of *Navis* Optical EMS.

The following table lists the documents included in the *LambdaUnite* MSS documentation set.

Document Number	**Title**
109192385 (365-374-053)	*LambdaUnite* MSS Applications and Planning Guide
109192393 (365-374-055)	*LambdaUnite* MSS User Operations Guide
109192377 (365-374-057)	*LambdaUnite* MSS Alarm Messages and Trouble Clearing Guide
109192401 (365-374-059)	*LambdaUnite* MSS Installation Guide
109192419 (365-374-061)	*LambdaUnite* MSS Operations System Engineering Guide (TL1 Reference Manual)
109192369 (365-374-063)	*Navis* Optical EMS Provisioning Guide (Application *LambdaUnite* MSS)
109088666	CD-ROM Documentation *LambdaUnite* MSS (all manuals on one CD-ROM)

The following additional documents can be helpful for planning and ordering:

- Ordering & Information Drawings
- Cable Ordering & Information Drawings

Documented feature set

This manual describes *LambdaUnite* MSS release 2.0. For technical reasons some of the documented features might not be available until later software versions. For precise information about the availability of features, please consult the Software Release Description (SRD) that is distributed with the network element software. This provides details of the status at the time of software delivery.

How to comment

As customer satisfaction is extremely important to Lucent Technologies, every attempt is made to encourage feedback from customers about our information products.

Customer Comment Form

A customer comment form is located immediately after the title page of this document. Please fill out the form and fax it to the number provided on the form.

How to order

If the customer comment form is missing, send or fax comments about this document to

Lucent Technologies Network Systems GmbH

Lucent Learning WO

Thurn-und-Taxis-Str. 10

90411 Nuernberg, Germany

Fax: +49 911 526 3545

1 Introduction

Overview

Purpose

This chapter introduces the *LambdaUnite*™ MultiService Switch (MSS).

Contents

LambdaUnite™ MSS network solutions

Overview

LambdaUnite MultiService Switch (MSS) is a global platform design supporting both the Synchronous Optical Network (SONET) standards as well as the Synchronous Digital Hierarchy (SDH) standards.

Using the experience Lucent Technologies gained with 40-Gbit/s TDM products in more than one year of successful field trials, *LambdaUnite* MSSis the next generation of Lucent's high speed TDM equipment for various 40-Gbit/s applications as well as 10-Gbit/s applications built upon a cost optimized, high density and future proof platform. The feature set in this first release has common points with existing SDH and SONET transport products as well as an advanced set of market-proven features. The feature set will grow continuously in future releases. For planning reasons, major future features will also be mentioned within this Applications and Planning Guide.

Key features

Key features of *LambdaUnite* MSS include:

- 10-Gbit/s and 2.5-Gbit/s optical synchronous interfaces (40-Gbit/s, further 10-Gbit/s and 2.5-Gbit/s, and 622/155-Mbit/s interfaces in future release)
- Direct Gigabit Ethernet (IEEE 802.3) optical interface
- DWDM and passive WDM compatible optics, in future release
- 2-fiber BLSR/MS-SPRing on 10-Gbit/s interfaces; 4-fiber version and transoceanic protocol for STM-64 interfaces in future release
- 2-fiber BLSR/MS-SPRing on 2.5-Gbit/s interfaces; 4-fiber version in future release
- Unidirectional Path Switched Ring (UPSR) / Subnetwork Connection Protection (SNC/I and SNC/N) for all types of cross connections and any mix of supported interfaces, also for the 1 Gigabit Ethernet interface
- 1+1 linear APS / MSP for 2.5-Gbit/s and for 10-Gbit/s interfaces
- Dual Ring Interworking (DRI, SONET) / Dual Node Interworking (DNI, SDH) between two BLSR / MS-SPRing / SNCP protected rings, also supports collapsed nodes, in future release

- Flexible, non-blocking STS-1/HO VC-3, STS-3c/VC-4, STS-12c/VC-4-4c, STS-48c/VC-4-16c and STS-192c/VC-4-64c granularity cross connect
- Cross Connection capability: 320 Gbit/s in total: 6144 x 6144 STS-1 / 2048 x 2048 VC-4, extension to 640 Gbit/s planned for future releases
- Multiple Ring Closure
- Flexible any card in any slot architecture
- Telcordia Management Support in future release
- TL1 operations interface
- Manageable by *Navis*™ Optical EMS element and subnetwork manager and *WaveStar*® CIT Craft Interface Terminal.

Applications

LambdaUnite MSS is designed to cover a variety of 10-Gbit/s and 40-Gbit/s (next release) applications in the metro and backbone domain, based on the same common hardware and software. *LambdaUnite* MSS can comprise one or more Terminal Multiplexer (TM) or Add/Drop Multiplexer (ADM) functions in a single node, but as well can also act as a fully non-blocking cross connect (XC). As a combination of the ADM function with the XC function, also multi ring applications are supported to directly interconnect added/dropped tributaries between 40-Gbit/s (in future), 10-Gbit/s and 2.5-Gbit/s rings. The ability to support and efficiently interconnect multiple rings using a single network element provides the basis for advanced networking capabilities and potential cost savings to a large amount.

The complete *LambdaUnite* MSS network element requires only one single sub-rack. The design is in compliance with ETSI / NEBS specifications.

Differentiators

The main differentiators of the product are:

- Minimized Number of Equipment Types
  - Innovative high flexible architectural design
  - Full configuration & application coverage with single shelf
  - Easy, restriction-less configuration via simple I/O pack plugging
- All configurations based on common HW/SW components
  - Same shelf, same units, same SW
  - Upgrade just means plugging of additional cards and new configuration
  - Drastically reduced spare part, maintenance and training costs for operators
- Minimized Floor Space and Equipment Cost
  - Lowest foot print by ultra compact single shelf
  - Outstanding architectural support for pay as you grow
  - High interface density merging today’s multiplexer farms into a single shelf
  - Multi Ring closure architecture prevents from back-to-back ADM arrays
- Multi Service Support
  - Global product design covering SONET, SDH and transoceanic (future release) application
  - Data transport with fixed Link Capacity Adjustment System (LCAS), flexible LCAS in future release, and direct low cost 1 Gigabit Ethernet interfacing. Low cost VSR OC/STM optics towards routers at full concatenation support
- Future proof investment
  - 640 Gbit/s switch capacity upgrade improves return on investment
  - Self aware services including fast provisioning and restoration

- Transparent Services
- Enables highest bandwidth for lowest cost/bit with 40-Gbit/s interfaces: Upgrade to 40 Gbit/s from initial deployment with 10 Gbit/s

- Full integration into Lucent Technologies' management solution

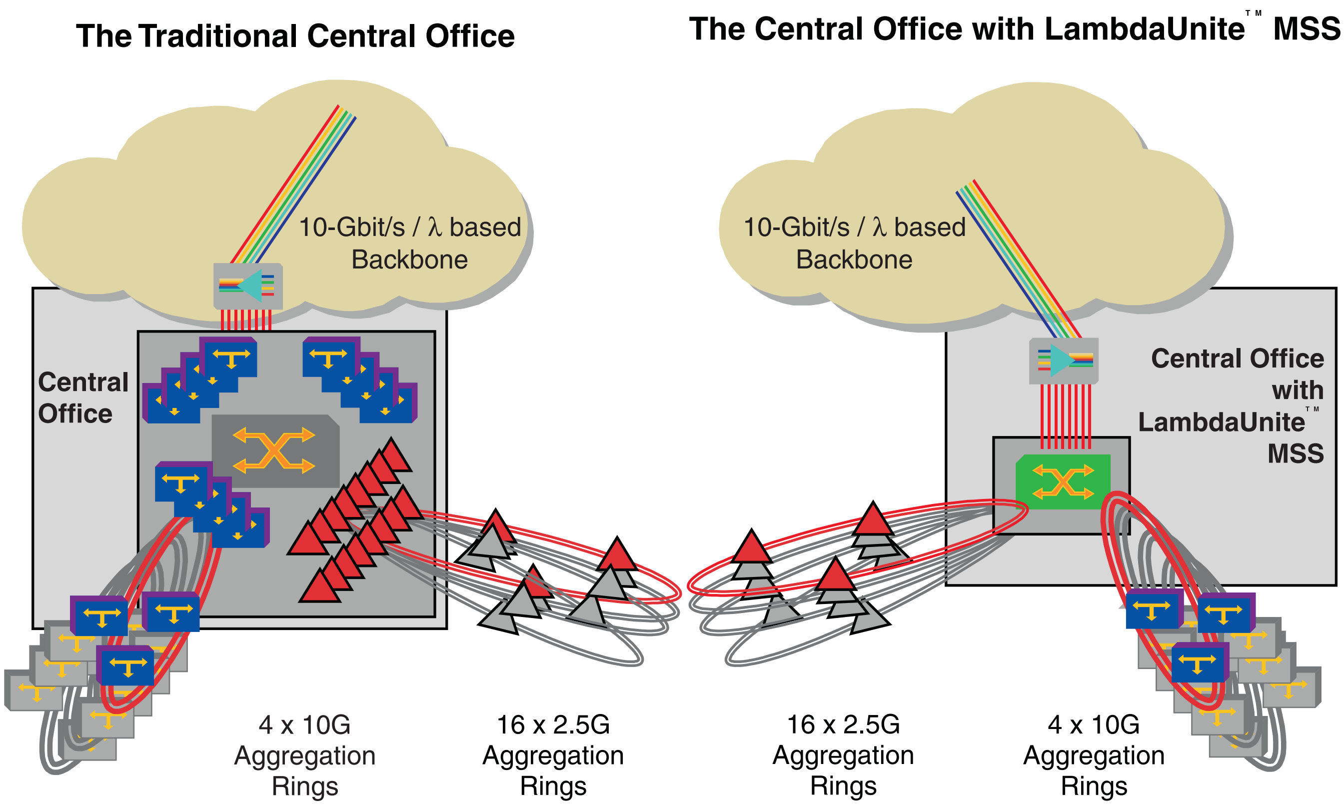
These features make the *LambdaUnite* MSS one of the most cost-effective, future-proof and flexible network elements available on the market today.

Comparison: central office

A comparison of a traditional central office and the future central office with *LambdaUnite* MSS impressively shows its advantages:

- significantly reduced floor space requirements
- lowering equipment cost
- reducing power requirements
- reducing cabling effort.

The following figure shows as an example a traditional central office consisting of 8 backbone feeder 10-Gbit/s ADMs, 4 metro 10-Gbit/s ADMs, 16 metro 2.5-Gbit/s ADMs and one 4/4 Digital Cross Connect (DXC) with 160 Gigabit cross connection capacity on the left. On the right, all these network elements are replaced by one *LambdaUnite* MSS NE.



Configurations

Because of the modular design of *LambdaUnite* MSS, the system can be configured as:

- One or multiple Add/Drop Multiplexer (ADM) system working at 40 Gbit/s (next release) or 10 Gbit/s line rate in rings or linear chains
- One or multiple Terminal Multiplexer (TM) system working at 40 Gbit/s (next release) or 10 Gbit/s line rate
- A Cross Connect (XC) system with 40-Gbit/s (future release), 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s (future release), 155-Mbit/s (future release) SDH/SONET interfaces, and 10-Gbit/s Ethernet (future release) or 1-Gbit/s Ethernet interfaces.

Management

Like most of the network elements of the Lucent Technologies Optical Networking Group (ONG) product portfolio, *LambdaUnite* MSS is managed by Lucent Technologies *Navis* Optical EMS, a user-friendly subnetwork and element level management system. On a network level, the network management system *Navis* Optical NMS can be used to manage, among others, the *LambdaUnite* MSS network elements. A local craft terminal, the *WaveStar* Craft Interface Terminal (CIT), is available for on-site, but also for remote operations and maintenance activities.

Interworking

LambdaUnite MSS is a member of the suite of next generation transport products which have the prefix "Lambda" in their name. The system can be deployed together with other Lucent Technologies transport products, for example *WaveStar* TDM 10G, *WaveStar* ADM-16/1, *WaveStar* BandWidth Manager, *Metropolis*™ DMX, *WaveStar* OLS 1.6T, *LambdaXtreme*™ Transport and *LambdaRouter*™ All Optical Switch systems today and in the future. This makes *LambdaUnite* MSS one of the main building blocks of today's and future transport networks.

If necessary, you can coordinate with Lucent Technologies what products are able to interwork with *LambdaUnite* MSS.

□

The optical networking products family

Overview

Lucent Technologies offers the industry's widest range of high-quality transport systems and related services designed to provide total network solutions. Included in this offering is the optical networking product family. The optical networking product family offers telecommunications service providers advanced services and revenue-generating capabilities.

Family members

The optical networking products family includes products designed to bring your networks forward into the next century.

The following table lists optical networking products that are currently available or under development.

Optical networking product	SONET	SDH
LambdaRouter™ All Optical Switch (AOS)	Yes	Yes
LambdaUnite™ MultiService Switch (MSS)	Yes	Yes
LambdaXtreme™ Transport	Yes	Yes
Metropolis™ DMX Access Multiplexer	Yes	No
Metropolis DMXpress Access Multiplexer	Yes	No
Metropolis Enhanced Optical Networking (EON OLS 40G/80G)	Yes	Yes
Navis™ Optical Element Management System (EMS)	Yes	Yes
Navis Optical Network Management System (NMS)	Yes	Yes
WaveStar® ADM 16/1	No	Yes
WaveStar ADM 16/1 Compact	No	Yes
WaveStar ADM 4/1	No	Yes
WaveStar AM1	No	Yes
WaveStar AM1 Plus	No	Yes
WaveStar BandWidth Manager	Yes	Yes
WaveStar DACS 4/4/1	No	Yes
WaveStar Digital Video System (DVS)	Yes	No
WaveStar External Orderwire (EOW)	Yes	Yes

Optical networking product	SONET	SDH
WaveStar Optical Line System (OLS) 1.6T	Yes	Yes
WaveStar OpticGate™ Subsystems	Yes	No
WaveStar R 16	No	Yes
WaveStar TDM 10G (OC-192)	Yes	No
WaveStar TDM 10G (STM-64)	No	Yes
WaveStar TDM 2.5G (OC-48)	Yes	No
WaveStar TM1	No	Yes
WaveStar TransLAN™ Card	No	Yes

Family features

The optical networking products family offers customers

- SDH and/or SONET-based services
- Scalable cross-connect, multiplex and transport services
- Network consolidation and reliability
- Interoperability with other vendors' products
- Coordination of network element and element management services

□

LambdaUnite™ MSS description

Overview

The *LambdaUnite* MSS system architecture is based on a 320 Gbit/s full non-blocking switch matrix with AU-3 granularity. This equals 6144 x 6144 STS-1s or 2048 x 2048 VC-4s. The switch can be upgraded to 640 Gbit/s capacity in a later release.

The system provides 32 universal slots, which can be flexibly configured with 40-Gbit/s (future release), 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s (future release), 155-Mbit/s (future release), 10-Gbit/s Ethernet WANPHY and 1-Gbit/s Ethernet optical interface circuit packs. Any one-slot wide interface circuit pack can be operated in any slot position with no connectivity restrictions in all configurations.

The mix and the number of 40-Gbit/s, 10-Gbit/s, 2.5-Gbit/s 2-fiber/4-fiber rings and linear links is only limited by the maximum number of slots. This makes *LambdaUnite* MSS a highly flexible system and allows for a variety of different configurations.

One whole network element fits in a double row sub-rack. The dimensions of the sub-rack are: 950 x 500 x 545 mm (37.4 x 19.7 x 21.5 in) (H x W x D). Therefore, two complete network elements fit in one rack. The sub-racks are in accordance with Rec. ETS 300 119-4 and Telcordia and can be mounted in ETSI racks (2200 mm (86.6 in) and 2600 mm (102.4 in) height) and Telcordia racks (2125 mm (83.7 in) height).

LambdaUnite MSS sub-rack

The following figure illustrates the *LambdaUnite* MSS sub-rack in top-position in an ETSI rack.

Building requirements for _LambdaUnite_ MSS operation

LambdaUnite MSS is designed for areas with restricted access, in particular:

- For central office (CO) applications according to Telcordia GR-1089-CORE, section 1.1 and GR-63-CORE, section 1.1,
- For telecommunication centres according to ETS 300 019-1-3, section 4.1.

2 Features

Overview

Purpose

This chapter briefly describes the features of *LambdaUnite*™ MultiService Switch (MSS).

For more information on the physical design features and the applicable standards, please refer to Chapter 6 and Chapter 10.

Standards Compliance

Lucent Technologies SONET and SDH products comply with the relevant ETSI, Telcordia and ITU-T standards. Important functions defined in SDH and SONET Standards such as the Data Communications Channel (DCC), the associated 7-layer OSI protocol stack, the SONET and SDH multiplexing structure and the Operations, Administration, Maintenance, and Provisioning (OAM&P) functions are implemented in Lucent Technologies product families.

Lucent Technologies is heavily involved in various study groups with ITU-T, Telcordia and ETSI work creating and maintaining the latest worldwide SONET and SDH standards. *LambdaUnite* MSS complies with all relevant and latest Telcordia, ETSI and ITU-T standards and supports both, SONET and SDH protocols in a single hardware-software configuration.

Contents

Physical interfaces

Overview

Purpose

This section provides information about all kinds of physical external interfaces of *LambdaUnite*™ MSS. For detailed technical data and optical parameters of the interfaces please refer to Chapter 10, “Technical Specifications”.

The *LambdaUnite* MSS hardware (HW) and software (SW) architecture supports terminal multiplexer (TM), add-dropp-multiplexer (ADM) and cross connect (XC) configurations (multi-ring terminal, optical switch) on all line rates within the same sub-rack and with a single common SW load. Any circuit pack, with exception of the 40-Gbit/s packs (future release), can be operated in any slot position of the sub-rack without any restrictions in terms of unit number and types; each of the 32 slots supports up to 10 Gbit/s traffic, handled by the switching matrix (up to 320 Gbit/s in this release, up to 640 Gbit/s in future release).

□

Synchronous interfaces

SONET and SDH interfaces

LambdaUnite™ MSS supports transmission rates of 10 Gbit/s and 2.5 Gbit/s. In the next release, 40-Gbit/s interfaces, further 10-Gbit/s and 2.5-Gbit/s interfaces, and 622-Mbit/s as well as 155-Mbit/s interfaces will be available. All circuit packs support SDH and SONET formatted signals.

The following synchronous interfaces are available:

- 10-Gbit/s long reach interface (80 km), 1550 nm
- 10-Gbit/s intermediate reach / short haul interface (40 km), 1550 nm
- 10-Gbit/s intra-office interface (600 m), 1310 nm
- 2.5-Gbit/s long reach interface (80 km), 1550 nm
- 2.5-Gbit/s long reach interface (40 km), 1310 nm
- 2.5-Gbit/s short reach / intra-office interface (2 km), 1310 nm.

In future will additionally be available:

- 40-Gbit/s long reach interface (80 km), 1550 nm, with out-of-band FEC
- 40-Gbit/s intermediate reach interface (40 km), 1550 nm, with out-of-band FEC
- 40-Gbit/s interface for direct *LambdaXtreme*™ Transport interworking, 64 wavelengths
- 40-Gbit/s intra-office interface (14 km), 1310 nm
- 10-Gbit/s interface for direct *LambdaXtreme* Transport interworking, 128 wavelengths
- 10-Gbit/s interface for direct *WaveStar*® OLS 1.6T (400G) interworking, 40 wavelengths
- 10-Gbit/s interface for direct *WaveStar* OLS 1.6T (800G) interworking, 80 wavelengths
- 2.5-Gbit/s intermediate reach / short haul interface (60 km), 1550 nm, passive WDM compatible, 32 wavelengths
- 622-Mbit/s intermediate reach / short haul interface (15 km), 1310 nm
- 155-Mbit/s intermediate reach / short haul interface (15 km), 1310 nm.

□

Data interfaces

Ethernet interface

LambdaUnite™ MSS supports an optical 1-Gbit/s (1000BASE-SX) Ethernet interface in accordance with IEEE 802.3-2000 Clause 38. The Ethernet interface supports auto-negotiation, as defined in Section 37 of IEEE 802.3. This feature, among others, enables IEEE-802.3-compliant devices with different technologies to communicate their enhanced mode of operation in order to inter-operate and to take maximum advantage of their abilities, see also "Ethernet data mapping (virtual concatenation)" (2-11) and "1-Gbit/s Ethernet" (10-9).

The 1 Gbit/s Ethernet circuit pack (GE1/SX4) supported by *LambdaUnite* MSS allows to transport Gigabit Ethernet signals over SDH or SONET networks by encapsulating Ethernet packets in virtually concatenated VC-4 or STS-1s. This GbE interface supports point-to-point connectivity.

Each GE1/SX4 circuit pack offers four bidirectional 1000BASE-SX Ethernet LAN ports (LC connectors). Each external port can be connected to seven virtually concatenated VC-4s, or in future also to flexibly configurable VC-4s or to STS-1s (the maximum amount of STS-1s per port is 21, in case of SDH operation it is 7 VC-4s).

10-Gbit/s Ethernet WANPHY: the 10-Gbit/s synchronous intermediate reach / short haul interface (40 km) supports 10-Gbit/s Ethernet WANPHY transmission.

□

Timing interfaces

Synchronization interfaces

LambdaUnite™ MSS provides two physical timing inputs and two timing outputs. For SONET applications, DS1 (B8ZS) Telcordia timing signals (SF or ESF) are supported. In SDH networks, ITU-T compliant 2.048 kHz and 2 Mbit/s (framed or unframed) timing signals can be used as inputs and outputs, see also "Timing features" (2-25).

□

User byte and orderwire interfaces

User byte and orderwire interfaces

LambdaUnite™ MSS provides six physical overhead access interface ports. Four ports are configurable to operate in G.703 or in V.11 mode. Two ports only support V.11 mode. In V.11 mode the interface supports frame clock and bit clock. The interfaces operate in contradirectional mode (timing provided by transport system). The engineering orderwire interface (EOW) will be supported in future.

□

Operations interfaces

Operations interfaces

LambdaUnite™ MSS is equipped with the following operations interfaces:

- Station alarm interface which drives three rack top lamps (indicating critical/prompt, major/deferred and minor/informal alarms)
- LEDs on each controlled circuit pack (red fault LED, green status LED)
- User panel with several LEDs to indicate alarms and status, an alarm cut-off (ACO) button, an LED test button, and one LAN interface to *WaveStar*® Craft Interface Terminal (CIT) or *Navis*™ Optical Element Management System (EMS)
- Eight miscellaneous discrete inputs and eight miscellaneous discrete outputs (MDI/MDO) for control and supervision purposes (in a future release)
- Three LAN connectors on the rear, two of them for management systems (e.g. *Navis* Optical EMS), and one for *LambdaXtreme*™ Transport interworking in a future release.

□

Power interfaces and grounding

Power supply

Two redundant power supply inputs are available per shelf. The supply voltage is -48 V DC to -60 V DC nominal, and the maximum power consumption supported in the present release is 2.700 W. The system powering meets the ETSI requirements ETS 300132-2, Telcordia Technologies General Requirements GR-1089-CORE and GR-499-CORE. Operation range is -40 V DC to -72 V DC.

System grounding

System grounding can be done according to

- ETSI requirements in ETS 300253 (mesh ground with the battery return connected to ground),
- Telcordia GR-1089-CORE.

□

Transmission features

Overview

Purpose

This section gives an overview of the transmission related features of the *LambdaUnite*™ MultiService Switch (MSS). For more detailed information on the implementation of the switch function in the NE please refer to Chapter 4, “Product Description”.

□

Cross-connection features

Cross-connection rates

LambdaUnite™ MSS supports unidirectional and bidirectional cross-connections for STS-1/HO VC-3, STS-3c/VC-4, STS-12c/VC-4-4c, STS-48c/VC-4-16c and STS-192c/VC-4-64c payloads. The assignment of unidirectional cross-connection does not occupy or restrict cross-connection capacity or cross-connection types in the reverse direction.

Cross-connection capacity

The cross-connection capacity of *LambdaUnite* MSS is 320 Gbit/s in total (6144 x 6144 STS-1 / 2048 x 2048 VC-4). In a future release it can be upgraded to 640 Gbit/s.

Bridged cross-connections (broadcast)

An existing cross-connection can be bridged by adding a unidirectional cross-connection from the existing input port to a second output port, resulting in a 1:2 broadcast. *LambdaUnite* MSS supports bridging for each of the supported cross-connection rates without impairing the existing signal. Conversely, either broadcast leg can be removed without impairing the remaining cross-connected signal.

Rolling cross-connections

The system supports facility rolling for all allowed cross-connection rates. Rolling means that for an existing cross-connection a new source can easily be selected, i.e. the cross-connection can be “rolled” to this new source without traffic interruption.

Fully non-blocking cross-connections

The system is strictly non-blocking for all supported cross-connection arrangements (point-to-point, multi-cast allowable port type connections, etc.) among all transmission interfaces within the cross-connection capacity of the system (320 Gbit/s in total: 6144 x 6144 STS-1 / 2048 x 2048 VC-4). Thus, within the system cross-connect capacity, a desired cross-connection can always be established, regardless of the state of other cross-connections. New cross-connections and/or disconnections do not cause any bit errors on existing cross-connections.

Ethernet data mapping (virtual concatenation)

Data which is intended to be transmitted via the 1-Gigabit Ethernet (GbE) interface can be mapped with the present release into seven VC-4s (fixed Link Capacity Adjustment Scheme (LCAS)).

In future the following unidirectional and bidirectional virtual concatenations will be supported:

- STS-1-Kv, where K = 1 up to 21 in steps of 1
- VC-4-Kv, where K = 1 up to 7 in steps of 1.

The mapping is compliant to the generic framing procedure acc. to T1X1.5/2000-147. Differential delays of up to 32 ms can be compensated. The flexible LCAS will then be supported which allows manual in-service dynamic sizing of bandwidth in an STS-1-Kv/VC-4-Kv link.

SONET pipe mode cross-connections

The system supports STS-3, STS-12, STS-48 and STS-192 unidirectional and bidirectional pipe-mode cross-connections. The STS-3 pipe mode cross-connection allows STS-3c or multiple STS-1 transport without extra provisioning. The STS-12 pipe-mode cross-connection allows STS-12c or multiple STS-3c / STS-1 transport or any mix without extra provisioning. The STS-48 pipe mode cross-connection allows STS-48c or multiple STS-12c / STS-3c / STS-1 transport or any mix without extra provisioning. The STS-192 pipe mode cross-connection allows STS-192c or multiple STS-48c / STS-12c / STS-3c / STS-1 transport or any mix without extra provisioning.

Pipe-mode processing can be configured at the port level. A pipe-mode cross-connection is created by provisioning a cross-connection with an input leg within a pipe-mode port. Path fault management and performance monitoring are performed independently for each of the path-level constituent signals within a pipe-mode port.

Inter-connection between SONET- and SDH-structured ports

The *LambdaUnite* MSS switching matrix supports an inter-connection between SONET and SDH structured ports: SONET signals can be cross-connected to the relative SDH signals and vice versa.

Unequipped signal insertion

In case an STS/VC is not cross-connected, an unequipped signal is inserted in downstream direction.

□

Forward error correction

Overview

Forward error correction (FEC) makes it possible to improve the optical signal-to-noise ratio (OSNR), and thus to lower the bit error ratio, of an optical line signal by adding redundant information. This redundant information can then be used to correct bit errors that unavoidably occur when an optical line signal is transmitted over longer distances over an optical fiber.

Out-of-band forward error correction

LambdaUnite™ MSS supports “strong” Forward Error Correction:

- Out-of-band FEC (also referred to as “strong FEC”)
  The redundant information is appended to the original signal resulting in an optical signal with a modified framing structure and extended bit rate. The bit rate is increased by approx. 7%. The new signal format is referred to as “Optical Channel” at the corresponding bit rate.

□

Dual Node Ring Interworking

DRI/DNI

LambdaUnite™ MSS will support dual node ring interworking for both, SONET and SDH formatted signals in a future release:

- SONET: Dual Ring Interworking (DRI)
- SDH: Dual Node Interworking (DNI).

□

Line protection

Overview

LambdaUnite™ MSS supports linear protection features:

- SONET: 1+1 linear Automatic Protection Switching (line APS)
- SDH: 1+1 Multiplex Section Protection (MSP)

Linear APS / MSP principle

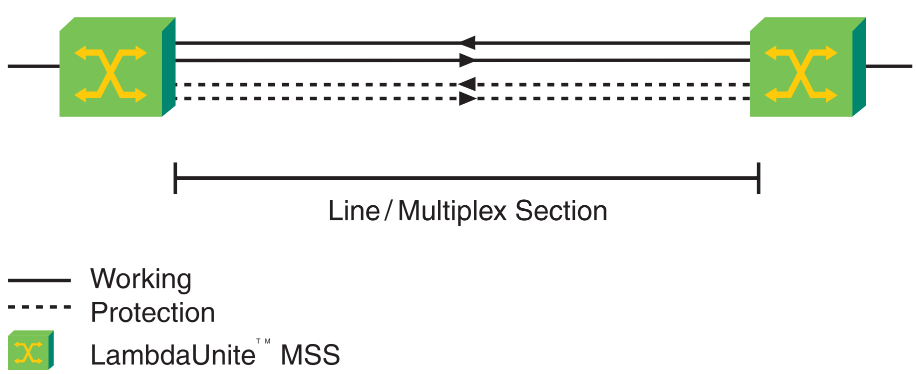
The principle of a linear APS is based on the duplication of the signals to be transmitted and the selection of the best signal available at the receiving port. The two (identical) signals are routed over two different lines, one of which is defined as the working line, and the other as protection line. The same applies to the opposite direction (bidirectional linear APS). The system only switches to the standby line if the main line is faulty.

It is possible to add/drop linear APS protected traffic from/to all ports in the NE. Linear APS protection switching can be configured revertive or non-revertive with *WaveStar*® CIT or *Navis*™ Optical EMS.

Linear APS / MSP schemes

Linear APS protection schemes can be configured with *LambdaUnite* MSS network elements for all synchronous interfaces. The SONET 1+1 Linear APS scheme complies with the ANSI T 1.105.01 APS standard. The SDH multiplex section protection (MSP) scheme complies with the ITU-T Rec. G.841.

The following figure shows an 1+1 linear APS protection example: one physical main (working) connection between multiplexers is protected by one physical stand-by (protection) connection.



The system supports multiple linear APS protections at the same time up to the full transmission/slot capacity. There is no restriction due to other configuration or performance limitations.

Linear APS protection switching can be configured with *WaveStar* CIT or *Navis* Optical EMS in the following modes: unidirectional, bidirectional (each revertive or non-revertive), or optimized.

□

Path protection

Overview

LambdaUnite™ MSS supports both, SONET and SDH path protection features:

- SONET: Unidirectional Path-Switched Ring (UPSR)
- SDH: Subnetwork Connection Protection (SNCP)

UPSR/SNCP benefits

This feature allows you to provide additional end-to-end survivability for selected circuits in a network.

UPSR/SNCP principle

The principle of a UPSR/SNCP is based on the duplication of the signals to be transmitted and the selection of the best signal available at the path termination. The two (identical) signals are routed over two different path segments (uni-directional paths), one of which is defined as the main path and the other as standby path. The same applies to the opposite direction (bidirectional UPSR/SNCP). The system only switches to the standby path if the main path is faulty.

UPSR/SNCP with *LambdaUnite* MSS

UPSR/SNCP protection switching can be configured with *WaveStar*® CIT or *Navis*™ Optical EMS in two modes: revertive or non-revertive. When revertive switching is configured, a Wait-To-Restore time (WTR) can be defined. Additionally a hold-off timer can be configured individually for each path selector to defer to other protection features in case of redundant protection.

UPSR/SNCP can be configured for all types of cross-connections (see “Cross-connection features” (2-11)). It is possible to add/drop UPSR/SNCP protected traffic from/to all ports in the NE. There are no restrictions regarding the types or mix of supported interfaces. Also traffic from 1 Gigabit Ethernet interfaces may be protected. UPSR/SNCP can be configured up to the total capacity of the system on the lowest path (cross-connection) granularity. The protection schemes comply with the Telcordia GR-1400-CORE, respectively ETS 300417 and ITU-T Rec. G.783.

UPSR

LambdaUnite MSS supports UPSR protection, also within logical ring applications.

SNCP

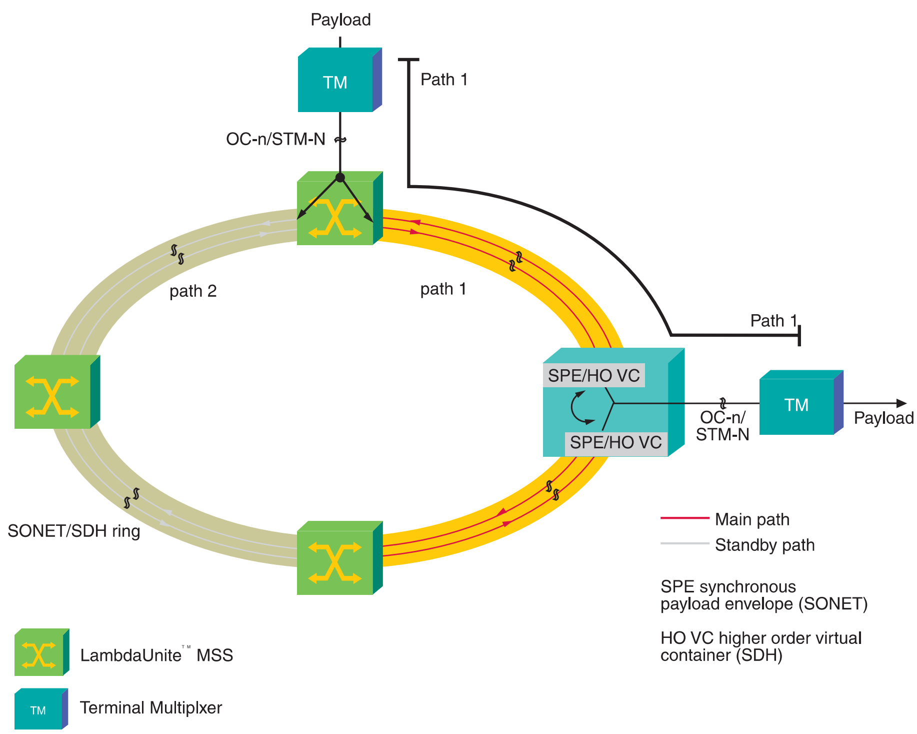
LambdaUnite MSS supports two types of SNCP:

- Inherently monitored subnetwork connection protection (SNC/I)
- Non-intrusively monitored subnetwork connection protection (SNC/N).

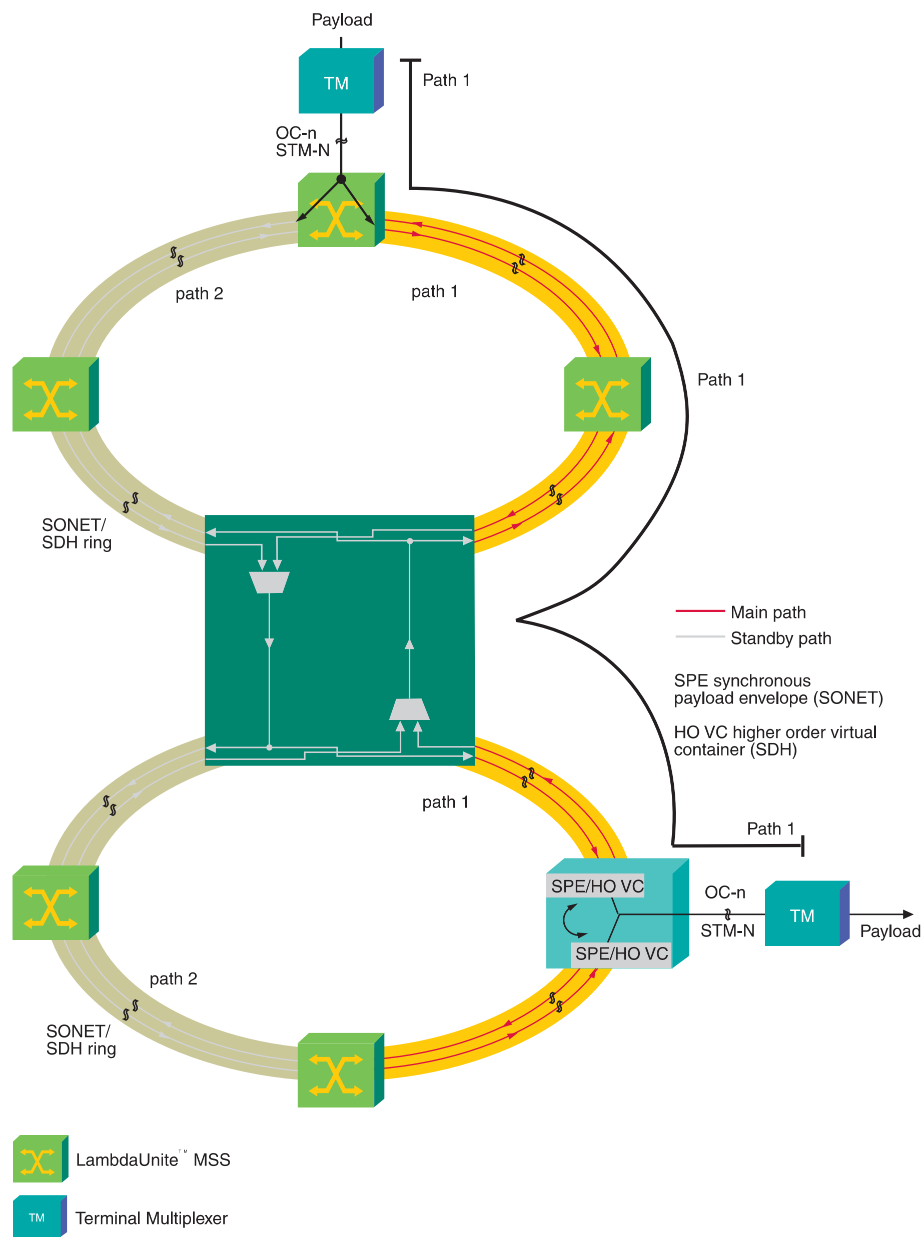
UPSR/SNCP configuration

The *WaveStar* CIT cross-connection Wizard supports the creation of UPSR/SNCP protected paths in single rings and in connected rings (ring-to-ring configuration, i.e., one NE connects to two rings). Please note that in the ring-to-ring configuration the full UPSR/SNCP is available within each ring. The connection between the rings, this means the connection within the network element, is unprotected, because in this example there is just a single-homed ring connection (refer to "Dual-homed vs. single-homed" (3-32)), no dual node ring interworking.

The following figure shows a single ring UPSR/SNCP application. Path 1 is the working (main) path, path 2 is the protection (standby) path in this example. The path termination is always outside *LambdaUnite* MSS. For simplification, the UPSR/SNCP switch is only shown for a unidirectional connection.



The following figure shows a ring-to-ring UPSR/SNCP configuration. Here, the UPSR/SNCP also consists of a broadcast in transmit direction. The signal then moves through the first ring via path 1 (working) and path 2 (protection). The ring is connected to another ring via one single NE. For simplification, the UPSR/SNCP switch is only shown for a unidirectional connection.



Manual switch

The following manual switching actions are possible with *WaveStar* CIT or *Navis* Optical EMS:

- Manual to working: switches the traffic to the main path if it is not faulty
- Manual to protection: switches the traffic to the standby path if it is not faulty
- Forced to working: causes switchover to the main (working) path (even if this path is faulty)
- forced to protection: causes forced switchover to the standby (protection) path (even if this path is faulty)
- Clear: clears any active manual switch request; clear will also release the wait-to-restore timer when provided for revertive switching.

Protection scheme independence

Due to the *LambdaUnite* MSS architecture protection schemes of different layers do not interact from a resource or provisioning perspective. Especially *LambdaUnite* MSS supports the back-to-back configuration of protection schemes. In a back-to-back configuration the selector of the first protection scheme is followed by the bridge function of the second protection scheme. Exceptions from that rule are DRI/DNI configurations (not supported in the present release).

□

Equipment features

Overview

Purpose This section provides information about *LambdaUnite*™ MSS features concerning hardware protection, inventory and failure reports.

□

Equipment protection

Circuit pack protection

To enhance the reliability of the system, the switch and timing function (physically combined on one circuit pack) form a 1+1 non revertive equipment protection. Besides automatic switching, manual (forced) switching is supported to minimize operations interruption e.g. in maintenance scenarios (exchange of circuit packs).

Power supply

The power feed is maintained duplicated throughout the system.

□

Equipment reports

Equipment inventory

LambdaUnite™ MSS automatically maintains an inventory of the following information of each installed circuit pack:

- Serial number
- ECI code
- CLEI code
- Functional name
- Apparatus code
- Series number
- Functional qualifier
- Software release (of the NE)

You can obtain this information by an inventory request command.

Equipment failure reports

Failure reports are generated for equipment faults and can be forwarded via the *WaveStar*® CIT and *Navis*™ Optical EMS interfaces.

Synchronization and timing

Overview

Purpose This section provides information about synchronization features, timing protection and timing interfaces of *LambdaUnite*™ MSS.

□

Timing features

Synchronization modes

Several synchronization configurations can be used. The *LambdaUnite*™ MSS can be provisioned for:

- Locked mode, internal Station Equipment Clock (SIC/SEC) locked to either:
  - One of two external synchronization inputs (each of them accepts 2.048 kHz, 2 Mbit/s (framed or unframed) or DS1 (B8ZS) signals (SF or ESF), or
  - One of up to six OC-n / STM-N input signals (choice of input is provisionable).

  Thus in the timing reference list up to eight timing references can be configured. The timing reference for the external timing output can be provisioned independently from the timing reference for the system clock.
- Hold-over mode (in locked mode of operation, if no acceptable references are available, the internal clock will switch to the hold-over state)
- Forced hold-over mode (the user can select the internal oscillator to use stored correction data of the last available used input reference)
- Free-running.

Synchronization provisioning

It is possible to provision manual timing reference switching, to set priorities for timing sources, to choose timing sources that are added to the sources list, to lock out of individual timing sources, etc. using the *WaveStar*® CIT or the *Navis*™ Optical EMS.

□

Timing protection

Timing unit protection

In *LambdaUnite*™ MSS the timing functionality is physically located on the switching circuit pack. Thus, 1+1 non-revertive protection of the timing functionality is provided (see "Equipment protection" (2-22)).

Timing reference selection

Automatic timing reference switching is supported by *LambdaUnite* MSS on signal failure of the active timing reference. The timing reference selection is according to ETSI 300 417.1.1 / ITU-T Rec. G.781 for SDH timing and Telcordia GR-253 for SONET timing. If all provisioned timing references fail or become unacceptable, the system will automatically switch over to the hold-over mode.

□

Timing interface features

External timing outputs

LambdaUnite™ MSS provides external timing output signals derived from the system clock or from the incoming aggregate signals. These output ports support 2 MHz or 2 Mbit/s (framed or unframed) signals as per ITU-T Rec. G.812 and G.703 or DS1 (B8ZS) signals (SF or ESF).

An external timing output will automatically be squelched as soon as its associated Quality Level (QL) drops below a provisionable threshold. Squelching is implemented by turning the timing output signal off.

Synchronization Status Message (SSM)

A Synchronization Status Message (SSM) can be used to indicate the signal quality level throughout a network. This will guarantee that all network elements will always be synchronized to the highest quality clock available.

On the *LambdaUnite* MSS system, the SSM algorithm is implemented according to ETS 300 417-6 and GR-253-CORE. SSM is supported on incoming and outgoing optical 2.5-Gbit/s and 10-Gbit/s interfaces, in future also 40-Gbit/s interfaces.

The user can assign a certain SSM value (overriding the received SSM, if any) to any synchronization reference signal that can be made available to the SSM selection algorithm.

It is possible to force each individual outgoing SSM value (overriding the SSM computed by the algorithm) to the value DNU/DUS (do not use for synchronization).

Additionally *LambdaUnite* MSS supports insertion of an SSM value into an outgoing 2-Mbit/s framed signal (external timing output) and evaluation of the SSM of an incoming 2-Mbit/s framed signal (external timing input). This feature complies to the ITU-T Rec. G.704 and Bellcore TR-NWT-000499 respectively.

□

Operations, Administration, Maintenance and Provisioning

Overview

Purpose The following section provides information about interfaces for Operations, Administration, Maintenance, and Provisioning (OAM&P) activities and the monitoring and diagnostics features of *LambdaUnite*™ MultiService Switch (MSS).

□

Interfaces

WaveStar® CIT and Navis™ Optical EMS

Operations, Administration, Maintenance, and Provisioning (OAM&P) activities are performed using either the *WaveStar* Craft Interface Terminal (CIT) or *Navis* Optical Element Management System (EMS). The *WaveStar* CIT and the *Navis* Optical EMS is a customer-supplied Windows NT PC running the *WaveStar* Graphical User Interface (GUI) software. You can plug it into the *LambdaUnite*™ MSS user panel or use it at a remote location to access *LambdaUnite* MSS by means of a LAN or of Data Communications Channel (DCC). You can use the *WaveStar* CIT and the *Navis* Optical EMS to run a fully featured GUI. The GUI provides access to the entire *LambdaUnite* MSS functionality and contains extensive menus and context-sensitive help.

