Lucent Technologies
Bell Labs Innovations

LambdaUnite® MultiService Switch (MSS)

Release 7.0

Applications and Planning Guide

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Trademarks

Software copyright

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.

Declaration of Conformity

The Declaration of Conformity (DoC) for this product can be found in this document at “Conformity statements” (p. 9-5) or at: http://www.lucent.de/ecl.

WEEE directive

The *Waste from Electrical and Electronic Equipment (WEEE) directive* for this product can be found in this document at “Eco-environmental statements” (p. 9-8).

Ordering information

The order number of this document is 365-374-176 (Issue 2).

Technical support

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

Developed by Lucent Technologies.

Please refer to “Documentation support” (p. 8-10).

Contents

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 issue 2 of this guide for *LambdaUnite*® MSS Release 7.0.

A new version of this document was needed to address all features supported by *LambdaUnite*® MSS Release 7.0. The most important features added to the previous release are:

- Cost reduced controller variants (CTL/4)
- New OP2G5 Single-Density Parent Board
- ONNS feature enhancements
  – ONNS M:N shared protection between multiple ports
  – M:N shared protection group modification
  – ONNS to UPSR/SNCP termination support
  – Restoration improvements
  – ONNS 1+1 path protection revertive
- Protection schemes enhancements
  – Path-protected pipe mode cross-connections
  – Enhanced SA/NSA detection for UPSR rings

- Automatic squelch map distribution
- Support for MS-Spring in conjunction with LO cross connections

For more detailed and complete feature information please refer to Chapter 2, "Features ".

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)
Glossary	Defines telecommunication terms and explains abbreviations and acronyms	
Index	Lists specific subjects and their corresponding page numbers	

Conventions used

These conventions are used in this document:

Numbering

The chapters of this document are numbered consecutively. The page numbering restarts at "1" in each chapter. To facilitate identifying pages in different chapters, the page numbers are prefixed with the chapter number. For example, page 2-3 is the third page in chapter 2.

Cross-references

Cross-reference conventions are identical with those used for numbering, i.e. the first number in a reference to a particular page refers to the corresponding chapter.

Keyword blocks

This document contains so-called keyword blocks to facilitate the location of specific text passages. The keyword blocks are placed to the left of the main text and indicate the contents of a paragraph or group of paragraphs.

Typographical conventions

Special typographical conventions apply to elements of the graphical user interface (GUI), file names and system path information, keyboard entries, alarm messages etc.

- Elements of the graphical user interface (GUI)

  These are examples of text that appears on a graphical user interface (GUI), such as menu options, window titles or push buttons:

  - **Provision...**, **Delete**, **Apply**, **Close**, **OK** (push-button)
  - **Provision Timing/Sync** (window title)
  - **Administration** → **Security** → **User Provisioning...** (path for invoking a window)
- File names and system path information

  These are examples of file names and system path information:

  - *setup.exe*
  - *C:\Program Files\Lucent Technologies*
- Keyboard entries

  These are examples of keyboard entries:

  - **F1**, **Esc X**, **Alt-F**, **Ctrl-D**, **Ctrl-Alt-Del** (simple keyboard entries)

    A hyphen between two keys means that both keys have to be pressed simultaneously. Otherwise, a single key has to be pressed, or several keys have to be pressed in sequence.
  - `copy abc xyz` (command)

    A complete command has to be entered.
- Alarms and error messages

  These are examples of alarms and error messages:

  - `Loss of Signal`
  - `HP-UNEQ`, `MS-AIS`, `LOS`, `LOF`

Abbreviations

Abbreviations used in this document can be found in the “Glossary” unless it can be assumed that the reader is familiar with the abbreviation.

Related documentation

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

- 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 (UOG) 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®* Craft Interface Terminal (CIT).
- Alarm Messages and Trouble Clearing Guide
  The *LambdaUnite®* MSS Alarm Messages and Trouble Clearing Guide (AMTCG) gives detailed information on each possible alarm message. Furthermore, it provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement.
- Installation Guide
  The *LambdaUnite®* MSS Installation Guide (IG) 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.
- Operations System Engineering Guide
  The *LambdaUnite®* MSS Operations System Engineering Guide (OSEG) 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 Element Management System (EMS) Provisioning Guide (Application *LambdaUnite®* MSS)
  The *Navis®* Optical EMS Provisioning Guide (Application *LambdaUnite®* MSS) (EMSPG) gives instructions on how to perform system provisioning, operations, and administrative tasks by use of *Navis®* Optical EMS.
- *LambdaUnite®* MSS Safety Guide
  The *LambdaUnite®* MSS Safety Guide provides users of *LambdaUnite®* MSS with the relevant information and safety guidelines to safeguard against personal injury, and it may be useful to prevent material damage to the equipment.

- *TransLAN®* Ethernet SDH Transport Solution Applications and Planning Guide
  The *TransLAN®* Ethernet SDH Transport Solution Applications and Planning Guide presents a detailed overview of the *TransLAN®* Ethernet SDH Transport Solution, it describes its applications, gives planning information, engineering rules, ordering information, and technical specifications. Additionally it provides some Ethernet background information.
- *LambdaUnite®* MSS Release 7.0 Software Release Description
  The *LambdaUnite®* MSS Release 7.0 Software Release Description provides procedural information for the installation of the *LambdaUnite®* MSS Network Element (NE) software and *WaveStar®* CIT software. It also includes a listing of features, known problems, fixed problems, and other helpful information.

The following table lists the documents included in the *LambdaUnite®* MSS documentation set, and related engineering drawings.

Document title	**Document code (UL-format)**
LambdaUnite® MSS Release 7.0 Applications and Planning Guide	109572339 (365-374-176)
LambdaUnite® MSS Release 7.0 User Operations Guide	109572354 (365-374-177)
LambdaUnite® MSS Release 7.0 Alarm Messages and Trouble Clearing Guide	109572347 (365-374-178)
LambdaUnite® MSS Release 7.0 Installation Guide	109572370 (365-374-179)
LambdaUnite® MSS Release 7.0 Operations System Engineering Guide (TL1 Reference Manual)	109572362 (365-374-180)
LambdaUnite® MSS Release 7.0 Safety Guide	109510909 (365-374-159)
CD-ROM Documentation *LambdaUnite®* MSS Release 7.0 (all *LambdaUnite®* MSS Release 7.0 guides on a CD-ROM)	109572388 (365-374-181)
TransLAN® Ethernet SDH Transport Solution Applications and Planning Guide	109548045 (365-377-001)
LambdaUnite® MSS Release 7.0 Software Release Description	This document is delivered with the NE software.
LambdaUnite® MSS Engineering and Ordering Information	Drawing ED8C948-10

Document title	Document code (UL-format)
LambdaUnite® MSS Interconnect and Circuit Information	Drawing ED8C948-20

These documents and drawings can be ordered at or downloaded from the Customer Information Center (CIC) at http://www.cic.lucent.com/, or via your Local Customer Support.

Related training

For detailed information about the *LambdaUnite®* MSS training courses and how to register please refer to "Training support" (p. 8-11) in this document.

Documented feature set

This manual describes *LambdaUnite®* MSS Release 7.0. 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. It provides details of the status at the time of software delivery.

Optical safety

IEC customer laser safety guidelines

Lucent Technologies declares that this product is compliant with all essential safety requirements as stated in IEC 60825-Part 1 and 2 "Safety of laser products" and "Safety of optical fibre telecommunication systems". Futhermore Lucent Technologies declares that the warning statements on labels on this equipment are in accordance with the specified laser radiation class.

Optical safety declaration (if laser modules used)

Lucent Technologies declares that this product is compliant with all essential safety requirements as stated in IEC 60825-Part 1 and 2 "Safety of Laser Products" and "Safety of Optical Fiber Telecommunication Systems". Furthermore Lucent Technologies declares that the warning statements on labels on this equipment are in accordance with the specified laser radiation class.

Optical fiber communications

This equipment contains an Optical Fiber Communications semiconductor laser/LED transmitter. The following Laser Safety Guidelines are provided for this product.

General laser information

Optical fiber telecommunication systems, their associated test sets, and similar operating systems use semiconductor laser transmitters that emit infrared (IR) light at wavelengths between approximately 800 nanometers (nm) and 1600 nm. The emitted light is above the red end of the visible spectrum, which is normally not visible to the human eye. Although radiant en at near-IR wavelengths is officially designated invisible, some people can see the shorter wavelength energy even at power levels several orders of magnitude below any that have been shown to cause injury to the eye.

Conventional lasers can produce an intense beam of monochromatic light. The term “monochromaticity” means a single wavelength output of pure color that may be visible or invisible to the eye. A conventional laser produces a small-size beam of light, and because the beam size is small the power density (also called irradiance) is very high. Consequently, lasers and laser products are subject to federal and applicable state regulations, as well as international standards, for their safe operation.

A conventional laser beam expands very little over distance, or is said to be very well collimated. Thus, conventional laser irradiance remains relatively constant over distance. However, lasers used in lightwave systems have a large beam divergence, typically 10 to 20 degrees. Here, irradiance obeys the inverse square law (doubling the distance reduces the irradiance by a factor of 4) and rapidly decreases over distance.

Lasers and eye damage

The optical energy emitted by laser and high-radiance LEDs in the 400-1400 nm range may cause eye damage if absorbed by the retina. When a beam of light enters the eye, the eye magnifies and focuses the energy on the retina magnifying the irradiance. The irradiance of the energy that reaches the retina is approximately 10^5, or 100,000 times more than at the cornea and, if sufficiently intense, may cause a retinal burn.

The damage mechanism at the wavelengths used in an optical fiber telecommunications is thermal in origin, i.e., damage caused by heating. Therefore, a specific amount of energy is required for a definite time to heat an area of retinal tissue. Damage to the retina occurs only when one looks at the light long enough that the product of the retinal irradiance and the viewing time exceeds the damage threshold. Optical energies above 1400 nm cause corneal and skin burns, but do not affect the retina. The thresholds for injury at wavelengths greater than 1400 nm are significantly higher than for wavelengths in the retinal hazard region.

Classification of lasers

Manufacturers of lasers and laser products in the U.S. are regulated by the Food and Drug Administration’s Center for Devices and Radiological Health (FDA/CDRH) under 21 CFR 1040. These regulations require manufacturers to certify each laser or laser product as belonging to one of four major Classes: I, II, lla, IlIa, lllb, or IV. The International Electro-technical Commission is an international standards body that writes laser safety standards under IEC-60825. Classification schemes are similar with Classes divided into Classes 1, 1M, 2, 2M, 3R, 3B, and 4. Lasers are classified according to the accessible emission limits and their potential for causing injury. Optical fiber telecommunication systems are generally classified as Class I/1 because, under normal operating conditions, all energized laser transmitting circuit packs are terminated on optical fibers which enclose the laser energy with the fiber sheath forming a protective housing. Also, a protective housing/access panel is typically installed in front of the laser circuit pack shelves The circuit packs themselves, however, may be FDA/CDRH Class I, IIIb, or IV or IEC Class 1, 1M, 3R, 3B, or 4.

Laser safety precautions for optical fiber telecommunication systems

In its normal operating mode, an optical fiber telecommunication system is totally enclosed and presents no risk of eye injury. It is a Class I/1 system under the FDA and IEC classifications.

The fiber optic cables that interconnect various components of an optical fiber telecommunication system can disconnect or break, and may expose people to laser emissions. Also, certain measures and maintenance procedures may expose the technician to emission from the semiconductor laser during installation and servicing. Unlike more familiar laser devices such as solid-state and gas lasers, the emission pattern of a semiconductor laser results in a highly divergent beam. In a divergent beam, the irradiance (power density) decreases rapidly with distance. The greater the distance, the less energy will enter the eye, and the less potential risk for eye injury. Inadvertently viewing an un-terminated fiber or damaged fiber with the unaided eye at distances greater than 5 to 6 inches normally will not cause eye injury, provided the power in the fiber is less than a few milliwatts at the near IR wavelengths and a few tens of milliwatts at the far IR wavelengths. However, damage may occur if an optical instrument such as a microscope, magnifying glass, or eye loupe is used to stare at the energized fiber end.

Laser safety precautions for enclosed systems

Under normal operating conditions, optical fiber telecommunication systems are completely enclosed; nonetheless, the following precautions shall be observed:

1. Because of the potential for eye damage, technicians should not stare into optical connectors or broken fibers
2. Under no circumstance shall laser/fiber optic operations be performed by a technician before satisfactorily completing an approved training course
3. Since viewing laser emissions directly in excess of Class I/1 limits with an optical instrument such as an eye loupe greatly increases the risk of eye damage, appropriate labels must appear in plain view, in close proximity to the optical port on the protective housing/access panel of the terminal equipment.

Laser safety precautions for unenclosed systems

During service, maintenance, or restoration, an optical fiber telecommunication system is considered unenclosed. Under these conditions, follow these practices:

1. Only authorized, trained personnel shall be permitted to do service, maintenance and restoration. Avoid exposing the eye to emissions from un-terminated, energized optical connectors at close distances. Laser modules associated with the optical ports of laser circuit packs are typically recessed, which limits the exposure distance. Optical port shutters, Automatic Power Reduction (APR), and Automatic Power Shut Down (APSD) are engineering controls that are also used to limit emissions. However, technicians removing or replacing laser circuit packs should not stare or look directly into the optical port with optical instruments or magnifying lenses. (Normal eye wear or indirect viewing instruments such as Find-R-Scopes are not considered magnifying lenses or optical instruments.)
2. Only authorized, trained personnel shall use optical test equipment during installation or servicing since this equipment contains semiconductor lasers (Some examples of optical test equipment are Optical Time Domain Reflectometers (OTDR's), Hand-Held Loss Test Sets.)
3. Under no circumstances shall any personnel scan a fiber with an optical test set without verifying that all laser sources on the fiber are turned off
4. All unauthorized personnel shall be excluded from the immediate area of the optical fiber telecommunication systems during installation and service.

Consult ANSI Z136.2, American National Standard for Safe Use of Lasers in the U.S.; or, outside the U.S., IEC-60825, Part 2 for guidance on the safe use of optical fiber optic communication in the workplace.

For the optical specifications please refer to "Transmission parameters " (p. 10-4).

How to order

This information product can be ordered with the order number 365-374-176 at the Customer Information Center (CIC), see http://www.cic.lucent.com/.

An overview of the ordering process and the latest software & licences information is given in Chapter 7, "Ordering" of this manual.

How to comment

To comment on this information product, go to the Online Comment Form (http://www.lucent-info.com/comments/enus/) or email your comments to the Comments Hotline (comments@lucent.com).

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

1 Introduction

Overview

Purpose

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

Contents

LambdaUnite® MSS network solutions

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 Time Division Multiplexing (TDM) products in several years of successful field trials, *LambdaUnite®* MSS is 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 Release 7.0 has common points with existing SDH and SONET transport products as well as an advanced set of market-proven features. The feature set will continue to 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:

- 40-Gbit/s, 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s optical , 155-Mbit/s and 45- / 51-Mbit/s electrical synchronous interfaces
- Direct 1-Gbit/s Ethernet and 10-Gbit/s Ethernet WANPHY compatible optical data interfaces
- DWDM and passive WDM compatible optics
- Optical Network Navigation System (ONNS), offering automatic connection set-up and removal, automatic restoration, automatic topology discovery and dynamic network optimization in meshed topologies
- 2-fiber BLSR/MS-SPRing on 40-Gbit/s, 10-Gbit/s and 2.5-Gbit/s interfaces
- 4-fiber BLSR/MS-SPRing on 10-Gbit/s and on 2.5 Gbit/s interfaces with asymmetric ring support
- 4-fiber MS-SPRing with TransOceanic Protocol ("TOP") on 10-Gbit/s and on 2.5-Gbit/s interfaces
- 1+1 linear APS / MSP for 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s interface ports, provisionable on existing cross connections
- 1:1 MSP (with Preemptible Protection Access) for 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s interface ports
- 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
- Dual Ring Interworking (DRI, SONET) / Dual Node Interworking (DNI, SDH) between two BLSR / MS-SPRing / UPSR / SNCP protected rings

- Flexible, non-blocking VT1.5, VC-12, VC-3 (lower-order), STS-1/VC-3 (higher-order), STS-3c/VC-4, STS-12c/VC-4-4c, STS-48c/VC-4-16c and STS-192c/VC-4-64c cross-connection granularity
- Capacity of the main switching units (XC): 160 Gbit/s (3072 x 3072 STS-1 / 1024 x 1024 VC-4), respectively 320 Gbit/s (6144 x 6144 STS-1 / 2048 x 2048 VC-4), or 640 Gbit/s (12288 x 12288 STS-1 / 4096 x 4096 VC-4)
- Capacity of the lower-order switching unit: 15 Gbit/s (288 x 288 VC-3 (lower order), 6048 x 6048 VC-12 or 8064 x 8064 VT1.5.)
- Multiple Ring Closure
- *Telcordia*™ Management Support
- TL1 operations interface
- Manageable by *Navis®* Optical Element Management System (EMS), by *Navis®* Optical Management System (MS) and by *WaveStar®* Craft Interface Terminal (CIT).

Applications

LambdaUnite® MSS is designed to cover a variety of 10-Gbit/s and 40-Gbit/s applications in the metro and backbone domain, based on the same common hardware and software for both SONET and SDH applications. *LambdaUnite®* MSS can comprise one or more Terminal Multiplexer (TM) or Add/Drop Multiplexer (ADM) functions in a single node, but it can also act as an optical switch or cross-connect. 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, 10-Gbit/s and 2.5-Gbit/s rings.

Additionally with the flexible ONNS feature *LambdaUnite®* MSS provides full Automatically Switched Transport Networks (ASTN) / Generalized Multi Protocol Label Switching (GMPLS) functionality, and as a hybrid node it allows to integrate ONNS domains into existing classical networks (please refer to "Optical Network Navigation System (ONNS)" (p. 2-54).)

The ability to support and efficiently interconnect multiple rings using a single network element combined with the ONNS integration capacities provide the basis for advanced networking capabilities and potential cost savings to a large amount.

Differentiators

The main differentiators of the product are:

- Minimized Number of Equipment Types
  – Innovative high flexible architectural design
  – Full configuration & application coverage with single sub-rack
  – Easy, restriction-less configuration via simple I/O pack plugging
- All configurations based on common HW/SW components
  – Same sub-rack, 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 sub-rack
  – Outstanding architectural support for pay as you grow
  – High interface density merging today's multiplexer farms into a single sub-rack
  – Multi Ring closure architecture eliminates the need for back-to-back ADM arrays
- Multi Service Support
  – Global product design covering SONET, SDH, transoceanic and flexible Automatically Switched Transport Network (ASTN) / Generalized Multi Protocol Label Switching (GMPLS) applications
  – Data transport with Link Capacity Adjustment Scheme (LCAS), and direct low cost 1 Gigabit Ethernet interfacing. Low cost VSR OC/STM optics and electrical STM-1 interfaces towards routers at full concatenation support
- Future proof investment
  – 640 Gbit/s switch capacity upgrade improves return on investment
  – 160 Gbit/s switch capacity provides pay-as-you-grow opportunities
  – Self aware ASTN/GMPLS services including fast provisioning and restoration
  – Transparent Services
  – Enables highest bandwidth for lowest cost/bit with 40-Gbit/s interfaces
- Full integration into Lucent Technologies' management solution

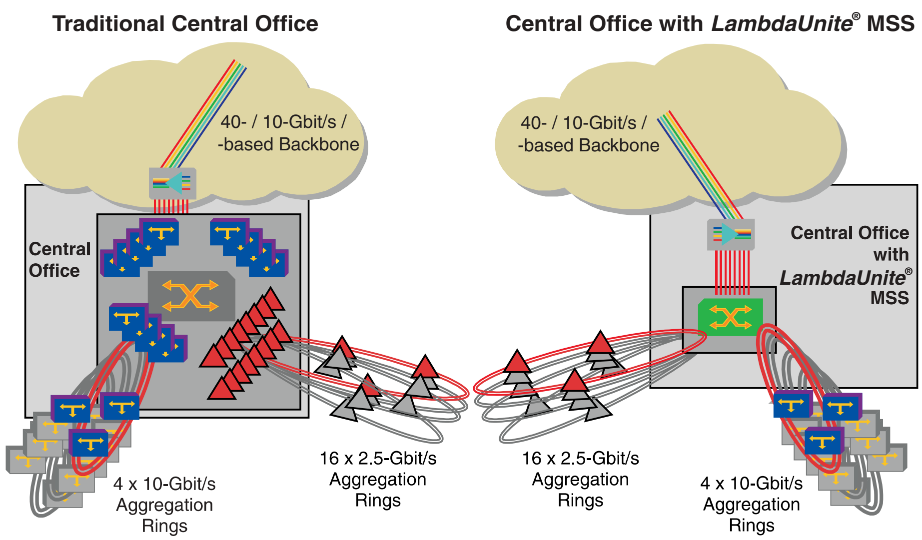
These features make the *LambdaUnite®* MSS one of the most cost-effective, future-proof and flexible network elements available on the market today.