Full TL1 command/message set

LambdaUnite MSS supports the full TL1 command and message set. The *WaveStar* CIT and the *Navis* Optical EMS convert user inputs at the GUI into the corresponding TL1 commands and convert TL1 responses and messages into the GUI displays.

TL1 cut-through interface

The *LambdaUnite* MSS system provides a TL1 cut-through interface via *WaveStar* CIT and *Navis* Optical EMS. Thus, you can interact with the NE using the TL1 language directly. *Navis* Optical EMS provides TL1 cut-through as a function within the GUI and also supports a special TL1 login. The TL1 cut-through is useful because it enables you to build custom macros of multiple TL1 commands coupled with a broadcast capability to send the TL1 commands to multiple NEs. Furthermore, TL1 cut-through is necessary for some infrequently used commands that are not supported by the *Navis* Optical EMS GUI.

Security

LambdaUnite MSS uses logins, passwords, authentication, and access levels to protect against unauthorized access. It also keeps the security log.

Local and remote software downloads

With *LambdaUnite* MSS software can be downloaded from the *WaveStar* CIT, or from the *Navis* Optical EMS. Software downloading does not affect transmission or operations. Activating the newly downloaded software may affect operations but does not affect transmission.

OSI LAN interface

LambdaUnite MSS also communicates with remote logins, operations systems and management systems by means of the standard 7-layer OSI protocol over a LAN.

TCP/IP tunnelling

TCP/IP tunnelling via OSI will be supported by *LambdaUnite* MSS in future.

DCC interfaces

The *LambdaUnite* MSS system supports operations via the standard 7-layer OSI protocol over Data Communications Channel (DCC). Section DCC (DCC_R) and line DCC (DCC_M) channels are available in 2.5-Gbit/s, 10-Gbit/s, and in a future release in 155-Mbit/s, 622-Mbit/s and 40-Gbit/s signals. DCC channel protection switching is supported in conjunction with protection switching of the respective optical interface.

NE level

Detailed information and system control is obtained by using the *WaveStar* CIT (Craft Interface Terminal) which supports provisioning, maintenance, configuration on a local basis. A similar facility is remotely (via a Q-LAN connection or via the DCC channels) available on the *WaveStar* CIT, or on the *Navis* Optical EMS, which provides a centralized maintenance view and supports maintenance activities from a central location.

Orderwire and User Channel

Orderwire and user channel interfaces are physically implemented on the Control Interface Panel. E1, E2 and F1 byte access will be supported in a future release.

□

Monitoring and diagnostics features

Performance monitoring

LambdaUnite™ MSS monitors performance parameters on the transmission interfaces, so monitoring can be full-time for each signal without requiring any additional cross-connect capacity.

Monitoring of optical interface parameters

The user can monitor the values of the laser bias current and the received and transmitted optical power of 40-Gbit/s (future release) and 10-Gbit/s interfaces.

Port monitoring modes

Each physical interface can be in one of three different modes: automatic (AUTO), monitored (MON) or non-monitored (NMON). In NMON mode all alarms that originate in the physical section termination function are suppressed, while in the MON mode they are reported. In the AUTO mode alarms are suppressed until an incoming signal is detected, then the mode of the port switches automatically to MON.

Transmission maintenance signals

Regenerator section, multiplex section, and higher order path maintenance signals are supported as per ITU-T Rec. G.783. The system can generate and retrieve path trace messages on STS-1 respectively higher order VC-3 and VC-4 level as well as section trace messages respectively STM-N RSOH messages.

Path termination point monitoring modes

Each Path Termination Point can be in one of two different modes, monitored (MON) or non-monitored (NMON). In NMON mode all alarms that originate in the termination point are suppressed, while in the MON mode they are reported .

Provisioned state record

LambdaUnite MSS automatically maintains a record of the provisioned state of each transmit and receive port on each circuit pack.

Loopbacks

LambdaUnite MSS supports facility loopbacks for testing and maintenance purposes. These loopbacks are available for each supported signal type. Facility loopbacks are established electrically on port-level on a port unit. Two different types are available:

- Near-side loopback (in-loop)
- Far-side loopback (out-loop)

The loopbacks can be configured via *WaveStar*® CIT and *Navis*™ Optical EMS.

Local and remote inventory

The *LambdaUnite* MSS system provides automatic version recognition of the entire hardware and software installed in the system. This greatly simplifies troubleshooting, dispatch decisions, and inventory audits. A list of detailed information, see "Equipment inventory" (2-23), is accessible via the local *WaveStar* CIT or via the *Navis* Optical EMS.

Self diagnostics (in-service)

The system runs audits and diagnostics to monitor its health. These self-diagnostics don't have any effect on the performance of the system.

Auto-recovery after input power interrupt

The system can restore itself automatically after an interruption of the power.

Recovery from configuration failures

If the system detects that its configuration database is empty or corrupted it will remain in the current configuration without impacting the traffic, will raise an alarm and will request an configuration update from the *Navis* Optical Network Management System (NMS).

□

Lucent Technologies
Bell Labs Innovations

3 Network topologies

Overview

Purpose

This chapter describes the key applications of *LambdaUnite*™ MultiService Switch (MSS). It gives an overview of the various network applications and identifies the key functions associated with these applications.

Network tiers

Optical networks can be structured into three tiers in order to simplify their understanding, modelling and implementation:

- Backbone (tier 3)
- Metro core/regional (tier 2)
- Access (tier1)

Due to the flexibility of *LambdaUnite* MSS it is able to cover many different applications especially in the backbone and metro core/regional tier. The following sections will identify some of the main applications and configurations for which *LambdaUnite* MSS is optimized.

Contents

Backbone applications

Overview

Purpose

This section provides, after a brief introduction to the backbone topology, information about backbone applications for *LambdaUnite*™ MSS.

Characterization of tier 3 topologies

The backbone network tier typically shows the following features:

- Ring and meshed network topology
- Long and very long distance (several thousand kilometers)
- High capacity per fiber (multiple terabit/s)
- Efficient protection schemes (e.g. 4-fiber BLSR/MS-SPRing)
- Traffic patterns of big pipes (2.5 Gbit/s and beyond)
- Edge grooming (45-Mbit/s up to 10-Gbit/s services)

Contents

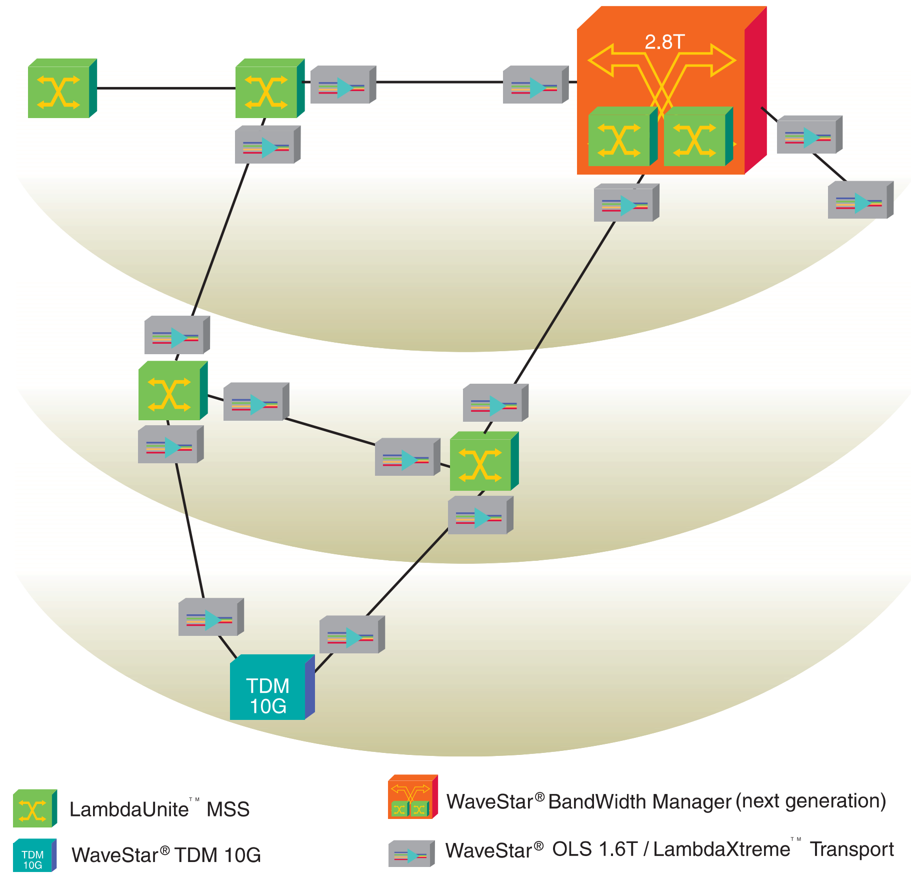
Classical backbones

Overview

This application shows the fit of *LambdaUnite*™ MSS in a backbone transport network, which uses a combination of DWDM and SONET/SDH technology in a meshed topology.

Classical backbone example

The given application is characterized by the use of DWDM equipment for cost optimized long distance point-to-point transport to link the Points of Presence (PoP) in the network. Network Protection Equipment (NPE) based on SONET/SDH is used in the PoPs to protect and redirect traffic, as well as to monitor transport quality and isolate faults. The service capacities handled in this network range from STS-1 (50 Mbit/s) or VC-4 (155 Mbit/s) on the low end to concatenated service signals with speeds up to 10 Gbit/s. For optimal reliability stacked BLSR/MS-SPRing rings are provisioned through the NPE in different PoPs. The selection of the network elements which form a ring is determined by the topology and the traffic pattern of the network.



LambdaUnite MSS fits very well in this application as the capacity and density of the system allows for easy and cost efficient scaling when new lambdas are lit in the DWDM equipment. Together with the next generation BWM and the TDM 10G solutions, Lucent Technologies offers an NPE solution set that meets all scalability needs. It is fully compliant to SONET/SDH cross-connection, protection and monitoring standards matching the expectations of operators. Additionally, in the case Lucent DWDM equipment is used, *LambdaUnite* MSS offers direct optics into the DWDM equipment allowing for substantial savings with respect to cost and footprint.

As the network evolves high-performance mesh service restoration schemes based on an intelligent network element control plane will appear as a way to provision and protect services in the application above. *LambdaUnite* MSS as well as the next generation BWM will support this functionality in a future release.

As transparent high capacity services become more important *LambdaUnite* MSS will support overhead transparent services with a capacity of 2.5 Gbit/s and 10 Gbit/s in a future release. This way transparent high capacity services and all lower speed transport services can be served from a single layer high capacity network. Especially for applications with a substantial portion of the services being in the lower speed range, this is a powerful and flexible solution.

For further increase of transport capacity per fiber and further reduction of the cost per transported bit, *LambdaUnite* MSS will provide 40-Gbit/s interfaces in a future release, including the very interesting option of using direct optics to the 40-Gbit/s DWDM system from Lucent Technologies. Deployment of 40-Gbit/s interfaces does not need any hardware change on the *LambdaUnite* MSS system – the interface pack can directly be plugged into free slots in the system.

□

Transoceanic applications

Overview

This application shows the fit of *LambdaUnite*™ MSS in a transoceanic transport network.

Transoceanic network

A transoceanic network is categorized by very long distance point-to-point DWDM transport links (several thousand kilometer length through the ocean). In addition to these links, shorter DWDM transport links in the terrestrial portion of the network are used to backhaul the traffic from the landing point on the shore of the ocean into the business centers located somewhere deeper in the country. Normally only a small portion of the lambdas available in the undersea and the backhaul links are utilized initially. More lambdas are lit as demand increases.

Network Protection Equipment (NPE) based on SONET/SDH is used in the Points of Presence (PoPs) at the end points of the DWDM links to protect and redirect traffic, as well as to monitor transport quality and isolate faults. The service capacity ranges from VC-4 (155 Mbit/s) to concatenated service signals with speeds up to 10 Gbit/s. The rate per lambda is 10 Gbit/s today with 40 Gbit/s expected in the next release.

***LambdaUnite* MSS in transoceanic topologies**

LambdaUnite MSS fits ideally in the transoceanic application mainly because of the following reasons: The system supports the special transoceanic version of the MS-SPRing protocol in a future release, which is a mandatory requirement for the given application. Even preemptible protection access is supported. *LambdaUnite* MSS allows for easy and cost efficient scaling when new lambdas are lit in the transoceanic and/or backhaul link. It’s capability to support both SONET and SDH out of single node makes it a perfect vehicle for transatlantic links. Finally, the system’s ability to not only support 10-Gbit/s line rates but also 40-Gbit/s line rates makes it perfectly prepared for future needs in this application space.

□

All Optical backbones

Overview

All-optical backbone applications are gaining importance as the need for bandwidth increases and more high capacity services (lambdas) are to be handled. The all-optical backbone serves as an underlying layer below the existing backbone transport layers and this way allows for best scalability at an optimized footprint and power level. Once high capacity services with a data rate of 2.5 Gbit/s, 10 Gbit/s or above become the predominant service types, an all-optical backbone layer shows its advantages. *LambdaUnite*™ MSS plays an important role in all-optical backbone applications, where it is inter-working with a pure OOO (optical-optical-optical) crossconnect like the *LambdaRouter*™ All Optical Switch (AOS).

All-optical backbone example

In the all-optical backbone layer, *LambdaUnite* MSS can be used to bridge the gap between lower speed services offered to customers and the lambda as the smallest unit of capacity that is handled by the all-optical part of the network:

Here *LambdaUnite* MSS performs:

- Aggregation of lower speed services into lambdas (backbone feeding)
- Grooming between different lambdas (sub-λ grooming)

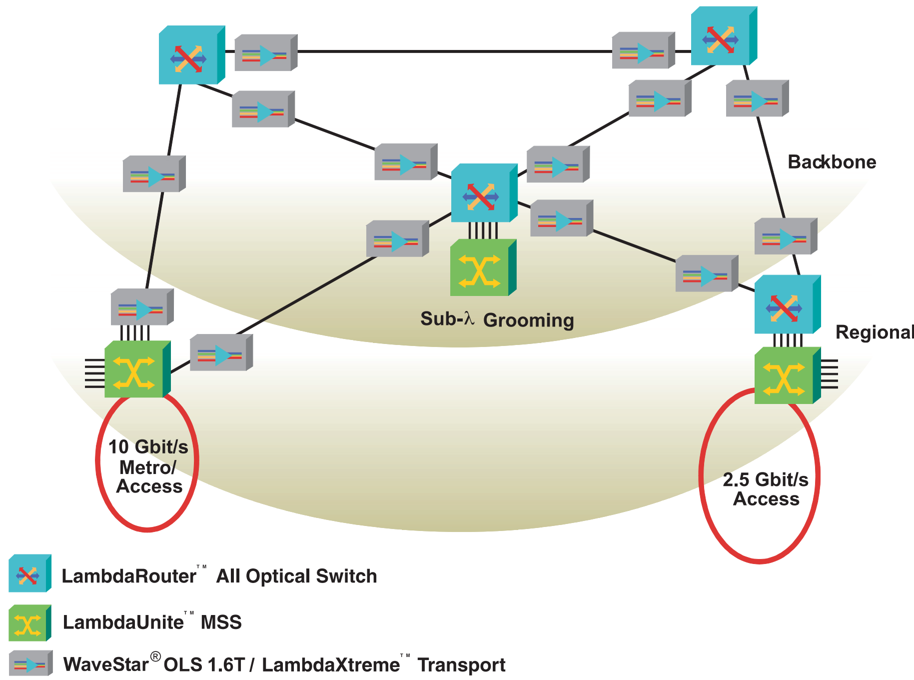
All-optical backbone example

In the picture below the left and middle part illustrates these two functions:

The leftmost *LambdaUnite* MSS element takes lower speed traffic from the regional network and aggregates this traffic into lambdas directly feeding DWDM gear. The lambdas in the network are then redirected via *LambdaRouter* All Optical Switches (AOSs) as the one on the top left of the picture.

The *LambdaUnite* MSS located in the middle of the picture illustrates the grooming function: The system is connected to a *LambdaRouter* AOS, takes the lambdas and regroups the services within the lambdas. This way each lambda can be efficiently utilized.

The right part of the picture illustrates the next evolution step of the all-optical backbone layer: *LambdaRouter* AOS is now taking on the functionality of restoring lambdas and therefore must be used at every Point of Presence (PoP) where traffic is entering the all-optical backbone network. Therefore the right hand side *LambdaUnite* MSS is aggregating services coming from the regional network and feeding the traffic into a *LambdaRouter* AOS, which will perform a wavelength reroute in case of a DWDM link in the all-optical backbone network fails.



As can be easily seen, *LambdaUnite* MSS plays the key role in handling lower speed or “Sub-lambda” services in both cases: *LambdaUnite* MSS takes the function of a DWDM feeder device, providing edge grooming and protection functionality.

Grooming functionality (down to STS-1/VC-3 level), together with flexible time slot assignment / interchange and fully non-blocking switching capability, enables efficient utilization in the high rate backbone network. Closing metropolitan rings reduces the cost, floorspace and maintenance complexity of the whole network. SONET-based traffic from the metro side may be transported via SDH-based back bone network and vice versa. Termination of this traffic is always done in the same mode (SONET or SDH) at both ends.

All Optical Switch *LambdaRouter* AOS

The central element of optical backbones are optical switches like the *LambdaRouter* All Optical Switch (AOS). This product is capable of operating at any optical layer bit rate, including 40 Gbit/s and beyond, ideal for an IP over wavelength network. This is a true optical cross connect system, operating an optical - rather than electrical - switching fabric.

Because optical to electrical to optical conversions do not occur within the system, transmission interfaces are transparent. The *LambdaRouter* AOS is also non-blocking, rate- and format-independent, large, and scalable - innovations that place it at the vanguard of optical technology.

Optical network platform

As more and more service providers deploy optical products in their networks, they need help provisioning bandwidth. Therefore Lucent Technologies recently unveiled an intelligent optical networking platform that will allow the customers to cost-effectively provide bandwidth-on-demand and other new revenue-generating services. The optical-data networking platform is built around the all-optical switch - the *LambdaRouter* AOS - and two new, industry-leading software products from Bell Labs that enable carriers to control individual wavelengths of light carrying all forms of telecommunications traffic.

The new intelligent routing software also will let our all-optical switches communicate with one another, instantly discover new switches and links as they are added to a network's topology and automatically redistribute wavelengths in response to fluctuating traffic demands and network resources. Using these products, service providers will be able to offer their customers networks with unparalleled levels of flexibility, reliability, auto-recovery and quality of service that can scale to multi-terabit capacities.

The *Navis*™ Optical Customer Service Manager (CSM), which Bell Labs brought from research to market in just eight months, is an innovative software platform that provides network operators with capabilities like "point-and-click" bandwidth provisioning. Using Lucent's *Navis* Optical CSM software, network operators can remotely direct a *LambdaRouter* AOS in Chicago, for example, to increase the number of wavelengths it is sending to Seattle and decrease the number it is sending to Denver as traffic between those cities fluctuates. This will enable carriers to offer such revenue-generating services as bandwidth trading, optical virtual private networks and dynamic bandwidth control, as well as create their own custom services.

□

Metro core/regional applications

Overview

Purpose

This section provides some information about the metro core/regional network tier and about regional/metro applications of *LambdaUnite*™ MSS.

Characterization of tier 2 topologies

The metro core/regional network tier typically shows the following features:

- Dominated by ring network topology
- Mid range distance (up to ~ 200 km)
- Partially high capacity per fiber (terabit/s)
- Efficient protection schemes (e.g. 2-fiber/4-fiber BLSR/MS-SPRing)
- Mixed traffic patterns (from 45-Mbit/s up to 10-Gbit/s services)
- Grooming (45-Mbit/s up to 10-Gbit/s services)
- Synchronous and data interfaces

Contents

□

Ring topologies

Overview

For many metro core applications around the world a ring based network topology with the associated ring protection schemes is used. This application example shows the benefits of using a *LambdaUnite*™ MSS system in these applications.

Ring based metro core/regional application

In this ring based application *LambdaUnite* MSS plays the role of a very flexible and expandable multi-ring terminal. This and the data capabilities of the system make it a representative of the new optical switches or optical edge devices (OEDs), which are brought to market and are greatly replacing classical ADM products. The multi-ring capability of the OED applies both to the aggregation of access rings as well as grooming between neighboring metro core/regional rings, which come together at central PoPs.

As described in the network picture below, the multi-ring terminals are aggregating traffic from the access rings, huge data nodes and business parks. Grooming functionality (down to STS1/HO-VC-3 or VC-4 level) together with flexible time slot assignment or interchange and fully non-blocking switching capability enables high utilization in the high rate metro ring.

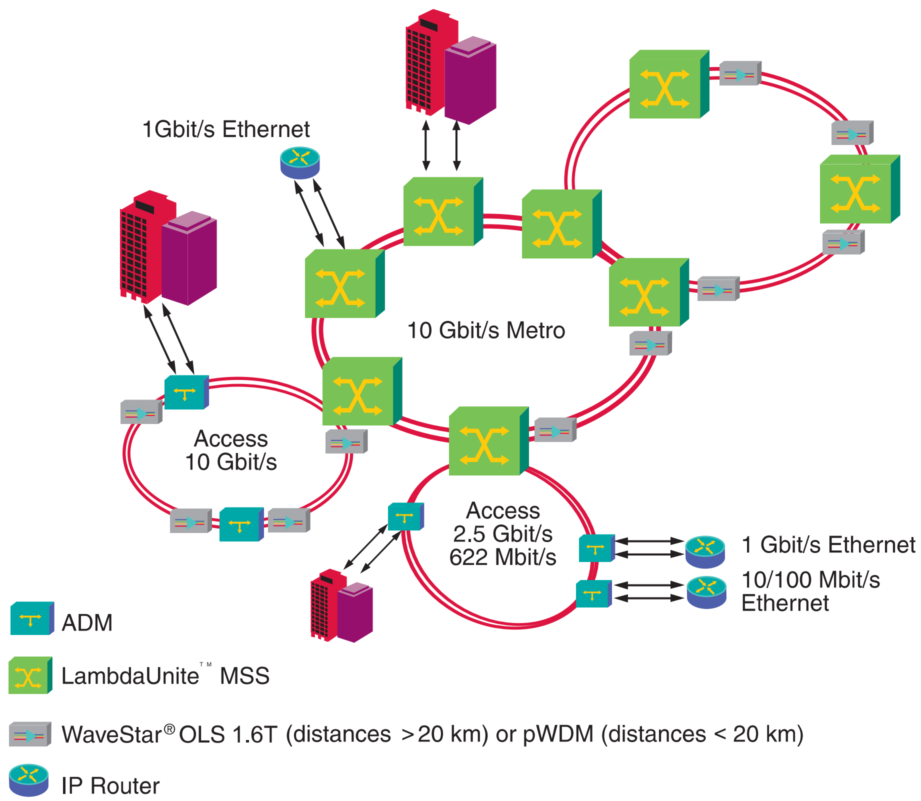
Taking into account the size of the metro ring (typically 5 to 10 nodes), 155-Mbit/s (later release), 622-Mbit/s (later release), 2.5-Gbit/s and 10-Gbit/s tributary interfaces are supported to address an appropriate bandwidth ratio between access and metro rings. The support of Gigabit Ethernet with flexible bandwidth assignment to the GbE service port is a key functionality to fit the operator's needs for flexible data transport solutions as part of a single network.

Due to the wide range of protection features supported by *LambdaUnite* MSS, protection schemes can be chosen dependent on traffic pattern (hubbed versus more neighboring traffic) and the protection schemes supported by the nodes to interwork with on the same ring. A combination with DWDM or "passive" WDM is supported for fiber constrained environments.

An important additional value proposition to use *LambdaUnite* MSS in these applications lies in the value that the system brings to the table as a backbone feeder node (see previous application descriptions). This way the very same *LambdaUnite* MSS system that interconnects Metro rings can also serve as the grooming and feeding device into the backbone network: All from a single node offering a very cost and space efficient solution.

Ring based metro core/regional example

In the following figure a ring based metro core/regional example is shown where *LambdaUnite* MSS acts as flexible multi-ring terminal, employing furthermore Wavelength Division Multiplexing, please refer to "Interworking with Wavelength Division Multiplexing" (3-38).



☐

Meshed topologies

Overview

As new metro core networks are built, mesh based topologies are starting to appear in fiber-rich metro environments. The benefits that these new topologies bring along are only possible with systems designed like *LambdaUnite*™ MSS. The following application description explain these benefits enabled by *LambdaUnite* MSS.

Meshed metro core/regional topology

Due to the flexible architecture of *LambdaUnite* MSS the creation and expansion of a meshed metro core topology is very easy. This can be combined with the ring closure capability towards the access network (the access network is still dominated by ring topologies due to its hubbed traffic pattern). Taking these capabilities, the system plays the role of a flexible Optical Edge Device (OED) supporting a wide range of services and topologies.

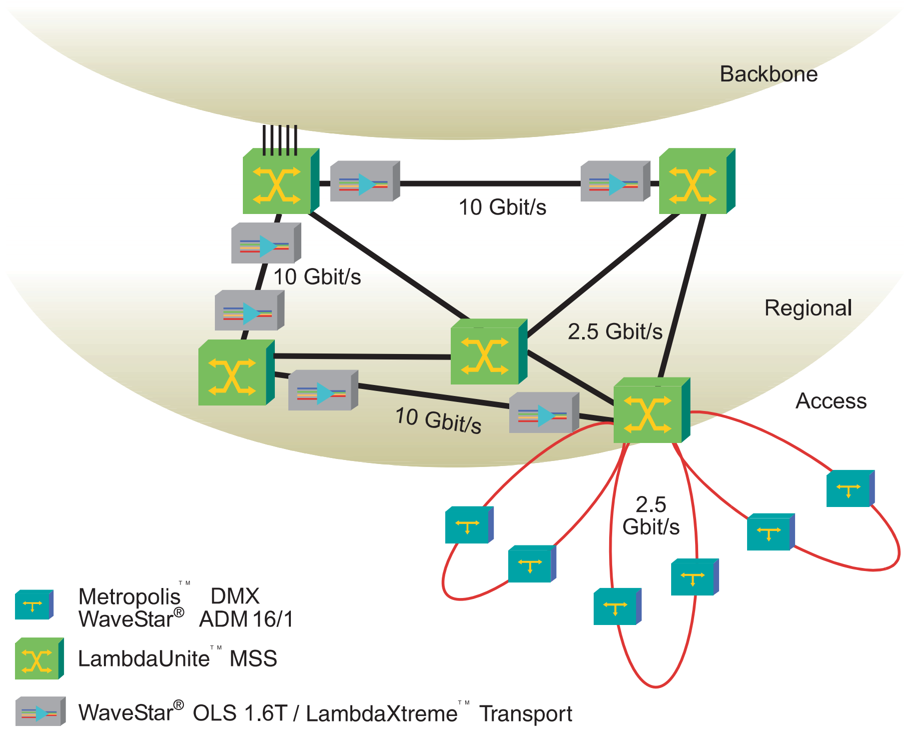
As described in the picture below, the OEDs are aggregating the traffic from the access nodes and are forwarding it into the metro core meshed network. The protection schemes used in the metro core network can be either BLSR/MS-SPRing or SNCP/UPSR, which supports meshed topologies more easily.

Service interfaces of the OEDs in the metro core network cover a wide range from 155 Mbit/s to 10 Gbit/s as well as Gigabit Ethernet. The fact that *LambdaUnite* MSS can act as a flexible backbone feeder node makes it possible to combine the metro core and backbone feeder node function into a single node, allowing for cost and floor space optimization.

In addition to the protection schemes mentioned above high-performance mesh service restoration schemes based on an intelligent network element control plane will appear as a way to provision and protect services in the given application. *LambdaUnite* MSS will support this functionality in a future release. This way the investment into a metro core build with *LambdaUnite* MSS is protected.

Meshed metro core/regional example

As illustrated in the figure below, the *LambdaUnite* MSS network elements, for example performing multiple access ring closure, can be interconnected at different line rates to realize a meshed topology.



□

Synchronous Network Navigator (SNN)

SNN advantages

The key drivers for the Synchronous Network Navigator (SNN) are:

- Fast, automatic service fulfillment
- Simplification of manual operations
- Elimination of connection design failure by using the network as the topology database.

As a part of the intelligent network platform, SNN will comprise a set of capabilities that automates SONET/SDH connection set-up, fast restoration, and the automatic discovery of the topology in SONET/SDH networks. In its initial releases, SNN will operate in conjunction with Lucent Technologies SONET or SDH products that are capable of switching at the STS-1 or STM-1 level. Although connections are supported without making use of the SNN, the SNN can set-up connections faster, using automated circuit design.

SNN functionalities

The SNN will provide route selection and connection set-up functions. It will discover available transport capacity, route, and provide connection management for a network of Lucent Technologies SONET or SDH switches and ADMs. SNN will enable the intelligent network elements to automatically set up end-to-end connections across the network. New Lucent Technologies network elements (NE) will support the signaling necessary to actively participate in the SNN. Older NEs may be passive participants in the SNN, merely transporting the channels switched by the newer NEs that support the signaling and control architecture of the SNN.

The SNN will be supported in a future release of *LambdaUnite*™ MSS.

□

Traffic hubbing

Overview

As mentioned before in this chapter, one of the key values of the flexible *LambdaUnite*™ MSS architecture lies in its ability to efficiently hub traffic from lower tiers of the network and feed this traffic into the next higher tier. This section illustrates the specifics and the value of this hubbing function from the access layer into the metro core/regional layer as well as from the metro core/regional layer into the backbone layer.

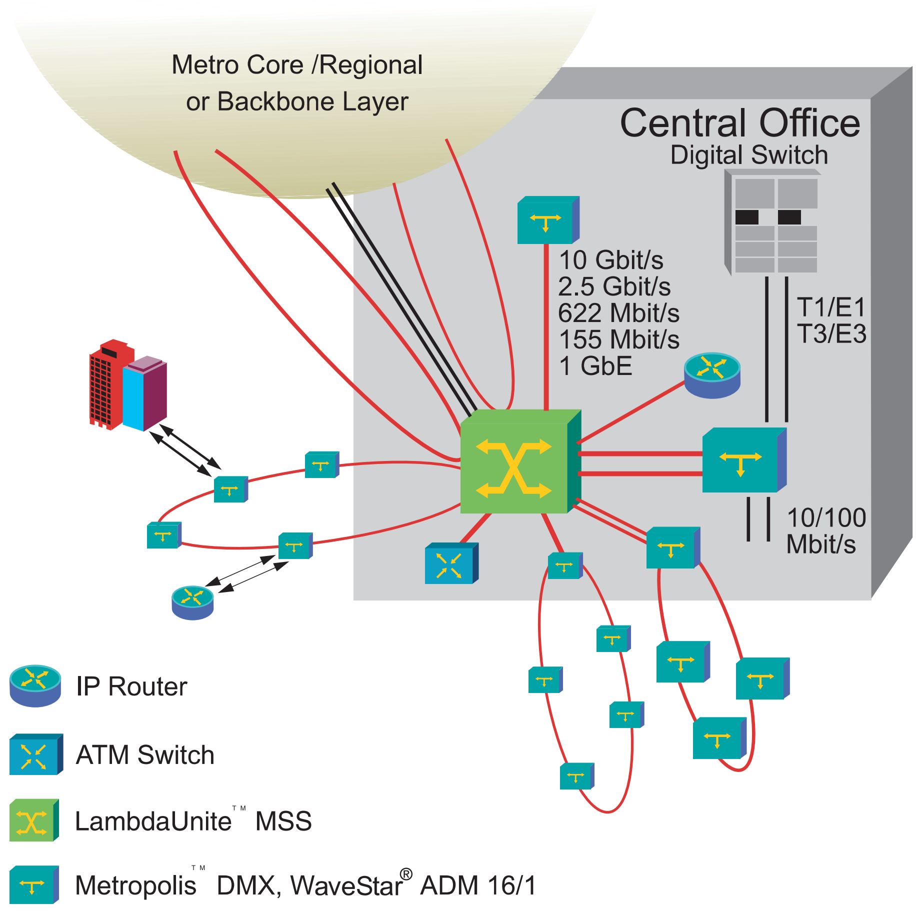
Metro core/regional hubbing example

In the 10-Gbit/s metro regional hub application *LambdaUnite* MSS acts as multi-ring terminal, hubbing (see also "Remote hubbing" (3-29)) the traffic from several lower rate access rings (see also "Closing rings" (3-31)) and providing the interconnection to one or more 10-Gbit/s metro/backbone networks. *LambdaUnite* MSS will be typically located in a central office where it provides numerous local interconnections to several routers of the different IS-providers, voice switches, backbone multiplexers, and DWDM equipment of other network operators.

Grooming functionality, together with flexible time slot assignment/interchange and fully non-blocking switching capability, enables high utilization in the 10-Gbit/s metro/backbone rings. *LambdaUnite* MSS can be efficiently coupled with another SONET/SDH multiplexer mounted in the same bay, in order to provide access for electrical signals as well as grooming of some remaining lower order traffic.

Depending on the capacity needs, configurations of 2-fiber ring can be supported, in a future release also 4-fiber ring or combinations with DWDM or "passive" WDM; see also "Growing demand for extra capacity" (3-38).

In the following figure the *LambdaUnite* MSS is performing a hub function for various rings and point-to-point connections.



□

Access/metro applications

Overview

Purpose

This section provides information about access/metro tier characteristics and access/metro applications for *LambdaUnite*™ MultiService Switch (MSS).

Characterization of tier 1 topologies

The access/metro network tier typically shows the following features:

- Point to point and ring network topology
- Short distance (up to ~ 40 km)
- Low capacity per fiber (2.5 Gbit/s and lower)
- Mixed traffic patterns (from 2 Mbit/s up to 2.5 Gbit/s services)
- Edge concentration
- Circuit and data interfaces

□

Tier 1 applications

Although *LambdaUnite*™ MultiService Switch (MSS) with its 320 Gbit/s switching matrix is designed rather for network tier 3 and tier 2 applications, it can be employed in topologies that initially perform access/metro functions, providing remarkable and cost-efficient growth capabilities.

□

Application details

Overview

Purpose

This chapter gives an overview of *LambdaUnite*™ MSS application details in basic topologies.

Contents

Ethernet applications

Overview

Data services based on IP are becoming more and more important. With Ethernet being the native LAN interface for IP traffic, offering Ethernet interface based WAN transport services becomes an important element for competitive service offerings.

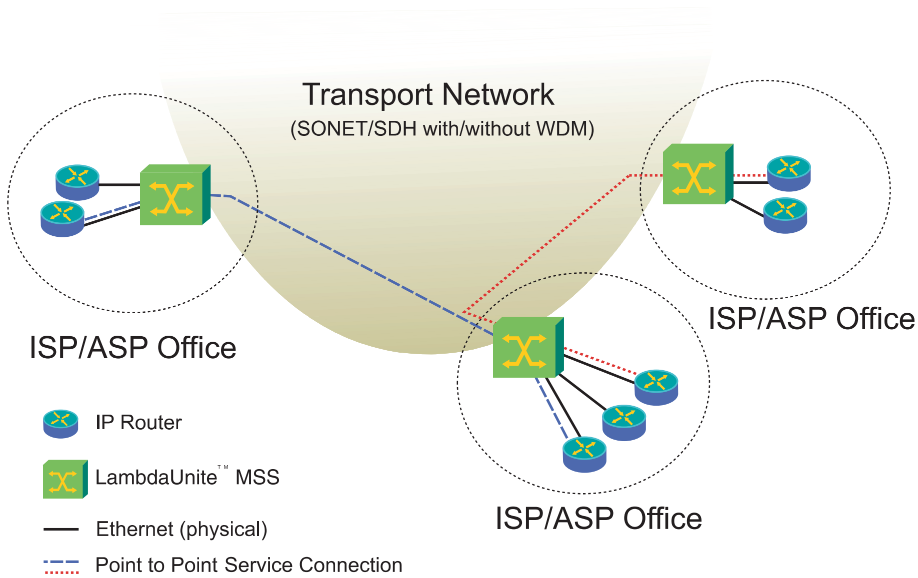
This section explains the Ethernet services and underlying applications supported by *LambdaUnite*™ MSS:

- Inter-PoP (Point-of-Presence) services
- Corporate LAN interconnections
- Virtual concatenation

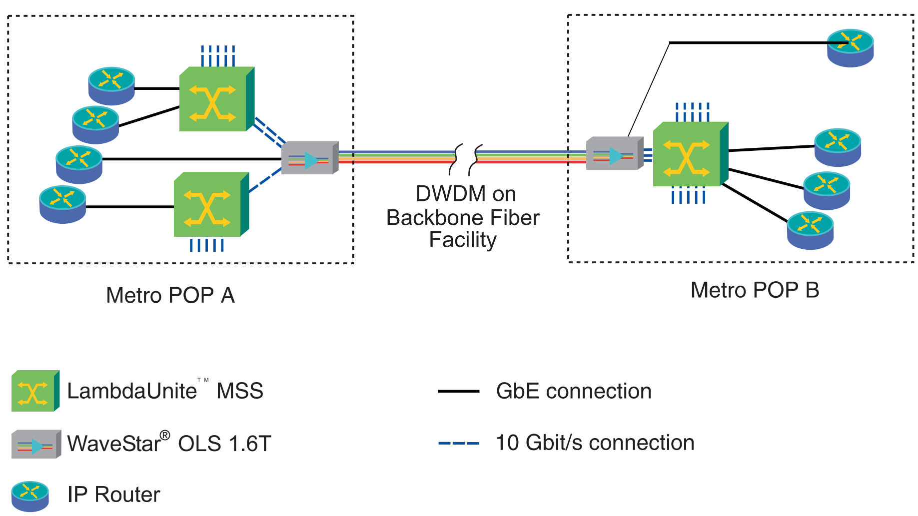
Inter-PoP services

Internet Service Providers (ISPs) and Application Service Providers (ASPs) need high but flexible bandwidth connections between their IP routers and their bandwidth wholesaler. An efficient solution for these connections are direct paths between the main routing locations (inter-PoP services) in the form of dedicated SONET/SDH and/or WDM signals, simply employing Ethernet interfaces in SONET/SDH add-drop-multiplexers.

This Hybrid Transport based on SONET/SDH with *LambdaUnite* MSS systems can provide high speed and simply leased line Ethernet connections between ISP/ASP offices over long distances, see the example given in the following figure.



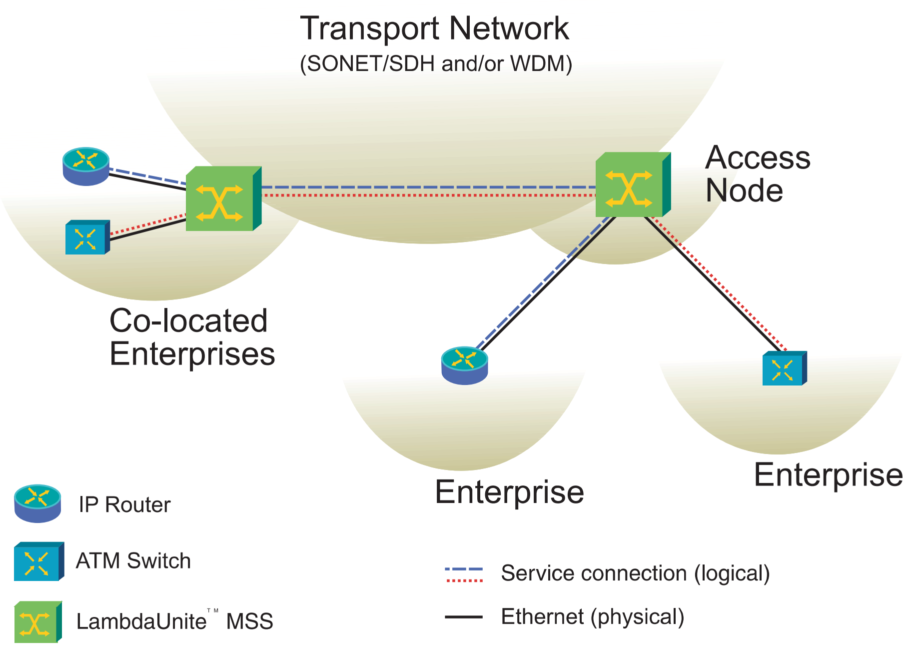
A specific option for high bandwidth between distant Metro POPs is to transport Gigabit Ethernet (GbE) traffic with Hybrid Transport over *LambdaUnite* MSS and *WaveStar*® OLS 1.6T, based on SONET/SDH and Dense Wavelength Division Multiplexing (DWDM) solutions, as shown in the example given in the following figure.



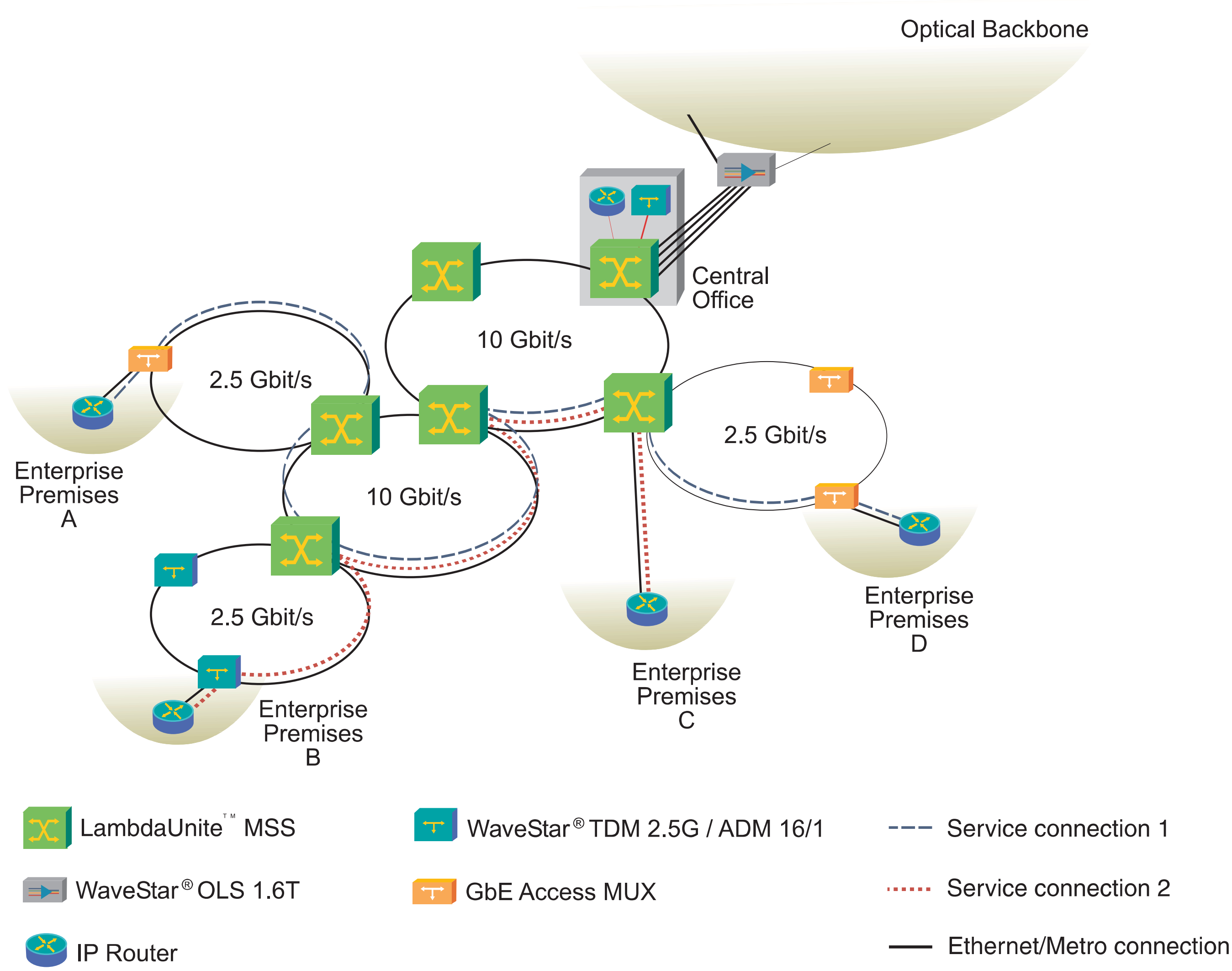
Corporate LAN interconnections

With the growing need to communicate across long distances, many enterprises find themselves faced with a severe problem: although they have Ethernet available in their Local Area Networks (LAN) in each of their geographically separated offices, a standard and cost-efficient way to connect them is missing.

Hybrid Transport with an Ethernet connection via *LambdaUnite* MSS systems over the public transport network (often referred to as Wide Area Network – WAN) provides a solution to this problem, connecting the different enterprise locations like in a single LAN. A schematic example for such a corporate LAN interconnection with two *LambdaUnite* MSS systems is shown in the following figure.