Comparison: central office

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

- significantly reduced floor space requirements
- lowering relative equipment cost
- reducing power requirements
- reducing cabling effort
- reduced personnel training costs.

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 network element.



Configurations

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

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

- An ONNS node, as part of an ASTN/GMPLS domain, offering automatic connection set-up and removal, automatic restoration, automatic topology discovery and dynamic network optimization in meshed topologies.
- Any combination of the applications mentioned above, playing the role of a hybrid network element and linking ONNS domains with traditional networks.

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 and *Navis®* Optical NMS, as well as by *Navis®* Optical Management System (MS). These user-friendly management systems provide information and management of *LambdaUnite®* MSS network elements on a subnetwork-level and a network level. 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 *Metropolis®* ADM, *Metropolis®* DMX, *WaveStar®* TDM 10G, *WaveStar®* ADM-16/1, *WaveStar®* OLS 1.6T, and *LambdaXtreme™* Transport. 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

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

With the Lucent Technologies optical networking products family you can start building your next-generation network today.

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

Optical networking product	SONET	SDH
FT-2000	Yes	No
LambdaUnite® MultiService Switch (MSS)	Yes	Yes
LambdaXtreme™ Transport	Yes	Yes
Metropolis® ADM compact shelf	No	Yes
Metropolis® ADM universal shelf	No	Yes
Metropolis® AM (former *WaveStar*® AM1+)	No	Yes
Metropolis® AMS	No	Yes
Metropolis® AMU	No	Yes
Metropolis® DMX Access Multiplexer	Yes	No
Metropolis® DMXpress Access Multiplexer	Yes	No
Metropolis® Enhanced Optical Networking (EON)	Yes	Yes
Metropolis® Wavelength Services Manager (WSM)	Yes	Yes
Navis® Optical Capacity Analyzer (CA)	Yes	Yes
Navis® Optical Customer Service Manager (CSM)	Yes	Yes
Navis® Optical Element Management System (EMS)	Yes	Yes
Navis® Optical Fault Manager	Yes	Yes
Navis® Optical Integrated Network Controller (INC)	Yes	Yes
Navis® Optical Management System (OMS)	Yes	Yes
Navis® Optical Network Management System (NMS)	Yes	Yes
Navis® Optical Performance Analyzer (PA)	Yes	Yes

Optical networking product	SONET	SDH
Navis® Optical Provisioning Manager (PM)	Yes	Yes
OptiGate™ OC-192 Transponder	Yes	No
OptiStar™ EdgeSwitch	Yes	No
OptiStar™ IP Encryption Gateway (IPEG)	Yes	No
OptiStar™ MediaServe	Yes	No
OptiStar™ Network Adapters	Yes	No
Radio OEM	No	Yes
Synchronization OEM	Yes	Yes
TransLAN® Ethernet SDH Transport Solution	No	Yes
WaveStar® ADM 16/1 (“senior”)	No	Yes
WaveStar® ADM 4/1	No	Yes
WaveStar® DACS 4/4/1	No	Yes
WaveStar® ITM-SC	Yes	Yes
WaveStar® Optical Line System (OLS) 1.6T	Yes	Yes
WaveStar® TDM 10G (OC-192)	Yes	No
WaveStar® TDM 10G (STM-64)	No	Yes
WaveStar® TDM 2.5G (OC-48)	Yes	No

Family features

The optical networking products family offers customers

- SONET and/or SDH-based services
- Scalable cross-connection, multiplex and transport services
- Ethernet transport over SONET or SDH networks
- Network consolidation and reliability
- Interoperability with other vendors’ products
- Coordination of network element and element management services

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LambdaUnite® MSS profile

The *LambdaUnite*® MSS system architecture is based on a central, fully non-blocking switching matrix (XC). Different switching matrix configurations with the following switching capacities are possible:

- 160 Gbit/s equals 3072 x 3072 STS-1 or 1024 x 1024 VC-4
- 320 Gbit/s equals 6144 x 6144 STS-1 or 2048 x 2048 VC-4
- 640 Gbit/s equals 12288 x 12288 STS-1 or 4096 x 4096 VC-4

For lower-order cross-connections an additional switching unit (LOXC) is available, with the following switching capacity:

- 15 Gbit/s equals 288 x 288 VC-3 (lower order), 6048 x 6048 VC-12 or 8064 x 8064 VT1.5.

Note that the LOXC pack is to be used in specific slots, refer to "Port location rules " (p. 6-10).

LambdaUnite® MSS provides advantageous pay-as-you-grow opportunities, as the upgrade to a more powerful configuration requires simply the replacement of the switching units.

The system provides 32 universal slots, which can be flexibly configured according to your service requirements with optical 40-Gbit/s, 10-Gbit/s (synchronous and WANPHY Ethernet), 2.5-Gbit/s, 622-Mbit/s, 155-Mbit/s and 1-Gbit/s Ethernet optical interface units. Besides these optical interface units *LambdaUnite*® MSS supports also 155-Mbit/s and 45- /51-Mbit/s electrical interface units that can be inserted into the upper row of the sub-rack.

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 broad 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.

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, "System planning and engineering" and to Chapter 10, "Technical specifications".

Standards Compliance

Lucent Technologies SONET and SDH products comply with the relevant European Telecommunication Standardization Institute (ETSI), *Telcordia*™ Technologies, and International Telecommunications Union - Telecommunication standardization sector (ITU-T) standards. Important functions defined in SONET and SDH 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 intelligent control plane, implemented in *LambdaUnite*® MSS as ONNS, is based on standards discussed in the ITU-T Automatically Switched Transport Networks (ASTN), the Internet Engineering Task Force (IETF) Generalized Multi Protocol Label Switching (GMPLS) Forum and the Optical Internet Forum (OIF).

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".

LambdaUnite® MSS supports a variety of configurations as described in the previous chapter, due to its flexible architecture within the same subrack with a single common SW load. The choice of synchronous and data interfaces described below provides outstanding transmission flexibility and integration capabilities.

Contents

Synchronous/electrical interfaces

SONET/SDH transmission interface overview

LambdaUnite® MSS supports the whole range of interfaces from 40 Gbit/s down to 45 Mbit/s. All optical interface units support SONET and SDH formatted signals.

The following synchronous interfaces are available in the present release:

- 40-Gbit/s long reach optical interface (80 km), 1550 nm
- 40-Gbit/s intra-office optical interface (2 km), 1310 nm
- 40-Gbit/s optical interface for direct *LambdaXtreme*™ Transport interworking, 64 wavelengths
- 10-Gbit/s long reach optical interface (80 km), 1550 nm
- 10-Gbit/s intermediate reach / short haul / WAN PHY optical Ethernet interface (40 km), 1550 nm
- 10-Gbit/s intra-office optical interface (600 m), 1310 nm
- 10-Gbit/s long reach hot-pluggable optical module (80 km), 1550 nm
- 10-Gbit/s intermediate reach / short haul hot-pluggable optical module (40 km), 1550 nm
- 10-Gbit/s intra-office interface hot-pluggable optical module (600 m), 1310 nm
- 10-Gbit/s optical interface for direct *WaveStar®* OLS 1.6T interworking, 80 wavelengths
- 10-Gbit/s intermediate reach / short haul optical interface (36 km), 1,5 µm, pWDM compatible, 16 wavelengths
- 2.5-Gbit/s long reach optical interface (80 km), 1550 nm
- 2.5-Gbit/s long reach optical interface (40 km), 1310 nm
- 2.5-Gbit/s short reach / intra-office optical interface (2 km), 1310 nm
- 2.5-Gbit/s long reach optical Small Form Factor Pluggable (SFP) interface module (80 km), 1550 nm
- 2.5-Gbit/s long reach optical SFP interface module (40 km), 1310 nm
- 2.5-Gbit/s short reach / intra-office optical SFP interface module (2 km), 1310 nm
- 2.5-Gbit/s long reach optical interface (40 km), 1,5 µm, pWDM compatible, 32 wavelengths
- 2.5-Gbit/s transparent optical transmission unit, for use with optical SFP interface modules
- 622-Mbit/s long reach / long haul optical SFP interface module (40 km), 1310 nm
- 622-Mbit/s intermediate reach / short haul optical SFP interface module (15 km), 1310 nm
- 622-Mbit/s intermediate reach / short haul optical interface (15 km), 1310 nm

- 155-Mbit/s long reach / long haul optical SFP interface module (40 km), 1310 nm
- 155-Mbit/s intermediate reach / short haul optical SFP interface module (15 km), 1310 nm
- 155-Mbit/s intermediate reach / short haul optical interface (15 km), 1310 nm
- 155-Mbit/s intra-office interface for electrical STM-1 signals
- 51-Mbit/s intra-office interface for electrical EC1 signals
- 45-Mbit/s intra-office interface for electrical DS3 signals

□

Data interfaces

Gigabit Ethernet interface

LambdaUnite® MSS supports optical 1-Gbit/s (1000BASE) Ethernet interfaces, as part of the *TransLAN™* Ethernet SDH Transport Solution.

Two optical 1-Gbit/s Ethernet interface units are supported, the short reach interface, called GE1/SX4, and the long reach interface, called GE1/LX4, with four ports each. These interfaces are in accordance with IEEE 802.3-2000 Clause 38. To optimize communication the Ethernet interface supports flow control and 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.

The GE1 interfaces provide enhanced flexibility for Gigabit Ethernet packet routing, for example virtual concatenation, multipoint MAC bridge, VLAN trunking and Spanning Tree Protocol (STP) with Generic VLAN Registration Protocol (GVRP). For further information please refer to "Ethernet features" (p. 2-14), to "Gigabit Ethernet short reach circuit pack" (p. 10-17) and to "Gigabit Ethernet long reach circuit pack" (p. 10-20).

Each GE1 circuit packs offer four bidirectional 1000BASE Ethernet LAN ports with LC connectors. If *LambdaUnite®* MSS is mounted in a rack with doors you must use fiber connectors with angled boots.

10-Gbit/s Ethernet WANPHY interface

The 10-Gbit/s synchronous intermediate reach / short haul interface (40 km) operates compliant to the 10-Gbit/s Wide Area Network Physical (WANPHY) Ethernet protocol, accepting some minor limitations. For further information please refer to "Optical transmission units OP10" (p. 4-16).

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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" (p. 2-48).