The Lucent portfolio allows service providers to offer LAN interconnection services to their customers with throughput rates of up to 1 Gbit/s, in future also 10 Gbit/s. These high bandwidth service connections require a high capacity metro network, as shown in the following figure. In this example two corporate LAN interconnections are depicted, between enterprise premises A and D, and between B and C, employing *LambdaUnite* MSS as multi-ring terminals and in the central office, connecting the metro network over a *WaveStar* OLS 1.6T system to the optical backbone.

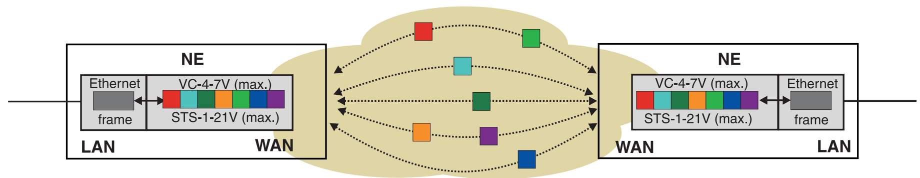


Virtual concatenation

STS-1/VC-4 concatenation can be used for the transport of payloads that do not fit efficiently into the standard set of synchronous payload envelopes (SONET) or virtual containers (SDH). Virtual concatenation splits the contiguous bandwidth into individual SPEs/VCs, transports these SPEs/VCs and recombines them to a contiguous functionality only at the path termination equipment, i.e. the GE1/SX4 Gigabit Ethernet circuit pack.

The following figure shows the principle of virtual concatenation in a point-to-point Gigabit Ethernet (GbE) network application example.

Protection of the VC-4-7c traffic, in future also STS-1-Kv/VC-4-kv traffic is possible via UPSR/SNCP and in ring topologies via BLSR/MS-SPRing protection schemes.



The H4 POH byte is used for the sequence and multi-frame indication specific for virtual concatenation.

Due to different propagation delay of the virtual containers a differential delay will occur between the individual virtual containers. This differential delay has to be compensated and the individual virtual containers have to be re-aligned for access to the contiguous payload area. The *LambdaUnite* MSS re-alignment process covers at least a differential delay of 32 ms.

□

Broadband transport

Broadband Services

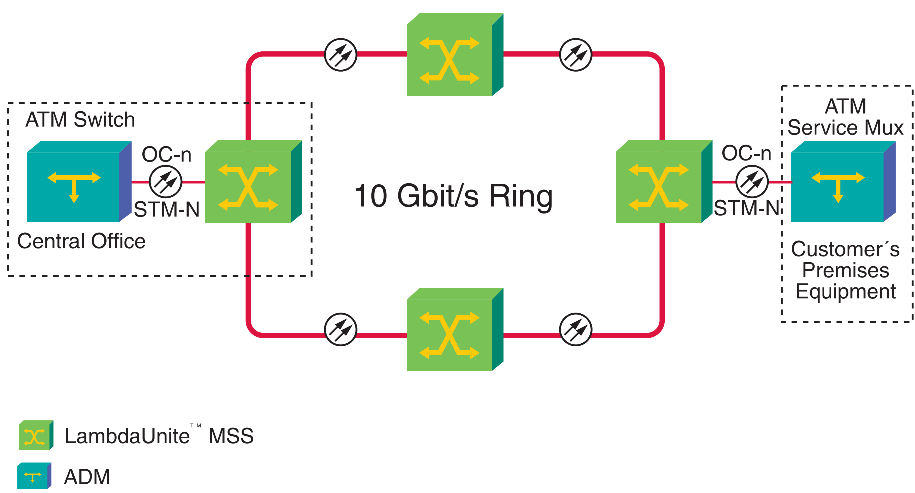
Broadband services that can be handled with *LambdaUnite*™ MultiService Switch (MSS) include:

- LAN interconnection
- Video distribution from a video server
- Medical imaging
- ATM traffic

These services can be conveniently switched by *LambdaUnite* MSS as concatenated payloads (STS-3c/VC-4, STS-12c/VC-4-4c, STS-48c/VC-4-16c or STS-192c/VC-4-64c) over all available line interfaces.

ATM transport example

As an example, the figure below shows *LambdaUnite* MSS transporting ATM traffic between a central office and a customer's premises.



□

Remote hubbing

What is remote hubbing?

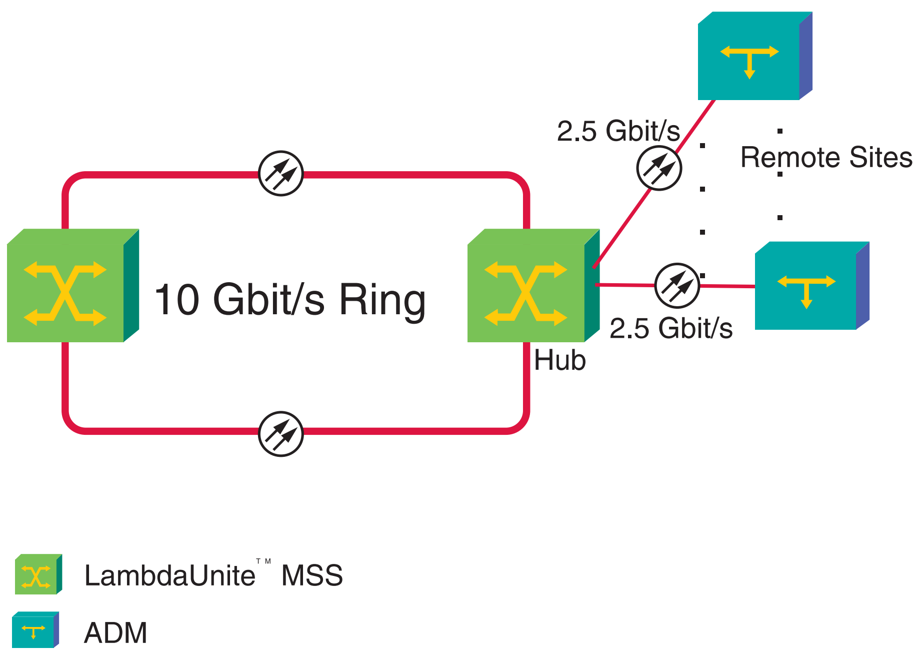
A network element is a hub when it is a collecting point for low rate lines. If the low rate lines are from remote sites, then the network element is performing remote hubbing.

The *LambdaUnite*™ MSS system performs remote hubbing for linear and ring networks. It can lower transport costs by consolidating lower rate traffic (typically 155 Mbit/s, 622 Mbit/s or 2.5 Gbit/s) and placing it on higher rate rings (typically 10 Gbit/s or 40 Gbit/s).

Remote hubbing linear networks

In this example, all the traffic for the 2.5-Gbit/s multiplexers passes through the *LambdaUnite* MSS hub using 2.5-Gbit/s optical interfaces.

The following figure shows a *LambdaUnite* MSS 10-Gbit/s ring serving a cluster of 2.5-Gbit/s multiplexers located at remote sites in a loop environment.



Remote hubbing ring networks

In some situations the traffic volume of a route does not warrant the expense of a full ring. It may be practical to evolve a linear network to a ring network gradually, moving first to a folded ring (please refer to "Folded ring" (3-31)).

However, you can still gain the benefit of a ring architecture on the route by using two interfaces per ring in one *LambdaUnite* MSS network element to close and link the rings. In this way *LambdaUnite* MSS acts as a hub for traffic from the lower rate ring that is to be carried on a 10-Gbit/s ring (in the next release also on a 40-Gbit/s ring), see also “Ring topologies” (3-31).

□

Ring topologies

Folded ring

A folded ring is a ring that uses a linear cable route between its end nodes. All traffic passes through the same geographical locations, perhaps even in the same cable sheaths between nodes, instead of through diverse locations. This is useful for networks in which not all locations are ready to be connected.

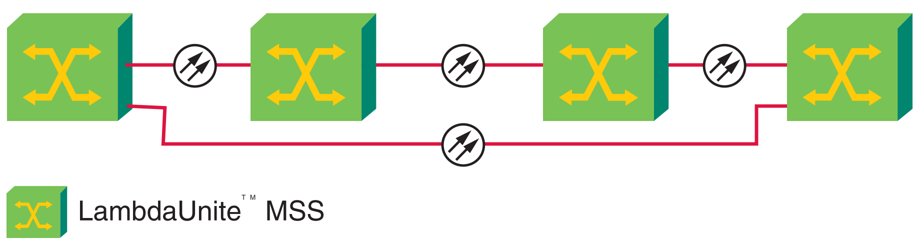
In many cases, a network starts out as a linear add/drop chain because of short-term service needs between some of the nodes. Later, it evolves into a ring when there is a need for service and fiber facilities to other nodes in the network. It is easier to evolve the linear add/drop network into a full ring configuration if a folded ring is used in the nodes that have this short-term service need. Folded rings have upgrade, operational, and self-healing advantages over other topologies for this type of evolution.

Reliability

In a folded ring configuration the traffic can be protected against node failures, but not against a fiber cut if all the fibers are in the same cable sheath. However, a folded ring configuration does enhance the reliability of a linear route until there is enough traffic to warrant expanding to full rings.

Folded ring example

In the folded ring configuration, shown in the following figure, a linear add/drop chain has been upgraded to a folded ring configuration by connecting the end nodes together.



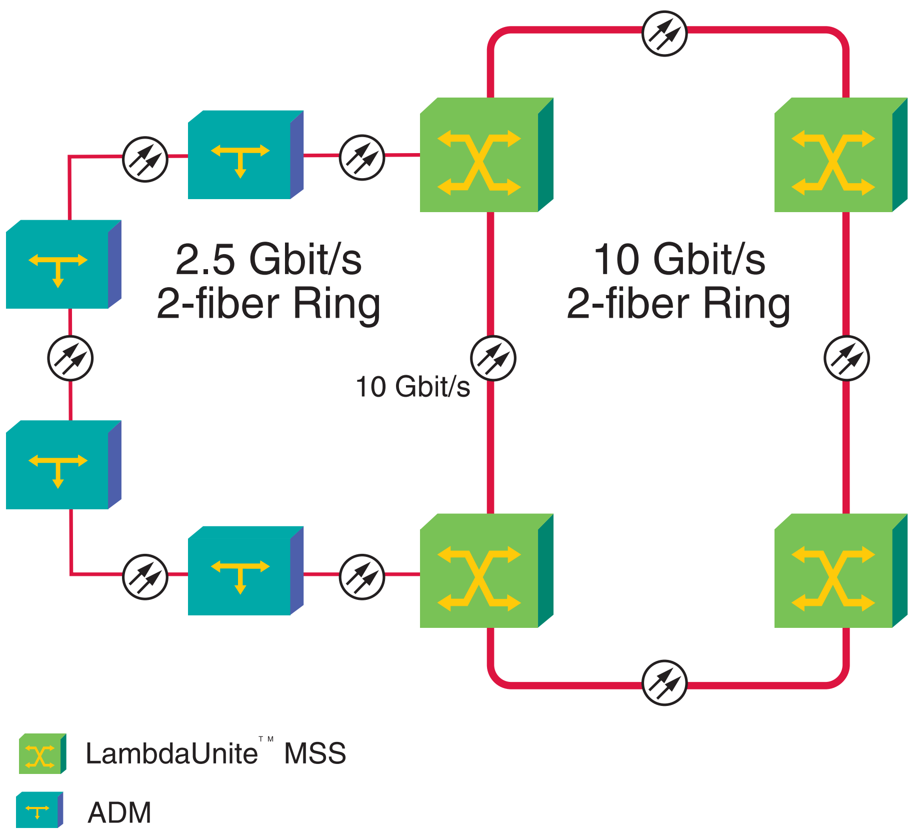
Closing rings

If a linear network is geographically close enough to a backbone system, then the linear network can be upgraded to a ring network by connecting both ends to the backbone. Traffic from the newly-formed ring can be transported by the backbone system, thereby closing the ring. This is referred to as closing or completing the ring, or ring transport.

A *LambdaUnite*™ MSS 10-Gbit/s ring carrying backbone traffic can be used to close up to 64 2.5-Gbit/s rings. The example below shows how *LambdaUnite* MSS 2.5-Gbit/s interfaces (short haul in this release, long haul available in the next release) can provide transport for a 2.5-Gbit/s ring. The *LambdaUnite* MSS 10-Gbit/s ring provides 48 OC-1s or 16 STM-1s of bandwidth to close one 2.5-Gbit/s ring.

Dual homing ring closure

In the following figure, a *LambdaUnite* MSS 10-Gbit/s ring is used to close an 2.5-Gbit/s ring. The topology example shown here is also known as dual-homing ring closure (see also "Dual-homed vs. single-homed" (3-32)).



Dual-homed vs. single-homed

The figure below illustrates a configuration with a 10-Gbit/s backbone ring and several rings connected to this backbone ring. This example shows the following types of connections between a *LambdaUnite* MSS 10-Gbit/s ring and the 2.5-Gbit/s rings:

- Dual-homed ring connections to a *LambdaUnite* MSS ring at nodes A and E
- Single-homed ring connections (unprotected) to a *LambdaUnite* MSS ring at node B
- Single-homed ring connections (unprotected) to a *LambdaUnite* MSS ring at node C

In a ***dual***-homed ring configuration, one ring connects to the other by ***two*** *LambdaUnite* MSS nodes, one 2.5-Gbit/s interface connection each.

In a ***single***-homed ring configuration, one ring connects to the other by a ***single*** *LambdaUnite* MSS node, with two 2.5-Gbit/s interface connections.

Ring topology example

The following figure shows two single-homed (on the top and on the right hand side) and one dual-homed (left hand side) ring configurations in a 10-Gbit/s backbone ring.

Multiple ring closure

LambdaUnite MultiService Switch (MSS) is an ideal ring closure network element because its architecture, although extremely compact, allows the insertion of up to eight 40-Gbit/s interfaces (in the next release), up to 32 10-Gbit/s interfaces, or up to 128 2.5-Gbit/s ports in one single shelf. Therefore up to four 40-Gbit/s rings, up to sixteen 10-Gbit/s rings or up to 64 2.5-Gbit/s rings can be closed by one *LambdaUnite* MultiService Switch (MSS). For all rings BLSR/MS-SPRing protection can be configured.

In the following figure *LambdaUnite* MultiService Switch (MSS) performs ring closure and ring connection on different levels, interworking with *WaveStar*® BandWidth Manager, *WaveStar* TDM 10G, *WaveStar* ADM 16/1, and Metropolis Trademark DMX.

Low rate grooming and protection

Closing rings that carry traffic structured below the STS-1 or VC-3 level, it may be required to perform

- grooming
- path protection

on traffic below the STS-1 or VC-3 level between rings on low rate levels. This can be done by connecting an additional low rate ADM to the *LambdaUnite* MultiService Switch (MSS).

As an example, the following figure illustrates a multiple ring closure, in this case with *WaveStar* ADM 16/1 and Metropolis Trademark DMX rings, with an additional *WaveStar* ADM 16/1 or Metropolis Trademark DMX connected to *LambdaUnite* MultiService Switch (MSS) in order to perform grooming / path protection below the STS-1 or VC-3 level.

□

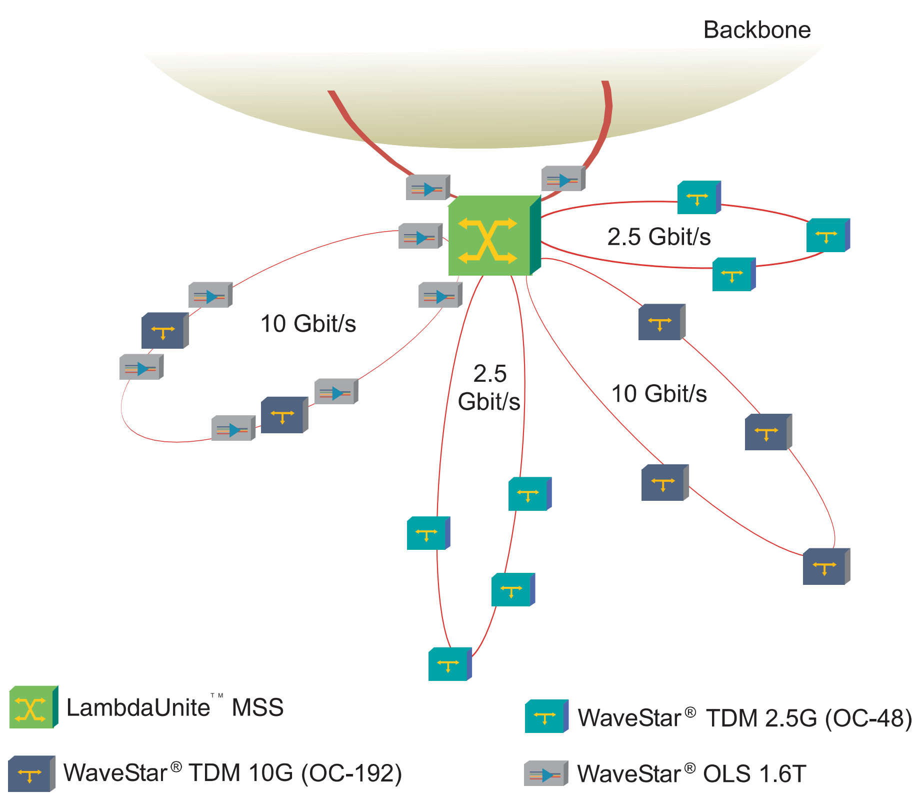
Interworking with *WaveStar*® TDM 10G/2.5G and *WaveStar* ADM 16/1

Overview

To provide grooming and feeding in the metro/core and access layer the *LambdaUnite*™ MSS system can be connected to various Add-Drop-Multiplexers (ADMs). Due to its flexibility *LambdaUnite* MSS supports contemporary interworking with SONET- and SDH-ADMs, provisioning the respective interface port according to the particular standard. This section describes interworking examples with some ideally fitting SONET- and SDH- ADMs: *WaveStar* TDM 10G (OC-192) and *WaveStar* TDM 2.5G (OC-48), respectively *WaveStar* TDM 10G (STM-64) and *WaveStar* ADM 16/1.

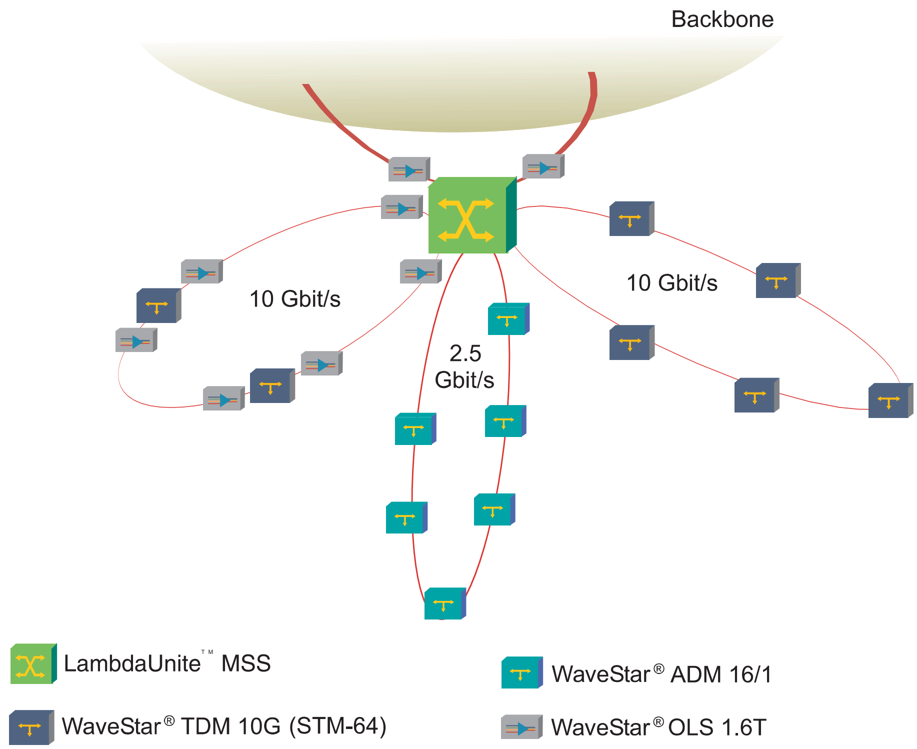
Interworking with *WaveStar* TDM 10G (OC-192) and *WaveStar* TDM 2.5G (OC-48)

The following figure shows an application example of *LambdaUnite* MSSacting as a multi-ring terminal, connected to several ring topologies with *WaveStar* TDM 10G (OC-192) systems, partly employing DWDM interfaces, and with *WaveStar* TDM 2.5G (OC-48) systems.



Interworking with *WaveStar* TDM 10G (STM-64) and *WaveStar* ADM 16/1

The figure below shows an application example of *LambdaUnite* MSS acting as a multi-ring terminal, connected to several ring topologies with *WaveStar* TDM 10G (STM-64) systems, partly employing DWDM interfaces, and with *WaveStar* ADM 16/1 systems.



□

Interworking with *WaveStar*® BandWidth Manager

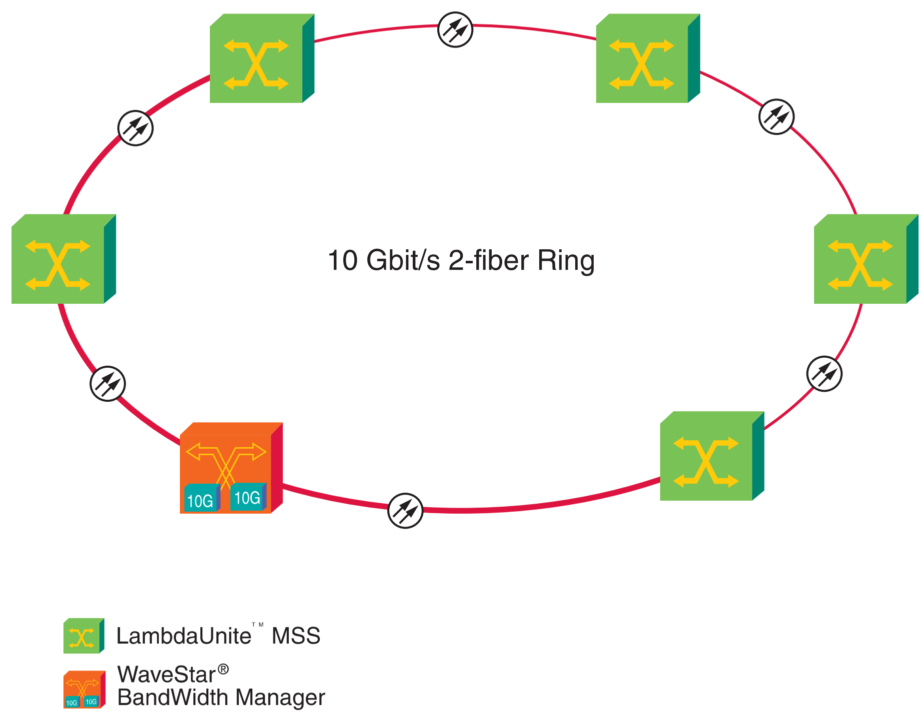
What is *WaveStar* BandWidth Manager?

The *WaveStar* BandWidth Manager integrates all access and transport rings within a network and efficiently manages bandwidth among these rings via a modular, scalable Synchronous Transport Module (STM) fabric. The switching fabric is surrounded by a common input/output and managed by a common system controller.

BWM as direct part of 10-Gbit/s ring

WaveStar BandWidth Manager can be equipped with integrated 10-Gbit/s interfaces, therefore it can be used as direct part of a 10-Gbit/s ring, BLSR/MS-SPRing protected in the 4-fiber as well as in the 2-fiber condition.

The following figure illustrates the interworking of *LambdaUnite*™ MSS with the *WaveStar* BandWidth Manager in a 2-fiber ring example.



BWM connection via synchronous interfaces

It is possible to connect the *WaveStar* BandWidth Manager, apart from the 10-Gbit/s interfaces, via 2.5-Gbit/s, and in a future release also via 622-Mbit/s or 155-Mbit/s interfaces to *LambdaUnite* MSS.

□

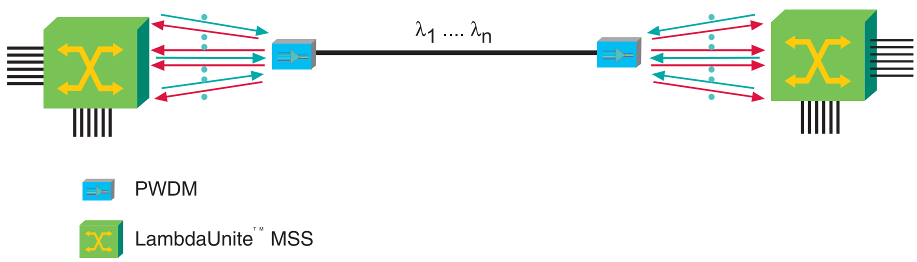
Interworking with Wavelength Division Multiplexing

Growing demand for extra capacity

A very efficient way to increase the capacity per fiber is to use distinct wavelength channels. *LambdaUnite*™ MSS supports both, Passive Wavelength Division Multiplexing (PWDM) and Dense Wavelength Division Multiplexing (DWDM).

Passive WDM

A Passive Wavelength Division Multiplexing application of *LambdaUnite* MSS is illustrated in the following figure. In the next release up to 32 different 2.5-Gbit/s signals can be passively multiplexed into a single fiber and transported cost-efficiently over short and intermediate distances this way.



The *LambdaUnite* MSS interface available in a future release for PWDM applications are:

- 2.5 Gbit/s intermediate reach / short haul interface (60 km), 1550 nm, passive WDM compatible, 32 colors.

Dense WDM

Dense Wavelength Division Multiplexing (DWDM) systems can be used both in a future release at the 10-Gbit/s and at the 40-Gbit/s interfaces of *LambdaUnite* MSS for cost-efficient data transport over long distances:

- *WaveStar*® Optical Line System (OLS) 1.6T (400G/800G) can be connected directly to 10-Gbit/s interfaces
- *LambdaXtreme*™ Transport, connected directly to 10-Gbit/s or 40-Gbit/s interfaces.

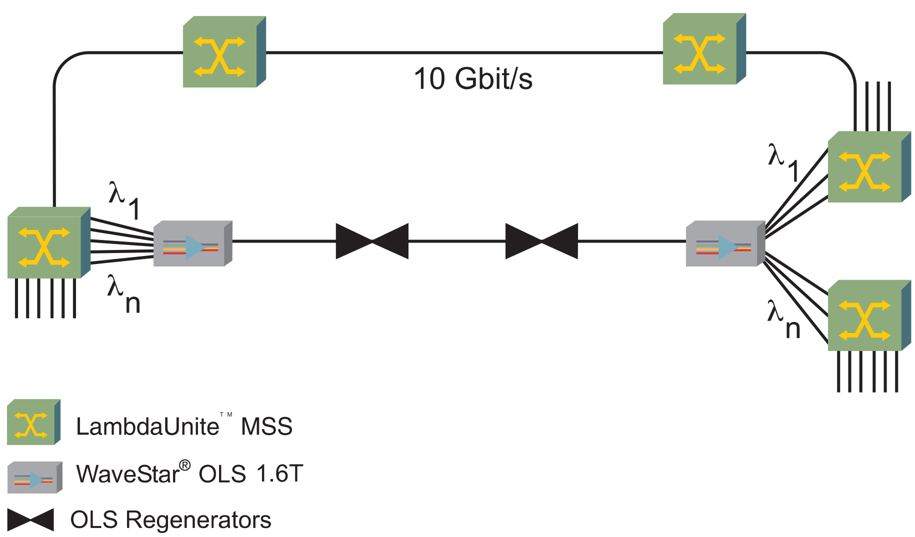
WaveStar OLS 1.6T (400G/800G)

Using the *WaveStar* OLS 1.6T (400G/800G), the traffic of up to 80 different 10-Gbit/s signals can be transmitted via one single optical line in a future release. Using special lasers (“colored laser”) in the *LambdaUnite* MSS system, which all have their individual wavelengths, it is possible to connect the 10-Gbit/s interfaces of *LambdaUnite* MSS directly to *WaveStar* OLS 1.6T (400G/800G).

Alternatively, Optical Translator Units (OTUs) can be used to translate the out-coming wavelength of the 10 Gbit/s interface to wavelengths specified for DWDM systems.

Distances of up to 1000 km can be bridged by using the *WaveStar* OLS 1.6T (400G/800G) together with *LambdaUnite* MSS.

The following figure shows a topology example using the *WaveStar* OLS 1.6T to transmit traffic from several *LambdaUnite* MSS aggregate interfaces via one single optical line.



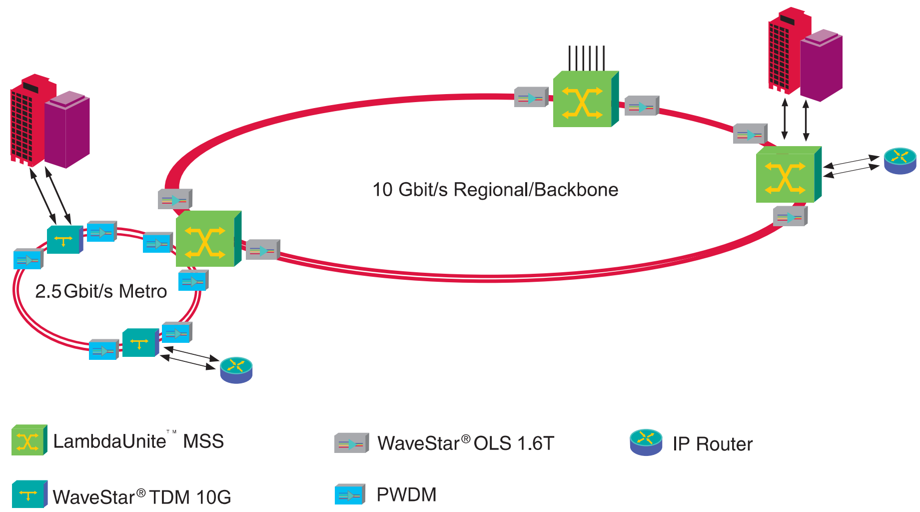
The *LambdaUnite* MSS interfaces available in a future release for DWDM applications are:

- 10-Gbit/s interface for direct *WaveStar* OLS 1.6T (400G) interworking, 40 colors
- 10-Gbit/s interface for direct *WaveStar* OLS 1.6T (800G) interworking, 80 colors

- 40-Gbit/s interface for direct *LambdaXtreme* Transport interworking, 64 colors
- 10-Gbit/s interface for direct *LambdaXtreme* Transport interworking, 128 colors.

Combined interworking with DWDM and PWDM

LambdaUnite MSS provides flexible WDM solutions for different data transport spans in a future release. Inserting for example 10-Gbit/s colored laser interfaces for direct *WaveStar* OLS 1.6T (800G) interworking, and 2.5-Gbit/s colored laser interfaces for passive WDM into a single *LambdaUnite* MSS provides cost-efficient long distance and intermediate distance WDM applications, as depicted in the following figure.



☐

Interworking with *LambdaRouter*™ AOS

Interfaces to *LambdaRouter* AOS

LambdaUnite™ MSS is able to feed both, passive and active ports of the all-optical cross-connect *LambdaRouter* AOS. *LambdaUnite* MSS provides several interfaces for this interworking feature:

- For active *LambdaRouter* AOS ports: 10-Gbit/s intra-office interface (1310 nm),
- For passive *LambdaRouter* AOS ports: 10-Gbit/s long haul and intermediate reach interfaces (1550 nm).

□

4 Product description

Overview

Purpose

This chapter describes the *LambdaUnite*™ MultiService Switch (MSS) in terms of basic architecture, physical configuration and circuit packs.

Chapter structure

After a concise system overview, the transmission architecture is presented. A closer look is taken to the switch function.

The shelf configuration of the *LambdaUnite* MSS shelf is described, followed by a short description of the circuit packs contained.

Furthermore, this chapter deals with synchronization aspects within the network element and outlines the control architecture and the power distribution concept.

Contents

Concise system description

Overview

The *LambdaUnite*™ MSS system architecture is based on a 320 Gbit/s full non-blocking switch matrix with STS-1/VC-4 granularity. This equals 6144 x 6144 STS-1s or 2048 x 2048 VC-4s. The switch can be upgraded to 640 Gbit/s capacity at a later release.

The system provides 32 universal slots, which can be flexible configured with 40-Gbit/s (future release), 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s (future release), 155-Mbit/s (future release), 10-Gbit/s Ethernet (future release) and 1-Gbit/s Ethernet optical interface circuit packs. Any available interface circuit pack can be operated in any slot position with no connectivity restrictions in all configurations.

The mix and the number of 40-Gbit/s, 10-Gbit/s, 2.5-Gbit/s 2F/4F rings and linear links is only limited by the maximum number of slots. This makes *LambdaUnite* MSS a highly flexible system and allows for a variety of different configurations.

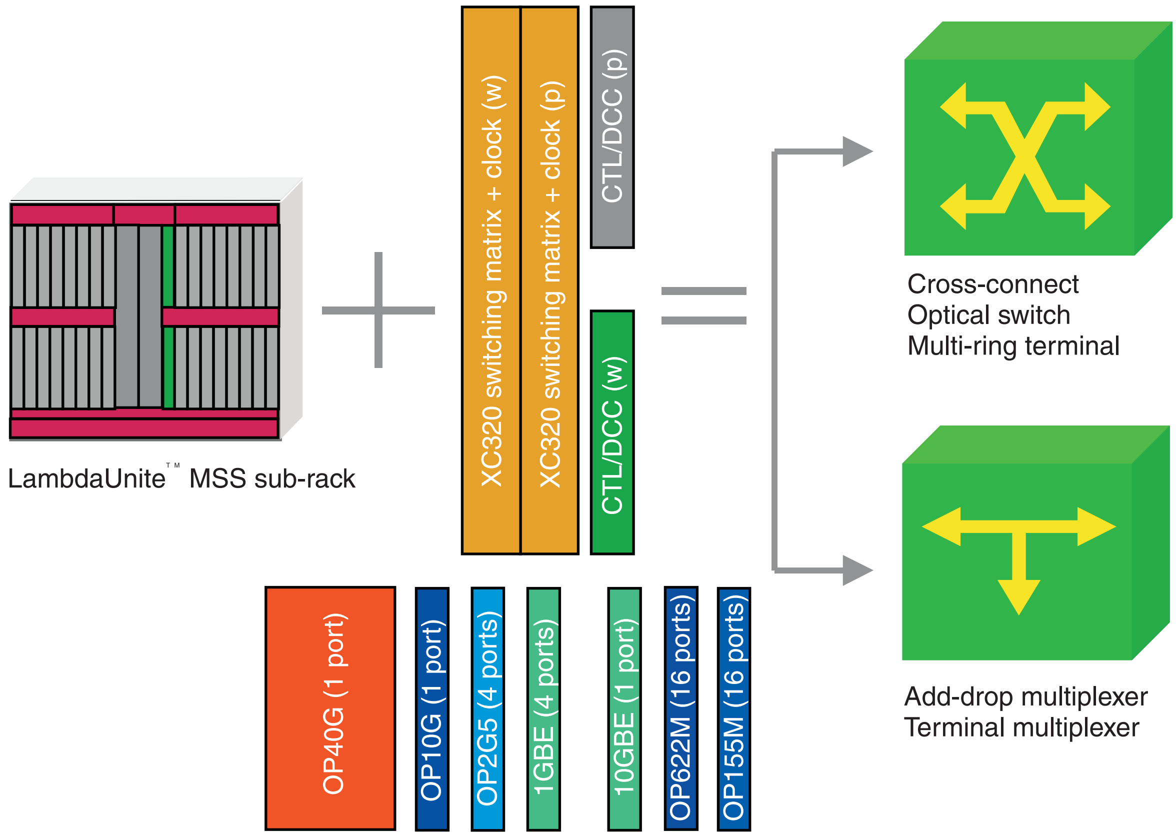
Applications

The system can be used as single or multiple Add/Drop Multiplexer (ADM), as single or multiple Terminal Multiplexer (TM) and as an Optical Switch (XC), using only one sub-rack. The system provides built-in cross-connect facilities and flexible interface circuit packs. Local and remote management and control facilities are provided via the TL1 interface and the Embedded Communication Channels (ECC). The cross-connect circuit packs are the core of the *LambdaUnite* MSS system.

Basic architecture

The basic *LambdaUnite* MSS architecture covers the network element as a whole and does not go into further detail on the required number of the individual circuit packs. This will be discussed later in this chapter.

The following figure gives an outline of the basic *LambdaUnite* MSS building blocks.



□

Transmission architecture

Overview

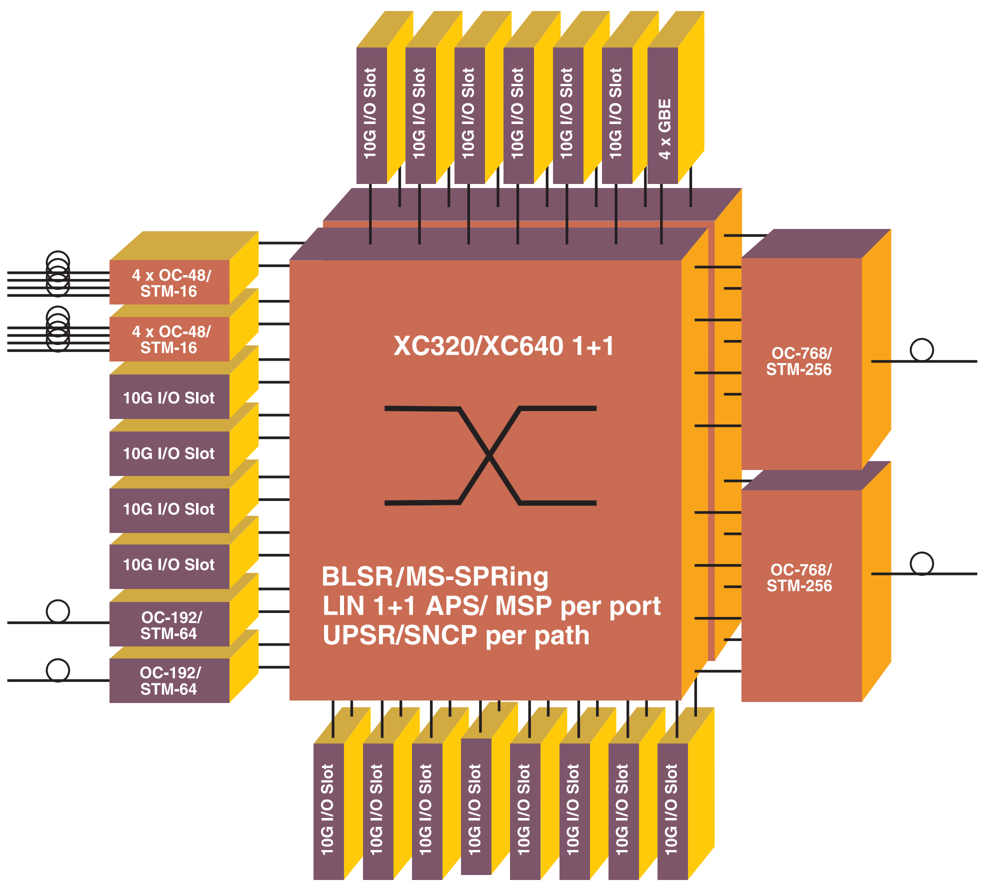
The *LambdaUnite*™ MSS transmission architecture is based on a centralized switch fabric which is 1+1 protected. All traffic from/to the ports is fed to the central switch.

Transmission provisioning

Provisioning of the transmission circuit packs is controlled by the system controller circuit pack. Commands are received from *Navis*™ Optical EMS or *WaveStar*® CIT, which can both be connected locally (*WaveStar* CIT at CIT-LAN port, *Navis* Optical EMS at respective port at CI-CTL) or remote via DCC channels.

Block diagram

The following figure shows a block diagram of the transmission architecture in the *LambdaUnite* MSS shelf. The depicted OC-768/STM-256 interfaces and the switching matrix XC640 will be available in a future release.



Switch function

Overview

All traffic from/to port units is fed from/to the central switch 1+1 protected (c.f. "Block diagram" (4-5) on the previous pages).

Switching capabilities

The total full none blocking switch capacity is 320 Gbit/s (= 6144 STS-1 / 2048 VC-4s). Additionally to SPE/VC switch capabilities, also overhead information from SONET/SDH I/O ports may be transparently switched. The switch itself is based on a bit sliced architecture providing this very high capacity on a single pack. Slicing / deslicing functions are part of the switch circuit pack.

Traffic protection

Traffic protection switching (linear APS / MSP, BLSR/MS-SPRing, UPSR/SNCP) is performed centrally on the switch unit. All necessary switch information is transported via internal transmission lines (2.5 Gbit/s TXI channels on the backplane) directly towards the switch, switch execution is done in Hardware. Therefore, no interaction with the central control function (system controller) is needed to perform traffic protection switching which increases speed and reliability.

1+1 Protection

To contribute to the overall system reliability and availability, the switching circuit packs are 1+1 equipment protected.

□

Shelf configurations

Overview

The *LambdaUnite*™ MSS shelf is designed for application in 600 mm (23.6 in) deep ETSI rack frames and in Telcordia/NEBS compliant racks.

The shelf provides the facilities to house the *LambdaUnite* MSS circuit packs. It consists of the mechanics, a backplane, a user panel and interface panels for the connections to the customer's infrastructure.

Interface panels

Access to station alarms, miscellaneous discretes, overhead channels, and Q-LAN is possible via the interface panels which are located at the rear of the shelf. Additionally, there is a User Panel (UPL) on the front of the shelf (see Chapter 2, "Features").

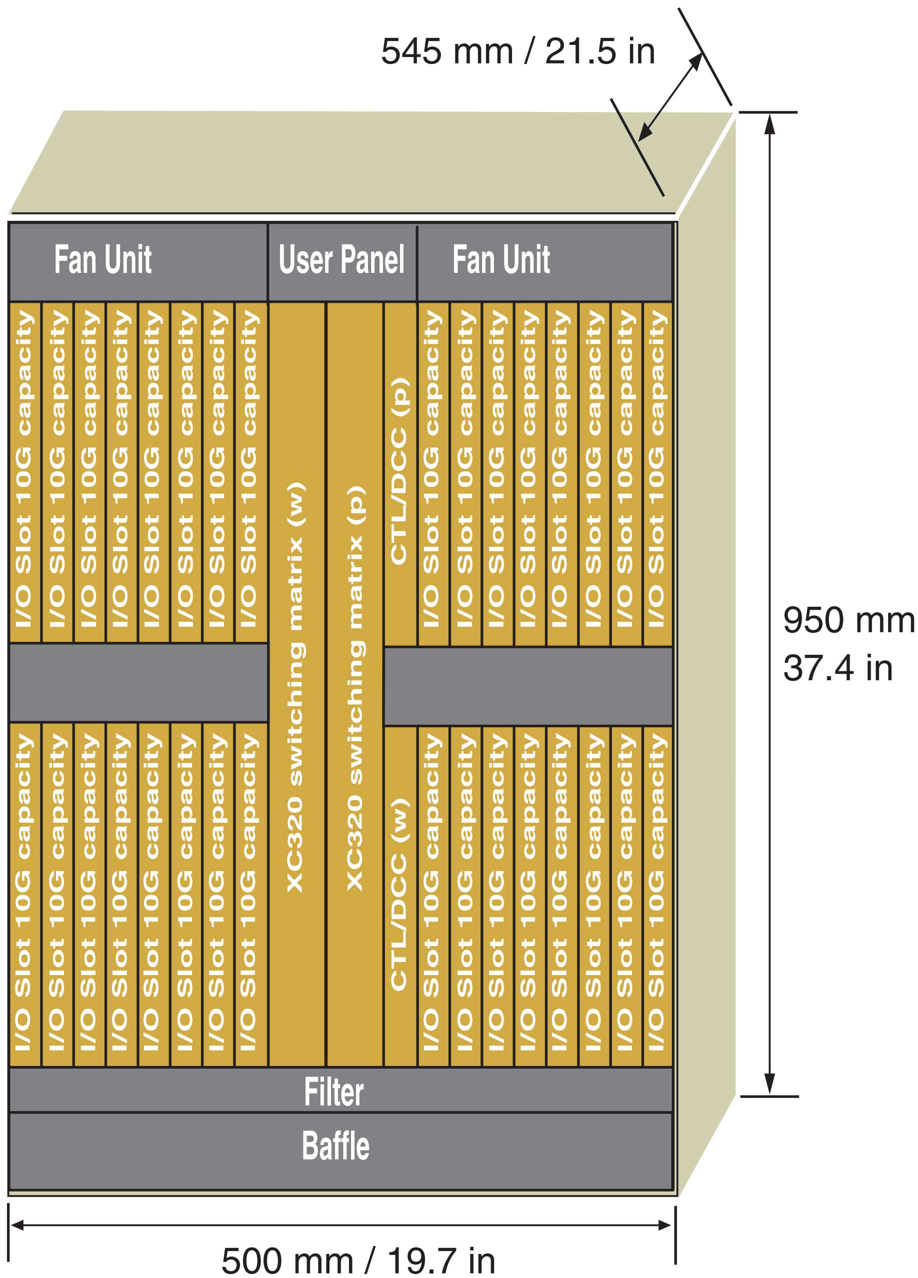
Optical interfaces

The optical interfaces are located on the front side of the optical circuit packs. From there, the optical fibres are guided to the rack connection panel.