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User byte and orderwire interfaces

User byte and orderwire interfaces

LambdaUnite® MSS provides six physical overhead access interface ports, using the E1, E2 and F1 bytes on the 10-Gbit/s- and on the 155-Mbit/s interfaces. Four ports are configurable to operate in G.703 or in V.11 mode, and 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).

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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)
- One LED on the double density parent board for each plug-in module (red fault 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 (LAN 1) to *WaveStar*® Craft Interface Terminal (CIT), *Navis*® Optical Element Management System (EMS) or *Navis*® Optical Management System (MS)
- Eight miscellaneous discrete inputs and eight miscellaneous discrete outputs (MDI/MDO) for control and supervision purposes
- Two additional LAN connectors (LAN 2 and 3) on the rear side for management systems (e.g. *Navis*® Optical EMS, *Navis*® Optical MS, or *WaveStar*® CIT), and one (LAN 4) reserved for future *LambdaXtreme*™ Transport interworking.

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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. 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.

For detailed information about the power consumption please refer to "System power consumption" (p. 6-3) and to "Weight and power consumption" (p. 10-31).

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.

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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".

Contents

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Cross-connection features

Cross-connection rates

LambdaUnite® MSS supports unidirectional and bidirectional cross-connections for VT1.5/VC-12, VC-3 (lower order), STS-1/VC-3 (higher order), 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 following switching units are available with the present release of *LambdaUnite*® MSS:

- the XC160 with a cross-connection capacity of 160 Gbit/s in total (3072 x 3072 STS-1 / 1024 x 1024 VC-4)
- the XC320 with a cross-connection capacity of 320 Gbit/s in total (6144 x 6144 STS-1 / 2048 x 2048 VC-4)
- the XC640 with a cross-connection capacity of 640 Gbit/s in total (12288 x 12288 STS-1 / 4096 x 4096 VC-4)
- the LOXC for lower-order cross-connections with a capacity of 15 Gbit/s in total (288 x 288 VC-3 (lower order), 6048 x 6048 VC-12 or 8064 x 8064 VT1.5), to be used in addition to the main XC switching units.

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.

The rolling of cross-connections is currently not supported for the rates that require the LOXC (VC-3 (lower order), VC-12 / VT1.5).

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. Thus, within the system cross-connection 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.

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.

Inter-connection between SONET/SDH networks and ASTN/GMPLS domains

Ports configured as Optical Network Navigation System (ONNS) edge ports (SONET/SDH structured ports to the outside) can be cross-connected with mere ONNS(I-NNI) ports. Thus *LambdaUnite*® MSS allows the inter-connection between SONET/SDH networks and ASTN/GMPLS domains.

Unequipped signal insertion

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

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Ethernet features

The Gigabit Ethernet interface provides an enhanced feature set for flexible Ethernet over SONET/SDH transport.

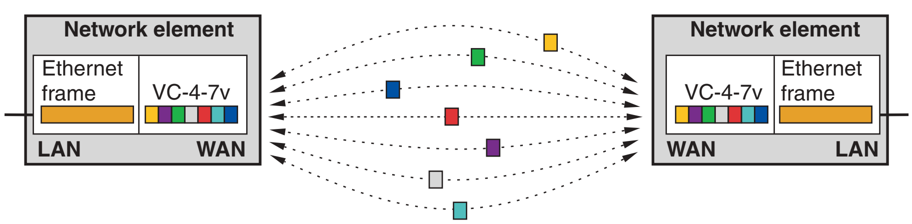
This section describes in brief some related features of *LambdaUnite®* MSS:

- Virtual concatenation
- Link Capacity Adjustment Scheme (LCAS)
- Virtual LAN
- Repeater mode
- VLAN tagging
- Multipoint mode
- VLAN trunking
- Spanning Tree Protocol (STP)
- Rapid spanning tree protocol (rSTP)
- Generic VLAN Registration Protocol

Virtual concatenation

The GE1 interface supported by *LambdaUnite®* MSS allows you to transport Gigabit Ethernet (GbE) signals over SONET/SDH networks by encapsulating Ethernet packets in virtually concatenated Synchronous Payload Envelopes (SPEs, SONET) or Virtual Containers (VCs, SDH).

The following figure shows the principle of virtual concatenation in a point-to-point Gigabit Ethernet (GbE) application example. Protection of the STS-1-Kv/VC-4-kv traffic is possible via UPSR/SNCP, via 1+1 line APS / 1+1 MSP 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.

Link Capacity Adjustment Scheme

Link Capacity Adjustment Scheme (LCAS) is an extension to virtual concatenation that allows dynamic changes in the number of STS-1/VC-4 channels per connection. In case channels are added or removed by management actions this will happen without loosing any customer traffic. LCAS allows a bandwidth service with scalable throughput in normal operation mode. In case of failure the connection will not be dropped completely only the affected STS-1s/VC-4s. The remaining channels will continue carrying the customer traffic. The implemented LCAS provides automatic decrease of bandwidth in case of link failure and reestablishment after link recovery.

The following unidirectional and bidirectional virtual concatenations are 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 GE1 circuit pack allows to transport Gigabit Ethernet signals efficiently over SONET or SDH networks by encapsulating Ethernet packets in virtually concatenated VC-4 or STS-1s, using the LCAS. This protection-by-load-sharing feature allows for efficient use of protection bandwidth, that can be added/removed hitlessly for Ethernet applications.

Virtual LAN

Virtual Local Area Networks (VLANs) can be used to establish broadcast domains within the network as routers do, but they cannot forward traffic from one VLAN to another. Routing is still required for inter-VLAN traffic. Optimal VLAN deployment is predicated on keeping as much traffic from traversing the router as possible.

VLAN supports the following advantages:

- Easy provisioning of VLANs
- Consistency of the VLAN membership information across the network
- Optimization of VLAN broadcast domains in order to save bandwidth
- Isolated service for different customers.

The operator configures VLANs on LAN ports, and GVRP takes care of configuring VLANs on Wide Area Network (WAN) ports in the most optimized way.

Repeater mode

The simplest form of Ethernet transport is to transparently forward all frames on the WAN that are transmitted by the end user via the LAN; this mode is called repeater mode (also referred to as promiscuous mode or no-tag mode). In this mode minimal provisioning is necessary.

VLAN tagging

Refer to "Tagging schemes" (p. 2-16).

Multipoint mode

LambdaUnite® MSS supports Ethernet multipoint applications for specific network topologies, for example if an end user has more than 2 sites that need to be connected. It is also possible to support multiple end users on the same Ethernet network, sharing the available bandwidth on the WAN ports over the SONET/SDH network.

The virtual switch implemented on the GE1 interface is a logical grouping of Ethernet ports and Virtual Concatenation Group (VCG) ports that share interconnect and a common set of properties. The virtual switch is automatically instantiated as soon as the VLAN tagging mode is set to IEEE802.1Q multipoint mode. All 4 LAN ports and all 4 WAN ports of the GE1 circuit pack are part of the single virtual switch.

Regarding multipoint Ethernet service a more general terminology is needed to cover the functions of LAN and WAN ports. The new application focused terms are:

- customer LAN ports (the default for LAN ports)
- network WAN ports (the default for WAN ports)
- network LAN ports
- customer WAN ports.

By default, network ports participate in STP and GVRP, and customer ports have a PVID and a Valid VLAN list assigned. LAN ports default to customer port role and WAN ports to network role. All default values can be overridden.

VLAN trunking

Trunking applications are those applications where traffic of multiple end users is handed-off via a single physical Ethernet interface to a router or switch for further processing. This scenario is also called "back-hauling", since all traffic is transported to a central location, e.g. a point-of-presence (PoP) of a service provider. Trunking applications can be classified into two topology types, trunking in the hub-node and distributed aggregation in the access network.

Further reading

For further information please refer to the chapter "Traffic provisioning concepts" of the *LambdaUnite*® MSS User Operations Guide.

Tagging schemes

LambdaUnite® MSS systems support these tagging schemes:

- IEEE 802.1Q VLAN tagging
- Transparent tagging

IEEE 802.1Q VLAN tagging

All frames on the network links have a single VLAN tag. This tag is either the tag that was created by the end user equipment; or it is inserted on the ingress "customer" port (the default VLAN id) by the *TransLAN*® switch. On egress customer ports the earlier inserted VLAN tag is removed if a default VLAN id is provided on that port; it should be the same VLAN id as on the associated ingress ports. To ensure customer isolation, you must allocate VLANs to customers and to the customer ports, and ensure that VLANs don't overlap. The IEEE 802.1Q VLAN tagging scheme supports VLAN trunking, i.e. traffic from multiple different end users is multiplexed over one physical interface towards an IP router in an ISP POP (cf. "VLAN trunking" (p. 2-16)). End user identification and isolation is done via the VLAN tag.

Transparent tagging

The "Transparent tagging" scheme, also known as "Double tagging" or "VPN tagging", is a Lucent Technologies proprietary tagging scheme.

All frames that enter the network are prefixed with a customer identification (CID) tag. Each customer port on the network is assigned a CID. As all frames are prefixed, there is no difference between end user frames that were originally VLAN tagged or untagged, only the CID is used in Ethernet switching decisions. There is no need for an operator to coordinate the end user VLAN schemes, but CIDs must be assigned consistently per customer over the whole Ethernet network. VLAN trunking is not supported, due to the proprietary tagging scheme.

Spanning Tree Protocol

The Spanning Tree Protocol (STP) is a standard Ethernet method for eliminating loops and providing alternate routes for service protection. Standard STP depends to information sharing among Ethernet switches/bridges to reconfigure the spanning tree in the event of a failure. The STP algorithm calculates the best loop-free path throughout the network. STP defines a tree that spans all switches in the network; it e.g. uses the capacity available bandwidth on a link (path cost) to find the optimum tree. It forces redundant links into a standby (blocked) state. If a link fails or if a STP path cost changes the STP algorithm reconfigures the Spanning Tree topology and may reestablish previously blocked links. The STP also determines one switch that will be the root switch; all leaves in the Spanning Tree extend from the root switch.

Rapid spanning tree protocol

Rapid Spanning Tree Protocol (rSTP) reduces the time that the STP protocol needs to reconfigure after network failures. Instead of several tens of seconds, rSTP can reconfigure in less than a second. The actual reconfiguration time depends on several parameters, the two most prominent are the network size and complexity. IEEE802.1w describes the standard implementation for rSTP.

Generic VLAN Registration Protocol

Generic VLAN Registration Protocol (GVRP) is an additional protocol that simplifies VLAN assignment on network ports and ensures consistency among switches in a network. Further it prevents unnecessary broadcasting of Ethernet frames by forwarding VLAN frames only to those parts of the network that have customer ports with that VLAN ID.

The operator configures VLANs on customer ports, and GVRP will take care of configuring VLANs on network ports - in the most optimized way. Note that GVRP and Spanning Tree Protocol interact with each other. After a stable Spanning Tree is determined (at initialization or after a reconfiguration due to a failure) the GVRP protocol will recompute the best VLAN assignments on all network ports, given the new Spanning Tree topology.

The provisioned VLANs on customer ports are called static VLAN entries; the VLANs assigned by GVRP are called dynamic VLAN entries. The dynamic VLAN entries need not be stored in NE's database.

GVRP can be enabled (default) or disabled per virtual switch:

- In the enabled case up to 247 VLANs can be supported through GVRP; an alarm will be raised if more then 247 VLANs are provisioned on an Ethernet network. This limitation depends on the processor performance.
- If GVRP is disabled up to 4093 VLANs per Gigabit Ethernet circuit pack port are supported.

Further reading

For further information please refer to the chapter "Traffic provisioning concepts" of the *LambdaUnite*® MSS User Operations Guide. For further information about the hardware implementation please refer to "Gigabit Ethernet short reach circuit pack" (p. 10-17) and "Gigabit Ethernet long reach circuit pack" (p. 10-20).

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Transparent SONET/SDH transport

With the transparent 2.5-Gbit/s interface units, the so called OPT2G5/PAR3, *LambdaUnite®* MSS uncloses a broad range of applications, as described in "Clear channel topologies" (p. 3-10).

Transparency features

In the OPT2G5 the concept of virtual concatenation (refer to "Ethernet features" (p. 2-14)) is employed to transport client SONET/SDH signals (SPE/VC and transport overhead) transparently over SONET/SDH networks; this functionality is also known as G.modem.

In the present release *LambdaUnite®* MSS provides 3 ports per OPT2G5 for OC-48/STM-16 synchronous signals, fed via SFPs. These client signals are split up and transported in 17 STS-3c/VC-4 containers over the server network, to be finally re-assembled and handed over as OC-48/STM-16 signals.

The main transparency features are:

- Full data transparency for signal payload and transport overhead
- Protection scheme independent
- Client signal timing transparency: Under certain limitations, the egressing signal can be used by subsequent equipment as a line timing source. The limitations relate to aspects like the amount of mapping/demapping stages and the number of pointer processor functions in between.

For further information please refer to "Transparent optical transmission units OPT2G5/PAR3" (p. 4-18), and to the *LambdaUnite®* MSS User Operations Guide.

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Forward error correction

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.

Forward error correction types

There are two types of Forward Error Correction:

- In-band FEC (also referred to as "multibit FEC")
  The redundant information is stored and transported in previously unused overhead bytes, the framing structure as well as the bit rate remain unchanged.
- 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 the factor 255/239. The new signal format is referred to as "Optical Channel" at the corresponding bit rate.

LambdaUnite® MSS supports the out-of-band FEC type, because it provides a higher margin improvement (about 5 dB). This feature is available on the following transmission units:

- 40-Gbit/s long haul interface
- 40-Gbit/s *LambdaXtreme*™ Transport interworking interface
- 10-Gbit/s *WaveStar*® OLS 1.6T interworking interface.

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Ring protection

LambdaUnite® MSS supports both, SONET and SDH ring protection features:

- SONET: Bidirectional Line Switched Ring (BLSR)
- SDH: Multiplex Section Shared Protection Ring (MS-SPRing)

BLSR

The following BLSR protection schemes can be configured:

- 2-fiber BLSR on OC-768, OC-192 and on OC-48 interfaces
- 4-fiber BLSR on OC-192 interfaces and on OC-48 interfaces, both with asymmetric ring support.

The protection scheme complies with the ANSI T1.105.01 Standard.

MS-SPRing

The following MS-SPRing protection schemes can be configured:

- 2-fiber MS-SPRing on STM-256, STM-64 and on STM-16 interfaces
- 4-fiber MS-SPRing on STM-64 interfaces and on STM-16 interfaces, both with asymmetric ring support.
- 4-fiber MS-SPRing with TransOceanic Protocol "TOP" on STM-64 and on STM-16 interfaces

The protection scheme complies with ITU-T Rec. G.841.

BLSR/MS-SPRing principle

BLSR/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. Because traffic flow is bidirectional between the nodes, traffic can be added at one node and dropped at the next without traveling around the entire ring. This leaves the spans between other nodes available for additional traffic. Therefore, with many traffic patterns a bidirectional ring can carry much more traffic than the same facilities could carry if configured for a unidirectional ring.

Self-healing Rings

LambdaUnite® MSS BLSR/MS-SPRings are self healing, that means transport is automatically restored after node or fiber failures. This is realized by using only half capacity for protected traffic (working), reserving the other half of the capacity for back up purpose (protection).

The following table gives an overview of the bidirectional transmission capacities of the various BLSR/MS-SPRing types:

BLSR	MS-SPRing	transmission capacity
2-fiber 40-Gbit/s		384 STS-1 equivalents protected
4-fiber 10-Gbit/s		192 STS-1 equivalents protected
2-fiber 10-Gbit/s		96 STS-1 equivalents protected
4-fiber 2.5-Gbit/s		48 STS-1 equivalents protected
2-fiber 2.5-Gbit/s		24 STS-1 equivalents protected
	2-fiber 40-Gbit/s	128 VC-4 equivalents protected
	4-fiber 10-Gbit/s	64 VC-4 equivalents protected
	4-fiber 10-Gbit/s "TOP"	64 VC-4 equivalents protected
	2-fiber 10-Gbit/s	32 VC-4 equivalents protected
	4-fiber 2.5-Gbit/s	16 VC-4 equivalents protected
	4-fiber 2.5-Gbit/s "TOP"	16 VC-4 equivalents protected
	2-fiber 2.5-Gbit/s	8 VC-4 equivalents protected

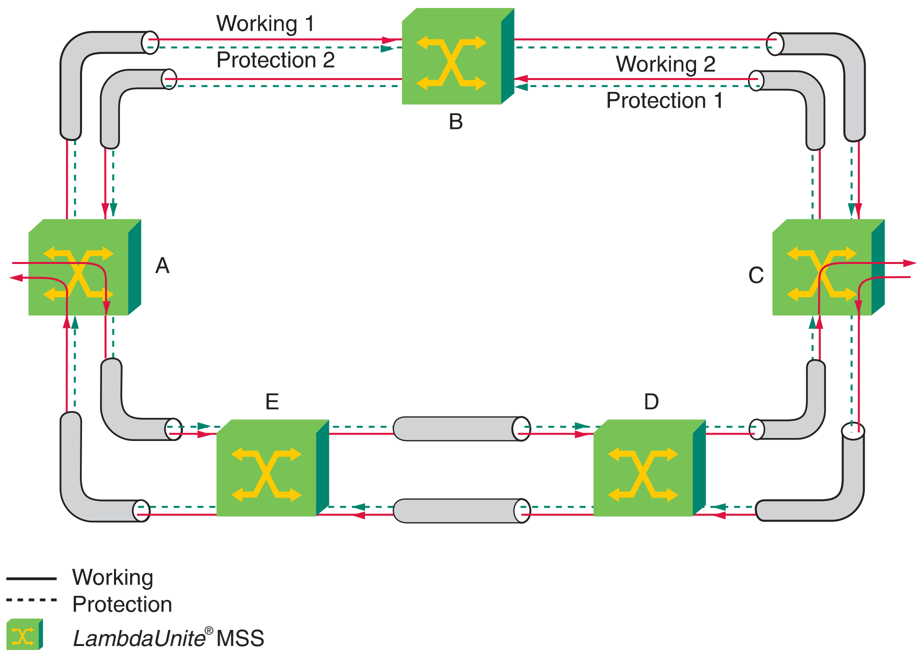
In the event of a fiber or node failure, service is restored by switching traffic from the working capacity of the failed line to the protection capacity in the opposite direction around the ring. (See "2-fiber BLSR/MS-SPRing traffic flow" (p. 2-23) and "Loopback protection switch in a 2-fiber BLSR/MS-SPRing" (p. 2-24).)

Protection Switching

When a line-level event triggers a protection switch, the affected nodes switch traffic on the protection capacity and transport it to its destination by looping it back the other way around the ring. (See "Loopback protection switch in a 2-fiber BLSR/MS-SPRing" (p. 2-24).) Service is reestablished on the protection capacity in less than 50 milliseconds after detection of the failure (for signal fail conditions in rings without existing protection switches or extra traffic).

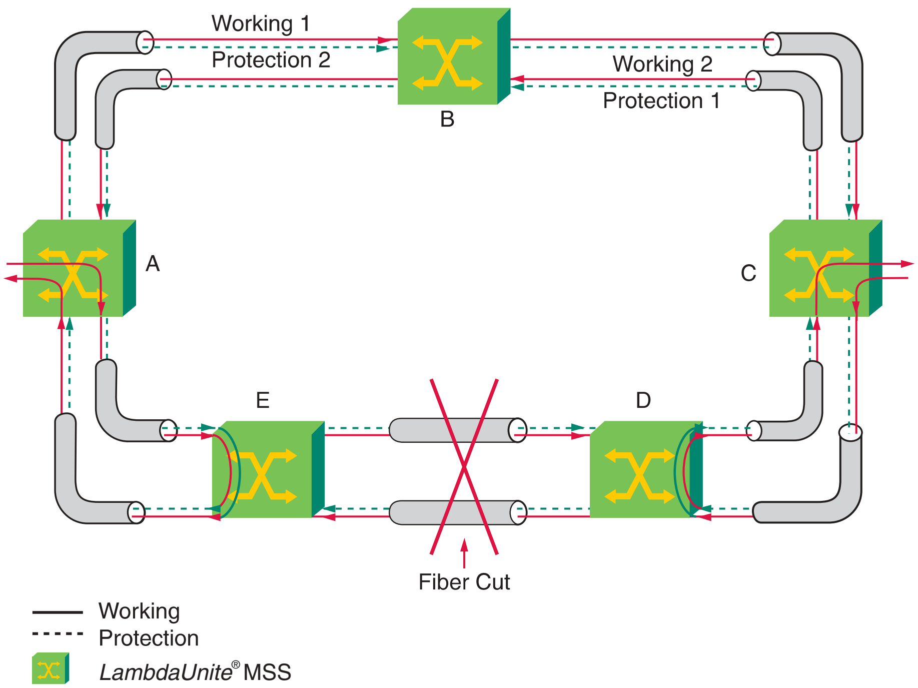
2-fiber BLSR/MS-SPRing traffic flow

The following figure shows normal (non-protection-switched) traffic flow in a *LambdaUnite®* MSS 2-fiber BLSR/MS-SPRing.