□

Shelf

Layout The following figure depicts the *LambdaUnite*™ MSS shelf circuit pack slots.



Circuit pack slots

The following table identifies the circuit packs used in the *LambdaUnite* MSS shelf. For additional information about the transmission interface circuit packs please refer to Chapter 10, "Technical specifications".

Slot designation	Slot equipage
Universal slots (32)	Any mix of transmission interface circuit packs: • 155-Mbit/s port units (future release) • 622-Mbit/s port units (future release) • 2.5-Gbit/s port units • 10-Gbit/s port units • 40-Gbit/s port units (future release) • 1-Gigabit Ethernet interface • 10-Gigabit Ethernet WANPHY interface
Controller slot (working)	CTL circuit pack. System controller including non-volatile memory and DCC controller for the whole network element.
Controller slot (protection)	Reserved for future use.
XC320 switch slot (working)	The switching circuit pack in this slot can make cross-connections for 6144 STS-1 / 2048 VC-4 equivalent circuits. This switch is paired with XC320 switch (protection) in a 1+1 non-revertive protection mode configuration. Furthermore, this circuit pack contains the timing generator function for the NE.
XC320 switch slot (protection)	The switching circuit pack in this slot can make cross-connections for 6144 STS-1 / 2048 VC-4 equivalent circuits. This switch is paired with XC320 switch (working) in a 1+1 non-revertive protection mode configuration. Furthermore, this circuit pack contains the timing generator function for the NE. After initial power up of the system this circuit pack is in standby mode.

Minimum complement of circuit packs

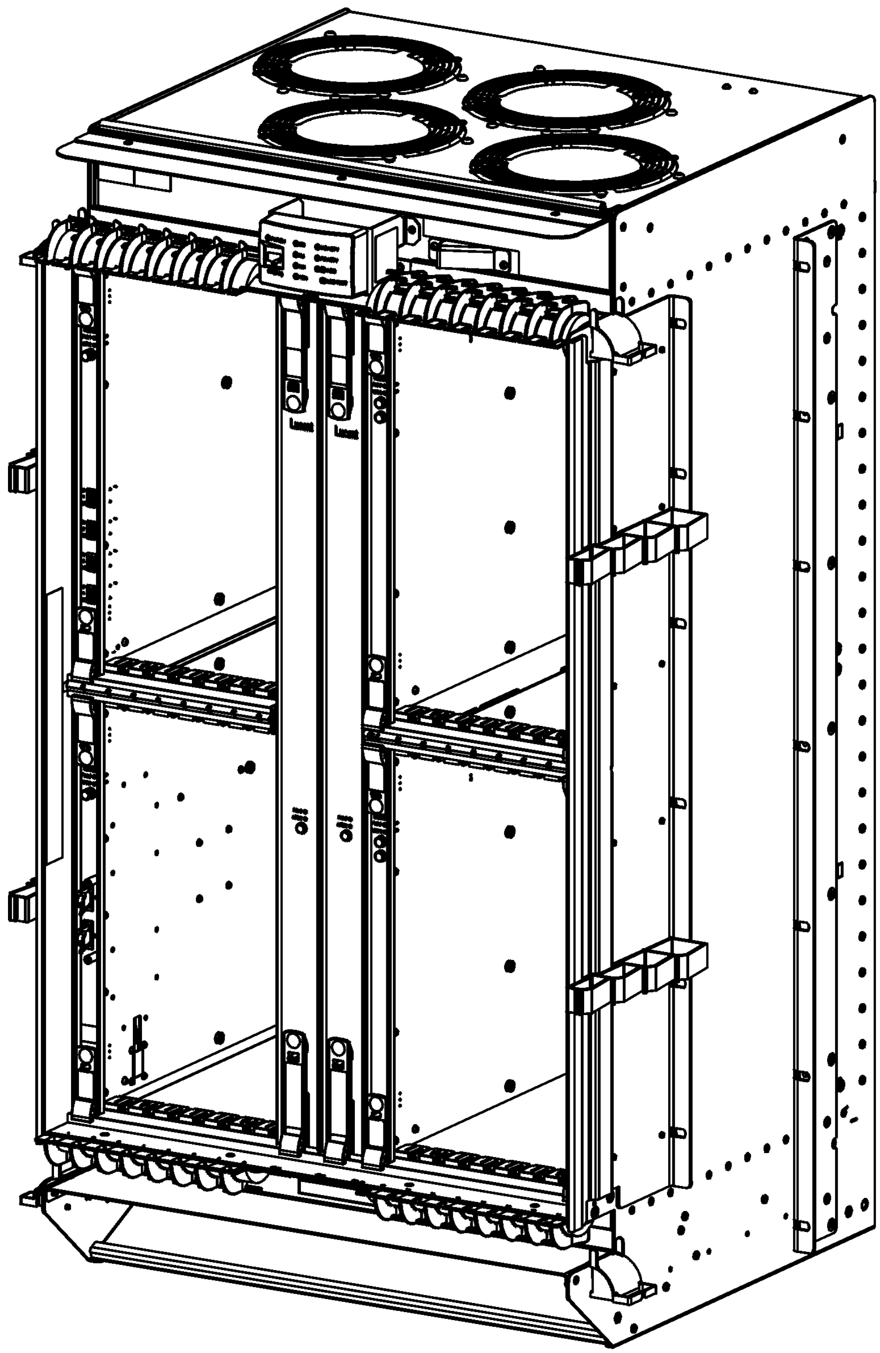
The minimum complement of circuit packs required for an operational *LambdaUnite* MSS shelf is

- Working XC320 switch circuit pack
- CTL circuit pack
- Any interface circuit packs in the universal slots

A shelf equipped with these circuit packs would be fully functional. Other essential parts of the system which always have to be installed in the shelf are the Power Interfaces (PI), the fan unit, the User Panel and a CI-CTL.

Front view of *LambdaUnite* MSS sub-rack

The following figure shows a front view of a *LambdaUnite* MSS sub-rack with two XC320 switching circuit-packs, one worker controller circuit pack and one protection controller circuit pack (supported in a future release). We can also distinguish the four fans of the fan unit, the user panel and fiber trays.



Interface panels

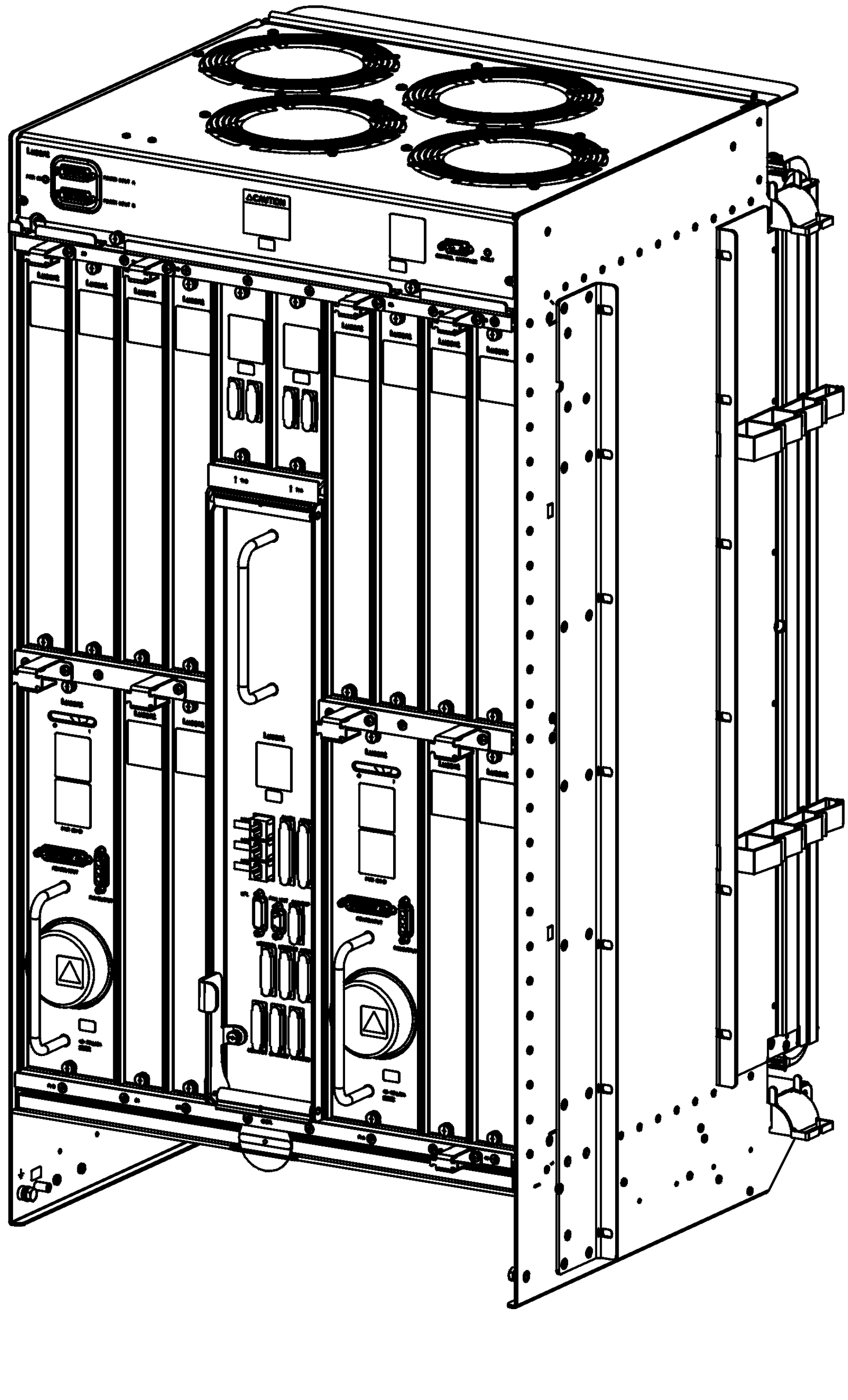
A variety of Interface Panel boards exist to be connected in between customer cabling and the backplane. All Interface Panel boards are inserted from the rear of the equipment.

Interface Panel boards available:

- Timing Interface (TI), provides external timing inputs/outputs
- Controller Interface (CI), provides the external LAN interface, station alarm interface, MDI/MDO interface (available in a future release), user byte interface and interface for cables to User Panel and Fan Unit.

Rear view of *LambdaUnite* MSS sub-rack

The following figure shows a rear view of a *LambdaUnite* MSS sub-rack with the different interface panels as illustrated above.



☐

Circuit packs

Overview The following circuit packs are used in the *LambdaUnite*™ MSS shelf:

Short Names	Function	Max. # in shelf
OP40G	Optical Interface Unit OC-768 / STM-256 (future release)	8
OP10G	Optical Interface Unit OC-192 / STM-64	32
OP2G5	Optical Interface Unit 4 x OC-48 / STM-16	32
OP622M	Optical Interface Unit 16 x OC-12 / STM-4 (future release)	32
OP155M	Optical Interface Unit 16 x OC-3 / STM-1 (future release)	32
GE1	Optical Interface Unit 4 x 1-Gigabit Ethernet	32
GE10	Optical Interface Unit 1 x 10-Gigabit Ethernet WANPHY	32
XC320	Switching Unit (incl. timing generator function) (upgradable)	2
CTL	System controller and DCC controller unit (upgradable, duplex controller in future release)	1

Max. 32 Interface Units can be used in a shelf. This can also be a mixed configuration, any one-slot wide card can be inserted in any slot.

For the optical interface units, there is a second level of identification (qualifier) which carries information about reach, lambda and other variants, e.g.: OP10G/1.5LR1, or OP40G/1.3IOR1 (see Chapter 7, “Ordering”).

The function of each circuit pack will now be described briefly. For the detailed optical interface specifications please refer to Chapter 10, “Technical specifications”.

Optical interface circuit pack OP10G

For interfacing to optical 10-Gbit/s signals, *LambdaUnite* MSS can be equipped with the OP10G circuit pack which is available in several variants:

- 10-Gbit/s long reach interface (80 km), 1550 nm
- 10-Gbit/s intermediate reach / short haul interface (40 km), 1550 nm
- 10-Gbit/s intra-office interface (600 m), 1310 nm
- 10-Gbit/s interface for direct OLS 1.6T (400G/800G) interworking, 40 / 80 colors (future release)
- 10-Gbit/s interface for direct *LambdaXtreme*™ Transport interworking, 128 colors (future release)

The electrical-to-optical and optical-to-electrical conversion is provided by the optics module(s) of these circuit packs. Several optical modules are used dependent on the required optical interface specifications.

The optics modules interface to the receive byte processor and the transmit byte processor by 16 times 622 Mbit/s (or 666 Mbit/s in case of strong FEC) interfaces.

The receive byte processor and transmit byte processor interface to the pointer processor through 16 times 622-Mbit/s TXI interfaces. The pointer processor itself provides the interface to the backplane with 4 times 2.5-Gbit/s TXI interfaces. These 2.5-Gbit/s TXI are doubled at the pointer processor, connecting to the working or the protection switch circuit pack (XC320) respectively.

The 155-MHz board clock which is fed to the byte processors and to the pointer processor is generated out of the 6.48-MHz reference clock provided via the backplane.

The circuit pack is equipped with an on-board function controller which interfaces with the system controller circuit pack (CTL).

Optical interface circuit pack OP2G5

For interfacing to four optical 2.5-Gbit/s signals, *LambdaUnite* MSS can be equipped with the OP2G5 circuit pack which is available in the current release in the following variant:

- 2.5-Gbit/s long reach interface (80 km), 1550 nm.
- 2.5-Gbit/s long reach interface (40 km), 1310 nm.

- 2.5-Gbit/s intra-office interface (2 km), 1310 nm.
- 2.5-Gbit/s intermediate reach pWDM interface, 32 colors (60 km), 1550 nm (future release).

The electrical-to-optical and optical-to-electrical conversion is provided by the four optical transceivers. Each transceiver interfaces to a MUX/DEMUX device.

The MUX/DEMUX devices interface to the byte and pointer processor device by 4 times 622-Mbit/s interfaces each.

The byte and pointer processor provides the interface to the backplane with four 2.5-Gbit/s TXI interfaces. The 2.5-Gbit/s TXIs are doubled at the byte and pointer processor, connecting to the working or the protection switch circuit pack (XC320) respectively.

The 155-MHz board clock which is fed to the byte and pointer processor is generated out of the 6.48-MHz reference clock provided via the backplane.

The circuit pack is equipped with an on-board function controller which interfaces with the system controller circuit pack (CTL).

Gigabit Ethernet interface circuit pack GE1/SX4

For interfacing to four optical 1-Gbit/s Ethernet signals, *LambdaUnite* MSS can be equipped with the GE1/SX4 circuit pack. Each port provides a 1000Base-SX optical Ethernet interface.

Each Ethernet port has a LAN port and a WAN port. A Crossbar device interconnects each LAN port with each WAN port. A function controller is used for on-board control and supervision purposes.

The LAN port consists of an optical module, a 1.25-Gbit Serialize/Deserialize (SerDes) device, and an Ethernet controller. The WAN port consists of an Ethernet controller and a Gigabit Ethernet Over SDH/SONET (GEOS) Flexible Programmable Gate Array (FPGA).

The interface to the backplane consists of two stages. The first stage is a backplane transceiver device which has an 8-bit parallel interface to the GEOS FPGA and a TXI622 interface to the second stage. The seconds stage combines the TXI622 interfaces to the TXI2G5 CML interface that is used on the backplane.

The function controller is built around an MPC860 processor. The asset uses 4 Mbyte of Flash memory and 16 Mbyte of SDRAM memory. A PQIO device is used to provide the interface to the system controller and to the ON (operations Network).

The timing function of the Gigabit Ethernet board is built around the clock sync distribution device (CSD2). Via this device a 77.76-MHz clock and a 8-kHz synchronization signal is distributed to the various devices on the circuit pack.

DC power is applied to the Gigabit Ethernet board via two -48-V battery feeds. On-board DC/DC converters generate 3.3 V, 2.5 V and 1.8 V.

Cross-connect circuit pack

The XC320 is connected with the interface circuit packs via the backplane bus (TXI). The XC320 is a bit-sliced cross-connect for 6144 STS-1 or 2048 VC-4 level signals. The bit-sliced data is generated in the data converter device, and will be desliced in the data converter after cross-connect. MS-SPRing/BLSR, 1+1 line APS / 1+1 MSP and SNCP/UPSR switching is supported on the cross-connect circuit pack.

The XC320 circuit pack receives the TXI2G5-signals unsliced (via the backplane) on the data converter devices. After 12-to-8 static preselection and a slicing function this data is forwarded to the switch matrix device. So, for each set of 12 incoming TXI2G5 links at the backplane side of the data converter devices, only 8 are active (static slot selection). The 8 active channels are 1-bit sliced and each bit slice is transported over a TXI2G5 link to the switch matrix device. In the switch matrix, the data is switched according to the defined scheme specified by using *WaveStar*® CIT or *Navis*™ Optical EMS. The 1-bit-sliced data which egresses the switch matrix devices is collected and desliced in the data converter devices before it leaves the XC320 circuit pack.

LambdaUnite MSS provides 1+1 equipment protection for the cross-connect circuit pack.

Timing generator function

The timing generator function in the *LambdaUnite* MSS network element is physically implemented on the cross-connect circuit pack (XC320). The external physical timing interfaces (inputs and outputs) are located on the Timing Interface (TI) panel.

The timing generator is designed as Stratum 3 version meeting the requirements of ITU-T Rec. G.813 (SDH) and Bellcore TR-1244 (SONET).

Timing modes available are:

- Free running
- Hold-over (deviation from the last source max. 4.6 ppm in two weeks)
- Locked with reference to:
  - one of the external synchronization inputs
  - one of all of the STM-N / OC-N input signals.

  LambdaUnite MSS provides 1+1 equipment protection for the timing function.

  For more information on the timing architecture, please refer to "Synchronization" (4-19).

Power Interface

The Power Interface (PI), which is integrated in the shelf performs the filtering functions for the primary voltage to meet the ETSI requirements. To maintain high availability this functionality is duplicated.

The actual DC/DC conversion is located on the individual circuit packs. The power feeds remain duplicated between the PI and the circuit packs.

Controller circuit pack CTL

The controller circuit pack CTL provides the central control, supervision and security functions in the network element. For this purpose, it communicates with the function controllers on the individual interface circuit packs and the switch circuit packs. Furthermore it maintains system configuration data and system software on an exchangeable 256 MB CompactFlash™ card.

The second area of functionality is as an adjunct controller which handles the Data Communication Network (DCN), the LAN and other external control interfaces. Thus, it acts as a network layer router, de-coupling the routing of DCN through traffic from system control. The CTL also provides data link protocol termination for DCC type HDLC links and for 802.3 LAN type links.

A further description of the control architecture in the shelf can be found on "Control" (4-25).

□

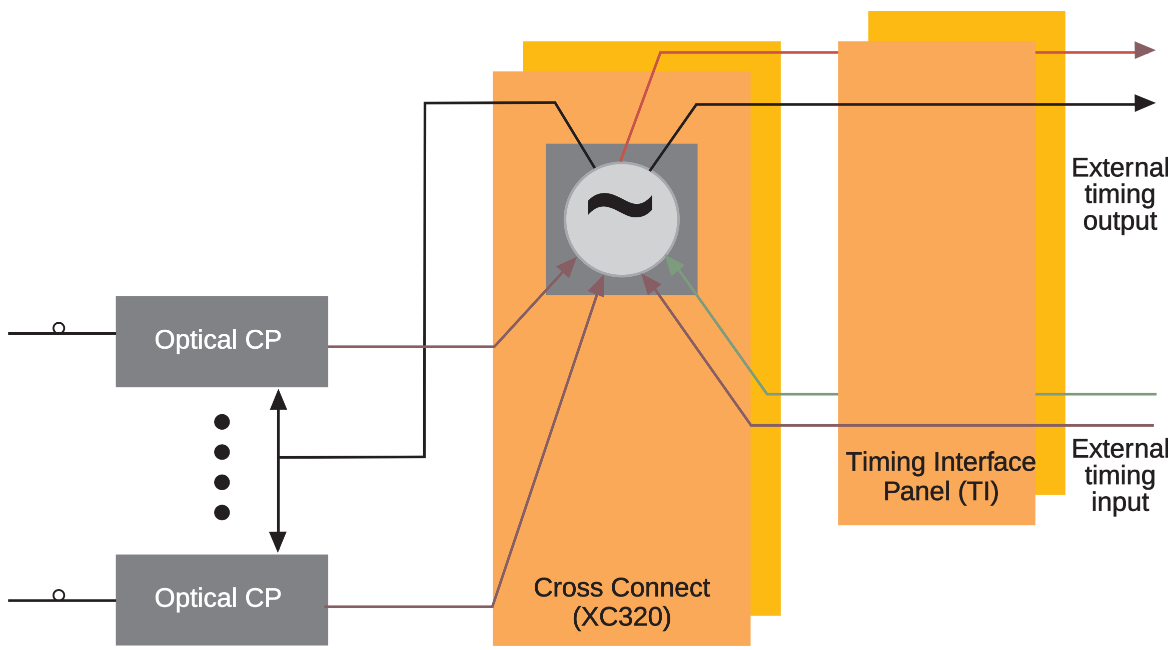
Synchronization

Overview

LambdaUnite™ MSS synchronizes add, drop and through signals by using one timing source for all transmission. The timing source is normally locked to an external reference signal, such as one from the SDH Equipment Clocks (SEC) or from the Synchronization Supply Units (SSU). In the *LambdaUnite* MSS shelf, the timing function is physically located on the switching circuit pack (XC320). If two XC320 circuit packs are present in the NE, 1+1 non-revertive protection of the timing sources is provided.

Timing function on the XC320 circuit packs

The timing functions on the XC circuit packs distribute timing signals throughout the shelf. These are used for clock, frame synchronization and multiframe synchronization.



Synchronization modes

LambdaUnite MSS runs in any of these synchronization modes

- Free-running operation
- Hold-over mode

- Locked mode, internal SDH Equipment Clock (SEC) locked to:
  - One of the two external netclock inputs; each of them is configurable for 2048-kHz or 2-Mbit/s signals, in a future release also for DS1 signals
  - One of up to six of the STM-N / OC-N input signals (choice of input is provisionable).

Timing reference signal collection

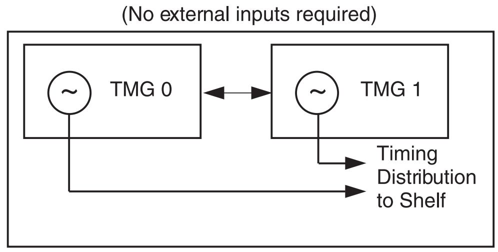
Up to 8 timing reference signals can be specified in the priority list by using *WaveStar*® CIT or *Navis*™ Optical EMS. Only one of these reference signals can be selected as the active timing reference for the system at a time.

The timing reference for the external netclock output can be provisioned independently from the timing reference for the system clock.

Free running mode

In the free running mode, the Stratum 3 clock in the timing function on the active XC320 circuit pack is not locked to an external timing reference signal. However, the standby timing generator, if any, remains locked to the active timing generator.

The following figure illustrates the free running mode, in which *LambdaUnite* MSS is synchronized by timing signals generated in the timing functions on the XC320 circuit pack.



Holdover mode

The active timing generator enters the holdover mode if all timing reference signals fail. In the holdover mode, the active timing generator keeps its internal Stratum 3 clock at the point at which it was synchronized to the last known good reference signal. The standby timing generator remains locked to the active timing generator. When the reference signal is restored, the active timing generator exits the holdover mode and resumes the normal locked timing mode.

Holdover mode is automatically available when the system clock is in the locked timing mode. The timing functions on the XC320 circuit packs monitor the quality of reference signals they receive. If one of the reference signals fails, *LambdaUnite* MSS uses the next in the priority list. If all reference signals fail, *LambdaUnite* MSS enters the holdover mode.

Furthermore the holdover mode can be entered intentionally by the operator command “forced holdover”.

Optical line timing

In the locked mode, the timing functions on the XC320 circuit packs can be provisioned to accept a timing reference signal from an incoming optical signal (10 Gbit/s or 2.5 Gbit/s, in future also 40 Gbit/s, 622 Mbit/s, or 155 Mbit/s). The timing functions then employ the provisioned timing reference signal from he specified port unit to synchronize the transmission port units.

The timing reference signal is continuously monitored for error-free operation. If the reference signal becomes corrupted or unavailable, the timing function selects the timing reference signal that is next in the priority list. If all configured timing reference signals are corrupted or unavailable, the timing function enters the holdover mode.

External netclock timing mode

In the external netclock timing mode, the timing function on the active XC320 circuit pack receives a 2.048-MHz, 2-Mbit/s ITU-T or a DS1 Telcordia (B8ZS, SF and ESF format; if in ESF format SSM is supported) reference signal from the external netclock inputs. The reference signals should be based on a Stratum 1 clock. The timing function on the active circuit pack synchronizes its internal Stratum 3 clock to the reference signal. The timing function on the standby XC320 circuit pack synchronizes its internal Stratum 3 clock to the active circuit pack. Then the timing functions distribute the clock signals to all circuit packs in the shelf.

Timing protection

LambdaUnite MSS uses non-revertive 1+1 protection switching to protect its timing function. If the active XC320 circuit pack fails and causes a switch to the standby circuit pack, the standby circuit pack becomes the active circuit pack. It remains the active circuit pack, even when the failed circuit pack is replaced. The replacement circuit pack becomes the standby circuit pack. There is no automatic revertive switching.

If the active timing generator were to fail while in holdover mode, then the standby timing generator would become the active timing generator and would switch to holdover mode (before switching, it was fed by the active timing generator) until the reference signal is restored to an acceptable quality.

Timing provisioning

The *LambdaUnite* MSS synchronization mode can be set to locked or free running by using *WaveStar* CIT. Additionally, either timing generator circuit pack can be switched to be the active timing generator. However, when *LambdaUnite* MSS is provisioned for the locked mode, the holdover mode is entered automatically upon loss of all reference signals. The holdover mode can be entered intentionally by the operator command "forced holdover".

Control and status

The behavior of the timing generators is controlled by switching them among several defined states. As commands are issued or as failures occur and are cleared, the timing system switches from one state to another. The status of the timing is retrievable for user observation. You can issue commands to obtain status reports or to manually change the synchronization state from one to another.

There are three categories of commands

- Modify – to provision operating parameters
- Retrieve – to obtain parameter values, states and statuses
- Operate – to lockout a switch, force a switch or holdover mode or clear a state

Synchronization switching

Synchronization operations that can be user-controlled by commands include

- Non-revertive synchronization equipment switching
- Synchronization reference switching
- Synchronization mode switching

Timing marker

The timing quality of the 40-Gbit/s, 10-Gbit/s and 2.5-Gbit/s data signals is coded in the timing marker (also known as synchronization status message, SSM) as per ITU-T Rec. G.783 and G.707. The timing marker is located in the lower four bits of the S1 byte. The S1 byte is located in the STM-N signal SOH (SDH) or in the first STS-1 of a STS-N (SONET).

The used bit combinations are listed in the following table. The remaining combinations are reserved for future use.

S1 Bits	Quality level (SDH)	Quality level (SONET)
0000	–	Synchronized – Traceability Unknown (STU)
0001	–	Primary Reference Source (PRS) acc. to Bellcore TR-1244
0010	Clock according to ITU-T Rec. G.811 (PRC)	–
0100	Transit node clock according to ITU-T Rec. G.812 (SSU-T)	–
0111	–	Stratum 2 clock acc. to Bellcore TR-1244
1000	Local node clock according to ITU-T Rec. G.812 (SSU-L)	–
1010	–	Stratum 3 clock acc. to Bellcore TR-1244
1011	SDH Equipment Clock (SEC) acc. to ITU-T G.81s	–
1100	–	–
1110	–	–
1111	Do not use for synchronization (DNU)	Do not use for synchronization (DUS)

The quality level “DNU/DUS” is inserted if AIS, LOS or LOF is detected in the incoming signal. Insertion of “DNU/DUS” at OC-M/STM-N output can also be configured by the operator in order to avoid timing loops in the network.

External timing outputs

The external timing output interfaces support 2048-kHz, 2-Mbit/s or Telcordia DS1 signals. For the external timing outputs, it is possible either to use the system timing reference (derived from internal oscillator) or a timing reference independent from the system timing reference (one out of available OC-M/STM-N signals). The external timing outputs will be squelched if the available timing quality drops below a configurable threshold.

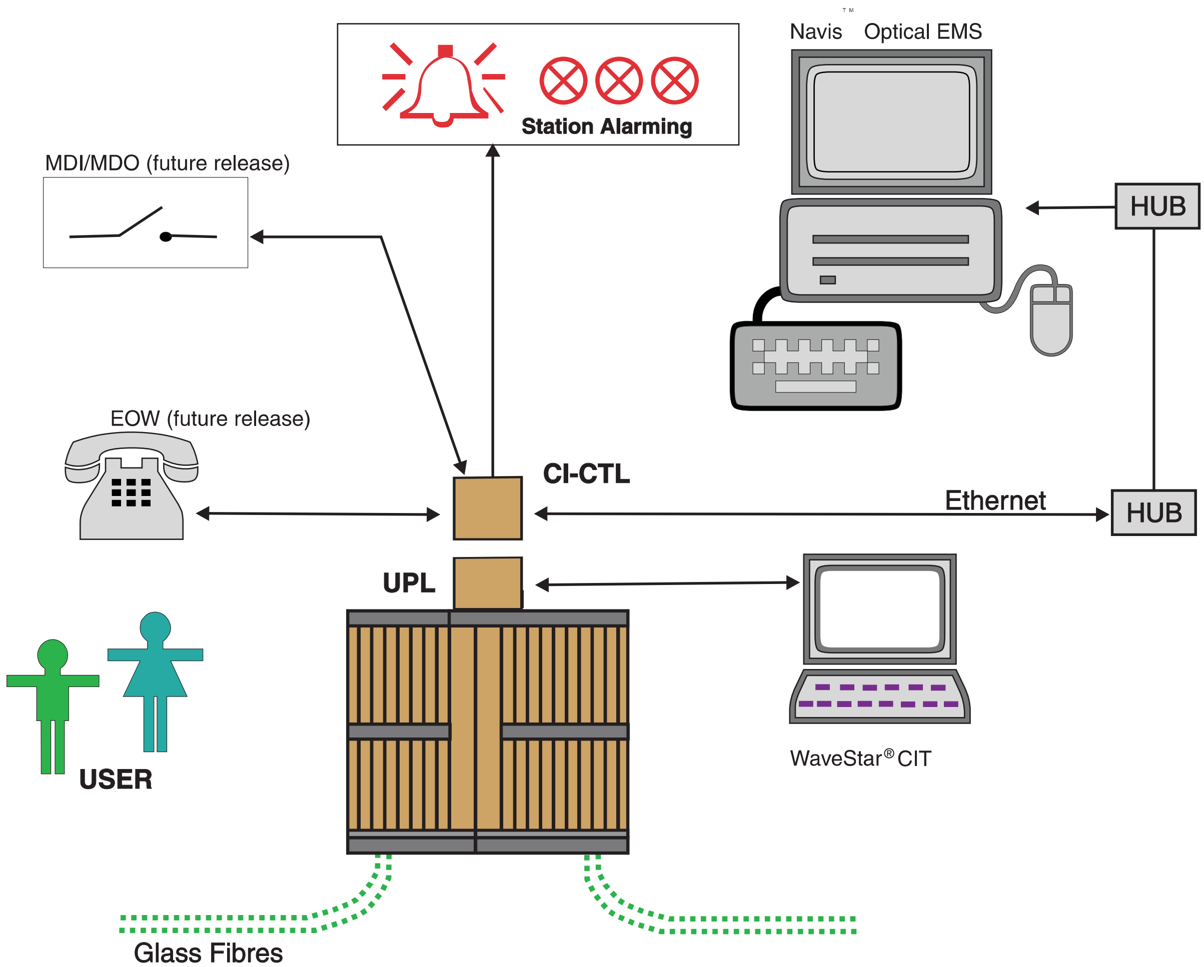
□

Control

Overview The functions in the *LambdaUnite*™ MSS network element are controlled by a system controller circuit pack (CTL) and by function controllers on the other circuit packs in the shelf. Overall shelf operation is controlled by signals received over the SDH Data Communication Channel (DCC) or the intra-office LAN (IAO LAN).

External control architecture

The following figure shows the external interfaces that have influence on the *LambdaUnite* MSS control architecture.



Internal control architecture

The following description shows the major paths of control and status information among the circuit packs in the *LambdaUnite* MSS shelf.

The control architecture is based on two levels of control. The highest level is the System Controller (CTL). Other circuit packs (OP2G5, OP10G, GE1, XC320) contain a function controller. The function controller performs the local unit control and is connected to the system controller via the Operations Network Interface (ONI). Each CTL has two control functions, the System Control Function (SCF) and the DCC Control Function (DCF). Both control functions run independently from each other.

The Operations Network (ON) is the internal communications network and is physically implemented in a star topology. An ON hub function is placed on the SCF on the controller circuit pack (CTL).

The equipment management (EMP) control function is responsible for inventory data access, reset lines and equipment sensing (check physical availability of circuit packs).

In case of DCN messages addressing the network element the DCN traffic is terminated on the DCC Control Function (DCF) on the CTL circuit pack. Application messages are forwarded to the System Control Function (SCF) on the CTL. In case of messages for other NEs the DCF decides on which of the channels listed below the message will be forwarded. Thus all channels are to be considered as bidirectional links.

The data communication network control function comprises the traffic

- from external interfaces and CIT at LAN ports forwarded via CIP to the DCF on CTL
- from the XC320 circuit pack where line DCC (DCCr) and section DCC (DCCm) are terminated via OHI to the DCF on CTL
- from OP40G circuit pack (in future release) where the DCCmx is terminated via MxDCC to the DCF on CTL.

Furthermore, the CTL is involved in user byte processing. The user bytes (E1, E2, F1, supported in a future release) which are physically made available as 64-kbit/s channels at the Control Interface (CI) are fed to this interface via the XC320 and CTL circuit pack.

The CTL is also responsible for the control of equipment protection switching.

The Timing Interface Control (TIC) interaction ensures the isolation of a timing function in case that the CTL detects misbehavior. Normally the timing function on both XC320 can share the assigned functionality. However in case of isolation one timing function can take over all functionality. This is controlled by the TIC lines.

Additionally, the CTL supports the status indicators on the User Panel (UPL).

□

Power

Overview

LambdaUnite™ MSS uses a distributed powering system, rather than bulk power supplies. It distributes -48V/-60V power throughout the shelf with an average fully loaded power consumption of 2.200 W, and each circuit pack uses its own on-board power converter to derive the necessary operating voltages.

Dual power feeds, power interfaces (PI)

Office power feeders A and B are filtered and protected by circuit breakers at the input to the shelf. This is done by the Power Interface (PI) units, one unit is assigned to each power feeder. After that, the supplies are distributed separately to each circuit pack, where they are filtered again and fused before being converted to the circuit pack working voltages.

The A and B power inputs are supervised individually by the system controller circuit pack (CTL). A green LED on every Power Interface (PI) indicates that the input power is available which means that it is above 39.0 VDC ± 1.0 VDC. As soon as the input voltage is below 39.0 VDC ±1. 0 VDC, an alarm message will be send to the CTL.

Power indicator

The green PWR ON indicator on the user panel remains lighted as long as either -48 V / -60 V supply is received from the circuit breakers.

□

Cooling

Overview

Cooling is provided by a plug-in fan unit placed on top of the sub-rack. Fans pull air through a filter below the circuit packs and force it through the sub-rack from bottom to top. An air flow baffle is integrated in the sub-rack to prevent the intake of exhaust air from below. The air filter should be replaced or cleaned every three months to ensure the proper cooling, as described in the UOG chapter “Periodic activities” or as part of a trouble clearing procedure as described in the AMTCG.

Fan controller

The fan unit includes four fans and a microcontroller that senses air flow, air temperature and fan faults. The microcontroller adjusts the speed of the fans to compensate for the failure of a fan or to conserve power when full air flow is not needed. It also reports the status of the fan unit to the shelf controller.

Important! The fan unit must be installed and operating in a shelf before any circuit packs are installed.

□

5 Operations, administration, maintenance, and provisioning

Overview

Purpose

This chapter describes hardware and software interfaces used for administration, maintenance, and provisioning activities, the system management function for the administration of the *LambdaUnite*™ MultiService Switch (MSS) and the maintenance and provisioning features available in the *LambdaUnite* MSS.

Contents

Operations

Overview

Purpose

This section describes the hardware and software interfaces used for administration, maintenance, and provisioning activities. These include

- Visible and audible indicators
- Graphical User Interface (GUI) on the *WaveStar*® CIT (Craft Interface Terminal)
- Operations interfaces

Please note that administration, maintenance, and provisioning activities via *Navis*™ Optical EMS are described in the separate *Navis* Optical EMS documentation set.

Visible and audible indicators

Visible and audible indicators notify you of maintenance conditions such as faults and alarms.

Graphical user interface

The GUI on the *WaveStar* CIT retrieves detailed information about local and remote network elements. The GUI is also used to provision local and remote *LambdaUnite*™ MSS circuit packs and the switching matrix.

Operations system interfaces

Operations interfaces include the DCC interfaces on the OC-M/STM-N port units and the IAO LAN (intra-office LAN) interface. Both the DCC interface and the IAO LAN interface can receive commands from operations systems (network element management systems) or from a remote *WaveStar* CIT.

Contents

Visible alarm indicators

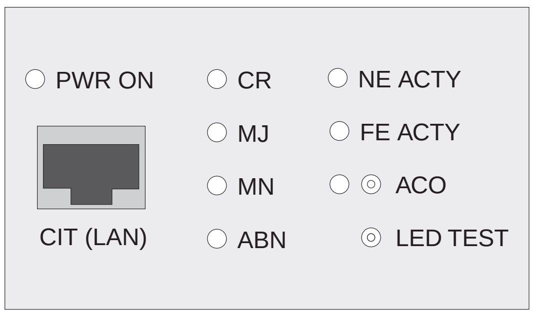
Overview

This section describes the visible indicators of the *LambdaUnite*™ MSS network element that are located on the

- User panel
  The user panel is the primary source of shelf-level visible alarm indicators.
- Circuit pack faceplates

User panel: Controls and indicators

The following figure illustrates the user panel of *LambdaUnite* MSS.



Indicators

The user panel provides the following indicators:

LED	Function
CR (Red)	indicates Critical (CR) alarms
MJ (Red)	indicates Major (MJ) alarms
MN (Yellow)	indicates Minor (MN) alarms
ABN (Yellow)	indicates Abnormal (ABN) conditions – temporary conditions that may potentially affect transmission
NE ACTY (Yellow)	indicates Near-end Activity (NE ACTY) – at least one near-end transmission alarm is active. Near-end alarms are all transport alarms except Remote Defect Indication (RDI)

LED	Function
FE ACTY (Yellow)	indicates Far-end Activity (FE ACTY) – at least one far-end transmission alarm is active
PWR ON (Green)	indicates that power is supplied to the shelf.

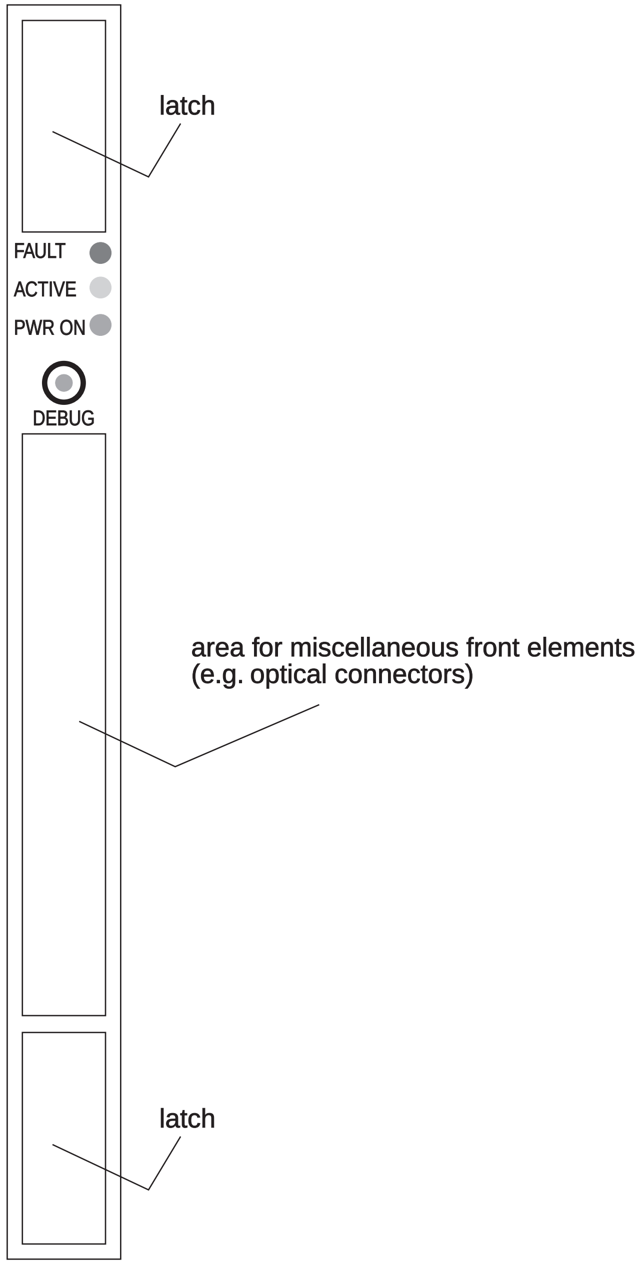
Controls and connectors

The user panel provides the following controls and connections:

Button/Connection	Function
LED TEST	Test button for testing all shelf LEDs (except PWR ON on the user panel and the fan unit LEDs)
ACO	Test button and LED; LED lights up yellow when button is pressed to silence audible office alarms
CIT (LAN)	LAN socket (4-wire RJ-45 for crossed cable) to connect a *WaveStar*® CIT to the system LAN.

Circuit pack indicators

The following figure illustrates the position of the LEDs on a circuit pack faceplate.



Circuit pack faceplate

All circuit pack faceplates are equipped with a Fault indicator and a Power (ACTIVE) indicator.

LED	Function
Fault (Red)	The LED is lit or flashes when the *LambdaUnite* MSS network element has detected a failure in or involving that circuit pack.
ACTIVE (Green)	LED is lit when the circuit pack is in the active (ON) mode, LED flashes when a circuit pack is inserted in a shelf.

□

WaveStar® CIT

Overview

LambdaUnite™ MSS is shipped with software for a Microsoft Windows®-NT or Windows-2000® -based GUI that runs on a customer-furnished desktop or laptop computer. The GUI provides

- Control of operations, administration, maintenance and provisioning activities
- Security features to prevent unauthorized access
- Easy-to-use Transaction Language 1 (TL1) interface.

Definition

WaveStar CIT is a PC-based GUI software handling the *LambdaUnite* MSS network elements one-by-one. It provides pull-down menus and extensive, context-sensitive on-line help. It offers a unified set of features for provisioning, testing, and reporting. The *WaveStar* CIT is necessary to install and accept the system.

PC requirements

These are the minimum PC requirements for running *WaveStar* CIT:

- *Pentium*® 266-MHz processor (*Pentium* III 500 MHz recommended) with 128 MB RAM (256 MB recommended)
- Standard floppy drive for 1.44-MB 3.5” floppy disks
- 150 MB of free hard drive space (for the *WaveStar* CIT software only; for the NE software generics and the online help files 120 MB additional free hard drive space should be reserved)
- CD-ROM drive (16X)
- *CompactFlash*™ card
- SVGA monitor set with 800x600 resolution and 256 colors (1024x768, 16 million colors recommended)
- 100BaseT LAN interface, installed and working
- *Microsoft*® *Windows NT*® 4.0 or *Windows*® 2000 operating system
- *Adobe*® *Acrobat*® Reader for *Windows* (version 3.01) to display documentation in PDF format stored on the Installation CD

The performance of the user interface can be enhanced by using a higher-performance personal computer.

An unshielded crossed Ethernet LAN cable (100BaseT) with 4-wire RJ-45 connectors is used for connecting the *WaveStar* CIT to the NE.

WaveStar CIT access

LambdaUnite MSS supports local and remote access using a *WaveStar* CIT. Remote access uses the DCC (data communications channel) or an external WAN connected to a *LambdaUnite* MSS LAN port.

Security function

LambdaUnite MSS provides a security function to protect against unauthorized access to the *WaveStar* CIT system functions (such as provisioning). Security is controlled through logins, passwords, and authorization levels for the system functions.

TL1 interface

You can use the GUI to manage all provisioning, testing, and report generation easily and intuitively, with the GUI handling the TL1 interface behind the scenes.

Maintenance and administrative activities

The *WaveStar* CIT provides detailed information and system control of the following specialized local/remote maintenance and administrative activities:

- Provisioning
- Cross-connect assignments
- Protection switching
- Displaying performance-monitoring data
- Fault management (alarms lists, etc.)
- Polling inventory data of the NE
- Software download to the NE
- Loopback operation and testing
- Reporting.