Loopback protection switch in a 2-fiber BLSR/MS-SPRing

The following figure illustrates a 2-fiber BLSR/MS-SPRing protection switch that results from a fiber cut.



Protection traffic flow

In case of loopback protection switch in a 2-fiber BLSR/MS-SPRing, the traffic going from Node A to Node C, that normally passed through Node E and Node D on “working 2 ”capacity, is switched onto the “protection 2” capacity of the line leaving Node E in the opposite direction. The traffic loops back around the ring via Node B, C, and D (where the loopback switch is active) to Node C. Similarly, traffic going from Node C to Node A that normally passed through Node D and Node E on “working 1” capacity is switched on to the “protection 1” capacity of the line leaving Node D in the opposite direction.

The same approach is used for a node failure. For example, if Node D were to fail, Nodes C and E would perform loopback protection switches to provide an alternate route for ring traffic.

Asymmetric ring provisioning

In standard (4 Fiber) BLSR/MS-SPRing, depending on traffic, some ring segments (especially overlapping ring segments) might be only partially filled. These ring segments have overcapacity for working traffic as standard BLSR/MS-SPRing schemes have to have equal capacity between service and protection line across the ring.

With the asymmetric ring functionality these only partially filled ring segments (spans) can be used for traffic.

Asymmetric ring protection schemes

The asymmetric ring protection schemes are supported for:

- 4-fiber MS-SPRing on STM-64 and on STM-16 interfaces
- 4-fiber BLSR on OC-192 and on OC-48 interfaces.

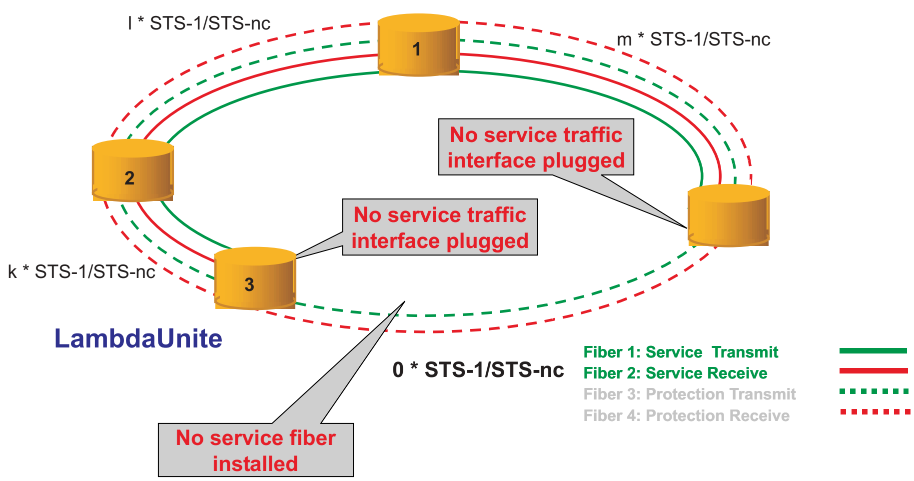
Asymmetric ring

An asymmetric 4-fiber ring is a subnetwork which consists of a set of nodes, where:

- each node is an ADM that interfaces with two spans;
- each span interconnects two nodes;
- each span consists of one or two lines (i.e. one or two bidirectional pairs of fibers);

There is at least one span consisting of one protection line (asymmetric property) and at least one span with two lines (worker and protection);

- the set of nodes is interconnected by the spans into a closed loop (a closed ring).
- all spans operate at the same rate.



Transoceanic protocol

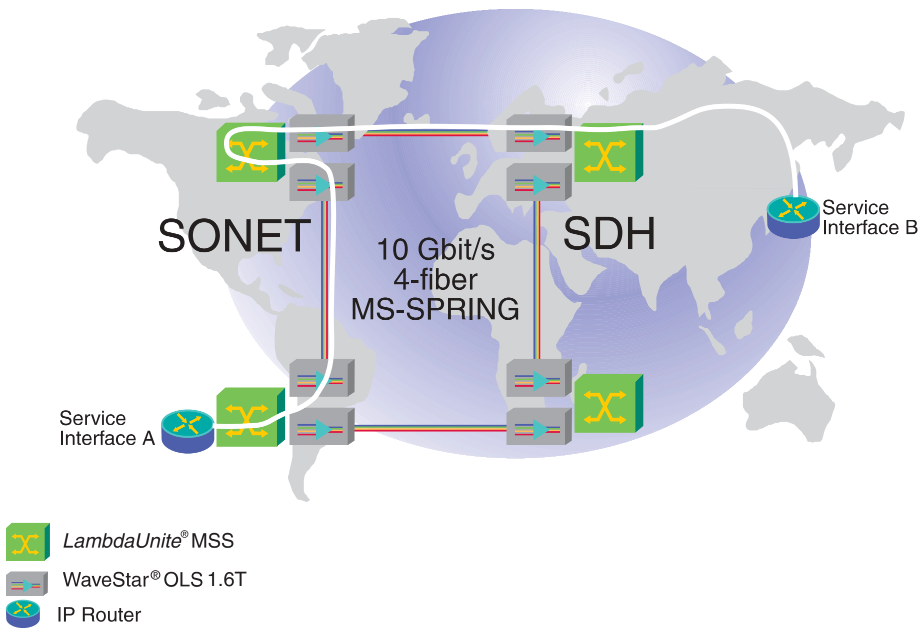
A special feature of *LambdaUnite*® MSS for very long-haul 4-fiber MS-SPRing applications is the TransOceanic Protocol (TOP).

It shortens the protection path in rings, avoiding loops over very long distance spans. Thus it greatly reduces the impact of propagation delay on the signal quality, and it saves fiber resources.

LambdaUnite® MSS supports 4-fiber MS-SPRing transoceanic protocol protection schemes on the 10-Gbit/s interfaces. The protection scheme complies with ITU-T Rec. G.841.

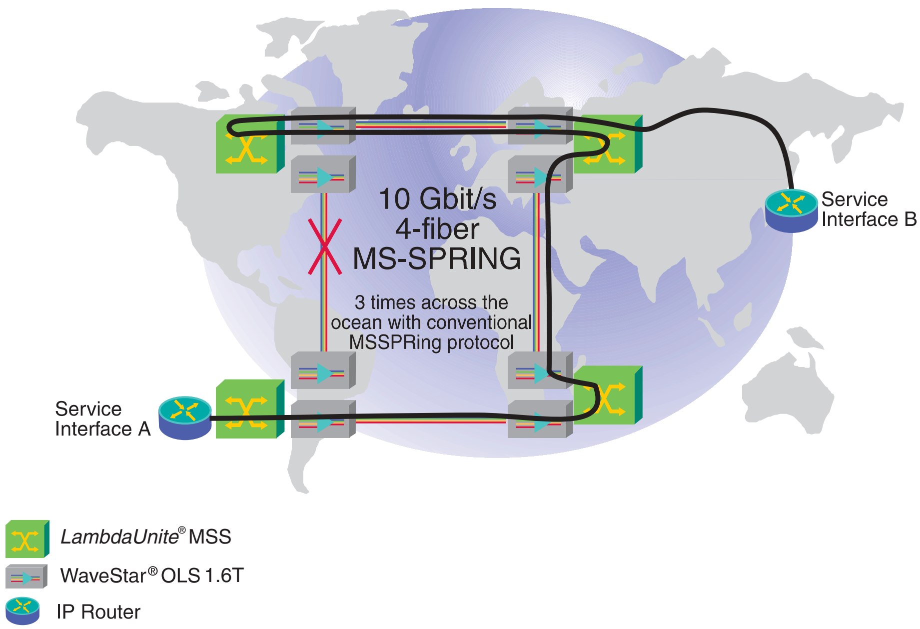
Transoceanic principle

The following figure provides a schematic view of *LambdaUnite*® MSS in a 4 fiber MS-SPRing very long distance configuration. The MS-SPRing is composed of four *LambdaUnite*® MSS elements. Under normal conditions (MS-SPRing idle) the traffic is routed from service interface A over *two* very long distance spans to service interface B.



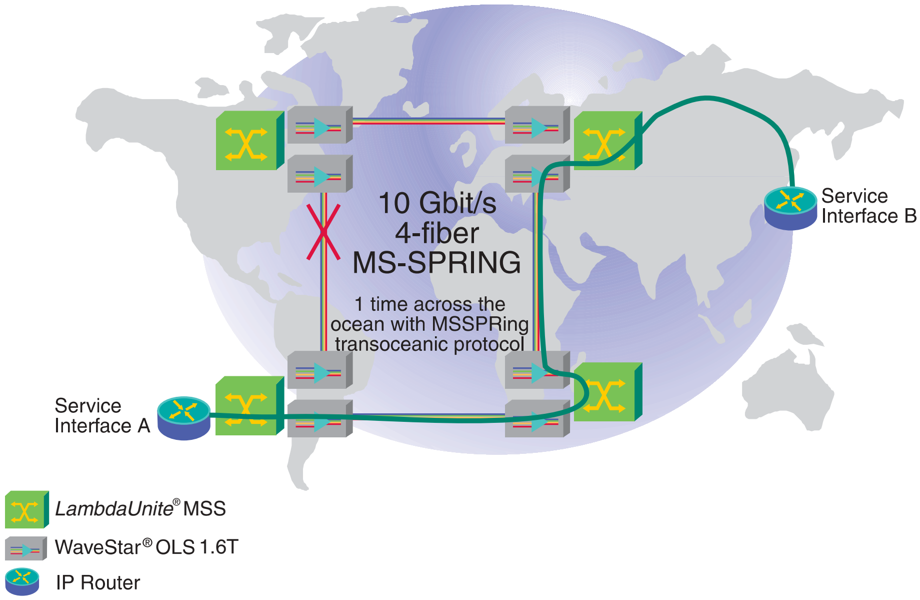
Regular MS-SPRing switching case

The figure below shows the traffic flow in the MS-SPRing protection condition (switching case) *without* transoceanic protocol. In case of a complete fiber cut as indicated by the red cross, the traffic is carried over *four* very long distance spans.



MS-SPRing with transoceanic protocol, switching case

In the protection condition (switching case) *with* transoceanic protocol, the traffic *passes the ocean only once*, running through *two* very long distance spans only, just like under normal conditions, as shown in the following figure. *LambdaUnite®* MSS routs the traffic directly to the service interface B, avoiding the loop over the ocean.



In this way *LambdaUnite®* MSS in the MS-SPRing with transoceanic protocol shortens the protection path strikingly, improving significantly the signal quality and increasing the performance of fiber resources.

□

DRI/DNI

LambdaUnite® MultiService Switch (MSS) supports both, SONET and SDH dual node ring interworking features:

- SONET Dual Ring Interworking (DRI) for BLSR and UPSR
- SDH Dual Node Interworking (DNI) for MS-SPRing and SNCP

SONET Dual ring interworking (DRI) for BLSR

LambdaUnite® MSS supports Dual Ring Interworking (DRI) for the purpose to protect between two BLSR protected rings. The DRI feature is compliant with ANSI T1.105.01 and *Telcordia*™ GR-1230-CORE, GR-1400-CORE standards. It provides a service selector for each STS-N tributary provisioned for DRI.

The service selector selects the better of two received path-level signals in accordance with a given hierarchy of conditions. These conditions include STS path signal fail and PDI-P (payload defect indicator - path level). This applies only to drop and continue, does not include dual transmit. Multiple DRIs (up to the maximum system capacity) are supported.

SONET Dual ring interworking (DRI) for UPSR

LambdaUnite® MSS supports Dual Ring Interworking (DRI) for the purpose to protect between two UPSR protected paths. The DRI feature is compliant with ANSI T1.105.01 and *Telcordia*™ GR-1230-CORE, GR-1400-CORE standards. It provides a service selector for each STS-N tributary provisioned for DRI.

The service selector selects the better of two received path-level signals in accordance with a given hierarchy of conditions. These conditions include STS path signal fail and PDI-P (payload defect indicator - path level). This applies only to drop and continue, does not include dual transmit. Multiple DRIs (up to the maximum system capacity) are supported.

SDH Dual node ring interworking (DNI) for MS-SPRing

LambdaUnite® MSS supports SDH Dual Node Interworking (DNI) for the purpose to protect between two MS-SPRING protected rings. The DNI feature is compliant with ITU-T G.842 standard. It provides a service selector for each VC-N tributary provisioned for DNI.

The service selector selects the better of two received path-level signals in accordance with a given hierarchy of conditions. These conditions include VC Path Signal Fail. Multiple DNIs (up to the maximum system capacity) are supported.

SDH Dual node ring interworking (DNI) for SNCP

The system supports SDH dual node interworking (DNI) for the purpose to protect between two SNC/I/N protected rings. The DNI feature is compliant with ITU-T Rec. G.842 standard. It provides a service selector for each VC-N tributary provisioned for DNI.

The service selector selects the better of two received path-level signals in accordance with a given hierarchy of conditions. These conditions include VC Path Signal Fail. Multiple DNIs (up to the maximum system capacity) are supported.

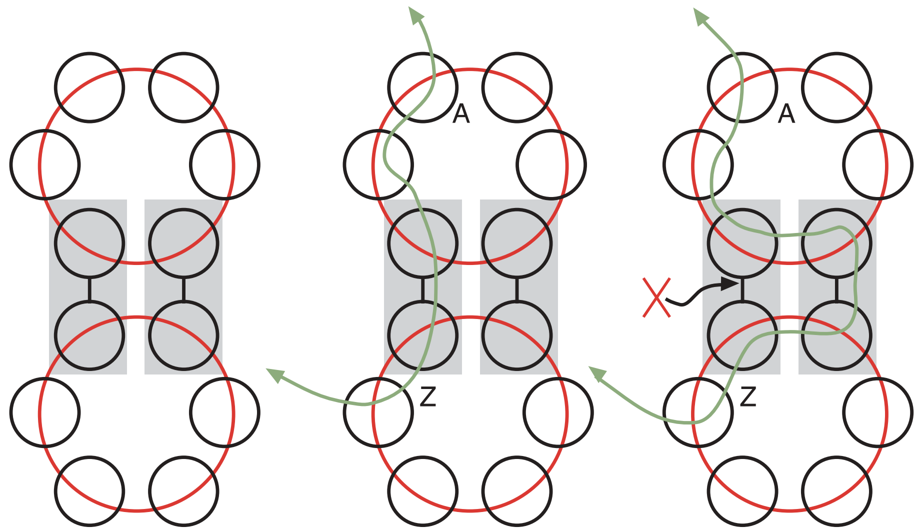
Dual ring interworking protection principle

The self-healing mechanisms of the two rings remain independent and together they protect against simultaneous single failures on both rings (not affecting the inter-connections). The DRI/DNI configuration additionally protects against failures in either of the inter-connections between the rings, whether the failure is in a facility or an inter-connection node.

DRI/DNI is a configuration that provides path-level protection for selected OC-n/STM-N circuits that are being carried through two rings. Protection for the route between the two rings is provided by inter-connecting the rings at two places, as shown in the figure below. Each circuit that is provisioned with DRI/DNI protection is dual-homed, meaning it is duplicated and subsequently terminated at two different nodes on a ring. The two inter-connecting nodes in each ring do not need to be adjacent.

DRI/DNI traffic flow

The following figures show a DRI/DNI configuration transporting traffic between nodes A and Z.



Description of the figures:

1. Two rings are interconnected by two nodes.
2. A path is set up from node A to node Z.
3. A failure, depicted by X, triggers a DRI/DNI switch at the top ring primary node, which automatically selects traffic from the secondary node.

Protection switching with *LambdaUnite®* MSS

The previous figure illustrates a failure of the inter-connection to a primary node at the point labeled “X” in figure 3. The failure results in a DRI/DNI switch at the primary node in the top ring. A DRI/DNI protection switch in a *LambdaUnite®* MSS occurs in ≤ 50 milliseconds (not counting the detection time) plus a provisionable hold-off time.

Primary and secondary nodes

In the BLSR/MS-SPRing, a bidirectional DRI/DNI-protected circuit to and from the terminating node is added and dropped at both a primary node and a secondary node, both of which inter-connect with the other ring. The primary and secondary nodes are defined and provisioned on a per-circuit basis.

Drop and continue

LambdaUnite® MSS supports the drop and continue method of DRI/DNI, in which the primary node is between the terminating node and the secondary node, and the primary node is the node that performs the drop-and-continue and path-selection functions.

The primary node drops the circuit in the direction of the other network and also continues (bridges) the circuit to the secondary node. The secondary node drops the circuit in the direction of the other network and adds the circuit from the other network in the direction of the terminating node.

The primary node either adds the circuit received on its tributary interface from the other network, or else passes through the duplicate signal received on the line from the secondary node, depending on standards-compliant path selection criteria.

Types of connections

The two types of connections shown in "Example: DRI/DNI via OC-3/STM-1 tributaries" (p. 2-33) are

- a direct intra-office connection between the primary nodes, Node 1 and Node 2, at the first central office (CO 1).
- an optically extended, direct secondary connection between the secondary nodes (Node 3 at the second central office (CO 2) and Node 4 of the *WaveStar*® ADM16/1 2.5-Gbit/s ring). This type of connection is achieved through the 155-Mbit/s interfaces at the inter-connected nodes and can go through other equipment.

Both types of connections can be used in either primary or secondary nodes.

Interworking

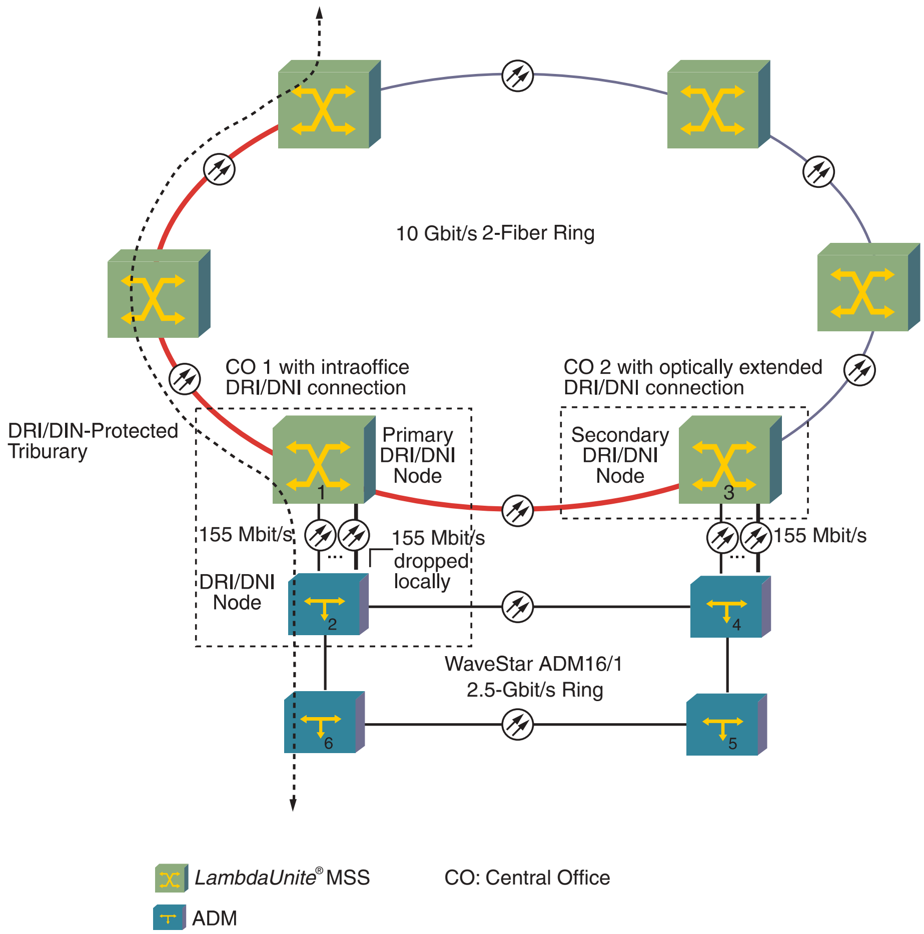
All *LambdaUnite*® MSS optical synchronous interfaces (40 Gbit/s, 10 Gbit/s, 2.5 Gbit/s, 622 Mbit/s and 155 Mbit/s) support dual node ring interworking. A *LambdaUnite*® MSS 10-Gbit/s ring can interwork with a 2-fiber BLSR/MS-SPRing, including rings using for example

- *WaveStar*® BandWidth Manager
- *WaveStar*® TDM 10G (OC 192)
- *WaveStar*® TDM 10G (STM-64)
- *Metropolis*® DMX Access Multiplexer
- *WaveStar*® ADM16/1

Additionally, there can be intermediate network elements in the inter-connection routes between the two rings.