□

Operations interfaces

Overview

LambdaUnite™ MultiService Switch (MSS) supports the following operations interfaces

- Office alarms interface
- Miscellaneous discrete interfaces
- Operations system LAN interface
- Data communications channels (DCC).

Office alarms interface

The office alarms interface is a set of discrete relays that control audible and visible office alarms. Separate relays handle the following alarm levels: either critical, major, and minor or prompt, deferred and info.

Miscellaneous discrete interfaces

The miscellaneous discrete interfaces, supported in a future release, allow an OS to control and monitor equipment co-located with *LambdaUnite* MSS through a set of input and output contact closures. There are 8 miscellaneous inputs that can monitor conditions such as open doors or high temperature, and 8 miscellaneous discrete outputs to control equipment such as fans and generators. These can be set by the user.

The status of the miscellaneous discrete inputs can be queried from the *WaveStar*® CIT. The *LambdaUnite* MSS network element collects miscellaneous discrete alarms and automatically sends them to the OS.

Message-based OS interface

The *LambdaUnite* MSS supports a message-based OS interface that uses the LAN to communicate with the OS. This interface supports Transaction Language 1 (TL1) and standard operations messages. It is compatible with Bellcore Network Monitoring and Analysis (NMA), Lucent Technologies Transvu II, and Lucent Technologies *Navis*™ Optical Element Management System (EMS). *Navis* Optical EMS is a type of OS element manager. It then collects and forwards the responses and autonomous messages from the Network Elements to itself. The information it receives is used to perform fault correlation and diagnose problems in the network. The *Navis* Optical EMS concentrates the data links to/from NEs into a single link back to a network management OS, thus reducing costs.

A message-based operations system can access the local *LambdaUnite* MSS (local access capability) and any remote network element in a maintenance subnetwork using the DCC capability.

Interface security function

LambdaUnite MSS also provides a security function to protect against unauthorized access to OS functions, such as provisioning. Security is controlled through logins, passwords, and authorization levels for the system functions.

Data communications channel (DCC)

The *WaveStar* CIT and operations interface features extend beyond the local *LambdaUnite* MSS to cover remote sites. This network operations capability uses the section DCC bytes in the OC-M/STM-N overhead. *WaveStar* CIT dialogues and operations interface messages travel in these DCC bytes.

□

Administration

Overview

Purpose

The system management function for the administration of *LambdaUnite*™ MultiService Switch (MSS) is operator administrated.

Security

The *WaveStar*® *LambdaUnite* MSS provides for secure system access by means of a two-tier security mechanism.

□

Security

Overview

This section describes the various security features that the *LambdaUnite*™ MSS provides to monitor and control access to the system.

Two-tier security

The two tiers of security that protect against unauthorized access to the *WaveStar*® CIT and the network element functions are

- User login security (*WaveStar* CIT)
- Network element login security ("System View")

User login security

User login security controls access to the system on an individual user basis by means of

- Login ID and password assignment
- Login and password aging
- Autonomous indications and history records
- User privilege codes.

Network element login security

NE login security controls access to the system through a lockout mechanism to disable all but administrative logins.

Login and password assignment

To access the system, the user must enter a valid login ID and password. *LambdaUnite* MSS allows up to 500 login IDs and passwords. Two of these login IDs are for the Superuser authorization level. The others are for Privileged User, Maintenance, Reports Only, and General User authorization levels.

Login and password aging

The following aging processes provide additional means of monitoring and controlling access to the system:

- Login aging deletes individual logins if unused for a pre-set number of days or on a particular date (for example, for a visitor or for temporary access during installation)
- Password aging requires that users change passwords periodically.

Autonomous indications and history records

The system provides autonomous indications and history log records of successful and unsuccessful logins, as well as intrusion attempts for security audits.

User privilege codes

When a user is added to the NE, a separate user privilege code, which may include an authorization level, is assigned to that user for each of the functional categories, based on the type of work the user is doing. The user privilege codes may be accompanied by an authorization level represented by a number between 1 and 5, with 5 being the highest level of access. It is permissible to grant access to any combination of commands using a privilege code, except for full privileges, which are reserved for the two pre-installed superusers.

Functional categories

The functional categories for the user privilege codes may include

- Security (S)
- Maintenance (M)
- Performance monitoring (PM)
- Testing (T)
- Provisioning (P).

Authorization levels

Users can execute any commands at their functional categories' authorization level, as well as all commands at lower levels. For example, a user with authorization level 4 in the maintenance category can also execute commands listed in levels 3, 2, and 1 in the maintenance category.

□

Maintenance

Overview

Purpose

This section introduces the maintenance features available in the *LambdaUnite*™ MultiService Switch (MSS).

Definition

Maintenance is the system's capability to continuously monitor its equipment and the signals that it carries in order to notify the user of any current or potential problems. This enables the user to take appropriate proactive (preventive) or reactive (corrective) action.

Contents

Maintenance signals

Overview

This section describes the maintenance signals available in *LambdaUnite*™ MultiService Switch (MSS).

Definition

LambdaUnite MSS maintenance signals notify downstream equipment that a failure has been detected and alarmed by some upstream equipment (Alarm Indication Signal) or the *LambdaUnite* MSS, and they notify upstream equipment that a downstream failure has been detected (yellow signals).

Standards compliant

The fault monitoring and maintenance signals supported in the *LambdaUnite* MSS are compliant to ITU-T and Telcordia standards.

Monitoring failures

LambdaUnite MSS continuously monitors its internal conditions and incoming signals. Read access to the path trace information is provided for all signals.

Signal maintenance

When defects are detected, the *LambdaUnite* MSS inserts an appropriate maintenance signal to downstream and/or upstream equipment.

Path unequipped

LambdaUnite MSS inserts the Path Unequipped identifier to downstream and/or upstream equipment if paths are intentionally not carrying traffic.

Fault detection and reporting

When a fault is detected, *LambdaUnite* MSS employs automatic diagnostics to isolate the failed component or signal. Failures are reported to local maintenance personnel and to the OS so that repair decisions can be made. If desired, OS personnel and local personnel can use the *WaveStar*® CIT to gain more detailed information about a specific fault condition.

Fault history

All alarmed fault conditions detected and isolated by *WaveStar LambdaUnite* MSS are stored and made available to be reported, on demand, through the *WaveStar* CIT. In addition, a history of the 1024 most recent alarm events, of the 500 most recent state change events and of the 1000 most recent database change events is maintained and available for on-demand reporting. Each event is date and time stamped.

Reports

LambdaUnite MSS automatically and autonomously reports all detected alarm and status conditions through the

- Office alarm relays
- User panel
- Equipment LEDs
- Message-based OS.

□

Loopbacks and tests

Overview

This section describes the loopbacks and tests that the *LambdaUnite*™ MSS performs.

Loopback definition

A loopback is a troubleshooting test in which a signal is transmitted through a port unit to a set destination and then returned to the originating port unit. The transmitted and received signals are measured and evaluated by the user to ensure that the received signal is accurate and complete when compared to the originating signal.

Software-initiated loopbacks

LambdaUnite MSS can perform software-initiated facility loopbacks within the port units (in-loopbacks and out-loopbacks). Active loopbacks are indicated by the abnormal (ABN) LED on the user panel.

Installation self-test

Installation self test and diagnostics are executed automatically during installation and after power up to verify correct system operation. Additional diagnostic tests are performed for fault isolation. These tests ensure that the system is capable of performing its required functions. If a defect is detected, the replaceable unit which should be replaced to repair the defect is identified.

Circuit pack self-test

LambdaUnite MSS supports a variety of self-tests designed to verify the health of individual transmission circuit packs.

□

Protection switching

Overview

This section describes the protection switching and redundancy mechanisms available in *LambdaUnite*™ MultiService Switch (MSS).

Definition

The following types of protection and redundancy are available (see Chapter 2, “Features”):

- 1+1 Linear APS on OC-192 and OC-48 level
- 1+1 Multiplex Section Protection (MSP)
- Bidirectional Line Switched Ring (BLSR)
- Multiplex Section Shared Protection Ring (MS-SPRing)
- Transoceanic Protocol (future release)
- Uni-directional Path Switched Ring (UPSR) on all supported cross connection types
- Sub-Network Connection Protection (SNCP) on all supported cross connection types
- Redundant Timing circuit packs: TMG protected with XC320
- Duplicated power feed throughout the system.

1+1 Line Protection (SONET), 1+1 MSP (SDH)

One physical working connection is protected by one physical stand-by connection.

BLSR (SONET), MS-SPRing (SDH)

A bidirectional line switched ring (BLSR) / multiplex section shared protection ring (MS-SPRing) is a self-healing ring configuration in which traffic is bidirectional between each pair of adjacent nodes and is protected by redundant bandwidth on the bidirectional lines that inter-connect the nodes in the ring.

UPSR (SONET), SNCP (SDH)

The principle of a UPSR/SNCP is based on the duplication of the signals to be transmitted and the selection of the best signal available at the subnetwork connection termination. The two (identical) signals are routed over two different path segments, one of which is defined as the main path and the other as standby path. The same applies to the opposite direction (bidirectional UPSR/SNCP). The system only switches to the standby path if the main path is faulty.

Redundant timing generator

TMG is protected with the switching circuit pack XC320.

Duplicated power feed

Power feed is duplicated throughout the system. Each circuit pack has its own DC/DC converter (distributed powering).

□

Performance monitoring

Overview

Performance Monitoring provides the user with the facility to systematically track the quality of a particular transport entity. This is done by means of continuous collection and analysis of the data derived from defined measurement points.

Basic measurement parameters

The following performance parameters are available to estimate the error performance of a section (SONET):

- SES (number of Severely Errored Seconds in the received signal)
- ES (number of Errored Seconds in the received signal)
- CV (number of Code Violations in the received signal)
- SEFS (number of seconds during which the Severely Errored Framing defect was detected)
- LOSS (number of seconds during which the Loss of Signal defect was detected)

The following performance parameters are available to estimate the error performance of a line (SONET):

- SES (number of Severely Errored Seconds in the received signal)
- ES (number of Errored Seconds in the received signal)
- CV (number of Code Violations in the received signal)
- UAS (number of Unavailable Seconds in the received signal)
- FC (number of times the incoming signal failed (AIS detected or inserted))
- AISS (number of seconds during which the AIS defect was detected)

The following performance parameters are available to estimate the error performance of an RS, MS (SDH):

- SES (number of Severely Errored Seconds in the received signal)
- ES (number of Errored Seconds in the received signal)
- BBE (number of Background Block Errors in the received signal)
- UAS (number of Unavailable Seconds in the received signal)

The following performance parameters are available to estimate the error performance of a VC sub-network connection (SDH):

- SES (number of Severely Errored Seconds in the received signal)
- ES (number of Errored Seconds in the received signal)
- BBE (number of Background Block Errors in the received signal)
- UAS (number of Unavailable Seconds in the received signal)

Enabling performance measurement points

Performance measurement points can be enabled via the Element Manager *Navis*™ Optical EMS and via the *WaveStar*® CIT. Please refer to the *LambdaUnite*™ MSS ***User Operations Guide***.

Data storage

All data is stored in the current bin. The managed NE has a current data register (current bin) for 15 minutes and 24 hours. Once a termination point for measurements has been configured, you are able to get a snapshot view of the data gathered at any time (default).

Historic bins

The network element keeps a store of the historic 15 minute and 24 hour bins.

Interval	Number of historic bins	Total storage time
15 minute	16	4 hours
24 hours	1	1 day

Data retrieval

Performance Data can be polled via the *Navis* Optical EMS and via the *WaveStar* CIT.

Reports

Via the *Navis* Optical EMS the user is able to create reports from history data stored in the database of the network management system.

Zero suppression

Performance data sets with counter value zero, i.e. no errors occurred, will not be stored in the performance data log.

Performance alarms

If the counter value of a performance parameter exceeds the threshold, in a future release an alarm can be generated and displayed on the *Navis* Optical EMS and *WaveStar* CIT.

Fault localization

Performance alarms only give a hint that the signal quality at a certain measurement point is degraded. They can be used as a help for fault localization. The severity of such an alarm is strongly dependent on the application of your network. Often it can be helpful to define a very low threshold value (supported in a future release) in order to realize a signal degradation at a very early stage .

Clearing

The clearing of the alarms is done automatically at the end of the first complete interval during which no threshold crossing occurred.

□

Reports

Overview

This topic contains information about the

- Active alarms and status reports
- Performance monitoring reports
- History reports
- Report on circuit pack, slot, port and switch states
- Version/equipment list
- Synchronization reports

Active alarms and status reports

LambdaUnite™ MSS provides an on-demand report (*WaveStar*® CIT NE Alarm List) that shows all the active alarm and status conditions. *LambdaUnite* MSS automatically displays the local alarm and status report on the *WaveStar* CIT. The *WaveStar* CIT can be configured to show the following alarm levels and alarm conditions: Either

- Critical (CR)
- Major (MJ)
- Minor (MN)
- Not Alarmed (status) (NA)

or

- Prompt
- Deferred
- Info

Among others, the alarm issue point and a description of each alarm condition are included in the report along with the date and time detected. The report also indicates whether or not the alarm is service-affecting.

Performance monitoring reports

LambdaUnite MSS provides reports that contain the values of all performance monitoring registers requested at the time of the report. The start time of each register's recording period is also included. The reports provide all performance monitoring data that was recorded in a series of 15-minute and 24-hour storage registers.

Performance parameters report

LambdaUnite MSS provides another report that contains a summary of all performance parameters that have crossed their provisioned

15-minute or 24-hour thresholds within the history of the 15-minute and 24-hour registers.

A series of 32 previous and one current 15-minute registers are provided for each parameter, allowing for up to 8 hours and 15 minutes (495 minutes) of history in 15-minute registers. Also, one current and one previous 24-hour registers are provided, allowing for up to 2 days (48 hours) of history in 24-hour registers.

History report

A history report displays the past 500 events. An event is any change in *LambdaUnite* MSS that may affect its performance (for example, a failure) or change its operation status (for example, loopback setup). This summary contains time stamps showing when each condition was detected and when it has cleared. The *WaveStar* CIT events contain a time stamp showing when the command was entered.

Report on pack, slot, port and switch states

This on-demand report displays

- Circuit pack, transmission port, and timing port state information
- Protection group switch states.

Version/equipment list

The version/equipment list report is an on-demand report that lists all

- Provisioned or pre-provisioned circuit packs
- Circuit packs that are present.

Synchronization report

The synchronization report is an on-demand report that lists the system synchronization status.

□

Maintenance condition

Definition

The system state of Maintenance Condition is a special state that the system is placed into for securing the integrity of the system's cross-connection maps and database in times of non-volatile memory (NVM) corruption, or when maintenance activities need to be performed on the NVM for purposes of installing a new software generic on the system, or restoring the database from a previously stored backup version. Any changes to NE-originated data during the Maintenance Condition is made only in the controller RAM of the processor that owns the data and is not made in the corresponding associated object or NVM.

□

Orderwire

Overview

This section provides information about orderwire.

Description

Engineering Orderwire (EOW) provides voice communications for maintenance personnel to perform facility maintenance. *LambdaUnite*™ MultiService Switch (MSS) provides two pairs of 64-kbit/s (E1 and E2) orderwire (OW) interfaces per shelf (supported in a future release).

Each pair includes

- Local Orderwire (SONET) / Regenerator Section Orderwire (SDH)
- Express Orderwire (SONET) / Multiplex Section Orderwire (SDH).

□

Provisioning

Overview

Purpose

This section contains information about the following features:

- Local or remote provisioning
- Preprovisioning circuit packs
- Circuit pack replacement provisioning
- Original value provisioning

Definition

Provisioning refers to assigning values to parameters used for specific functions by network elements. The values of the provisioned parameters determine many operating characteristics of a network element.

References

For more information about provisioning parameters and original values using the *WaveStar*® CIT, refer to the *LambdaUnite*™ MSS User Operations Guide.

☐

Introduction

Local or remote provisioning

The *LambdaUnite*™ MSS software allows local and remote provisioning of all user-provisionable parameters. The provisionable parameters and values (current and original) are maintained in the nonvolatile memory of the controller circuit pack.

Preprovisioning circuit packs

To simplify circuit pack installation, parameters can be provisioned before inserting the corresponding circuit pack. The appropriate parameters are automatically downloaded when the corresponding circuit pack is installed. All system parameters and values (current and original) are retrievable on demand regardless of the means used for provisioning.

Circuit pack replacement provisioning

Replacement of a failed circuit pack is simplified by the *LambdaUnite* MSS automatic provisioning of the original circuit pack values. The controller circuit packs maintain a provisioning map of the current provisioning values. When a transmission and/or a timing circuit pack is replaced, the controller automatically downloads the previous provisioning parameters to the new circuit pack.

Original value provisioning

Installation provisioning is minimized with factory-preset values. Each provisionable parameter is assigned an original value at the factory. The provisionable parameters are automatically set to their original values during installation.

There are two complete sets of data (parameters and their values) located in the nonvolatile memory of the controller circuit pack under normal conditions:

- The first set contains the system parameters and their original values (values assigned to a parameter at the factory).
- The second set contains the system parameters and their current values (values currently being used by the system).

Please note that the original values assigned at the factory cannot be changed. However, the current values can be overridden through local or remote provisioning.

□

6 System planning and engineering

Overview

Purpose

This chapter provides general System Planning and Engineering information for *LambdaUnite*™ MultiService Switch (MSS).

Contents

General planning information

Overview

This section provides general planning information for *LambdaUnite*™ MSS.

Planning considerations

When planning your network, you should consider the

- Power planning
- Cooling Equipment
- Transmission capacity
- Port location rules
- Synchronization
- Floor plan layout
- Equipment interconnection.

Engineering and installation services group

Lucent Technologies maintains an Engineering and Installation Services group to assist you in planning and engineering a new system. The Engineering and Installation Services group is a highly skilled force of support personnel dedicated to providing customers with quality engineering and installation services. These specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services.

For more information about the Engineering and Installation Services group, refer to Chapter 8, “Product support”.

□

Power planning

Overview

This section provides general power planning information for *LambdaUnite*™ MSS. The *LambdaUnite* MSS sub-rack uses a distributed powering system, rather than bulk power supplies. It distributes -48 V DC / -60 V DC power throughout the sub-rack up to a maximum power consumption of 2.200 W, and each circuit pack uses its own onboard power converter to derive the necessary operating voltages.

Dual power feeds, power interfaces (PI)

Office power feeders A (working) and B (protection) are filtered and protected by circuit breakers at the input to the sub-rack. This is done by the PI units, one unit is assigned to each power feeder. The supplies are distributed separately to each circuit pack, where they are filtered again and fused before being converted to the circuit pack working voltages. For the main over-current protection of the system a centralized 63-A circuit breaker located in the PI is used.

The A and B power inputs are supervised individually by the system controller circuit pack (CTL). A green LED on every Power Interface (PI) indicates that the input power is available which means that it is above 39.0 V ± 1.0 V. As soon as the input voltage is below 39.0 V ±1. 0 V, an alarm message will be send to the CTL.

Power distribution

The power supply of the rack is provided by the Power Distribution Panel (PDP) at the top of the rack. This PDP provides doubled power supply to the sub-rack.

Grounding

The grounding and earthing of the system covers the requirements for MESH-BN and MESH-IBN according to ETSI 300 253 or ITU K.27. With the PDP it is possible to connect or to disconnect the DC returns to GRD. At this way, the system can be applied in a MESH-BN or MESH-IBN environment.

Power consumption

For more information about power consumption of the whole sub-rack and of the individual circuit packs, refer to Chapter 10, “Technical specifications”.

For this release the system can be equipped up to a maximum power consumption of 2.700 W.

Cooling equipment

Overview

This section provides general cooling equipment information for *LambdaUnite*™ MSS.

Fan units

Cooling is done by fans. Fans in a fan unit located above the upper row of boards in the DUR sub-rack aspirate air through a filter located below the lower row of boards and force the air through the sub-rack from bottom to top.

Air flow baffle

An air flow baffle is integrated in the sub-rack to prevent the fan unit from drawing in the exhaust air from the sub-rack below.

Mounting the sub-rack allow no gaps between the baffle mounted below the *LambdaUnite* MSS sub-rack and any equipment mounted directly below. Observing this rule avoids thermic stress due to hot exhaust air from the equipment below the sub-rack entering the air flow baffle.

References

For more information about cooling, refer to Chapter 4, "Product description".

□

Transmission capacity

Overview

This section provides general information about transmission capacity for *LambdaUnite*™ MSS.

Capacity

The *LambdaUnite* MSS Dual Unit Row sub-rack (DUR) provides 2048 x STM-1 or 6144 x STS-1 capacity. This allows you to equip the sub-rack with any mixture of 155-Mbit/s (future release), 622-Mbit/s (future release), 2.5-Gbit/s, 10-Gbit/s, 40-Gbit/s (future release), 1-Gigabit Ethernet and 10-Gigabit Ethernet (future release) port units.

Port unit capacities

The following table lists the transmission capacity required for each port unit.

Port unit	max. STM-1 Equivalents	max. STS-1 Equivalents
155 Mbit/s (16 ports per unit) (future release)	16	48
622 Mbit/s (16 ports per unit) (future release)	64	192
2.5 Gbit/s (4 ports per unit) (in future release 2 or 4 ports per unit)	64	192
10-Gbit/s synchronous and WANPHY Ethernet (1 port per unit)	64	192
40 Gbit/s (1 port per unit) (future release)	256	768
1-Gigabit Ethernet (4 ports per unit)	max. 28	max. 84

References

For more information about transmission capacity, refer to Chapter 4, "Product description".

☐

Port location rules

Overview

This section provides recommendations about using port units and port unit circuit pack slots efficiently.

40-Gbit/s port units

If 40-Gbit/s port units are planned to be used be aware that each of them requires four universal slots, either on the left or on the right edge of a sub-rack quadrant.

Optical port unit protection

In the case of optical port protection (1+1 Linear APS / 1+1 MSP) it is recommended to place the working port unit and the protection port unit side by side for ease of maintenance.

10-Gbit/s port units and 1-Gbit/s Ethernet interface

It is recommended, to avoid thermic stress, not to place a 10-Gbit/s port unit directly above a GE1/SX4 port unit.

References

For more information about port location rules and sub-rack configuration, refer to Chapter 4, “Product description”.

□

Floor plan layout

Overview

This section gives information about the space needed to mount *LambdaUnite*™ MSS sub-racks and racks.

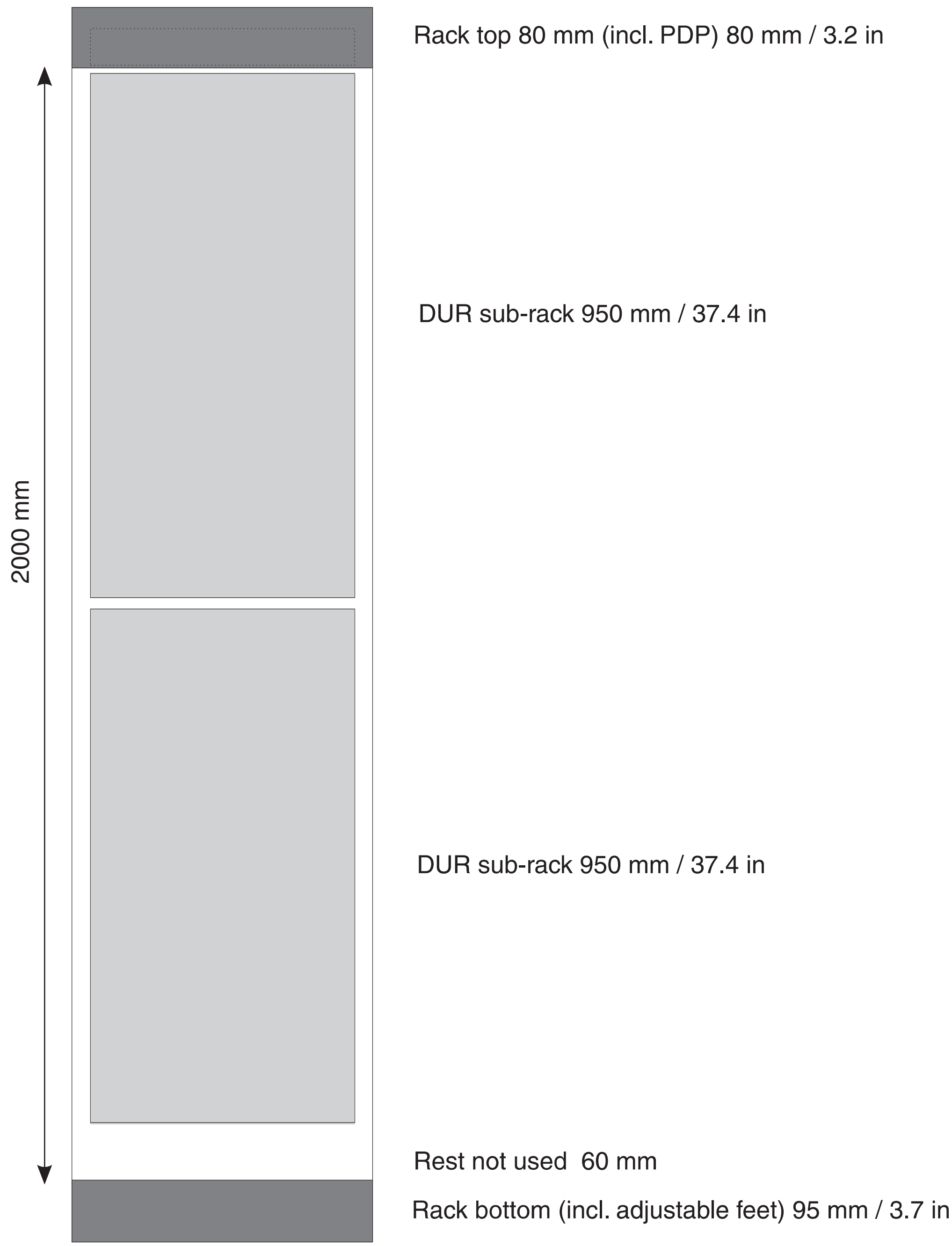
Rack dimensions

The racks require an area of 600 mm x 600 mm (23.6 in x 23.6 in) (width x depth) in accordance with ETSI 300 119 and with Bellcore GR-63. This area represents the absolute system limits which is not exceeded in the operating state by protruding elements such as switches or plugs. The rack height can be chosen in accordance with the local conditions. Standard height is 2.2 m (86.6). Heights 2.6 m (102.4 in), 2.125 m (83.66 in) and a seismic rack (2.0 m (78.7 in) height) are possible depending on customer requirements (not standard delivery).

Rack equipping

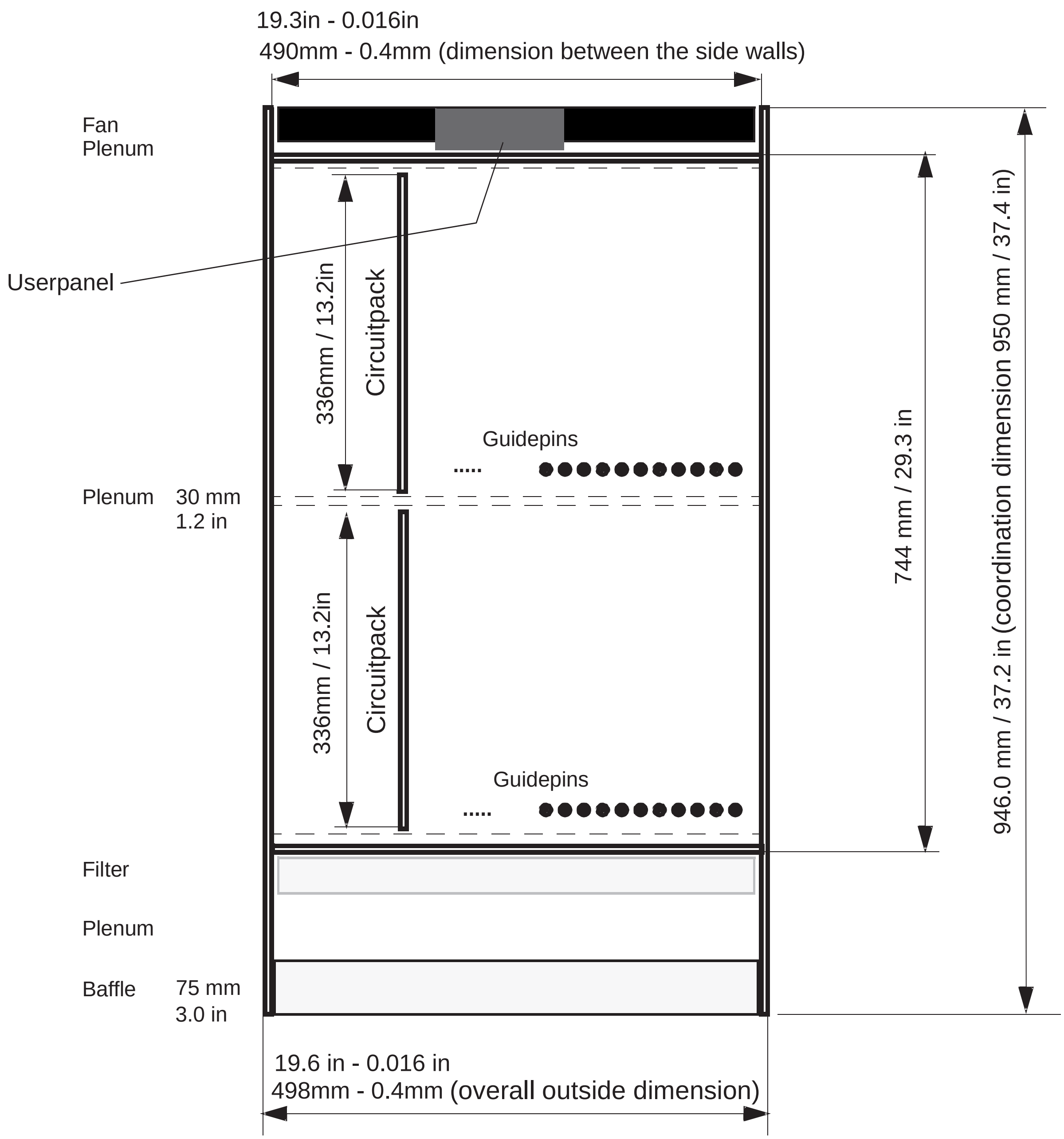
Depending on the desired configuration, the appropriate rack height must be chosen. The following figure gives an example of a 2.2 m

(86.6 in) rack (ETSI 300 119) equipped with two Dual Unit Row (DUR) shelves.



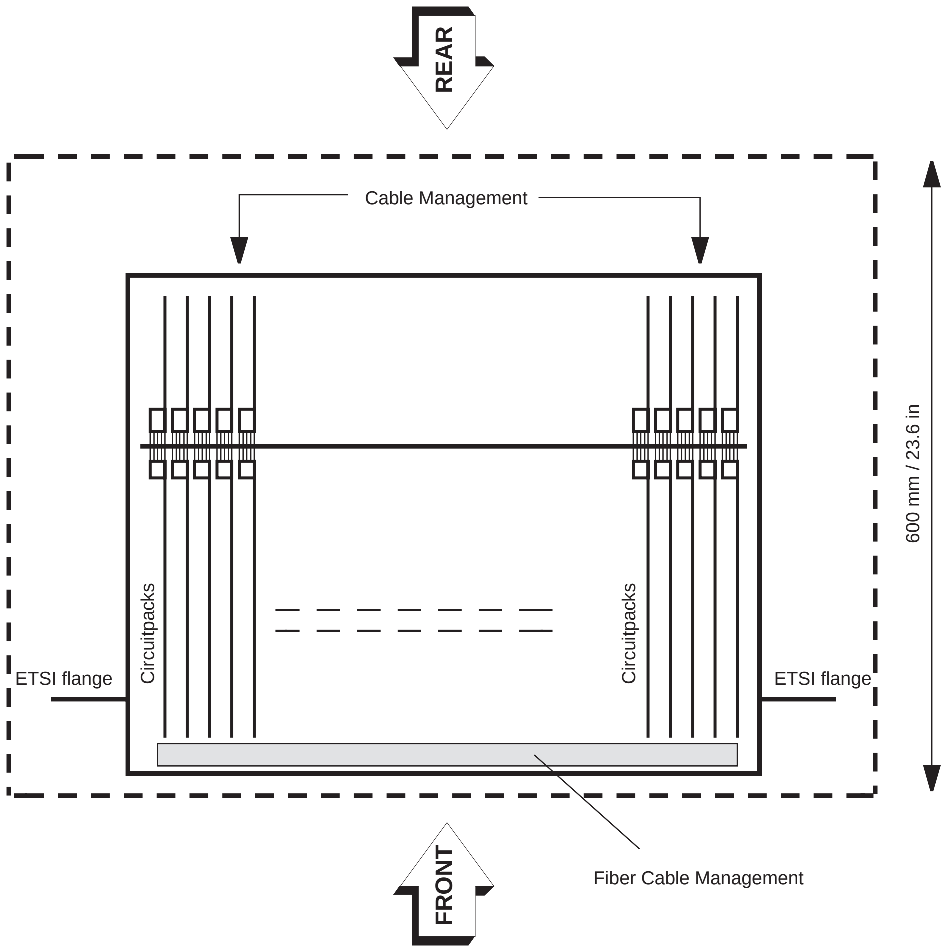
Sub-rack dimensions

The size of the DUR sub-rack is 950 mm x 500 mm x 545 mm (37.4 in x 19.7 in x 21.5 in) (height x width x depth). The air flow baffle mounted in the lower part of the sub-rack is already included in this value.



Front and rear access

The following view-from-above figure illustrates the space required for front and rear access to the system. Front access is required for operations activities and rearrangements of the optical port units. Rear access is required for upgrades that require cable rearrangements.



□

Equipment interconnection

Overview

This section describes equipment interconnection in *LambdaUnite*™ MSS.

Optical connectors

The optical port units provide optical connections through faceplate-mounted LC connectors. The LC connectors are designed as a duplex configuration that offers a high-density fiber-to-fiber pitch.

The following figure illustrates the LC connectors.

LBOs

If required, *LambdaUnite* MSS provides optical attenuation using lightguide build-outs (LBOs) on the optical port units (10 Gbit/s, 40 Gbit/s). All these optical interfaces are factory-equipped with 0-dB LC-type connectors. The optical attenuation can be changed by replacing the LBO. LBOs are available for attenuations from 0.5-dB to 10 dB in 0.5-dB steps and from 10 dB to 20 dB in 1-dB steps.

Transceiver module

The optical port units of the 2.5-Gbit/s, 622-Mbit/s, 155-Mbit/s and 1-Gbit/s Ethernet circuit packs are equipped with transceiver modules: transmitter, receiver and connector are integrated in one component.

Electrical connectors

The following table shows the types of electrical connectors used for the *LambdaUnite* MSS interfaces.

Interface Function	Connector Type
Alarm (station)	D-Sub shielded - filtered
MDI/MDO (future release)	D-Sub shielded - filtered

Interface Function	Connector Type
LAN 1 (external LAN interface to local CIT)	RJ 45 crossed - shielded
LAN2, LAN3, LAN4	RJ 45 crossed - shielded
Racktop (alarm lamps)	D-Sub shielded - filtered
FAN Signals (from fan controller board)	D-Sub shielded
UPL internal interface (from user panel)	D-Sub shielded
G703 interface	D-Sub shielded
V11 interface	D-Sub shielded
Station clock interface	1.6 / 5.6 coax connector

□

7 Ordering

Overview

Purpose

This chapter provides an overview of ordering information for *LambdaUnite*™ MultiService Switch (MSS).

Contents

Ordering information

Overview The *LambdaUnite*™ MSS has been carefully engineered and all equipment kitted to simplify the ordering process. The tables in this chapter give an overview of the most important marketable items necessary to engineer your application.

Contact For all questions concerning ordering of *LambdaUnite* MSS, for a complete list of the marketable items and their comcodes, and for ordering the equipment please contact your Account Executive for *LambdaUnite* MSS or your Lucent Technologies local customer team.

Core HW (rack, shelf, circuit packs) The following table lists the orderable racks, the shelf and the circuit packs. For the different versions of the DWDM compatible optical port units, please refer to the respective tables.

Description	Functional Name	ITEM CODE	APP. CODE	COMCODE
Rack:				
ETSI rack	RACK/ETSI-2			848727095
ETSI rack reduced w/o doors	RACK/ETSI-2r			848775649
Set ETSI-2 doors	Door set ETSI-2			848795001
Side plates ETSI rack	side plates ETSI-2			848780177
NEBS rack (available only with doors)	RACK/NEBS			848727103
Set NEBS-2000 doors	Door set NEBS-2000			848795019
Side plates NEBS rack	side plates NEBS			848780185
Core DUR assembly and contained components:				
Core DUR assembly *LambdaUnite* MSS				300339140

Description	Functional Name	ITEM CODE	APP. CODE	COMCODE
Power Distribution Panel (contained in Core DUR assembly)	PDP	PDP20		848727129
Fan Unit (contained in Core DUR assembly)	FU			848730644
Power Interface (contained in Core DUR assembly)	PI	PBH1		109001446
User Panel (contained in Core DUR assembly)	UPL			848730636
Timing Interface E1/DS1 (contained in Core DUR assembly)	TI/E1/DS1	PBI1		109001453
Controller Interface (contained in Core DUR assembly)	CI	PBJ1		109001461
Controller (contained in Core DUR assembly)	CTL		KFA1	109000158
Switch Pack 320G & Timing (contained in Core DUR assembly)	XC320		KFD1	109000299
Optical circuit packs:				
OC192/STM64, 1 port, LR/LH 1550 nm, (80km)	OP10G/1.5LR1		KFA6	109000208
OC192/STM64 or 10-Gigabit Ethernet WANPHY, 1 port, IR/SH 1550 nm, (40km)	OP10G/1.5IR1		KFA14	109077073

Description	Functional Name	ITEM CODE	APP. CODE	COMCODE
OC192/STM64, 1 port, Intra-Office 1310 nm (600m)	OP10G/1.3IOR1		KFA7	109000216
OC48/STM16, 4 ports, LR 1550 nm, 80 km	OP2G5/1.5LR4		KFA204	109055665
OC48/STM16, 4 ports, LR 1310 nm, 40 km	OP2G5/1.3LR4		KFA203	109055657
OC48/STM16, 4 ports, IR/SH 1310 nm, 2 km	OP2G5/1.3SR4		KFA12	109000265
1000 Base SX (1-Gigabit) Ethernet Interface, 4 ports	GE1/SX/4		KFA13	109000273

Software and licenses

The following table lists the available software and licenses for *LambdaUnite* MSS.

Description	Functional Name	ITEM CODE	APP. CODE	COMCODE
CD *LambdaUnite* MSS Rel 2.0 NE SW & Licences	NE SW&Li R2	SCA113		109177873

Lightguide build-outs and cables

A complete list of the available lightguide build-outs and of the different cables for *LambdaUnite* MSS with the relative comcodes you can find in the *LambdaUnite* MSS Installation Guide in chapters three and four. Some specific spare-unit recommendations are provided there, too.

Required spare parts

The following table indicates how many spare plug-in units or other pieces of equipment are required for the customer’s spare stock(s). For further information please contact your Lucent Technologies local customer team.

	1 pack-used	up to 10 packs used	up to 100 packs used	up to 1000 packs used	up to 10000 packs used
OC-192/STM-64, 1 port, Intra-Office 1310 nm (600m)	1	1	4	12	64
all other OC-192/STM-64 and 10-GbE WANPHY	1	2	4	13	69
OC-48/STM-16, 4 ports, IR/SH 1310 nm (2km)	1	1	3	11	58
all other OC-48/STM-16	1	2	4	14	81
1000 Base SX Ethernet Interface	1	1	3	10	51
Switch Pack XC320	1	2	4	17	101
Controller	1	1	3	11	58
Dual Unit Row Subrack	1	1	1	2	5
Power Interface	1	1	1	1	3
Timing Interface E1/DS1	1	1	1	2	4
Controller Interface	1	1	2	5	19
Fan Unit	1	1	1	2	4
User Panel	1	1	2	5	20

□

8 Product support

Overview

Purpose

This chapter provides information about the support for the *LambdaUnite*™ MultiService Switch (MSS).

Contents

Engineering and installation services

Overview

This section describes the engineering and installation services available to support *LambdaUnite*™ MSS.

Engineering and installation services group

The engineering and installation services group has a highly skilled force of support personnel dedicated to providing customers with quality engineering and installation services. These specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services.

Services provided

The services include

- Analyzing your equipment requests
- Preparing detailed specifications for manufacturing and installation
- Creating and maintaining job records
- Installing equipment
- Testing and turning over working systems

Tailored services

When you purchase Lucent Technologies engineering and installation services, your system order is integrated into a complete working system tailored to your office conditions and preferences.

Providing for all your needs

The Engineering and Installation Services group provides for all your needs, including provisions for

- Cabling
- Lighting
- Power equipment
- Connections to local and/or remote alarms

Reference

For more information about specialized engineering and installation services, engineering consultations, and/or database preparation, please contact your local Account Executive.

□

Technical support

Overview

This section describes the technical support available for *LambdaUnite*™ MSS.

Technical support groups

Technical support is available through

- Local/Regional Customer Support (LCS/RCS)
- Customer Technical Support (CTS).

Contacting your LCS/RCS

LCS/RCS personnel troubleshoot field problems 24 hours a day over the phone and on site (if necessary) based on Lucent Technologies Service Contracts.

For technical assistance, call your Local/Regional Customer Support Team. If the request cannot be solved by LCS/RCS, it will be escalated to the central Customer Technical Support (CTS) teams in Merrimack Valley, USA or Nuremberg, Germany.

Customer technical support

Lucent Technologies Customer Technical Support (CTS) organization is committed to providing customers with quality product support services. Each segment of the CTS organization regards the customer as its highest priority and understands your obligations to maintain quality services for your customers.

The CTS team maintains direct contact with Lucent Technologies manufacturing, Bell Laboratories development, and other organizations to assure fast resolution of all assistance requests.

Services

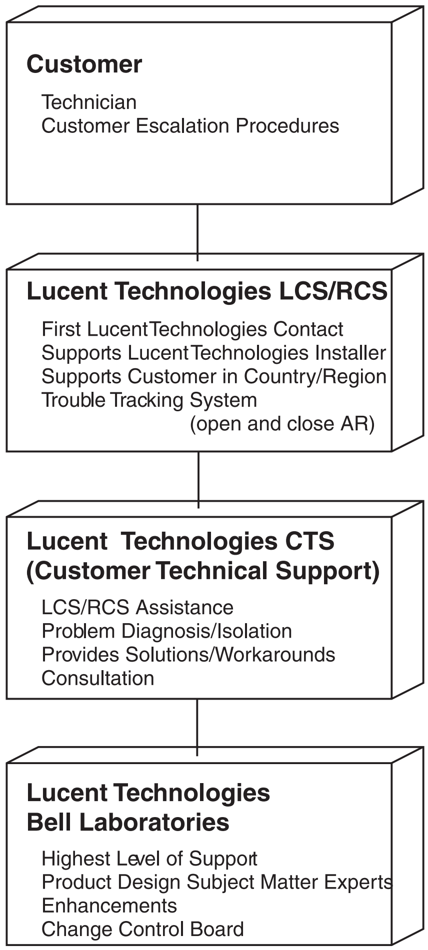
LambdaUnite MSS is complemented by a full range of services available to support planning, maintaining, and operating your system. Applications testing, network integration, and upgrade/conversion support is also available.

A technical support platform

A global online trouble tracking system is used by all support teams to track customer assistance requests. The system communicates details about product bulletins, troubleshooting procedures, and other critical information to customers. All details of a request are entered into this database until closure. For online access to your trouble tickets via the web please contact your local support team.

Reference For additional information about technical support, please contact your Lucent Technologies Customer Team.

Product support levels The following figure shows the levels of product support for Lucent Technologies products.



□

Documentation support

Overview

The Lucent Learning (former Customer Training and Information Products) organization provides comprehensive product documentation tailored to the needs of the different audiences. An overview of the documentation set can be found in the chapter "About This Document".

Customer comment form

Lucent Learning (LL) provides a customer comment form in the front of this guide. Please use the form to report errors or make suggestions about the document.

Is the form missing?

If the customer comment form is missing, please send or fax your comments to

Lucent Technologies Network Systems GmbH

Lucent Learning WO

Thurn-und-Taxis-Str. 10

90411 Nürnberg, Germany

Fax: +49 911 526 3545.

□

Training

Overview The Lucent Learning organization offers a formal training package to complement your product needs.

On-site training On-site training is available for all *LambdaUnite*™ MSS training courses.

Registering for a course or arranging an on-site training session To enroll in a training class at one of the Lucent Technologies corporate training centers or to arrange an on-site training session at your facility, please contact

in Germany	Dieter Kellermeier voice: +49 911 526 6145 fax: +49 911 526 6145 e-mail: dkellermeier@lucent.com
in the USA	Carlos Sarabasa voice: +1 407 767 4933 fax: +1 407 767 2760 e-mail: sarabasa@lucent.com
in Singapore	Jenny Ong voice: +65 240 8000 fax: +65 240 8017 e-mail: jennyong@lucent.com

Training courses

Overview

This section describes the *LambdaUnite*™ MSS training courses.

SDH optical networking products overview

This introductory course (TR9204) provides an operational overview of Lucent Technologies SDH optical networking products. The course explains a variety of applications of these products and develops networking scenarios using these products. This course can be customized to the needs of individual customers.

Audience

This course is designed for telecommunications professionals, engineers, project managers, account executives, and other sales personnel who need to understand the basic functionality of Lucent Technologies Synchronous Digital Hierarchy (SDH) optical networking products in a network.

Objectives

This course is designed to enable students to

- Get an overview of Lucent Technologies' Synchronous Digital Hierarchy (SDH) optical networking products
- Understand all applications and features.

Prerequisites

Students should be familiar with basic SDH or SONET principles.

Media

A combination of instructor lectures and written exercises.

Duration

Approx. 3 days

Applications, Architecture, and Planning Course (instructor led)

The *LambdaUnite* MSS Applications, Architecture, and Planning Course (TR6070) provides a detailed introduction to *LambdaUnite* MSS, covering equipment functions and requirements, system capabilities and network topology applications.

Audience

Network planners and engineers; Lucent Technologies sales and marketing personnel, product managers, technical consultants and account representatives, generally anyone who needs a high-level description of the *LambdaUnite* MSS equipment.

Course length

2 days

Applications, Architecture, and Planning (e-learning)

The *LambdaUnite* MSS Applications, Architecture, and Planning Course is also available as a comprehensive e-learning (TR6070M) on CD-ROM. The course provides a detailed introduction to *LambdaUnite* MSS, covering equipment functions and requirements, system capabilities and network topology applications.

Audience

Network planners and engineers; Lucent Technologies sales and marketing personnel, product managers, technical consultants and account representatives, generally anyone who needs a high-level description of the *LambdaUnite* MSS equipment.

Duration

Time needed to complete the CBT is approx. 3–4 hours.

Local Operations and Maintenance via *WaveStar*® CIT Course (instructor led)

The *LambdaUnite* MSS Local Operations and Maintenance Course via *WaveStar* CIT (TR6071) provides a detailed introduction to *LambdaUnite* MSS, covering equipment functions and requirements, system capabilities and network topology applications. It describes in detail the initial turn up and day-to-day operations and maintenance tasks, and it puts emphasis on developing skills using the *LambdaUnite* MSS User Operations Guide and the *LambdaUnite* MSS Alarm Messages and Trouble Clearing Guide. The course uses the GUI-based *WaveStar* CIT to provision the equipment, to create cross-connections, to perform administrative functions, to run diagnostic tests, and to perform manual protection switching.

Audience

Technicians, installers, maintenance engineers, technical support personnel, product evaluators, and anyone desiring operations and maintenance information for *LambdaUnite* MSS.

Course length

5 days

Local Operations and Maintenance via *WaveStar* CIT (e-learning)

The *LambdaUnite* MSS Local Operations and Maintenance via *WaveStar* CIT Course is also available as comprehensive e-learning (TR6071M) on CD-ROM. It supplements and replenishes the Applications, Architecture, and Planning (e-learning), teaching the initial turn up and day-to-day operations and maintenance tasks to be performed with the GUI-based *WaveStar* CIT.

Audience

Technicians, installers, maintenance engineers, technical support personnel, product evaluators, and anyone desiring operations and maintenance information for *LambdaUnite* MSS.

Duration

Approx. 4 hours

Installation and Test Course

The *LambdaUnite* MSS Installation and Test Course (TR6072) includes step-by step guidance to system installation and setup. It also includes information needed for pre-installation site planning and post-installation acceptance testing. The course is based on the contents of the *LambdaUnite* MSS Installation Guide.

Audience

Installers, maintenance engineers, technical support personnel.

Course length

2 days

Operations and Maintenance via *Navis*™ Optical EMS Course

The *LambdaUnite* MSS Operations and Maintenance Course via *Navis* Optical EMS provides a detailed introduction to *LambdaUnite* MSS, covering equipment functions and requirements, system capabilities and network topology applications. It prepares students for operating, monitoring and maintaining the product on a subnetwork level using *Navis* Optical EMS. The course is based on the *LambdaUnite* MSS Applications, Architecture, and Planning Course and on the contents of the *Navis* Optical EMS Provisioning Guide for the application *LambdaUnite* MSS, it combines instructor lectures and hands-on exercises.

Audience

Persons that are responsible for operation and maintenance of *LambdaUnite* MSS via *Navis* Optical EMS. It is also useful to technical support personnel working with *Navis* Optical EMS.

Course Length

5 days

□

9 Quality and reliability

Overview

Purpose

This chapter provides information about the quality and reliability of *LambdaUnite*™ MultiService Switch (MSS).

Contents

Quality

Overview

Purpose This section describes Lucent's Commitment to Quality and Reliability and how quality is ensured.

Contents

Lucent’s commitment to quality and reliability

Overview

Lucent Technologies is extremely committed to providing our customers with products of the highest level of quality and reliability in the industry. *LambdaUnite*™ MSS is a prime example of this commitment.

Quality policy

Lucent Technologies is committed to achieving sustained business excellence by integrating quality principles and methods into all we do at every level of our company to

- Anticipate and meet customer needs and exceed their expectations, every time
- Relentlessly improve how we work – to deliver the world’s best and most innovative communications solutions – faster and more cost-effectively than our competitors

Reliability in the product life-cycle

Each stage of the life cycle of *LambdaUnite* MSS relies on people and processes that contribute to the highest product quality and reliability possible. The reliability of a product begins at the earliest planning stage and continues into

- Product architecture
- Design and simulation
- Documentation
- Prototype testing during development
- Design change control
- Manufacturing and product testing (including 100% screening)
- Product quality assurance
- Product field performance
- Product field return management

The R&D community of Lucent Technologies is certified by ISO 9001.

□

Ensuring quality

Overview

This section describes the critical elements that ensure product quality and reliability within

- Product development
- Manufacturing

Critical elements of product development

The product development group's strict adherence to the following critical elements ensures the product's reliability

- Design standards
- Design and test practices
- Comprehensive qualification programs
- System-level reliability integration
- Reliability audits and predictions
- Development of quality assurance standards for manufactured products

Critical elements of manufacturing

Note: Independent Quality Representatives are also present at manufacturing locations to ensure shipped product quality.

The manufacturing and field deployment groups' strict adherence to the following critical elements ensures the product's reliability

- Pre-manufacturing
- Qualification
- Accelerated product testing
- Product screening
- Production quality tracking
- Failure mode analysis
- Feedback and corrective actions

□

Reliability specifications

Overview

Purpose

This section describes how reliability is specified.

Contents

General specifications

Overview

This section provides general reliability specifications for *LambdaUnite*™ MSS.

Mean time between irregular maintenance activities

The Mean Time Between Irregular Maintenance Activities for the *LambdaUnite* MSS shelf is 12 months.

Mean time to repair

The mean time to repair for *LambdaUnite* MSS is assumed to be 4 hours. This figure includes dispatch, diagnostic, and repair time.

Infant mortality factor

Note: The steady state failure rate is equal to the failure rate of the system.

The number of failures that a product experiences during the first year of service after turn-up may be greater than the number of subsequent annual steady state failures. This is the early life or infant mortality period. The ratio of the first year failure rate to the steady state failure rate is termed the infant mortality factor (IMF).

The infant mortality factor (IMF) for *LambdaUnite* MSS is 2.5. Therefore, the first year failure rate (or infant mortality rate [IMR]) is 2.5 times the steady state failure rate.

Product design life

The product design life for *LambdaUnite* MSS is 15 years except for the fan units. The fan unit design life is 7 years.

Maintainability specifications

Note: The fan filter, located below the fan unit in the shelf, must be replaced once every 3 months (Fan Filter Short Term) or once every 12 months (Fan Filter Long Term) to ensure the proper operation of the fan units.

LambdaUnite MSS does not require periodic electronic equipment maintenance activities. Continuous performance monitoring enables the system to detect conditions before they become service-affecting.

□

Lucent Technologies
Bell Labs Innovations

10 Technical specifications

Overview

Purpose

This chapter provides the technical specifications for *LambdaUnite*™ MultiService Switch (MSS). These data are necessary for planning the use of a *LambdaUnite* MSS network element in an existing or new network.

Contents

Interfaces

Standards compliance

LambdaUnite™ MSS is compliant with the following standards:

	SONET	SDH
General	ANSI T1.105-1191, T1.1066-1988	ITU-T Rec. G.707
Equipment		ITU-T Rec. G.781, G.782, G.783, G.784, G.813
Physical interface	Bellcore GR-253 SR-1, IEEE 802.3-2000	ITU-T Rec. G.957, G.691, G.692
Performance requirements	Telcordia GR-253-CORE	ITU-T Rec. G.823, G.825, G.826

Optical interfaces

The detailed specifications of the optical interfaces can be found in "Optical parameters" (10-4).

Data interfaces

The following table lists the data interfaces:

Standard External clock interfaces (Input)	2 physical separated interfaces configurable to 2 MHz (G.703.10), 2 Mbit/s (G.703.6), or DS1. The impedance of the interfaces of 75 Ω (coaxial) or 120 Ω (symmetrical) is determined at installation.
Standard External clock interfaces (Output)	2 physical separated interfaces configurable to 2 MHz (G.703.10), 2 Mbit/s (G.703.6), or DS1. The impedance of the interfaces of 75 Ω (coaxial) or 120 Ω (symmetrical) is determined at installation.
Orderwire	E1, E2 bytes as 64 kbit/s data channel at G.703
User Channel	F1 byte as 64 kbit/s data channel at V.11

Station alarm interfaces

The station alarm interface offers six isolated contact output pairs: Critical (visual, audible), Major (visual, audible), Minor (visual, audible) which can be used by the customer to extend the alarm signals from the system into the station alarm scheme. The critical contact can be configured to be active without system power. The contacts are able to switch 0.5 A at 72 V and 2 A at 30 V and are ESD safe up to 2 kV.

Miscellaneous discretes interfaces

The system supports 8 MDI and 8 MDO ports (supported in a future release). All ports are configurable to be isolated or non isolated. The output ports are capable to switch 0.5 A at 72 VDC and 2 A at 30 VDC and are ESD safe up to 2 kV. The input ports are sensitive to passive switches ($R_{on} \leq 50\ \Omega$, $R_{off} \geq 20\ k\Omega$) or input voltages up to -72 VDC (threshold voltage - 3 VDC to - 10 VDC) and are ESD safe up to 2 kV.

□

Optical parameters

Planning data

Data for planning a transmission route with the optical transmitters and receivers is listed in the following tables. With these data it is possible to determine the maximum link distance between the network elements.

Port unit designation

The designation of the various types of optical port units reflects their application and functional characteristics:

- ***SH*** stands for ***s***hort-***h***aul
- ***LH*** stands for ***l***ong-***h***aul
- ***VLH*** stands for ***v***ery ***l***ong-***h***aul
- ***ULH*** stands for ***u***ltra ***l***ong-***h***aul

Application code

The application code used in the tables is as follows:

application-[STM level.]suffix

Please note that in SONET applications the STM level is not part of the application code.

Application (SDH)

In the applicable SDH standards, the following abbreviations are available for designating the application: I, S, L, V, U.

- ***I*** stands for ***i***ntra-office
- ***S*** stands for ***s***hort-haul
- ***L*** stands for ***l***ong-haul
- ***V*** stands for ***v***ery long-haul
- ***U*** stands for ***u***ltra long-haul

I, S, L, V and U are internationally standardized designations.

Application (SONET)

In the applicable SONET standards, the following abbreviations are available for designating the application: SR, IR, LR, VR.

- ***SR*** stands for ***s***hort ***r***ange
- ***IR*** stands for ***i***ntermediate ***r***ange
- ***LR*** stands for ***l***ong ***r***ange
- ***VR*** stands for ***v***ery ***l***ong ***r***ange

VSR, SR, IR, LR and VR are internationally standardized designations.

OC / STM level

The OC level can be 48 and 192 (additionally 3, 12 and 768 in future releases). The STM level can be 16 and 64 (additionally 1, 4 and 256 in future releases).

Suffix

The fibre-optic type and the nominal wavelength of the laser used are denoted by a suffix number.

- “1” denotes the use of nominally 1310 nm laser sources on standard fibres as per ITU-T Rec. G.652
- “2” denotes the use of nominally 1550 nm laser sources on standard single mode fibres as per ITU-T Rec. G.652 / G.691
- “3” denotes the use of nominally 1550 nm laser sources on dispersion-shifted fibres as per ITU-T Rec. G. 653.
- “5” denotes the use of NZ-DSF fibre applications with G. 655 fibres.

For STM-64 interfaces, an appendix of a, b, or c to the suffix refers to the dispersion accommodation techniques used. For I-64 codes an “r” is added after the suffix number to indicate a reduced target distance.

10 Gbit/s single color

The following table lists the End of Life power budget of the single channel optical interfaces for 10-Gbit/s signals.

Application code	**Unit**	**I-64.1r (VSR)**	**S-64.2b/3b IR-2/3**	**L-64.2b/3/5b LR-2b/3/5b**
Functional name		**OP10/1.3IOR1**	**OP10/1.5IR1**	**OP10/1.5LR1**
SDH/SONET level		STM-64/OC192	STM-64/OC192	STM-64/OC192
Type of plug-in unit		OP101.3Ir	OP101.5SH	OP101.5LH
Transmission rate	kbit/s	9 953 280	9 953 280	9 953 280
Transmission code		NRZ, scrambled	NRZ, scrambled	NRZ, scrambled
Wavelength	nm	1260 … 1360	1530 … 1565	1530 … 1565
Transmitter at reference point S and MPI-S (acc. G.691) respectively				
Source type		FP / DFB	EML	EML / MZM +OA
Max. spectral RMS width	nm	3	—	—

Application code	**Unit**	**I-64.1r (VSR)**	**S-64.2b/3b IR-2/3**	**L-64.2b/3/5b LR-2b/3/5b**
Functional name		**OP10/1.3IOR1**	**OP10/1.5IR1**	**OP10/1.5LR1**
Spectral width at –20 dB	nm	—	ffs	ffs
Min. side mode suppression	dB	—	30	30
Mean launched power range	dBm	– 6… – 1	– 1 … + 2	+ 10 … + 13
Minimum Extinction ratio	dB	6	8.2	8.2
Receiver at reference point R and MPI-R (acc.G.691) respectively				
Receiver type		PIN	PIN	PIN
Min. optical sensitivity (BER $=10^{-12}$)	dBm	– 11	– 14	– 14
Max. optical path penalty	dB	1	2 (SSMF), 1 (DSF and NZ-DSF)	2 (SSMF), 1 (DSF and NZ-DSF)
Minimum overload	dBm	– 1	– 1	– 1
Maximum reflectance of receiver	dB	– 14	– 27	– 27
Optical path between S and R				
Minimum optical return loss of cable at point S (incl. any connectors)	dB	14	24	24
Maximum discrete reflectance between S and R	dB	– 27	– 27	– 27
Maximum chromatic dispersion	ps/nm	3.8	800	1600
Optical attenuation range	dB	0 … 4	3 … 11 (0 … 11 with LBOs)	14 … 22 (0 … 22 with LBOs)
Nominal target distance	km	0.6	40	80

2.5 Gbit/s The following table lists the power budget of the optical interfaces for 2.5-Gbit/s signals.

Application code	**Unit**	**I-16** **SR**	**L-16.1** **LR-1**	**L-16.2** **LR-2**
Functional name		**OP2G5/1.3SR4**	**OP2G5/1.3LR4**	**OP2G5/1.5LR4**
SDH Level/SONET level		STM-16/OC48	STM-16/OC48	STM-16/OC48
Type of plug-in unit		OP2G5/1.3SR4	OP2G5/1.3LR4	OP2G5/1.5LR4
Transmission rate	kbit/s	2488320	2488320	2488320
Transmission code		NRZ, scrambled	NRZ, scrambled	NRZ, scrambled
Wavelength	nm	1266 … 1360	1280 … 1335	1530 … 1560
Transmitter at reference point S and MPI-S (acc. G.957) respectively				
Source type		MLM	SLM	SLM
Max. spectral RMS width	nm	4	n/a	n/a
Spectral width at –20 dB	nm	n/a	<1	<1
Min. side mode suppression ratio	dB	n/a	30	30
Mean launched power range	dBm	-10 … -3	-2 … +2	-2 … +2
Minimum Extinction ratio	dB	8.2	8.2	8.2
Receiver at reference point R and MPI-R (acc.G.957) respectively				
Receiver type		PIN	PIN	PIN
Min. optical sensitivity (BER $=10^{-10}$)	dBm	–18	–27	–28
Max. optical path penalty	dB	1	1	2 / 1 (L-16.3)
Minimum overload	dBm	–3	–8	–8
Maximum reflectance of receiver	dB	–27	–27	–27

Application code	**Unit**	**I-16** **SR**	**L-16.1** **LR-1**	**L-16.2** **LR-2**
Functional name		**OP2G5/1.3SR4**	**OP2G5/1.3LR4**	**OP2G5/1.5LR4**
Optical path between S and R				
Minimum optical return loss of cable at point S (incl. any connectors)	dB	24	24	24
Maximum discrete reflectance between S and R	dB	-27	-27	-27
Maximum chromatic dispersion	ps/nm	12	230	1600 / 600 (L-16.3)
Optical attenuation range	dB	0 … 7	10 … 24	10 … 24 / 25 (L-16.3)
Nominal target distance	km	2	40	80

1-Gbit/s Ethernet

The GE1/SX4 port unit supports 4 fully independent bidirectional ports. Ethernet frames received from a GE1/SX4 port are mapped into VC-4s, in future also into STS1s, using Virtual Concatenation. The number of STS1s/VC-4s per virtual concatenated signal can be user provisioned in a future release as ≤ 21 STS1s/7 VC-4s at single STS1/VC-4s intervals. This will offer an effective capacity usage over a network from 50/155 to 1000 Mbit/s in steps of 50/155 Mbit/s.

The GE1/SX4 port unit supports standard BLSR/MS-SPRing and UPSR/SNCP protection schemes on the individual STS1s/VC-4s that are part of the Virtually Concatenated signal.

The GE1/SX4 port unit uses a Low Power Laser (laser class 1M according to IEC 60825).

The GE1/SX4 port unit complies with IEEE 802.3-2000 Clause 38.

The table below describes the various operating ranges for the GE1/SX4 port unit over each optical fiber type.

Fiber Type	Modal Bandwidth @ 850 nm (min. 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 MMF	N/A	Not supported

The following table lists the specific transmission characteristics for a GE1/SX4 port unit.

Description	Unit	62.5 µm MMF	50 µm MMF
Transmitter type		**Shortwave Laser**	
Signaling speed (range)	GBd	1.25 ± 100 ppm	
Wavelength (range)	nm	770 to 860	
T_{rise}/T_{fall} (max, 20–80%, $\lambda >$ 830 nm)	ns	0.26	
T_{rise}/T_{fall} (max, 20–80%, $\lambda \leq$ 830 nm)	ns	0.21	
RMS spectral width (max)	nm	0.85	
Average launch power (max)	dBm	Shall be the less of the class 1M safety limit as defined by IEEE 802.3–2000 Clause 38.7.2.	
Average launch power (min)	dBm	–9.5	
Average launch power of OFF transmitter (max)	dBm	–30 (During all conditions when the PMA is powered in the OFF mode, the AC signal (data) into the transmit port will be valid encoded 8B/10B patterns except for short durations during system power-on-reset or diagnostics when the PMA is placed in a loopback mode.)	
Extinction ratio (min)	dB	9	
RIN (max)	dB/Hz	–117	
Coupled Power Ratio (CPR) (radial overfilled launches, while they meet CPR ranges, should be avoided)	dB	9 < CPR	

The following table lists the specific receive characteristics for a GE1/SX4 port unit.

Description	Unit	62.5 µm MMF	50 µm MMF
Signaling speed (range)	**GBd**	**1.25 ± 100 ppm**	
Wavelength (range)	nm	770 to 860	
Average receive power (max)	dBm	0	
Receive sensitivity	dBm	–17	
Return loss (min)	dB	12	
Stressed receive sensitivity (measured with conformance test signal at TP3 for BER = 10^{-12} at the eye center) (measured with a transmit signal having a 9 dB extinction ratio; if another extinction ratio is used, the stressed received sensitivity should be corrected for the extinction ratio penalty)	dBm	12.5	13.5
Vertical eye-closure penalty (is a test condition for measuring stressed receive sensitivity, it is not a required characteristic of the receiver)	dB	2.60	2.20
Receive electrical 3 dB upper cutoff frequency (max)	MHz	1500	

The following table lists the worst-case power budget and link penalties for a GE1/SX4 port unit. Link penalties are used for link budget calculations.

Description	Unit	62.5 µm MMF		50 µm MMF	
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	**MHz*km**	**160**	**200**	**400**	**500**
Low power budget	dB	7.5	7.5	7.5	7.5

Description	Unit	62.5 µm MMF		50 µm MMF	
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	**MHz*km**	**160**	**200**	**400**	**500**
Operating distance	m	220	275	500	550
Channel insertion loss (a wavelength of 830 nm is used to calculate the values)	dB	2.38	2.60	3.37	3.56
Link power penalties (a wavelength of 830 nm is used to calculate the values)	dB	4.27	4.29	4.07	3.57
Unallocated margin in link power budget (a wavelength of 830 nm is used to calculate the values)	dB	0.84	0.60	0.05	0.37

Bandwidth management

Specifications

The following specifications apply to *LambdaUnite*™ MSS with regard to bandwidth management:

- System capacity: 320 Gbit/s non-blocking switching capacity (for details please refer to Chapter 4, “Product description”)
- STS-1/HO VC-3, STS-3c/VC-4 cross-connect granularity
- Uni- & Bi-directional cross-connecting
- 1:2 broadcast connections for all cross-connection rates
- STS-12c/VC-4-4c, STS-48c/VC-4-16c and STS-192c/VC-4-64c contiguous concatenations
- unidirectional and bidirectional virtual concatenated cross-connections STS-1-Kv (K=1...21), VC-4-Kv (K=1...7)
- STS-3c, STS-12c, STS-48c unidirectional and bidirectional pipe mode cross-connections
- Uni-directional Drop & Continue
- Higher Order Cross-connect size 6144 x 6144 STS-1s or 2048 x 2048 VC-4s
- Bridging and rolling commands for in-service rearrangement of circuits

☐

Performance requirements

Specifications

The following specifications apply to *LambdaUnite*™ MSS with regard to performance requirements:

	SDH	SONET
Jitter on STM-N / STS-N interfaces	G.813, G.825	Telcordia GR-253
Jitter on PDH interfaces	G.823, G.783	Telcordia GR-253
Performance monitoring	G.784, G.826	Telcordia GR-253

Supervision and alarms

Specifications

The following specifications apply to *LambdaUnite*™ MSS with regard to supervision and alarms:

- Plug-in circuit pack indication: red fault and green service/active LED per circuit pack
- System Controller indicators/buttons:
  - User Panel LED indicators: Prompt, Deferred and Info alarm, Abnormal, Near-End Activity, Far-End Activity, Power On, Alarm Cut-off (ACO)
  - Push-buttons: ACO button to acknowledge office alarms, LED test button
- Station Alarm Interface: Offers six isolated contact output pairs: Critical (visual, audible), Major (visual, audible), Minor (visual, audible), which can be used to extend the alarm signals from the system into the station alarm scheme.
- Rack Top Alarm Lamps: Two red and one yellow lamp are present in top of the rack to signal a Critical, Major and Minor alarm, respectively.
- CIT connector for connecting the CIT to the system LAN
- Floating station alarm interface outputs
- Miscellaneous discretes (future release)
- Q-LAN interface to connect to EMS or other Network Elements

□

Timing and synchronization

Overview The following specifications apply to *LambdaUnite*™ MSS with regard to timing and synchronization.

Clock The clock has the following specifications:

Clock	Specification
Built-in oscillator Stratum-3	Accuracy 4.6 ppm acc. to G.813 option 1, Stability 0.37 ppm/ first 24 hours

Timing modes The timing modes are specified as follows:

Timing mode	Specification
Free running mode	Accuracy 20 ppm over 15 years
Hold-over mode	Accuracy 4.6 ppm of the frequency of the last source in two weeks
Locked mode with reference to	• one of the external sync. inputs • one of the 10-Gbit/s or 2.5-Gbit/s inputs
Automatic ref. signal switching	compliant with ETSI ETS 300 417–6
Support of Sync. Status Message (SSM)	OC-M / STM-N ports

□

OAM and P

Specifications

The following specifications apply to *LambdaUnite*™ MSS with regard to operation, administration, maintenance, and provisioning:

- Testing
  - Self-test after installation (system level)
  - LAN interface self test
  - LED self test
  - Facility loopbacks for interface testing
- Recovery
  Auto recovery after input power failure
- Local O & M via faceplate LEDs, buttons on User Panel, CIT LAN interface
- Centralized O & M via LAN interface, DCC link
- SW-downloading via LAN interface, DCC link
- Alarms
  - Categories for indication of alarm severity
  - Station alarm interfaces
  - Rack alarms
- Miscellaneous Discrete in- and outputs (future release)
- Self-diagnostics
- Local workstation (*WaveStar*® CIT)
- Auto-provisioning by the insertion of a circuit pack

□

Network management

Specifications The following specifications apply to *LambdaUnite*™ MSS with regard to network management:

- Fully manageable by *Navis*™ Optical EMS
- Integration into path management *Navis* Optical NMS
- Access to Embedded Communication Channels
- Via in-station EMS interface: TL1 message protocol / 100BaseT interface
- *WaveStar*® CIT for small network management: RJ-45 CIT interface / 100BaseT interface

□

Physical design

Specifications

The following specifications apply to *LambdaUnite*™ MSS with regard to physical design:

Subrack dimensions	DUR Shelf: 950 x 498 x 438 mm (37.4 x 19.6 x 17.2 in) (H x W x D) in accordance with ETSI Standard ETS 300 119-4
Weight	DUR Shelf (without circuit packs): approx. 27 kg
Rack types	ETSI (D700) rack
Connectors optical	LC connectors on all optical interfaces
Connectors electrical	SUB-D on Alarm, Timing, User Byte IF, 1.6/5.6 on station clock IF, Western RJ45 on LAN interfaces
Station power input (battery)	-48 V / -60 VDC (Range: -40 ... -72 VDC)
Power consumption	2200 W for a typical configuration. For power consumption of the individual units, please refer to "Power consumption" (10-19)

Transmission Fibers

LambdaUnite MSS uses the following transmission fibers: [G.652, G.655]

- Standard single-mode fiber acc. to ITU-T Rec. G. 652
- Dispersion shifted fiber acc. to ITU-T Rec. G.653
- Non-zero dispersion shifted fiber acc. to ITU-T Rec. G.655
- Multimode fiber (MMF) for Gigabit Ethernet acc. to IEEE 1802.3

□

Power consumption

Specifications

The following specifications apply to *LambdaUnite*™ MSS with regard to worst case power consumption of the individual parts/circuit packs:

Part	Worst Case Power Consumption. [W]
Power Interface	15
Controller Interface	45
User Panel	0
Subrack Double Height	52
Fan Unite	160
Switch Pack 320G & Timing	246
Timing Interface E1/DS1	9
Controller Pack	30
10-Gbit/s long reach interface (80 km), 1550 nm	59
10-Gbit/s intermediate reach / short haul interface / WANPHY Ethernet interface (40 km), 1550 nm	47
10-Gbit/s intra-office interface (600 m), 1310 nm	45
2.5-Gbit/s long reach / LH interface (80 km), 1550 nm	39
2.5-Gbit/s long reach / LH interface (40 km), 1310 nm	39
2.5-Gbit/s short reach / intra-office interface (2 km), 1310 nm	23
1-Gbit/s (1000BASE-SX) Ethernet data interface	81

□

Environmental conditions

Environment

Compliant with EN300 019-1-3 for Class 3.1 Environment “Stationary use at weather protected locations” and Telcordia GR 63 (Bellcore):

	Temperature range	Humidity
Normal operation	+5°C to +40°C	up to 85%
Short term operation	-5°C to +50°C	up to 90% (conditions last at most 72 hours per year during at most 15 days)
Storage	-25°C to +55°C	up to 100%

EMC

LambdaUnite™ MSS meets the emissions requirement as per FCC 47 CFR part 15 Subpart B for class A computing device.

LambdaUnite MSS is compliant with EN300 386-2: “EMC requirements for Public Telecommunication Network Equipment”, IEC 61000-4-x series (immunity) and Telcordia GR-1089-core (emission and immunity).

Radiated emission	EN 55 022 Class A GR-1089-core chapter 3
Conducted emission	DC-power, ETS 300 386-1, 20 kHz - 30 MHz (corresponds with EN 55022 class A) Telecom. Ports, CISPR 22 Amd, Class B GR-1089-core
Electro-static discharge	IEC 61000-4-2, tested at level 4 (contact discharge 8 kV, air 15 kV; NEBS level 3 requirement) GR-1089-core chapter 2
Radiated immunity	IEC 61000-4-3, tested at level 3 GR-1089-core
Electrical fast transients	DC Power, IEC 61000-4-4 (tested at level 1, 0.5 kV) Telecom. Ports, IEC 61000-4-4 (tested at level 1, 0.5 kV) There is no requirement regarding G-1089 but there are objectives in GR513 (O4-21) for power ports. GR-1089-core

Surges	IEC 61000-4-5, tested at level 1 (0.5 kV with performance criterion B and additional 0.8 kV (series resistor 6 Ω) and 1.5 kV (series resistor 12 Ω) the system shall not be damaged and shall continue to operate. Indoor Telecom. Ports, ETS 300 386-1, Tested at 0.5 kV GR-1089-core ITU K.41
Continuous wave	IEC 61000-4-6 DC Power, IEC 61000-4-6 (tested at level 3) Telecom. Ports, IEC 61000-4-6 (tested at level 3) GR-1089-core
Compliant with LVD	EN 60950
NEBS L3 compliance	The subrack and all circuit packs comply with NEBS Level 3.
CE Certification	CE compliant with European Directive 89/336/EEC

Appendix A: An SDH overview

Overview

Purpose

This chapter briefly describes the Synchronous Digital Hierarchy (SDH).

Synchronous Digital Hierarchy

In 1988, the ITU-T (formerly CCITT) came to an agreement on the Synchronous Digital Hierarchy (SDH). The corresponding ITU-T Recommendation G.707 forms the basis of a global, uniform optical transmission network. SDH can operate with plesiochronous networks and therefore allows the continuous evolution of existing digital transmission networks.

The major features and advantages of SDH are:

- Compatibility of transmission equipment and networks on a worldwide basis
- Uniform physical interfaces
- Easy cross connection of signals in the network nodes
- Possibility of transmitting PDH (Plesiochronous Digital Hierarchy) tributary signals at bit rates commonly used at present
- Simple adding and dropping of individual channels without special multiplexers (add/drop facility)
- Easy transition to higher transmission rates

- Due to the standardization of the network element functions SDH supports a superordinate network management and new monitoring functions and provides transport capacity and protocols (Telecommunication Management Network, TMN) for this purpose in the overheads of the multiplex signals.
- High flexibility and user-friendly monitoring possibilities, e.g. end-to-end monitoring of the bit error ratio.

Purpose of SDH

The basic purpose of SDH is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in today's network, as well as those planned for the future.

SDH currently defines standard rates and formats and optical interfaces. Today, mid-span meet is possible at the optical transmission level. These and other related issues continue to evolve through the ITU-T committees.

ITU-T addressed issues

The set of ITU-T Recommendations defines

- Optical parameters
- Multiplexing schemes to map existing digital signals (PDH) into SDH payload signals
- Overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions
- Criteria for optical line Automatic Protection Switch (APS)

References

For more detailed information on SDH, refer to

- ITU-T Recommendation G.703, "Physical/electrical characteristics of hierarchical digital interfaces", October 1996
- ITU-T Recommendation G.707, "Network Node Interface For The Synchronous Digital Hierarchy (SDH)", March 1996
- ITU-T Recommendation G.780, "Vocabulary of terms for synchronous digital hierarchy (SDH) networks and equipment" , November 1993
- ITU-T Recommendation G.783, "Characteristics of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks ", April 1997
- ITU-T Recommendation G.784, "Synchronous Digital Hierarchy (SDH) Management ", January 1994

- ITU-T Recommendation G.785, “Characteristics of a flexible multiplexer in a synchronous digital hierarchy environment “, November 1996
- ITU-T Recommendation G.813, “Timing characteristics of SDH equipment slave clocks (SEC)“, August 1996
- ITU-T Recommendation G.823, “The control of jitter and wander within digital networks which are based on the 2048-kbit/s hierarchy“, March 1993
- ITU-T Recommendation G.825, “The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)“, March 1993
- ITU-T Recommendation G.826, “ Error performance Parameters and Objectives for International, Constant Bit Rate Digital Paths at or Above the Primary Rate”, February 1999
- ITU-T Recommendation G.957, “Optical interfaces for equipments and systems relating to the synchronous digital hierarchy“, July 1995

Contents

SDH signal hierarchy

Overview

This section describes the basics of the SDH hierarchy.

STM-1 Frame

The SDH signal hierarchy is based on a basic “building block” frame called the Synchronous Transport Module 1 (STM-1), as shown in “SDH STM-1 frame” (A-5).

The STM-1 frame has a rate of 8000 frames per second and a duration of 125 microseconds

The STM-1 frame consists of 270 columns and 9 rows.

Each cell in the matrix represents an 8-bit byte.

Transmitting Signals

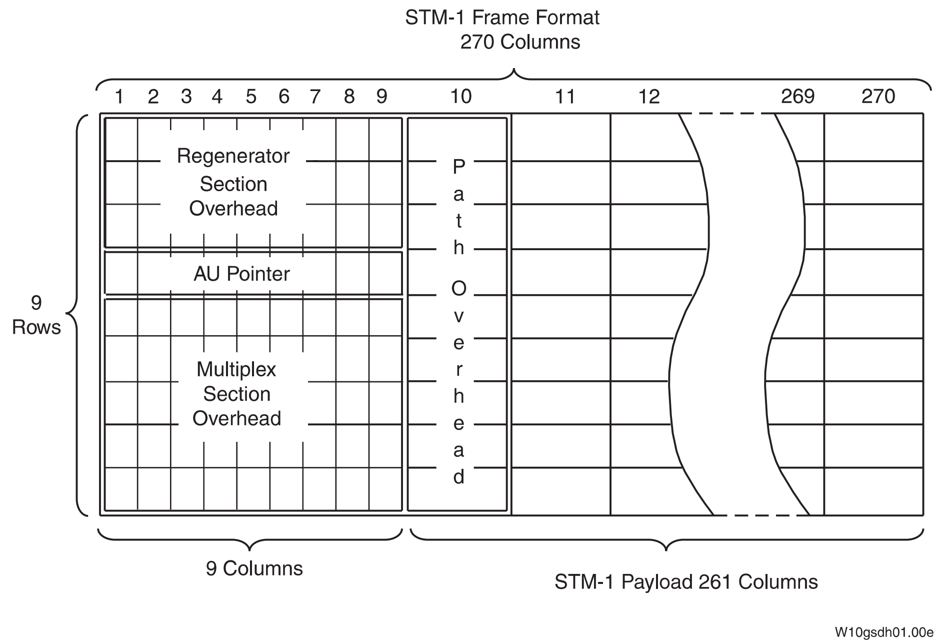
The STM-1 frame (STM = Synchronous Transport Module) is transmitted serially starting from the left with row 1 column 1 through column 270, then row 2 column 1 through 270, continuing on, row-by-row, until all 2430 bytes (9x270) of the STM-1 frame have been transmitted. Because each STM-1 frame consists of 2430 bytes and each byte has 8 bits, the frame contains 19440 bits a frame. There are 8000 STM-1 frames a second, at the STM-1 signal rate of 155.520.000 (19440 x 8000) kbit/s.

Three higher bit rates are also defined:

- 622.080 Mbit/s (STM-4)
- 2488.320 Mbit/s (STM-16)
- 9953.280 Mbit/s (STM-64)
- 39813.120 Mbit/s (STM-256)

The bit rates of the higher order hierarchy levels are integer multiples of the STM-1 transmission rate.

SDH STM-1 frame



Section overhead (SOH) The first nine bytes of each row with exception of the fourth row are part of the SOH (Section OverHead). The first nine byte of the fourth row contain the AU pointer (AU = Administrative Unit).

STM-1 payload Columns 10 through 270 (the remainder of the frame), are reserved for payload signals.

□

SDH path and line sections

Overview

This section describes and illustrates the SDH path and line sections.

SDH layers

SDH divides its processing functions into the following three path and line sections:

- Regenerator section
- Multiplex section
- Path

These three path and line sections are associated with

- Equipment that reflects the natural divisions in network spans
- Overhead bytes that carry information used by various network elements

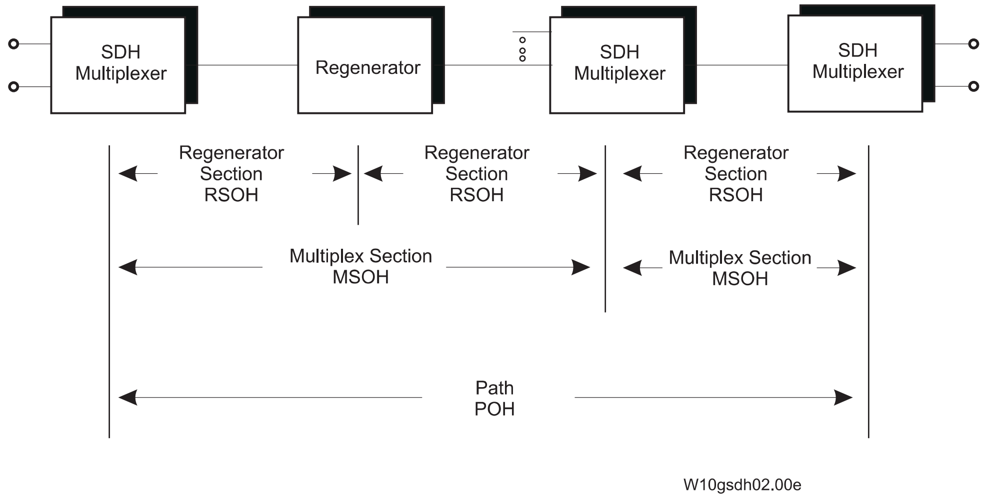
Equipment layers

The following table lists and defines each SDH equipment path and line section.

Path and line sections	Definition
Regenerator section	A regenerator section describes the section between two network elements. The network elements, however, do not necessarily have to be regenerators.
Multiplex section	A multiplex section is the section between two multiplexers. A multiplex section is defined as that part of a path where no multiplexing or demultiplexing of the STM-N frame takes place.
Path	A path is the logical signal connection between two termination points. A path can be composed of a number of multiplex sections which themselves can consist of several regenerator sections.

Path, MS and RS

The following figure illustrates the equipment path, multiplex sections and regenerator sections in a signal path.

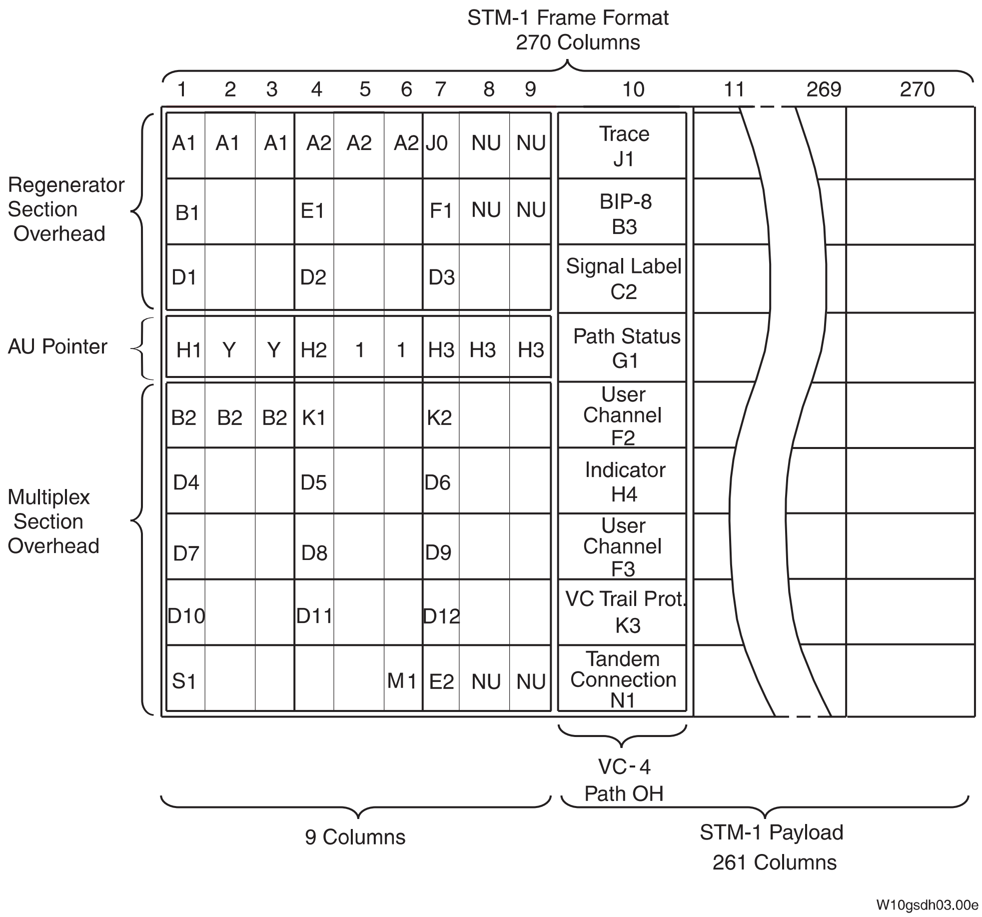


Overhead bytes

The following table lists and defines the overhead associated with each SDH path and line section.

Overhead byte section	Definition
Regenerator section	Contains information that is used by all SDH equipment including repeaters.
Multiplex section	Used by all SDH equipment except repeaters.
Path	The POH contains all the additional signals of the respective hierarchy level so that a VC can be transmitted and switched through independently of its contents.

SDH frame The following figure illustrates the SDH frame sections and its set of overhead bytes.



□

SDH frame structure

Overview

This section provides detailed information on the locations and functions of various overhead bytes for each of the following SDH path and line sections:

- Regenerator Section
- Multiplex Section
- Path

Section overhead

The following table identifies the location and function of each regenerator section overhead byte.

Bytes	Function
A1, A2	Frame alignment A1 = 1111 0110 ; A2 = 0010 1000 ; These fixed-value bytes are used for synchronization.
B1	BIP-8 parity test Regenerator section error monitoring; BIP-8 : Computed over all bits of the previous frame after scrambling; B1 is placed into the SOH before scrambling; BIP-X: (Bit Interleaved Parity X bits) Even parity, X-bit code; first bit of code = even parity over first bit of all X-bit sequences;
B2	Multiplex section error monitoring; BIP-24 : B2 is computed over all bits of the previous STM-1 frame except for row 1 to 3 of the SOH (RSOH); B2 is computed after and placed before scrambling;
Z0	Spare bytes
D1 - D3 (= DCC_R) D4 - D12 (= DCC_M)	Data Communication Channel (network management information exchange)
E1	Orderwire channel
E2	Orderwire channel
F1	User channel

Bytes	Function
K1, K2	Automatic protection switch
K2	MS-AIS/RDI indicator
S1	Synchronization Status Message
M1	REI (Remote Error Indication) byte
NU	National Usage

Path overhead

The Path Overhead (POH) is generated for all plesiochronous tributary signals in accordance with ITU-T Rec. G.709. The POH provides for integrity of communication between the point of assembly of a Virtual Container VC and its point of disassembly. The following table shows the POH bytes and their functions.

Byte	Location and Function
J1	Path Trace Identifier byte
B3	Path Bit Interleaved Parity (BIP-8) Provides each path performance monitoring. This byte is calculated over all bits of the previous payload before scrambling.
C2	Signal Label All ″0″ means unequipped; other and ″00000001″ means equipped
G1	Path Status Conveys the STM-1 path terminating status, performance, and remote defect indication (RDI) signal conditions back to an originating path terminating equipment.
F2, F3	User Data Channel Reserved for user communication.
H4	Multiframe Indicator Provides a general multiframe indicator for VC-structured payloads.
K3	VC Trail protection.

Byte	Location and Function
N1	Tandem connection OH

AU pointer

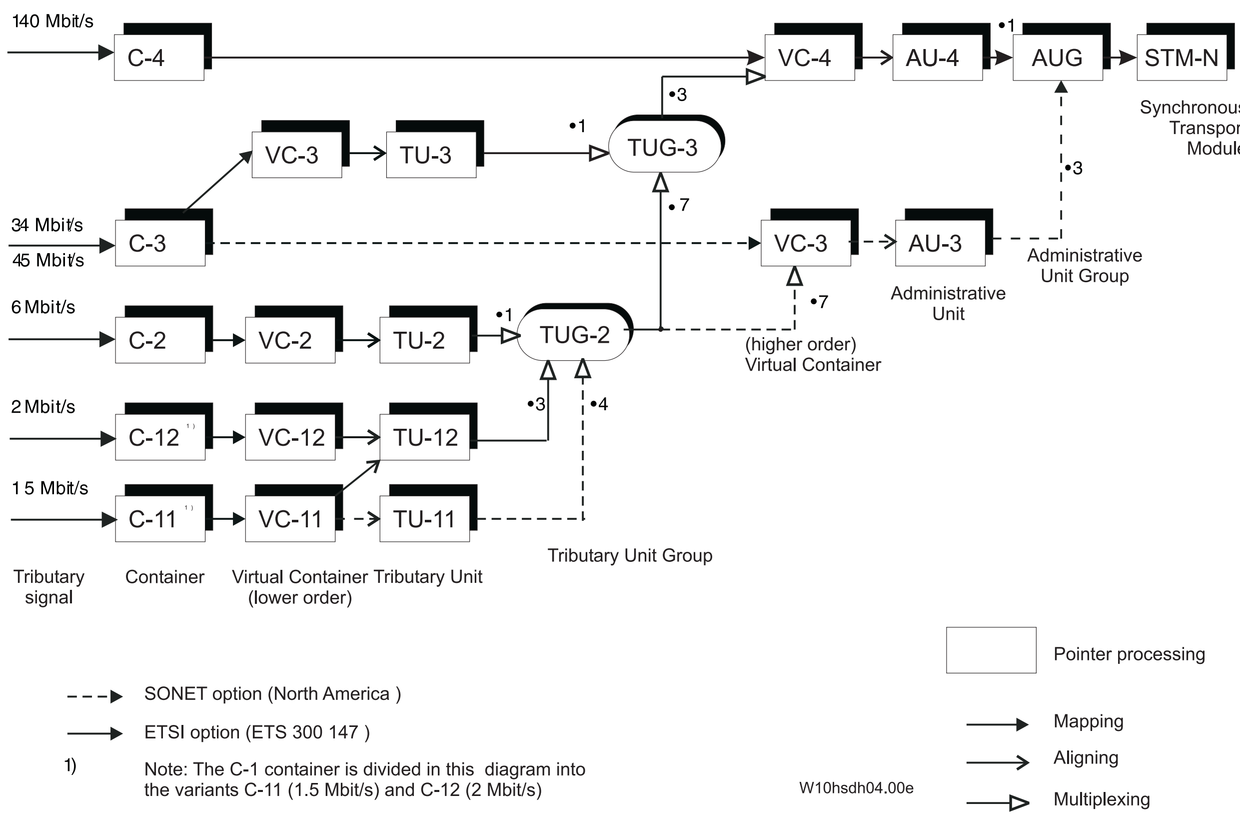
The AU pointer together with the last 261 columns of the STM-1 frame forms an AUG (Administrative Unit Group). An AUG may contain one AU-4 or three byte-multiplexed AU-3s (an AU-3 is exactly one third of the size of an AU-4). AU-3s are also compatible with the SONET standard (Synchronous Optical NETwork) which is the predecessor of SDH (and still the prevailing technology within the USA). Three byte-multiplexed STS frames (SONET frame), each containing one AU-3 can be mapped into one STM-1.

□

SDH digital multiplexing

Overview Digital multiplexing is SDH's method of byte mapping tributary signals to a higher signal rate, which permits economical extraction of a single tributary signal without the need to demultiplex the entire STM-1 payload. In addition, SDH provides overhead channels for use by OAM&P groups.

SDH digital multiplexing The following figure illustrates the SDH technique of mapping tributary signals into an STM-1 frame.



Transporting SDH payloads Tributary signals are mapped into a digital signal called a virtual container (VC). The VC is a structure designed for the transport and switching of sub-STM-1 payloads. There are five sizes of VCs: VC-11, VC-12, VC-2, VC-3, and VC-4.

Table The following table provides the digital signals that can be transported as SDH payloads.

Input tributary	Voice Channels	Rate	Mapped Into
1.5 Mbit/s	24	1.544 Mbit/s	VC-11
2 Mbit/s	32	2.048 Mbit/s	VC-12
6 Mbit/s	96	6.312 Mbit/s	VC-2
34 Mbit/s	672	34.368 Mbit/s	VC-3
45 Mbit/s	672	44.736 Mbit/s	VC-3
140 Mbit/s	2016	139.264 Mbit/s	VC-4

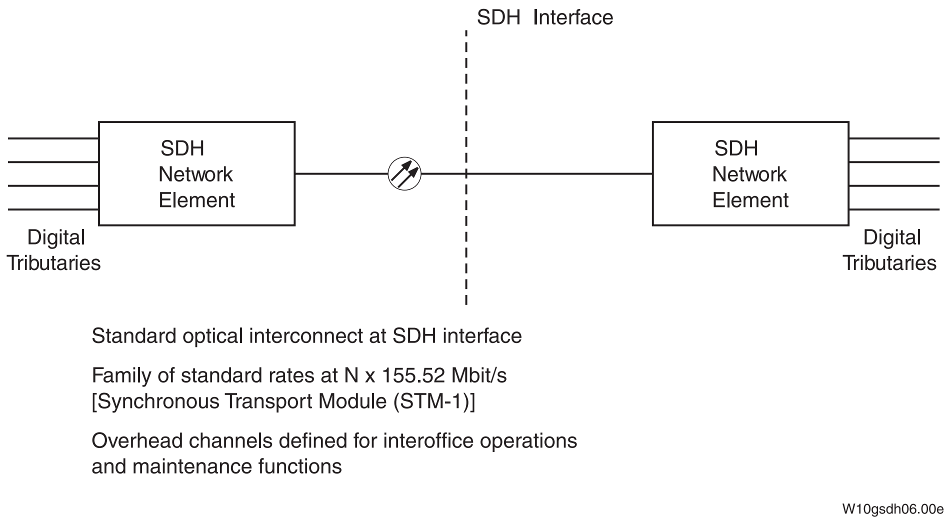
□

SDH interface

Overview This section describes the SDH interface.

Description The SDH interface provides the optical mid-span meet between SDH network elements. An SDH network element is the hardware and software that affects the termination or repeating of an SDH standard signal.

SDH interface



SDH multiplexing process

Overview

SDH provides for multiplexing of 2-Mbit/s (C-12) and 34-Mbit/s (C-3) signals into an STM-1 frame.

Furthermore, multiplexing paths also exist for the SONET specific 1.5-Mbit/s, 6-Mbit/s and 45-Mbit/s signals.

Process

The following describes the process for multiplexing a 2-Mbit/s signal. The "SDH digital multiplexing" (A-12) illustrates the multiplexing process.

1 Input 2-Mbit/s tributary is mapped

- Each VC-12 carries a single 2-Mbit/s payload.
- The VC-12 is aligned into a Tributary Unit TU-2 using a TU pointer.
- Three TU-2 are then multiplexed into a Tributary Unit Group TUG-2.
- Seven TUG-2 are multiplexed into an TUG-3.
- Three TUG-3 are multiplexed into an VC-4.
- The VC-4 is aligned into an Administrative Unit AU-4 using a AU pointer.
- The AU-4 is mapped into an AUG which is then mapped into an STM-1 frame.

2 After VCs are multiplexed into the STM-1 payload, the section overhead is added.

3 Scrambled STM-1 signal is transported to the optical stage.

□

SDH demultiplexing process

Overview Demultiplexing is the inverse of multiplexing. This topic describes how to demultiplex a signal.

Process The following describes the process for demultiplexing an STM-1 signal to a 2 Mbit/s signal. The "SDH digital multiplexing" (A-12) illustrates the demultiplexing process.

1 The unscrambled STM-1 signal from the optical conversion stages is processed to extract the path overhead and accurately locate the payload.

2 The STM-1 path overhead is processed to locate the VCs. The individual VCs are then processed to extract VC overhead and, via the VC pointer, accurately locate the 2-Mbit/s signal.

3 The 2-Mbit/s signal is desynchronized, providing a standard 2-Mbit/s signal to the asynchronous network.

Key points SDH STM pointers are used to locate the payload relative to the transport overhead.

Remember the following key points about signal demultiplexing:

- The SDH frame is a fixed time (125 µs) and no bit-stuffing is used.
- The synchronous payload can float within the frame. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing).

SDH transport rates

Overview

Higher rate STM-N frames are built through byte-multiplexing of N STM-1 signals.

Creating higher rate signals

A STM-N signal can only be multiplexed out of N STM-1 frames with their first A1 byte at the same position (i.e. the first A1 byte arriving at the same time).

STM-N frames are built through byte-multiplexing of N STM-1 signals. Not all bytes of the multiplexed SOH (size = N x SOH of STM-1) are relevant in an STM-4/16.

For example there is only one B1 byte in an STM-4/16 frame which is computed the same way as for an STM-1. Generally the SOH of the first STM-1 inside the STM-N is used for SOH bytes that are needed only once. The valid bytes are given in ITU-T G.707.

SDH transport rates

Designation	Line rate (Mbit/s)	Capacity
STM-1	155.520	1 AU-4 or 3 AU-3
STM-4	622.080	4 AU-4 or 12 AU-3
STM-16	2488.320	16 AU-4 or 48 AU-3
STM-64	9953.280	64 AU-4 or 192 AU-3
STM-256	39813.120	256 AU-4 or 768 AU-3

□

Appendix B: A SONET overview

Overview

Purpose

This chapter briefly describes the Synchronous Optical Network (SONET).

History of the SONET name

The American National Standards Institute (ANSI) recognized the need for an optical signal standard for future broadband transmission, and a committee began working on optical signal and interface standards in 1984.

In 1985, Bellcore proposed a network approach to fiber system standardization to T1X1. In the proposal, Bellcore suggested the following:

- Hierarchical family of signals whose rates would be integer multiples of a basic modular signal
- Synchronous multiplexing technique, leading to the coining of the term ***Synchronous Optical Network*** (SONET)

CCITT interest in SONET

The International Telegraph and Telephone Consultative Committee (CCITT) was interested in SONET and held conferences in 1987 and 1988 which resulted in coordinated specifications and approval of both the American National Standard (SONET) and the CCITT-International Standard, Synchronous Digital Hierarchy (SDH) in 1988.

Important! The CCITT is now named International Telecommunication Union, Telecommunication Standardization Sector (ITU-T). For more information refer to the “Standards: Their Global Impact” in the ***IEEE Communications Magazine***, Vol. 32, No. 1, January 1994.

Purpose

The basic purpose of SONET is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in the networks of today, as well as those planned for the future.

SONET currently defines standard rates and formats and optical interfaces. Today, mid-span meet is possible at the optical transmission level. These and other related issues continue to evolve through the ANSI committees.

ANSI addressed issues

The set of American National Standards defines:

- Optical parameters
- Multiplexing schemes to map existing digital signals (that is, DS1 and DS3) into SONET payload signals
- Overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions
- Criteria for optical line automatic protection switch (APS)

References

For more detailed information on SONET, refer to:

- ANSI T1.105 – 1995 American National Standard for Telecommunications, Synchronous Optical Network (SONET)
- ANSI T1.106-1988 American National Standard for Telecommunications – Digital Hierarchy Optical Interface Specifications, Single Mode
- ITU Recommendations G.707, G.708, G.709
- R. Ballart and Y. C. Ching, SONET: Now It’s the Standard Optical Network, ***IEEE Communications Magazine***, Vol. 27, No. 3 (March 1989): 8-15

□

SONET signal hierarchy

Introduction

This section describes the basics of the SONET hierarchy.

STS-1 frame

The SONET signal hierarchy is based on a basic “building block” frame called the synchronous transport signal-level 1 (STS-1), as shown in “Figure of SONET STS-1 frame” (B-4).

The STS-1 frame has:

- A recurring rate of 8000 frames a second
- The frame rate of 125 microseconds

The STS-1 frame consists of:

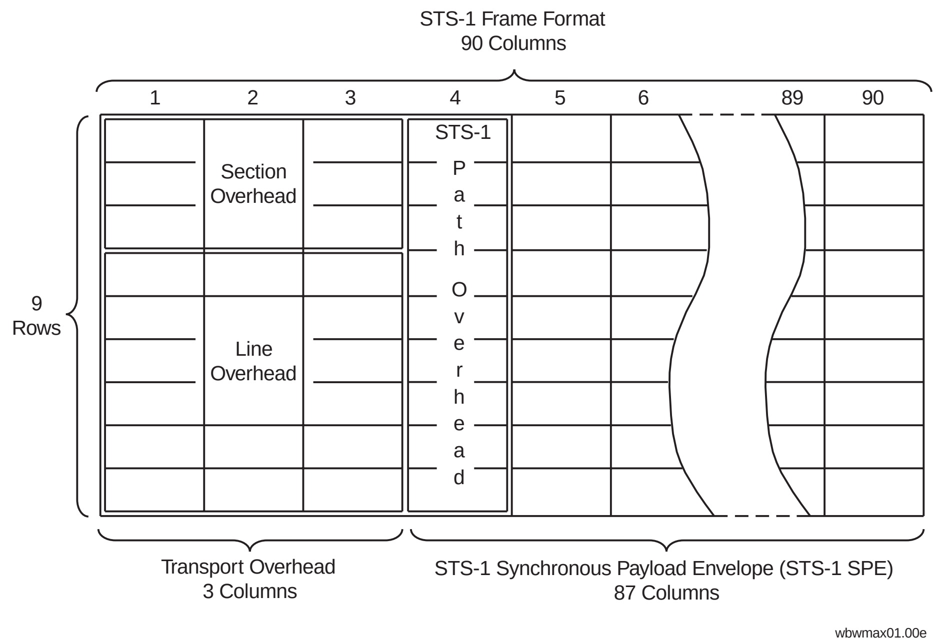
- 90 columns
- 9 rows

Important! Each cell in the matrix represents an 8-bit byte.

Transmitting signals

The STS-1 frame is transmitted serially starting from the left with row 1 column 1 through column 90, then row 2 column 1 through 90, continuing on, row-by-row, until all 810 bytes (9x90) of the STS-1 frame have been transmitted. Because each STS-1 frame consists of 810 bytes and each byte has 8 bits, the frame contains 6480 bits a frame. There are 8000 STS-1 frames a second, at the STS-1 signal rate of 51,840,000 (6480x8000) bits a second.

Figure of SONET STS-1 frame



Transport overhead

The first three columns in each of the nine rows carry the section and line overhead bytes. Collectively, these 27 bytes are referred to as transport overhead.

Synchronous payload envelope

Columns 4 through 90 (the remainder of the frame), are reserved for payload signals (for example, DS1 and DS3) and is referred to as the STS-1 synchronous payload envelope (STS-1 SPE). The optical counterpart of the STS-1 is the optical carrier level 1 signal (OC-1), which is the result of a direct optical conversion after scrambling.

□

SONET layers

SONET layers

SONET divides its processing functions into the following three layers:

- Section
- Line
- Path

These three layers are associated with:

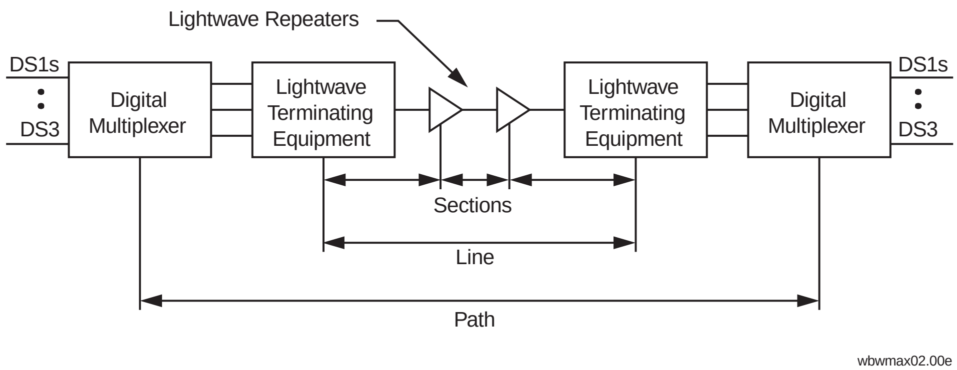
- Equipment that reflects the natural divisions in network spans
- Bytes that carry information used by various network elements

Equipment layers

The following table lists and defines each SONET equipment layer.

Layer	Definition
Section and Section Terminating Equipment	The transmission spans (Spans between regenerators are also referred to as sections.) between lightwave terminating equipment and the regenerators. This equipment provides regenerator functions which terminate the section overhead to provide single-ended operations and section performance monitoring.
Line and Line Terminating Equipment	The transmission span between terminating equipment (STS-1 cross-connects) that provides line performance monitoring.
STS-1 and Virtual Tributary (VT) Path Terminating Equipment	The SONET portion of the transmission span for an end-to-end tributary (DS1 or DS3) signal that provides signal labeling and path performance monitoring for signals as they are transported through a SONET network. STS-1 path terminating equipment also provides cross-connections for lower-rate, (that is, DS1) signals. A VT is a sub-DS3 payload and is described later in more detail.

The following figure illustrates the equipment layers (section, line, and path) in a signal path.



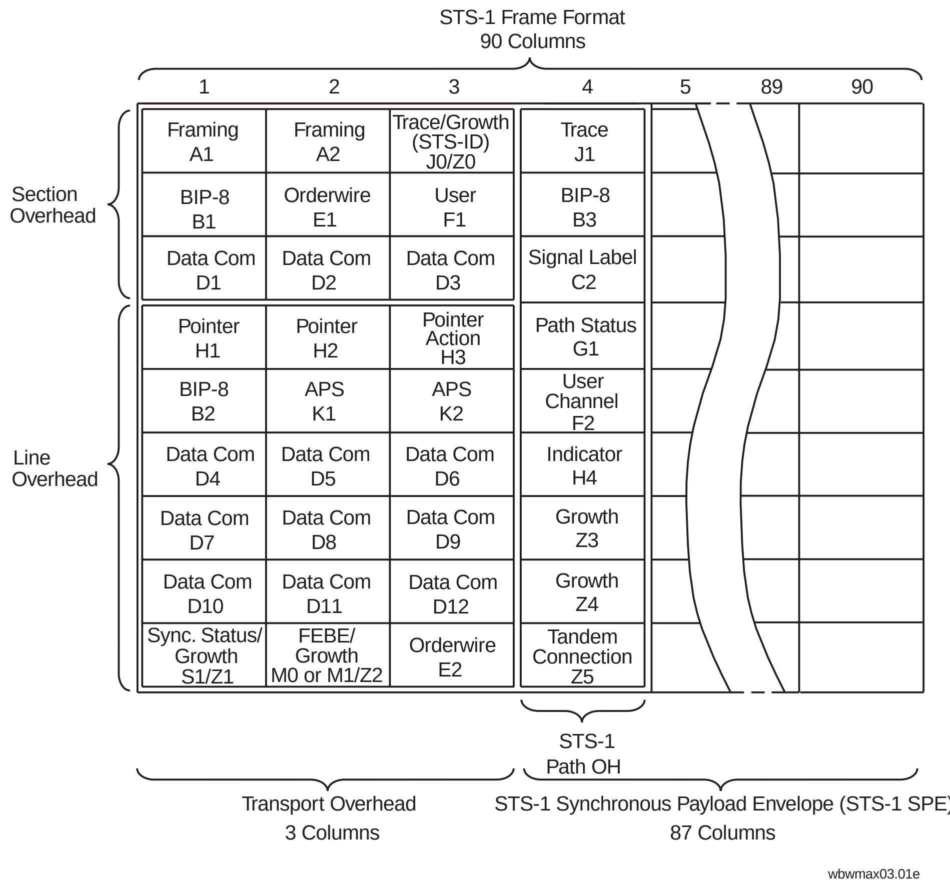
Overhead byte layers

Table B-2 “Overhead Byte Layers” lists and defines the overhead associated with each SONET layer.

Overhead Byte Layer	**Definition**
Section	Contains information that is used by all SONET equipment including repeaters.
Line	Used by all SONET equipment except repeaters.
Path	Carried within the payload envelope across the end-to-end path with: • STS-1 remaining with the STS-1 SPE until its payload is demultiplexed • VTN (N= 1.5, 2, 3, or 6) remaining with the VTN until it is demultiplexed to its asynchronous signal

Figure of SONET Frame Format

The following figure illustrates each SONET layer and its set of overhead bytes.



SONET frame structure

Introduction

This section provides detailed information on the locations and functions of various overhead bytes for each of the following SONET layers:

- Section
- Line
- Path (STS-1 and VT)

Section overhead

Table B-3 "Section overhead bytes" identifies the location and function of each section overhead byte.

Byte	Location and Function
Framing (A1 & A2)	Provides framing for each STS-1.
Trace/Growth (J0/Z0)	The Section Trace and Section Growth bytes replace STS-1 ID (C1). J0/Z0 are for future use and the locations are as follows: • J0 byte is in the first STS-1 of an STS-N. • Z0 byte is in the second through Nth STS-1 of the STS-N.
Section Bit Interleaved Parity (BIP-8) (B1)*	Provides section performance monitoring and is calculated over all bits of the previous STS-N frame.
Section Orderwire (E1)*	Provides a local orderwire for voice communication channel between regenerators.
Section User Channel (F1)*	Set aside for the purpose of the user.
Section Data Communications Channel (D1, D2, D3)*	A 192-kbit/s message-based channel that is used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment.

Notes:

1. * Defined only for STS-1 #1 of an STS-N signal.

Line overhead

Table B-4 “Line Overhead Bytes” identifies the location and function of each line overhead byte.

Byte	Location and Function
Pointer (H1, H2)	Two bytes indicating the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).
Pointer Action (H3)	Allocated for frequency justification.
Line Bit Interleaved Parity (BIP-8) (B2)	Provided for line performance monitoring in all STS-1 signals within an STS-N signal.
Automatic Protection Switching (APS) (K1, K2)*	Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF).
Line Data Communications Channel (D4 - D12)	This is a 576-kbit/s message-based channel.
Synchronization Status (S1)	• Located in the first STS-1 of an STS-N. • Conveys the synchronization status of the Network Element.
Growth (Z1)	• Located in the second through Nth STS-1 of an STS-N. • Reserved for future growth.
Line Orderwire (E2)*	Allocated to be used as an express orderwire between line entities.

Notes:

1. * Defined only for STS-1 #1 of an STS-N signal.

STS-1 path overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is demultiplexed and is used for functions that are necessary to transport all synchronous payload envelopes.

Use Table B-5 “STS-1 Path Overhead Bytes” to determine the location and function of each STS-1 path overhead byte.

Byte	Location and Function
STS-1 Path Trace (J1)	Repetitively transmits a 64 byte, fixed length string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.
STS-1 Path Bit Interleaved Parity (BIP-8) (B3)	Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.
STS-1 Path Signal Label (C2)	Indicates the construction of the STS-1 synchronous payload envelope (SPE).
Path Status (G1)	Conveys the STS-1 path terminating status, performance, and remote defect indication (RDI) signal conditions back to an originating STS-1 path terminating equipment.
Path User Channel (F2)	Reserved for user communication.
Indicator (H4)	Provides a general multiframe indicator for VT-structured payloads.
Path Growth (Z3 - Z4)	Reserved for future growth.
Tandem Connection (Z5)	Allocated for Tandem Connection Maintenance and the Path Data Channel, as specified by ANSI T1.105.05.

SPE values

Table A-6, “Synchronous Payload Envelopes” lists the types of STS-1 synchronous payload envelope values and their meanings. The system can generate 00, 01, or 04 and can carry any of the other values within the path layer overhead.

Hexadecimal Code	STS-1 SPE
00	Unequipped

Hexadecimal Code	STS-1 SPE
01	Equipped nonspecific payload
02	VT-Structured STS-1 SPE
04	Asynchronous mapping for DS3
12	DS4NA Asynchronous mapping
13	Mapping for ATM
14	Mapping for DQDB
15	Asynchronous mapping FDDI

VT path overhead

Virtual tributary (VT) path overhead provides important functions for managing sub-STS-1 payloads; such as, error checking, path status, and signal label. These functions are similar to those provided for STS-1 paths.

□

SONET digital multiplexing

Introduction

SONET provides the following two multiplexing schemes:

- Asynchronous
- Synchronous

Asynchronous multiplexing

When fiber optic facilities are used to carry DS3 signals, the signal consists of a combination of the following payload signals:

- 28 DS1s
- 14 DS1s
- 7 DS2s

M23 format

Typically, 28 DS1 signals are multiplexed into a DS3 signal, using the M23 format. The M23 format involves bit interleaving of four DS1 signals into a DS2 signal and then bit interleaving of seven DS2 signals into a DS3. In addition, the DS3 rate is not a direct multiple of the DS1 or the DS2 rates due to the bit-stuffing synchronization technique used in asynchronous multiplexing.

Disadvantages of M23 format

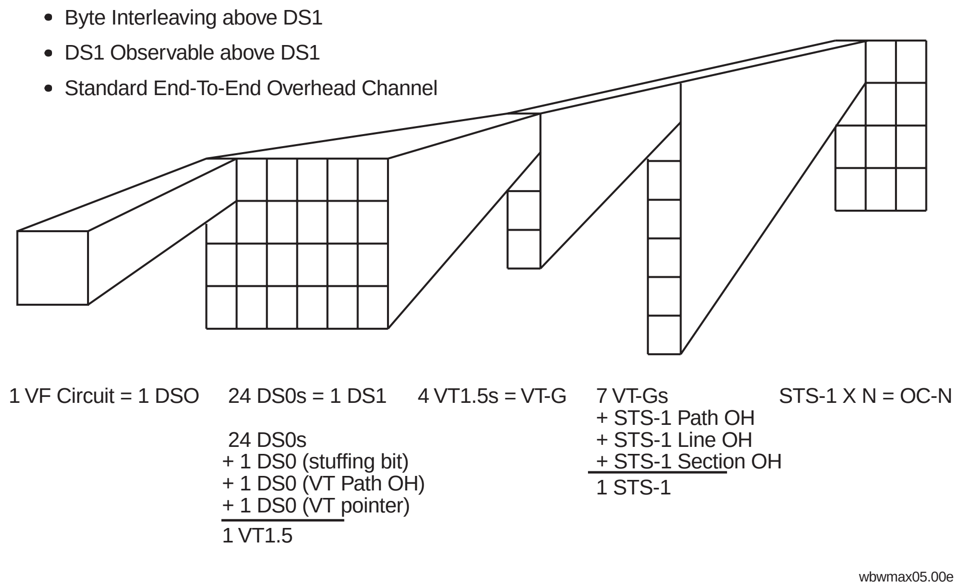
When using an M23 format, identification of DS0s contained in any DS-N signal is complex, and DS0s cannot be directly extracted. An asynchronous DS3 signal must be demultiplexed down to the DS1 level to access and cross-connect DS0 and DS1 signals. In addition, the M23 format does not provide an end-to-end overhead channel for use by OAM&P groups.

Synchronous multiplexing

Synchronous multiplexing is the SONET method of byte interleaving DS1s to a higher signal rate, which permits economical extraction of a single DS1 without the need to demultiplex the entire STS-1 SPE. In addition, SONET provides overhead channels for use by OAM&P groups.

Figure of synchronous multiplexing

The following figure illustrates the SONET technique of mapping a single asynchronous DS1 signal into an STS-1 SPE.



Transporting SONET payloads

Sub-DS3 asynchronous signals (DS1, DS1C, DS2, and E1) are ***byte interleaved*** into a digital signal called a virtual tributary (VT). The VT is a structure designed for the transport and switching of sub-DS3 payloads. There are four sizes of VTs: 1.5, 2, 3, and 6.

Table

Digital signals DS1 and DS3 are the most important asynchronous signals in the current network. Broadband payloads, such as ATM, are also of great importance.

Input Tributary	Voice Channels (DS0s)	Rate	SONET Signal	Rate
DS1	24 DS0s	1.544 Mbit/s	VT1.5	1.728 Mbit/s
E1 (CEPT)	32 DS0s	2.048 Mbit/s	VT2	2.304 Mbit/s
DS1C	48 DS0s	3.152 Mbit/s	VT3	3.456 Mbit/s
DS2	96 DS0s	6.312 Mbit/s	VT6	6.912 Mbit/s
DS3	672 DS0s	44.736 Mbit/s	STS-1	51.840 Mbit/s

Input Tributary	Voice Channels (DS0s)	Rate	SONET Signal	Rate
DS4NA	2016 DS0s	139.264 Mbit/s	STS-3c	155.520 Mbit/s
ATM	2016 DS0s	149.760 Mbit/s	STS-3c	155.520 Mbit/s
FDDI	2016 DS0s	125.000 Mbit/s	STS-3c	155.520 Mbit/s

SONET interface

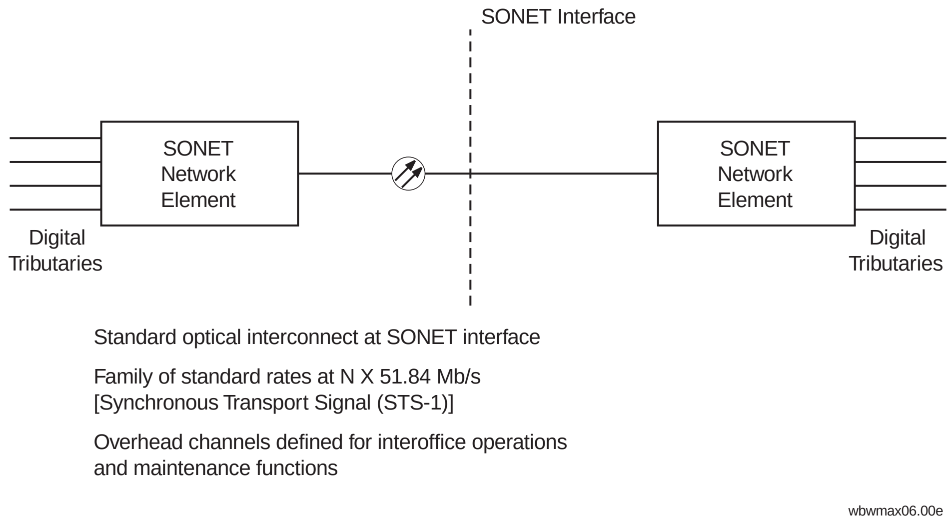
Introduction

This section describes the SONET interface.

Description

The SONET interface provides the optical mid-span meet between SONET network elements. A SONET network element is the hardware and software that affects the termination or repeating of a SONET standard signal.

Figure of SONET interface



SONET multiplexing process

Introduction

SONET provides for multiplexing of asynchronous DS1s, synchronous DS1s, and asynchronous DS3s.

Multiplexing process

The following describes the process for multiplexing a signal.

1 Input DS1 or DS3 tributary is mapped.

In the case of DS1 inputs, three time slots (DS0s) are added to the incoming signal, becoming a VT1.5.

An asynchronous DS1 that fully meets the specified rate is mapped into the VT1.5 SPE as clear channel input since no framing is needed.

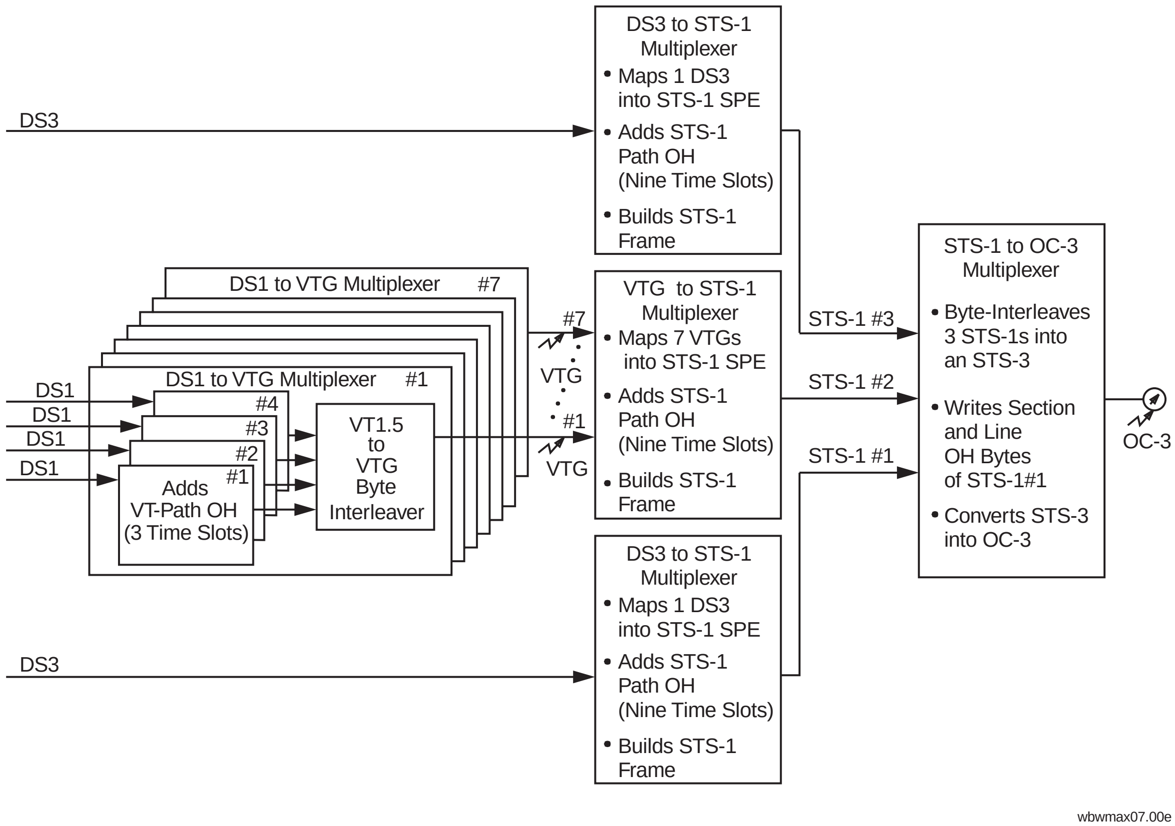
- Each VT1.5 carries a single DS1 payload.
- Four VT1.5s are bundled into a VT group (VT-G).
- Seven VT-Gs are byte interleaved into an STS-1 frame.

Important! The VT-G to-STS-1 multiplex is a simple byte interleaving process, so individual VT signals are easily observable within the STS-1. Thus, cross-connections and add/drop can be accomplished without the back-to-back mux/demux steps required by asynchronous signal formats.

2 After VTs are multiplexed into the STS-1 SPE, the path, line, and section overhead is added.

3 Scrambled STS-N signal is transported to the optical stage.

Figure of SONET multiplexing process



□

SONET demultiplexing process

Introduction

Demultiplexing is the inverse of multiplexing. This topic describes how to demultiplex a signal.

Demultiplexing process

The following describes the process for demultiplexing an STS-1 signal to a DS1 signal.

1 The unscrambled STS-1 signal from the optical conversion stages is processed to extract the section and line overhead and accurately locate the SPE.

2 The STS-1 path overhead is processed to locate the VTs. The individual VTs are then processed to extract VT overhead and, via the VT pointer, accurately locate the DS1.

3 The DS1 is desynchronized, providing a standard DS1 signal to the asynchronous network.

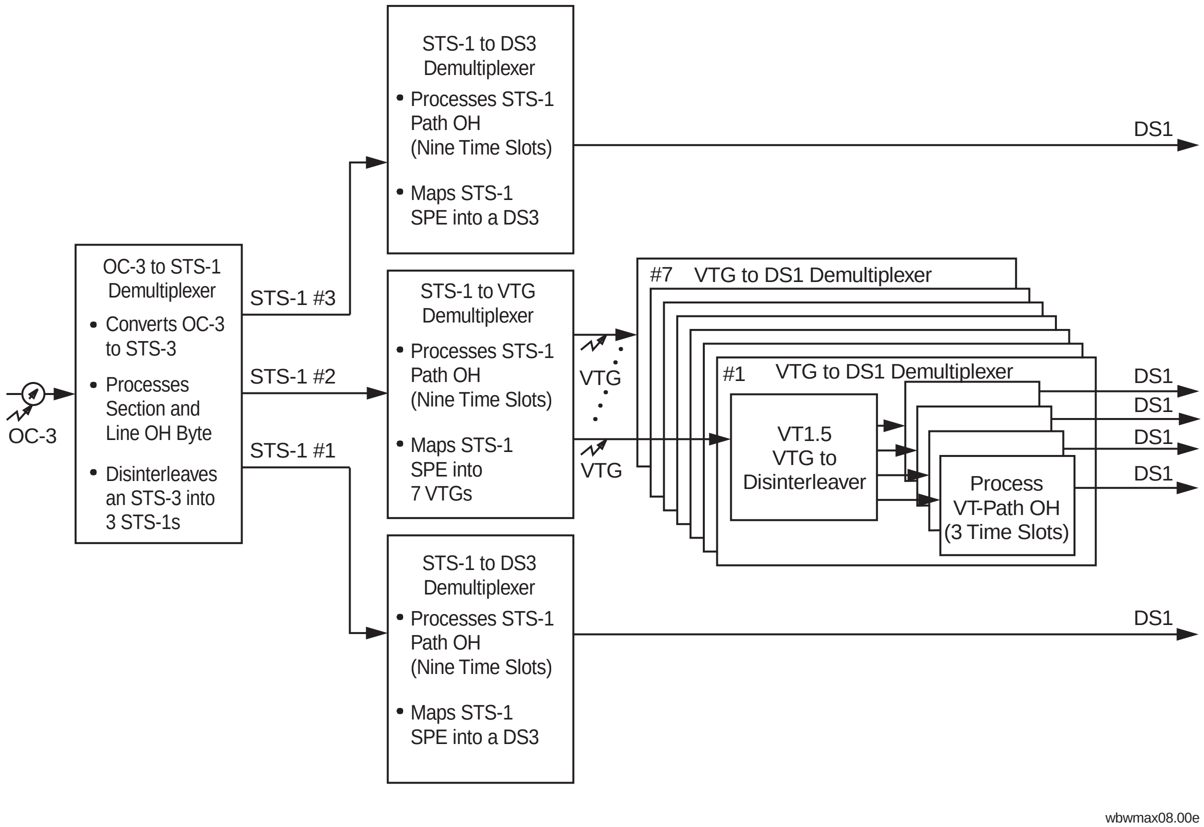
Key points

Remember the following key points when demultiplexing a signal:

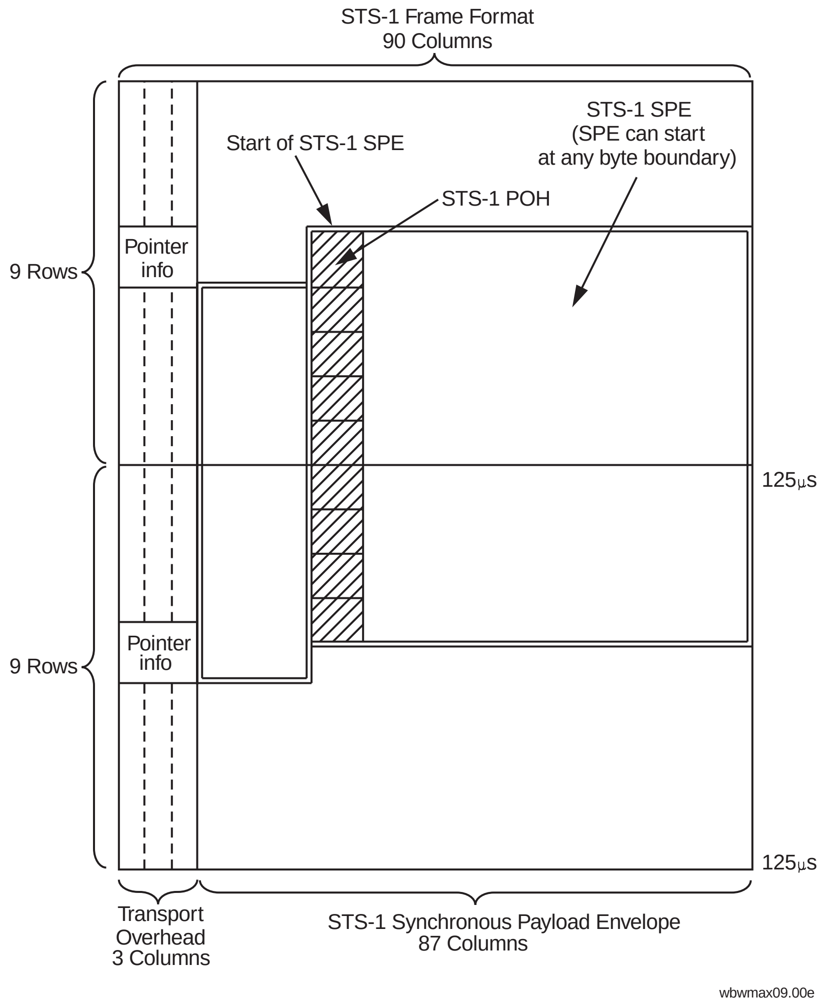
- The SONET frame is a fixed time (125 ***m***s) and no bit-stuffing is used.
- The synchronous payload envelope (SPE) can ***float*** within the frame. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing). The SPE can also ***drift*** across the 125-***m***s frame boundary.

Important! SONET STS pointers are used to locate the SPE relative to the transport overhead.

Figure of SONET demultiplexing process



SPE figure The following figure illustrates the SPE floating within an STS-1 frame.



□

SONET transport rates

Introduction

Higher rate SONET signals are created by byte-interleaving N STS-1s to form an N STS-1 signal.

Creating higher rate signals

The desired N STS-1s are created by:

- Adjusting all payload pointers and regenerating the section and line overhead bytes to be in phase with each other and the outgoing multiplexed signal
- Scrambling and converting the N STS-1 to an optical carrier – level N (OC-***N***) signal

SONET transport rates

OC Level	Line Rate (Mbit/s)	Capacity
OC-1	51.84	28 DS1s or 1 DS3
OC-3	155.52	84 DS1s or 3 DS3s
OC-12	622.08	336 DS1s or 12 DS3s
OC-48	2488.32	1344 DS1s or 48 DS3s
OC-192	9953.28	5376 DS1s or 192 DS3s
OC-768	39813.12	21504 DS1s or 768 DS3s

Glossary

µ
Microns

NUMERICS

0x1 Line Operation
0x1 means unprotected operation. The connection between network elements has one bidirectional line (no protection line).

1+1 Line Protection
A protection architecture in which the transmitting equipment transmits a valid signal on both the working and protection lines. The receiving equipment monitors both lines. Based on performance criteria and OS control, the receiving equipment chooses one line as the active line and designates the other as the standby line.

1xN Equipment Protection
1xN protection pertains to N number of circuit pack/port units protected by one circuit pack or port unit. When a protection switch occurs, the working signals are routed from the failed pack to the protection pack. When the fault clears, the signals revert to the working port unit.

12NC (12-digit Numerical Code)
Used to uniquely identify an item or product. The first ten digits uniquely identify an item. The eleventh digit is used to specify the particular variant of an item. The twelfth digit is used for the revision issue. Items with the first eleven digits the same, are functionally equal and may be exchanged.

A

ABN
Abnormal (condition)

ABS (Absent)
Used to indicate that a given circuit pack is not installed.

AC
Alternating Current

ACO (Alarm Cut-Off)
A button on the user panel used to silence audible alarms.

ACT (Active)
Used to indicate that a circuit pack or module is in-service and currently providing service functions.

Adaptive-rate tributary operation of a port (Pipe mode)
Mode of operation of a port in which tributaries are ***not*** explicitly provisioned for the expected signal rates. The signal rates are automatically identified.

ADM (Add/Drop Multiplexer)
The term for a synchronous network element capable of combining signals of different rates and having those signals added to or dropped from the stream.

AEL
Accessible Emission Limits

Agent
Performs operations on managed objects and issues events on behalf of these managed objects. All SDH managed objects will support at least an agent. Control of distant agents is possible via local "Managers".

AGNE
Alarm Gateway Network Element

AID (Access Identifier)
A technical specification for explicitly naming entities (both physical and logical) of an NE using a grammar comprised of ASCII text, keywords, and grammar rules.

AIS (Alarm Indication Signal)
A code transmitted downstream in a digital network that indicates that an upstream failure has been detected and alarmed if the upstream alarm has not been suppressed.

AITS
Acknowledged Information Transfer Service: Confirmed mode of operation of the LAPD protocol.

Alarm
Visible or audible signal indicating that an equipment failure or significant event/condition has occurred.

Alarm Correlation
The search for a directly-reported alarm that can account for a given symptomatic condition.

Alarm Severity
An attribute defining the priority of the alarm message. The way alarms are processed depends on the severity.

Alarm Suppression
Selective removal of alarm messages from being forwarded to the GUI or to network management layer OSs.

Alarm Throttling
A feature that automatically or manually suppresses autonomous messages that are not priority alarms.

Aligning
Indicating the head of a virtual container by means of a pointer, for example, creating an Administrative Unit (AU) or a Tributary Unit (TU).

AMI (Alternate Mark Inversion)
A line code that employs a ternary signal to convert binary digits, in which successive binary ones are represented by signal elements that are normally of alternative positive and negative polarity but equal in amplitude and in which binary zeros are represented by signal elements that have zero amplitude.

Anomaly
A difference between the actual and desired operation of a function.

ANSI
American National Standards Institute

APD
Avalanche Photo Diode

APS (Automatic Protection Switch)
A protection switch that occurs automatically in response to an automatically detected fault condition.

ASCII (American Standard Code for Information Interchange)
A standard 7-bit code that represents letters, numbers, punctuation marks, and special characters in the interchange of data among computing and communications equipment.

ASN.1
Abstract Syntax Notation 1

Assembly
Gathering together of payload data with overhead and pointer information (an indication of the direction of the signal).

Association
A logical connection between manager and agent through which management information can be exchanged.

Asynchronous
The essential characteristic of time-scales or signals such that their corresponding significant instants do not necessarily occur at the same average rate.

ATM (Asynchronous Transfer Mode)
A high-speed transmission technology characterized by high bandwidth and low delay. It utilizes a packet switching and multiplexing technique which allocates bandwidth on demand.

Attribute
Alarm indication level: critical, major, minor, or no alarm.

AU (Administrative Unit)
Carrier for TUs.

AU PTR (Administrative Unit Pointer)
Indicates the phase alignment of the VC-N with respect to the STM-N frame. The pointer position is fixed with respect to the STM-N frame.

AUG
Administrative Unit Group

AUTO (Automatic)
One possible state of a port or slot. When a port is in the AUTO state and a good signal is detected, the port automatically enters the IS (in-service) state. When a slot is in the AUTO state and a circuit pack is detected, the slot automatically enters the EQ (equipped) state.

Autolock
Action taken by the system in the event of circuit pack failure/trouble. System switches to protection and prevents a return to the working circuit pack even if the trouble clears. Multiple protection switches on a circuit pack during a short period of time cause the system to autolock the pack.

Autonomous Message
A message transmitted from the controlled Network Element to the *Navis*™ Optical EMS which was not a response to an *Navis* Optical EMS originated command.

AVAIL
Available

B

Bandwidth
The difference in Hz between the highest and lowest frequencies in a transmission channel. The data rate that can be carried by a given communications circuit.

Baud Rate
Transmission rate of data (bits per second) on a network link.

BER (Bit Error Rate)
The ratio of error bits received to the total number of bits transmitted.

Bidirectional Line
A transmission path consisting of two fibers that handle traffic in both the transmit and receive directions.

Bidirectional Ring
A ring in which both directions of traffic between any two nodes travel through the same network elements (although in opposite directions).

Bidirectional Switch
Protection switching performed in both the transmit and receive directions.

BIP-N (Bit Interleaved Parity-N)
A method of error monitoring over a specified number of bits (BIP-3 or BIP-8).

Bit
The smallest unit of information in a computer, with a value of either 0 or 1.

Bit Error Rate Threshold
The point at which an alarm is issued for bit errors.

BLD OUT LG
Build-Out Lightguide

Bridge Cross-Connection
The setting up of a cross-connection leg with the same input tributary as that of an existing cross-connection leg. Thus, forming a 1:2 bridge from an input tributary to two output tributaries.

Broadband Communications
Voice, data, and/or video communications at greater than 2 Mbit/s rates.

Broadband Service Transport
STM-1 concatenation transport over the *LambdaUnite*™ MSS for ATM applications.

Byte
Refers to a group of eight consecutive binary digits.

C

C
Container

CC (Clear Channel)
A digital circuit where no framing or control bits are required, thus making the full bandwidth available for communications.

CC (Cross-Connection)
Path-level connections between input and output tributaries or specific ports within a single NE. Cross-connections are made in a consistent way even though there are various types of ports and various types of port protection. Cross-Connections are re-configurable interconnections between tributaries of transmission interfaces.

Cell Relay
Fixed-length cells. For example, ATM with 53 octets.

CEPT
Conférence Européenne des Administrations des Postes et des Télécommunications

Channel
A sub-unit of transmission capacity within a defined higher level of transmission capacity.

Circuit
A set of transmission channels through one or more network elements that provides transmission of signals between two points, to support a single communications path.

CIT or *WaveStar*® CIT (Craft Interface Terminal)
The user interface terminal used by craft personnel to communicate with a network element.

CL
Clear

CLEI
Common Language Equipment Identifier

Client
Computer in a computer network that generally offers a user interface to a server.

CLLI
Common Language Location Identifier

Closed Ring Network
A network formed of a ring-shaped configuration of network elements. Each network element connects to two others, one on each side.

CM (Configuration Management)
Subsystem that configures the network and processes messages from the network.

CMI
Coded Mark Inversion

CMIP
Common Management Information Protocol. OSI standard protocol for OAM&P information exchange.

CMISE
Common Management Information Service Element

CO (Central Office)
A building where common carriers terminate customer circuits.

Co-Resident
A hardware configuration where two applications can be active at the same time independently on the same hardware and software platform without interfering with each others functioning.

Collocated
System elements that are located in the same location.

Command Group
An administrator-defined group that defines commands to which a user has access.

Concatenation
A procedure whereby multiple virtual containers are associated one with each other resulting in a combined capacity that can be used as a single container across which bit sequence integrity is maintained.

Correlation
A process where related hard failure alarms are identified.

CP
Circuit Pack

CPE
Customer Premises Equipment

CPU
Central Processing Unit

CR (Critical (alarm))
Alarm that indicates a severe, service-affecting condition.

CRC
Cyclical Redundancy Check

Cross-Connect Map
Connection map for an SDH Network Element; contains information about how signals are connected between high speed time slots and low speed tributaries.

Crosstalk
An unwanted signal introduced into one transmission line from another.

CSMA/CD
Carrier Sense Multiple Access with Collision Detection

CTIP
Customer Training and Information Products

CTS
Customer Technical Support within Lucent Technologies

Current Value
The value currently assigned to a provisionable parameter.

D

DACS/DCS
Digital Access Cross-Connect System

Data
A collection of system parameters and their associated values.

Database Administrator
A user who administers the database of the application.

dB
Decibels

DC
Direct Current

DCC (Data Communications Channel)

The embedded overhead communications channel in the synchronous line, used for end-to-end communications and maintenance. The DCC carries alarm, control, and status information between network elements in a synchronous network.

DCE (Data Communications Equipment)
The equipment that provides signal conversion and coding between the data terminating 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.

DCF
Data Communications Function; Dispersion Compensation Fiber

DCM (Dispersion Compensation Module)
A device used to compensate the dispersion, the pulse spreading properties of an optical fiber. DCMs are necessary for very-long-haul applications and high bit rates.

DCN
Data Communications Network

Default
An operation or value that the system or application assumes, unless a user makes an explicit choice.

Default Provisioning
The parameter values that are pre-programmed as shipped from the factory.

Defect
A limited interruption of the ability of an item to perform a required function. It may or may not lead to maintenance action depending on the results of additional analysis.

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)
A device that splits a combined signal into individual signals at the receiver end of transmission.

Deprovisioning
The inverse order of provisioning. To manually remove/delete a parameter that has (or parameters that have) previously been provisioned.

Digital Link
A transmission span such as a point-to-point 2 Mbit/s, 34 Mbit/s, 140 Mbit/s, VC12, VC3 or VC4 link between controlled network elements.

Digital Multiplexer

Equipment that combines by time-division multiplexing several digital signals into a single composite digital signal.

Digital Section

A transmission span such as an STM-N signal. A digital section may contain multiple digital channels.

Disassembly

Splitting up a signal into its constituents as payload data and overhead (an indication of the direction of a signal).

Dispersion

Time-broadening of a transmitted light pulse.

Dispersion Shifted Optical Fiber

1330/1550 nm minimum dispersion wavelength.

Divergence

When there is unequal amplification of incoming wavelengths, the result is a power divergence between wavelengths.

DNI (Dual Node Ring Interworking)

A topology in which two rings are interconnected at two nodes on each ring and operate so that inter-ring traffic is not lost in the event of a node or link failure at an interconnecting point.

Doping

The addition of impurities to a substance in order to attain desired properties.

Downstream

At or towards the destination of the considered transmission stream, for example, looking in the same direction of transmission.

DPLL

Digital Phase Locked Loop

DRAM

Dynamic Random Access Memory

Drop and Continue

A circuit configuration that provides redundant signal appearances at the outputs of two network elements in a ring. Can be used for Dual Node Ring Interworking (DNI) and for video distribution applications.

Drop-Down Menu
A menu that is displayed from a menu bar.

DSNE (Directory Service Network Element)
A designated Network Element that is responsible for administering a database that maps Network Elements names (node names) to addresses (node Id). There can be one DSNE per (sub)network.

DTE (Data Terminating Equipment)
The equipment that originates data for transmission and accepts transmitted data.

DTMF
Dual Tone Multifrequency

DUR
Dual Unit Row (subrack)

DUS
Do not Use for Synchronization

DWDM (Dense Wavelength Division Multiplexing)
Transmitting two or more signals of different wavelengths simultaneously over a single fiber.

E

EBER (Excessive Bit Error Rate)
The calculated average bit error rate over a data stream.

ECC
Embedded Control Channel

EEPROM
Electrically Erasable and Programmable Read-Only Memory

EIA (Electronic Industries Association)
A trade association of the electronic industry that establishes electrical and functional standards.

EM (Event Management)
Subsystem of *Navis* Optical EMS that processes and logs event reports of the network.

EMC (Electromagnetic Compatibility)
A measure of equipment tolerance to external electromagnetic fields.

EMI (Electromagnetic Interference)
High-energy, electrically induced magnetic fields that cause data corruption in cables passing through the fields.

EMS
Element Management System

Entity
A specific piece of hardware (usually a circuit pack, slot, or module) that has been assigned a name recognized by the system.

Entity Identifier
The name used by the system to refer to a circuit pack, memory device, or communications link.

EPROM
Erasable Programmable Read-Only Memory

EQ (Equipped)
Status of a circuit pack or interface module that is in the system database and physically in the frame, but not yet provisioned.

ES (Errored Seconds)
A performance monitoring parameter. ES “type A” is a second with exactly one error; ES “type B” is a second with more than one and less than the number of errors in a severely errored second for the given signal. ES by itself means the sum of the type A and type B ESs.

ESD
Electrostatic Discharge

ESP
Electrostatic Protection

Establish
A user initiated command, at the *WaveStar* CIT, to create an entity and its associated attributes in the absence of certain hardware.

ETSI
European Telecommunications Standards Institute

Event
A significant change. Events in controlled Network Elements include signal failures, equipment failures, signals exceeding thresholds, and protection switch activity. When an event occurs in a controlled Network Element, the controlled Network Element will generate an alarm or status message and send it to the management system.

Event Driven
A required characteristic of network element software system: NEs are reactive systems, primarily viewed as systems that wait for and then handle events. Events are provided by the external interface packages, the hardware resource packages, and also by the software itself.

Externally Timed

An operating condition of a clock in which it is locked to an external reference and is using time constants that are altered to quickly bring the local oscillator's frequency into approximate agreement with the synchronization reference frequency.

Extra traffic

Unprotected traffic that is carried over protection channels when their capacity is not used for the protection of working traffic.

F

Fault

Term used when a circuit pack has a hard (not temporary) fault and cannot perform its normal function.

Fault Management

Collecting, processing, and forwarding of autonomous messages from network elements.

FCC

Federal Communications Commission

FDA/CDRH

The Food and Drug Administration′s Center for Devices and Radiological Health.

FDDI (Fiber Distributed Data Interface)

Fiber interface that connects computers and distributes data among them.

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.

FEBE (Far-End Block Error)

An indication returned to the transmitting node that an errored block has been detected at the receiving node. A block is a specified grouping of bits.

FEC (Forward Error Correction)

An error correction technique in which redundant bits are added to the payload signal enabling the receiving station to detect and correct bit errors that unavoidably occur when an optical line signal is transmitted over longer distances over an optical fiber. FEC is used to increase the transmission span length.

FEPROM (Flash EPROM)

A technology that combines the non-volatility of EPROM with the in-circuit re-programmability of EEPROM.

FERF (Far-End Receive Failure)

An indication returned to a transmitting Network Element that the receiving Network Element has detected an incoming section failure. Also known as RDI.

FIT (Failures in Time)
Circuit pack failure rates per 10^9 hours as calculated using the method described in Reliability Prediction Procedure for Electronic Equipment, BellCore Method I, Issue 6, December 1997.

Fixed-rate tributary operation of a port
Mode of operation of a port in which tributaries are provisioned for the expected signal rates. This provisioning information is used for cross-connection rate validation and for alarm handling (for example “Loss of Pointer”).

Folded Rings
Folded (collapsed) rings are rings without fiber diversity. The terminology derives from the image of folding a ring into a linear segment.

Forced
Term used when a circuit pack (either working or protection) has been locked into a service-providing state by user command.

FR (Frame Relay)
A form of packet switching that relies on high-quality phone lines to minimize errors. It is very good at handling high-speed, bursty data over wide area networks. The frames are variable lengths and error checking is done at the end points.

Frame
The smallest block of digital data being transmitted.

Framework
An assembly of equipment units capable of housing shelves, such as a bay framework.

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.

G

GB
Gigabytes

Gbit/s
Gigabits per second

GHz
Gigahertz

Global Wait to Restore Time
Corresponds to the time to wait before switching back to the timing reference. It occurs after a timing link failure has cleared. This time applies for all timing sources in a system hence the name global. This can be between 0 and 60 minutes, in increments of one minute.

GNE (Gateway Network Element)
A network element that passes information between other network elements and management systems through a data communication network.

Grooming
In telecommunications, the process of separating and segregating channels, as by combing, such that the broadest channel possible can be assembled and sent across the longest practical link. The aim is to minimize de-multiplexing traffic and reshuffling it electrically.

H

Hard Failure
An unrecoverable non-symptomatic (primary) failure that causes signal impairment or interferes with critical network functions, such as DCC operation.

HDB3 (High Density Bipolar 3 Code)
Line code for 2 Mbit/s transmission systems.

HDLC (High Level Data Link Control)
OSI reference model datalink layer protocol.

HMI
Human Machine Interface

HML (Human Machine Language)
A standard language developed by the ITU for describing the interaction between humans and dumb terminals.

HO
High Order

Holdover
An operating condition of a clock in which its local oscillator is not locked to an external reference but is using storage techniques to maintain its accuracy with respect to the last known frequency comparison with a synchronization reference.

Hot Standby
A circuit pack ready for fast, automatic placement into operation to replace an active circuit pack. It has the same signal as the service going through it, so that choice is all that is required.

HPA (Higher Order Path Adaptation)
Function that adapts a lower order Virtual Container to a higher order Virtual Container by

processing the Tributary Unit pointer which indicates the phase of the lower order Virtual Container Path Overhead relative to the higher order Virtual Container Path Overhead and assembling/disassembling the complete higher order Virtual Container.

HPC (Higher Order Path Connection)
Function that provides for flexible assignment of higher order Virtual Containers within an STM-N signal.

HPT (Higher Order Path Termination)
Function that terminates a higher order path by generating and adding the appropriate Virtual Container Path Overhead to the relevant container at the path source and removing the Virtual Container Path Overhead and reading it at the path sink.

HS
High Speed

HW
Hardware

Hz
Hertz

I

I/O
Input/Output

IAO LAN
Intraoffice Local Area Network

ID
Identifier

IEC
International Electro-Technical Commission

IEEE
Institute of Electrical and Electronics Engineers

IMF
Infant Mortality Factor

Insert
To physically insert a circuit pack into a slot, thus causing a system initiated restore of an entity into service and/or creation of an entity and associated attributes.

Interface Capacity

The total number of STM-1 equivalents (bidirectional) tributaries in all transmission interfaces with which a given transmission interface shelf can be equipped at one time. The interface capacity varies with equipage.

IS (Intermediate System)

A system which routes/relays management information. A Network Element may be a combined intermediate and end system.

IS (In-Service)

A memory administrative state for ports. IS refers to a port that is fully monitored and alarmed.

IS-IS Routing

The Network Elements in a management network route packets (data) between each other, using an ***IS-IS level protocol***. The size of a network running IS-IS Level 1 is limited, and therefore certain mechanisms are employed to facilitate the management of larger networks.
For STATIC ROUTING, the capability exists for disabling the protocol over the LAN connections, effectively causing the management network to be partitioned into separate IS-IS Level 1 ***areas***. In order for the network management system to communicate with a specific Network Element in one of these areas, the network management system must identify through which so-called ***Gateway Network Element*** this specific Network Element is connected to the LAN. All packets to this specific Network Element are routed directly to the Gateway Network Element by the network management system, before being re-routed (if necessary) within the Level 1 area.
For DYNAMIC ROUTING an IS-IS Level 2 routing protocol is used allowing a number of Level 1 areas to ***interwork***. The Network Elements which connect an IS-IS area to another area are set to run the IS-IS Level 2 protocol within the Network Element and on the connection between other Network Elements. Packets can now be routed between IS-IS areas and the network management system does not have to identify the Gateway Network Elements.

ISDN

Integrated Services Digital Network

ITM

Integrated Transport Management

ITM-NM

Integrated Transport Management Network Module

ITU

International Telecommunications Union

ITU-T

International Telecommunications Union — Telecommunication standardization sector. Formerly known as CCITT: Comité Consultatif International Télégraphique & Téléphonique; International Telegraph and Telephone Consultative Committee.

J **Jitter**
Short term variations of amplitude and frequency components of a digital signal from their ideal position in time.

K **kbit/s**
Kilobits per second

L **LAN (Local Area Network)**
A communications network that covers a limited geographic area, is privately owned and user administered, is mostly used for internal transfer of information within a business, is normally contained within a single building or adjacent group of buildings, and transmits data at a very rapid speed.

LAPD (Link Access Procedure D-bytes)
Protocol used on Data Link Layer (OSI layer two) according to ITU-T Q.921.

LBC
Laser Bias Current

LBFC
Laser Backface Currents

LBO (Lightguide Build-Out)
An attenuating (signal-reducing) element used to keep an optical output signal strength within desired limits.

LCN
Local Communications Network

LCS
Local Customer Support

LED
Light-Emitting Diode

LH
Long Haul

Line
A transmission medium, together with the associated equipment, required to provide the means of transporting information between two consecutive network elements. One network element originates the line signal; the other terminates it.

Line Protection

The optical interfaces can be protected by line protection. Line protection switching protects against failures of line facilities, including the interfaces at both ends of a line, the optical fibers, and any equipment between the two ends. Line protection includes protection of equipment failures.

Line Timing

Refers to a network element that derives its timing from an incoming STM-N signal.

Link

The mapping between in-ports and out-ports. It specifies how components are connected to one another.

LL

Lucent Learning (former CTIP)

LO

Low Order

Location

An identifier for a specific circuit pack, interface module, interface port, or communications link.

Lockout of Protection

The *WaveStar* CIT command that prevents the system from switching traffic to the protection line from a working line. If the protection line is active when a “Lockout of Protection” is entered – this command causes the working line to be selected. The protection line is then locked from any Automatic, Manual, or Forced protection switches.

Lockout State

The Lockout State shall be defined for each working or protection circuit pack. The two permitted states are: None – meaning no lockout is set for the circuit pack, set meaning the circuit pack has been locked out. The values (None & Set) shall be taken independently for each working or protection circuit pack.

LOF (Loss of Frame)

A failure to synchronize an incoming signal.

LOM

Loss Of Multiframe

Loop Timing

A special case of line timing. It applies to network elements that have only one OC-N/STM-N interface. For example, terminating nodes in a linear network are loop timed.

Loopback
Type of diagnostic test used to compare an original transmitted signal with the resulting received signal. A loopback is established when the received optical or electrical external transmission signal is sent from a port or tributary input directly back toward the output.

LOP (Loss of Pointer)
A failure to extract good data from a signal payload.

LOS (Loss of Signal)
The complete absence of an incoming signal.

Loss Budget
Loss (in dB) of optical power due to the span transmission medium (includes fiber loss and splice losses).

LPA (Lower order Path Adaptation)
Function that adapts a PDH signal to a synchronous network by mapping the signal into or de-mapping the signal out of a synchronous container.

LPC (Lower Order Path Connection)
Function that provides for flexible assignment of lower order VCs in a higher order VC.

LPT (Lower Order Path Termination)
Function that terminates a lower order path by generating and adding the appropriate VC POH to the relevant container at the path source and removing the VC POH and reading it at the path sink.

LS
Low Speed

LTE
Line Terminating Equipment

M

μm
Micrometer

MAF
Management Application Function

Maintenance Condition
An equipment state in which some normal service functions are suspended, either because of a problem or to perform special functions (copy memory) that can not be performed while normal service is being provided.

Management Connection
Identifies the type of routing used (STATIC or DYNAMIC), and if STATIC is selected allows the gateway network element to be identified.

Manager
Capable of issuing network management operations and receiving events. The manager communicates with the agent in the controlled network element.

Manual Switch State
A protection group shall enter the Manual Switch State upon the initiation and successful completion of the Manual Switch command. The protection group leaves the Manual Switch state by means of the Clear or Forced Switch commands. While in the Manual Switch state the system may switch the active unit automatically if required for protection switching.

Mapping
The logical association of one set of values, such as addresses on one network, with quantities or values of another set, such as devices or addresses on another network.

MB
Megabytes

Mbit/s
Megabits per second

MCF (Message Communications Function)
Function that provides facilities for the transport and routing of Telecommunications Management Network messages to and from the Network Manager.

MD (Mediation Device)
Allows for exchange of management information between Operations System and Network Elements.

MDI
Miscellaneous Discrete Input

MDO
Miscellaneous Discrete Output

MEC (Manufacturer Executable Code)
Network Element system software in binary format that after being downloaded to one of the stores can be executed by the system controller of the network element.

MEM
Memory

Mid-Span Meet
The capability to interface between two lightwave network elements of different vendors. This applies to high-speed optical interfaces.

MIPS
Millions of Instructions Per Second

Miscellaneous Discrete Interface
Allows an operations system to control and monitor equipment collocated within a set of input and output contact closures.

MJ (Major (alarm))
Indicates a service-affecting failure, main or unit controller failure, or power supply failure.

MMF
Multi-Mode Fiber

MMI
Man-Machine Interface

MML
Human-Machine Language

MN (Minor (alarm))
Indicates a non-service-affecting failure of equipment or facility.

MO
Managed Object

MS
Multiplexer Section

ms
Millisecond

MS-SPRING (Multiplexer Section Shared Protection Ring)
A protection method used in Add-Drop Multiplexer Network Elements.

MSOH (Multiplexer Section OverHead)
Part of the Section Overhead. Is accessible only at line terminals and multiplexers.

MSP (Multiplexer Section Protection)
Provides capability for switching a signal from a working to a protection section.

MST (Multiplexer Section Termination)
Function that generates the Multiplexer Section OverHead in the transmit direction and

terminates the part of the Multiplexer Section overhead that is acceptable in the receive direction.

MTBF
Mean Time Between Failures

MTBMA
Mean Time Between Maintenance Activities

MTIE
Maximum Time Interval Error

MTPI
Multiplexer Timing Physical Interface

MTS (Multiplexer Timing Source)
Function that provides timing reference to the relevant component parts of the multiplex equipment and represents the SDH Network Element clock.

MTTR
Mean Time To Repair

Multiplexer
A device (circuit pack) that combines two or more transmission signals into a combined signal on a shared medium.

Multiplexing
A procedure by which multiple lower order path layer signals are adapted into a higher order path, or the multiple higher order path layer signals are adapted into a multiplex section.

N

NA
Not Applicable

***Navis* Optical NMS**
Optical Network Management System

NE (Network Element)
A node in a telecommunication network that supports network transport services and is directly manageable by a management system.

NEBS
Network Equipment-Building System

nm
Nanometer (10^{-9} meters)

NMON (Not Monitored)
A provisioning state for equipment that is not monitored or alarmed.

No Request State
This is the routine-operation quiet state in which no external command activities are occurring.

Node
A network element in a ring or, more generally, in any type of network. In a network element supporting interfaces to more than one ring, node refers to an interface that is in a particular ring. Node is also defined as all equipment that is controlled by one system controller. A node is not always directly manageable by a management system.

Non-Revertive Switching
In non-revertive switching, an active and stand-by line exist on the network. When a protection switch occurs, the standby line is selected to support traffic, thereby becoming the active line. The original active line then becomes the stand-by line. This status remains in effect even when the fault clears. That is, there is no automatic switch back to the original status.

Non-Synchronous
The essential characteristic of time-scales or signals such that their corresponding significant instants do not necessarily occur at the same average rate.

NORM
Normal

NPI
Null Pointer Indication

NPPA (Non-Preemptible Protection Access)
Non-preemptible protection access increases the available span capacity for traffic which does not require protection by a ring, but which cannot be preempted.

NRZ
Nonreturn to Zero

NSA
Non-Service Affecting

NSAP Address (Network Service Access Point Address)
Network Service Access Point Address (used in the OSI network layer 3). An automatically assigned number that uniquely identifies a Network Element for the purposes of routing DCC messages.

NVM (Non-Volatile Memory)
Memory that retains its stored data after power has been removed. An example of NVM would be a hard disk.

O

O&M
Operation and Maintenance

OA
Optical Amplifier

OAM&P
Operations, Administration, Maintenance, and Provisioning

OC, OC-n
Optical Carrier

OC-12
Optical Carrier, Level 12 Signal (622.08 Mbit/s)

OC-192
Optical Carrier, Level 192 (9953.28 Mbit/s) (10 Gbit/s)

OC-3
Optical Carrier, Level 3 Signal (155 Mbit/s)

OC-48
Optical Carrier, Level 48 (2488.32 Mbit/s) (2.5 Gbit/s)

OC-768
Optical Carrier, Level 768 (39813.12 Mbit/s) (40 Gbit/s)

OI (Operations Interworking)
The capability to access, operate, provision, and administer remote systems through craft interface access from any site in an SDH network or from a centralized operations system.

OLS
Optical Line System

OOF
Out-of-Frame

OOS (Out-of-Service)
The circuit pack is not providing its normal service function (removed from either the working or protection state) either because of a system problem or because the pack has been removed

from service.

Open Ring Network
A network formed of a linear chain-shaped configuration of network elements. Each network element connects to two others, one on each side, except for two network elements at the ends which are connected on only one side. A closed ring can be formed by adding a connection between the two end nodes.

Operations Interface
Any interface providing you with information on the system behavior or control. These include the equipment LEDs, user panel,*WaveStar* CIT, office alarms, and all telemetry interfaces.

Operator
A user of the system with operator-level user privileges.

Optical Channel
A STM-N wavelength within an optical line signal. Multiple channels, differing by 1.5 µm in wavelength, are multiplexed into one signal.

Optical Line Signal
A multiplexed optical signal containing multiple wavelengths or channels.

Original Value Provisioning
Preprogramming of a system's original values at the factory. These values can be overridden using local or remote provisioning.

OS (Operations System)
A central computer-based system used to provide operations, administration, and maintenance functions.

OSF
Open Software Foundation; Operations System Function

OSI (Open Systems Interconnection)
Referring to the OSI reference model, a logical structure for network operations standardized by the International Standards Organization (ISO).

Outage
A disruption of service that lasts for more than 1 second.

OW (Orderwire)
A dedicated voice-grade line for communications between maintenance and repair personnel.

P **Parameter**

A variable that is given a value for a specified application. A constant, variable, or expression that is used to pass values between components.

Parity Check

Tests whether the number of ones (or zeros) in an array of binary bits is odd or even; used to determine that the received signal is the same as the transmitted signal.

Pass-Through

Paths that are cross-connected directly across an intermediate node in a network.

Path

A logical connection between the point at which a standard frame format for the signal at the given rate is assembled, and the point at which the standard frame format for the signal is disassembled.

Path Terminating Equipment

Network elements in which the path overhead is terminated.

PCB

Printed Circuit Board

PCM

Pulse Code Modulation

PDH

Plesiochronous Digital Hierarchy

PI

Physical Interface

Pipe mode (Adaptive-rate tributary operation of a port)

Mode of operation of a port in which tributaries are ***not*** explicitly provisioned for the expected signal rates. The signal rates are automatically identified.

Platform

A family of equipment and software configurations designed to support a particular application.

Plesiochronous Network

A network that contains multiple subnetworks, each internally synchronous and all operating at the same nominal frequency, but whose timing may be slightly different at any particular instant.

PM (Performance Monitoring)

Measures the quality of service and identifies degrading or marginally operating systems (before an alarm would be generated).

PMD (Polarization Mode Dispersion)
Output pulse broadening due to random coupling of the two polarization modes in an optical fiber.

POH (Path Overhead)
Informational bytes assigned to, and transported with the payload until the payload is de-multiplexed. It provides for integrity of communication between the point of assembly of a virtual container and its point of disassembly.

Pointer
An indicator whose value defines the frame offset of a virtual container with respect to the frame reference of the transport entity on which it is supported.

POP
Point of Presence

Port (also called Line)
The physical interface, consisting of both an input and output, where an electrical or optical transmission interface is connected to the system and may be used to carry traffic between network elements. The words “port” and “line” may often be used synonymously. “Port” emphasizes the physical interface, and “line” emphasizes the interconnection. Either may be used to identify the signal being carried.

Port State Provisioning
A feature that allows a user to suppress alarm reporting and performance monitoring during provisioning by supporting multiple states (automatic, in-service, and not monitored) for low-speed ports.

POTS
Plain Old Telephone Service

PP
Pointer Processing

PRC (Primary Reference Clock)
The main timing clock reference in SDH equipment.

Preprovisioning
The process by which the user specifies parameter values for an entity in advance of some of the equipment being present. These parameters are maintained only in NVM. These modifications are initiated locally or remotely by either *WaveStar* CIT or *Navis* Optical EMS. Preprovisioning provides for the decoupling of manual intervention tasks (for example, install circuit packs) from those tasks associated with configuring the node to provide services (for

example, specifying the entities to be cross-connected).

PRI
Primary

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.

Protection Access
To provision traffic to be carried by protection tributaries when the port tributaries are not being used to carry the protected working traffic.

Protection Group Configuration
The members of a group and their roles, for example, working protection, line number, etc.

Protection Path
One of two signals entering a path selector used for path protection switching or dual ring interworking. The other is the working path. The designations working and protection are provisioned by the user, whereas the terms active path and standby path indicate the current protection state.

Protection State
When the working unit is currently considered active by the system and that it is carrying traffic. The “active unit state” specifically refers to the receive direction of operation — since protection switching is unidirectional.

PROTN (Protection)
Extra capacity (channels, circuit packs) in transmission equipment that is not intended to be used for service, but rather to serve as backup against equipment failures.

PROV (Provisioned)
Indicating that a circuit pack is ready to perform its intended function. A provisioned circuit pack can be active (ACT), in-service (IS), standby (STBY), provisioned out-of-service (POS), or out-of-service (OOS).

PSDN
Public Switched Data Network

PSTN
Public Switched Telephone Network

PTE
Path Terminating Equipment

PTR
Pointer

PWR
Power

PWR ON
Power On

Q

Q-LAN
Thin Ethernet LAN which connects the manager to Gateway Network Elements so that management information between Network Elements and management systems can be exchanged.

QL (Quality Level)
The quality of the timing signal(s) provided to synchronize a Network Element. In case of optical line timing the level can be provided by the Synchronization Status Message (S-1 byte). If the System and Output Timing Quality Level mode is “Enabled”, and if the signal selected for the Station Clock Output has a quality level below the Acceptance Quality Level, the Network Element “squelches” the Station Clock Output Signal, which means that no signal is forwarded at all.

QOS
Quality of Service

R

RAM
Random Access Memory

RDI (Remote Defect Indication)
An indication returned to a transmitting terminal that the receiving terminal has detected an incoming section failure. [Previously called far-end-receive failure (FERF).]

Reactive Maintenance
Refers to detecting defects/failures and clearing them.

Receive-Direction
The direction towards the Network Element.

Regeneration
The process of reconstructing a digital signal to eliminate the effects of noise and distortion.

Regenerator Loop

Loop in a Network Element between the Station Clock Output(s) and one or both Station Clock Inputs, which can be used to de-jitterize the selected timing reference in network applications.

Regenerator Section Termination (RST)

Function that generates the Regenerator Section Overhead (RSOH) in the transmit direction and terminates the RSOH in the receive direction.

Reliability

The ability of a software system performing its required functions under stated conditions for a stated period of time. The probability for an equipment to fulfill its function. Some of the ways in which reliability is measured are: MTBF (Mean Time Between Failures) expressed in hours; Availability = (MTBF)/(MTBF+MTTR)(%) [where MTTR = mean time to restore]; outage in minutes per year; failures per hour; percentage of failures per 1,000 hours.

Remote Network Element

Any Network Element that is connected to the referenced Network Element through either an electrical or optical link. It may be the adjacent node on a ring, or N nodes away from the reference. It also may be at the same physical location but is usually at another (remote) site.

Restore Timer

Counts down the time (in minutes) during which the switch waits to let the worker line recover before switching back to it. This option can be set to prevent the protection switch continually switching if a line has a continual transient fault.

Revertive

A protection switching mode in which, after a protection switch occurs, the equipment returns to the nominal configuration (that is, the working equipment is active, and the protection equipment is standby) after any failure conditions that caused a protection switch to occur, clear, or after any external switch commands are reset. (See “Non-Revertive”.)

Revertive Switching

In revertive switching, there is a working and protection high-speed line, circuit pack, etc. When a protection switch occurs, the protection line, circuit pack, etc. is selected. When the fault clears, service “reverts” to the working line.

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 the protection capacity.

Route

A series of contiguous digital sections.

Router
An interface between two networks. While routers are like bridges, they work differently. Routers provide more functionality than bridges. For example, they can find the best route between any two networks, even if there are several different networks in between. Routers also provide network management capabilities such as load balancing, partitioning of the network, and trouble-shooting.

RSOH
Regenerator Section OverHead; part of SOH

RST
Regenerator Section Termination

RT
Remote Terminal

RTRV
Retrieve

RZ (Return to Zero)
A code form having two information states (termed zero and one) and having a third state or an at-rest condition to which the signal returns during each period.

S

SA
Service Affecting

SA
Section Adaptation

SD
Signal Degrade

SDH (Synchronous Digital Hierarchy)
A hierarchical set of digital transport structures, standardized for the transport of suitable adapted payloads over transmission networks.

SDS
Standard Directory Service based on ANSI recommendation T1.245

SEC
Secondary

SEC
SDH Equipment Clock

Section
The portion of a transmission facility, including terminating points, between a terminal network element and a line-terminating network element, or two line-terminating network elements.

Section Adaptation
Function that processes the AU-pointer to indicate the phase of the VC-3/4 POH relative to the STM-N SOH and assembles/disassembles the complete STM-N frame.

Self-Healing
A network's ability to automatically recover from the failure of one or more of its components.

SEMF (Synchronous Equipment Management Function)
Function that converts performance data and implementation specific hardware alarms into object-oriented messages for transmission over the DCC and/or Q-interface. It also converts object-oriented messages related to other management functions for passing across the S reference points.

Server
Computer in a computer network that performs dedicated main tasks which generally require sufficient performance.

Service
The operational mode of a physical entity that indicates that the entity is providing service. This designation will change with each switch action.

SES (Severely Errored Seconds)
This performance monitoring parameter is a second in which a signal failure occurs, or more than a preset amount of coding violations (dependent on the type of signal) occurs.

SH
Short Haul

Single-Ended Operations
Provides operations support from a single location to remote Network Elements in the same SDH subnetwork. With this capability you can perform operations, administration, maintenance, and provisioning on a centralized basis. The remote Network Elements can be those that are specified for the current release.

Site Address
The unique address for a Network Element.

Slot
A physical position in a shelf designed for holding a circuit pack and connecting it to the backplane. This term is also used loosely to refer to the collection of ports or tributaries connected to a physical circuit pack placed in a slot.

SM or SMF (Single-Mode Fiber)
A low-loss, long-span optical fiber typically operating at either 1310 nm, 1550 nm, or both.

SMN
SDH Management Network

SNC/I
SubNetwork Connection (protection) / Inherent monitoring

SNC/N
SubNetwork Connection (protection) / Non-Intrusive Monitoring

SNR (Signal-to-Noise Ratio)
The relative strength of signal compared to noise.

Software Backup
The process of saving an image of the current network element's databases, which are contained in its NVM, to a remote location. The remote location could be the*WaveStar* CIT or *Navis* Optical EMS.

Software Download
The process of transferring a generic (full or partial) or provisioned database from a remote entity to the target network element's memory. The remote entity may be the*WaveStar* CIT or *Navis* Optical EMS. The download procedure uses bulk transfer to move an un-interpreted binary file into the network element.

Software ID
Number that provides the software version information for the system.

SOH (Section Overhead)
Capacity added to either an AU-4 or assembly of AU-3s to create an STM-1. Contains always STM-1 framing and optionally maintenance and operational functions. SOH can be subdivided in MSOH (multiplex section overhead) and RSOH (regenerator section overhead).

SONET (Synchronous Optical Network)
The North American standard for the rates and formats that defines optical signals and their constituents.

Span
An uninterrupted bidirectional fiber section between two network elements.

Span Growth
A type of growth in which one wavelength is added to all lines before the next wavelength is added.

SPE
Synchronous Payload Envelope

SPF (Single point of failure)
A single failure in the OSI-network (DCC, LAN or node), that causes isolation of more than one node in the OSI-network. The use of IS-IS areas, without obeying all rules & guidelines, increases the risk of a single point of failure in the network.

SPI
SDH Physical Interface

Squelch Map
This map contains information for each cross-connection in a ring and indicates the source and destination nodes for the low-speed circuit that is part of the cross-connection. This information is used to prevent traffic misconnection in rings with isolated nodes or segments.

SSM
Synchronization Status Marker

SSU_L
Synchronization Supply Unit — Local

SSU_T
Synchronization Supply Unit — Transit

Standby Path
One of two signals entering a constituent path selector, the standby path is the path not currently being selected.

State
The state of a circuit pack indicates whether it is defective or normal (ready for normal use).

Station Clock Input
An external clock may be connected to a Station Clock Input.

Status
The indication of a short-term change in the system.

STBY (Standby)
The circuit pack is in service but is not providing service functions. It is ready to be used to replace a similar circuit pack either by protection or by duplex switching.

STM
Synchronous Transport Module (SDH)

STM-N (Synchronous Transport Module, Level N)

A building block information structure that supports SDH section layer connections, where N represents a multiple of 155.52 Mbit/s. Normally N = 1, 4, 16, 64 or 256.

Stream (Line; aggregate)
A synchronous high rate connection between multiplexers, typically 10 or 40 Gbit/s.

STS
Synchronous Transport Signal (SONET)

Subnetwork
A group of interconnected/interrelated Network Elements. The most common connotation is a synchronous network in which the Network Elements have data communications channel (DCC) connectivity.

Supervisor
A user of the application with supervisor user privileges.

Suppression
A process where service-affecting alarms that have been identified as an “effect” are not displayed to a user.

SYNC
Synchronizer

Synchronization Messaging
Synchronization messaging is used to communicate the quality of network timing, internal timing status, and timing states throughout a subnetwork.

Synchronous
The essential characteristic of time scales or signals such that their corresponding significant instances occur at precisely the same average rate, generally traceable to a single Stratum 1 source.

Synchronous Network
The synchronization of transmission systems with synchronous payloads to a master (network) clock that can be traced to a reference clock.

Synchronous Payload
Payloads that can be derived from a network transmission signal by removing integral numbers of bits from every frame. Therefore, no variable bit-stuffing rate adjustments are required to fit the payload in the transmission signal.

SYSCTL
System Controller circuit pack

System Administrator

A user of the computer system on which the system's OS software application can be installed.

T **TARP**

Target Identifiers Address Resolution Protocol

TBD

To Be Determined

TCA (Threshold-Crossing Alert)

A message type sent from a Network Element that indicates that a certain performance monitoring parameter has exceeded a specified threshold.

TDM (Time Division Multiplexing)

A technique for transmitting a number of separate data, voice, and/or video signals simultaneously over one communications medium by interleaving a portion of each signal one after another.

TEN

Telecommunications Management Network

Through (or Continue) Cross-Connection

A cross-connection within a ring, where the input and output tributaries have the same tributary number but are in lines opposite each other.

Through Timing

Refers to a network element that derives its transmit timing in the east direction from a received line signal in the east direction and its transmit timing in the west direction from a received line signal in the west direction.

THz

Terahertz (10^{12} Hz)

TID (Target Identifier)

A provisionable parameter that is used to identify a particular Network Element within a network. It is a character string of up 20 characters where the characters are letters, digits, or hyphens (-).

TL1 (Transaction Language One)

A subset of ITU's human-machine language.

TM (Terminal Multiplexer)

An Add/Drop Multiplexer with only one stream interface.

Transmit-Direction
The direction outwards from the Network Element.

Tributary
A signal of a specific rate (2 Mbit/s, 34 Mbit/s, 140 Mbit/s, VC12, VC3, VC4, STM-1 or STM-4) that may be added to or dropped from a line signal.

Tributary
A path-level unit of bandwidth within a port, or the constituent signal(s) being carried in this unit of bandwidth, for example, an STM-1 tributary within an STM-N port.

Tributary Unit Pointer
Indicates the phase alignment of the VC with respect to the TU in which it resides. The pointer position is fixed with respect to the TU frame.

True Wave™ Optical Fiber
Lucent Technologies' fiber generally called non-zero dispersion-shift fiber, with a controlled amount of chromatic dispersion designed for amplified systems in the 1550/1310 nm range.

TRY
Technical Requirement

TSA (Time Slot Assignment)
A capability that allows any tributary in a ring to be cross-connected to any tributary in any lower-rate, non-ring interface or to the same-numbered tributary in the opposite side of the ring.

TSI (Time Slot Interchange)
The ability of the user to assign cross-connections between any tributaries of any lines within a Network Element. Three types of TSI can be defined: Hairpin TSI, Interring TSI (between rings), and intra-ring TSI (within rings).

TSO
Technical Support Organization

TTP
Trail Termination Point

TU (Tributary Unit)
An information structure which provides adaptation between the lower order path layer and the higher path layer. Consists of a VC-n plus a tributary unit pointer (TU PTR).

TUG
Tributary Unit Group

Two-Way Point-to-Point Cross-Connection
A two-legged interconnection, that supports two-way transmission, between two and only two tributaries.

Two-Way Roll
The operation which moves a two-way cross-connection between tributary i and tributary j to a two-way cross-connection between the same tributary i and a new tributary k with a single user command.

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.

UITS (Unacknowledged Information Transfer Service)
Unconfirmed mode of LAPD operation.

UNEQ
Path Unequipped

Upstream
At or towards the source of the considered transmission stream, for example, looking in the opposite direction of transmission.

User Privilege
Permissions a user must perform on the computer system on which the system software runs.

UTC (Universal Time Coordinated)
A time-zone independent indication of an event. The local time can be calculated from the Universal Coordinated Time.

V

V
Volts

VAC
Volts Alternating Current

Value
A number, text string, or other menu selection associated with a parameter.

Variable
An item of data named by an identifier. Each variable has a type, such as int or Object, and a scope.

VC (Virtual Container)
Container with path overhead.

VDC
Volts Direct Current

VF
Voice frequency

Virtual
Refers to artificial objects created by a computer to help the system control shared resources.

Virtual Circuit
A logical connection through a data communication (for example, X.25) network.

Voice Frequency (VF) Circuit
A 64 kilobit per second digitized signal.

Volatile Memory
Type of memory that is lost if electrical power is interrupted.

W

WAD
Wavelength Add/Drop

WAN (Wide Area Network)
A communication network that uses common-carrier provided lines and covers an extended geographical area.

Wander
Long term variations of amplitude frequency components (below 10 Hz) of a digital signal from their ideal position in time possibly resulting in buffer problems at a receiver.

Wavelength Interchange
The ability to change the wavelength associated with an STM-N signal into another wavelength.

***WaveStar* OLS 1.6T (400G/800G)**
WaveStar Optical Line System 1.6 Terabit/s (400Gbit/s/800Gbit/s)

WDCS
Wideband Digital Cross-Connect System

WDM (Wavelength Division Multiplexing)
A means of increasing the information-carrying capacity of an optical fiber by simultaneously transmitting signals at different wavelengths.

Wideband Communications
Voice, data, and/or video communication at digital rates from 64 kbit/s to 2 Mbit/s.

Working
Label attached to a physical entity. In case of revertive switching the working line or unit is the entity that is carrying service under normal operation. In case of nonrevertive switching the label has no particular meaning.

Working State
The working unit is currently considered active by the system and that it is carrying traffic.

WRT (Wait to Restore Time)
Corresponds to the time to wait before switching back after a failure has cleared, in a revertive protection scheme. This can be between 0 and 15 minutes, in increments of one minute.

WS
Work Station

WTR (Wait to Restore)
Applies to revertive switching operation. The protection group enters the WTR state when all Equipment Fail (EF) conditions are cleared, but the system has not yet reverted back to its working line. The protection group remains in the WTR state until the Wait-to-Restore timer completes the WTR time interval.

X

X.25
An ITU standard defining the connection between a terminal and a public packet-switched network

X.25 Interface/Protocol
The ITU packet-switched interface standard for terminal access that specifies three protocol layers: physical, link, and packet for connection to a packet-switched data network.

XC
Cross Connect

Z

Zero Code Suppression
A technique used to reduce the number of consecutive zeros in a line-coded signal (B3ZS, B8ZS).

Index