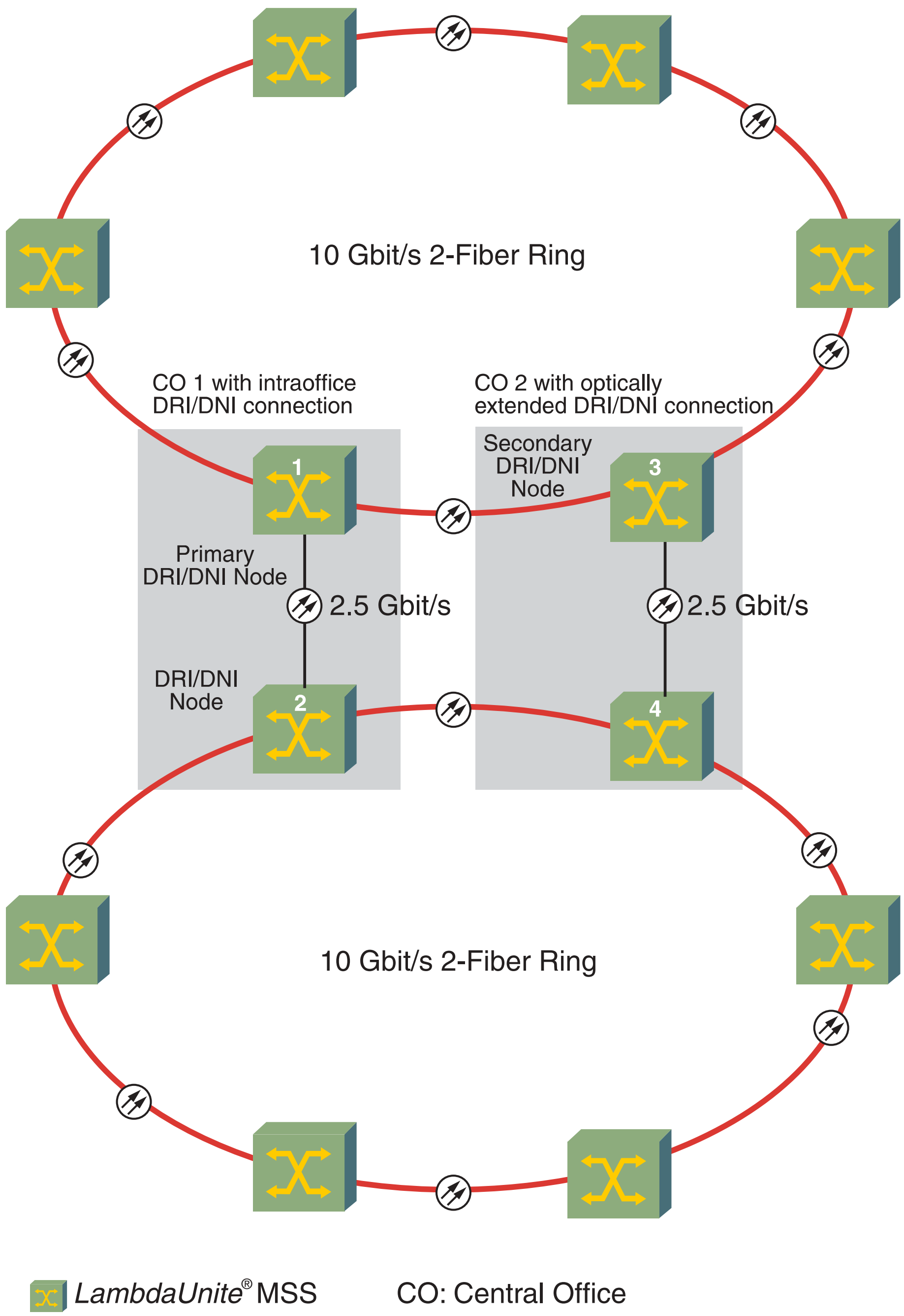
Example: DRI/DNI via OC-3/STM-1 tributaries

The following figure illustrates a DRI/DNI configuration that uses OC-3/STM-1 interfaces between a *LambdaUnite*® MSS 10-Gbit/s ring and a *WaveStar*® ADM16/1 2.5-Gbit/s ring.



Example: DRI/DNI via 2.5-Gbit/s tributaries

The following figure illustrates a DRI/DNI configuration that uses 2.5-Gbit/s interfaces between two *LambdaUnite*® MSS 10-Gbit/s rings.



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Line protection

LambdaUnite® MSS supports both, SONET and SDH linear protection features on all optical 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s ports:

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

Linear APS / MSP principle

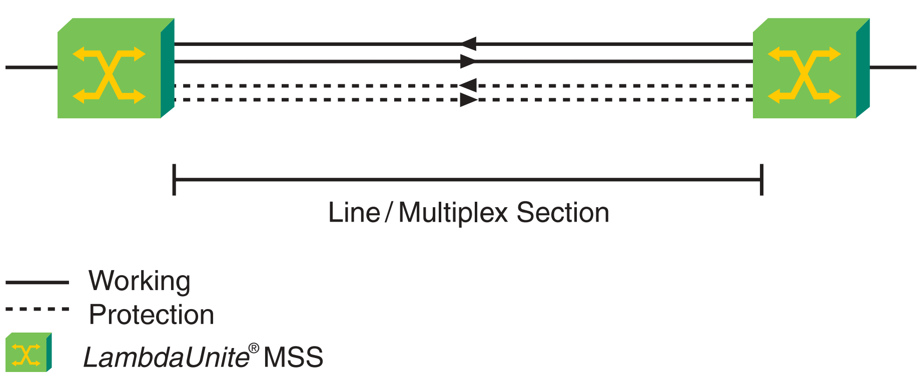
The principle of a linear APS is based on the duplication of the signals to be transmitted and the selection of the best signal available at the receiving port. The two (identical) signals are routed over two different lines, one of which is defined as the working line, and the other as protection line. 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 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s ports in the NE. Linear APS protection switching can be configured with *WaveStar®* CIT, *Navis®* Optical MS or *Navis®* Optical EMS.

Linear APS / MSP schemes

Linear APS protection schemes can be configured with *LambdaUnite®* MSS network elements for all 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s 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 including annex B (optimized protocol).

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.

The linear APS feature can be provisioned also directly on existing cross connections.

Linear APS / MSP can be configured in the following modes:

Protocol	SONET	SDH
1+1 uni-directional revertive	on OC-192 ... OC-3 ports	on STM-64 ... STM-1 ports
1+1 uni-directional non-revertive	on OC-192 ... OC-3 ports	on STM-64 ... STM-1 ports
1+1 bi-directional revertive	on OC-192 ... OC-3 ports	on STM-64 ... STM-1 ports
1+1 bi-directional non-revertive	on OC-192 ... OC-3 ports	on STM-64 ... STM-1 ports
1+1 optimized (bi-directional non-revertive)	-	on STM-64 ... STM-1 ports
1:1 bi-directional revertive (with extra traffic)	-	on STM-64 ... STM-1 ports

1:1 MSP provides so called extra traffic, using the protection ports in order to carry some additional, low priority traffic; this extra traffic is dropped in the switching case.

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Path protection

LambdaUnite® MSS supports both, SONET and SDH path protection features on all available cross-connection rates:

- 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 paths in a subnetwork. It can also be provisioned directly on existing cross-connections.

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, *Navis®* Optical MS 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" (p. 2-12)). 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.

Path-protected Pipe Mode Cross Connections

LambdaUnite® MSS supports the operation of path selectors (UPSR) for all SONET pipe-mode cross connections rates. Protection switching is performed and reported independently for each of the path-level constituent signals within a path-protected pipe-mode cross connection. This feature does not apply for ONNS ports.

SNCP

LambdaUnite® MSS supports two types of SNCP:

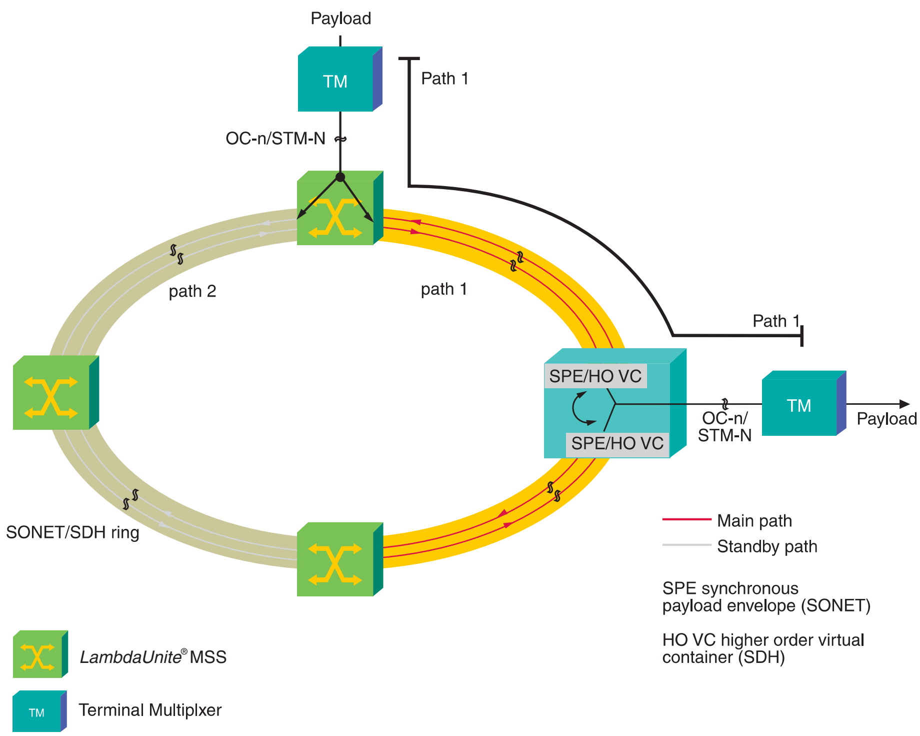
- Inherently monitored subnetwork connection protection (SNC/I)
  SNC/I protection generally protects against failures in the server layer. This means AU-4 or STS-1 defects are detected and the switch is triggered by the Server Signal Fail (SSF) signal.
- Non-intrusively monitored subnetwork connection protection (SNC/N)
  SNC/N protection, generally, protects against failures in the server layer and against failures and degradation in the client layer. This means the non-intrusive monitor function detects Signal Fail (SF) and Signal Degrade (SD) events on the incoming signal and triggers the switch accordingly.

For more detailed information please refer to the chapter “Traffic provisioning concepts” of the User Operations Guide.

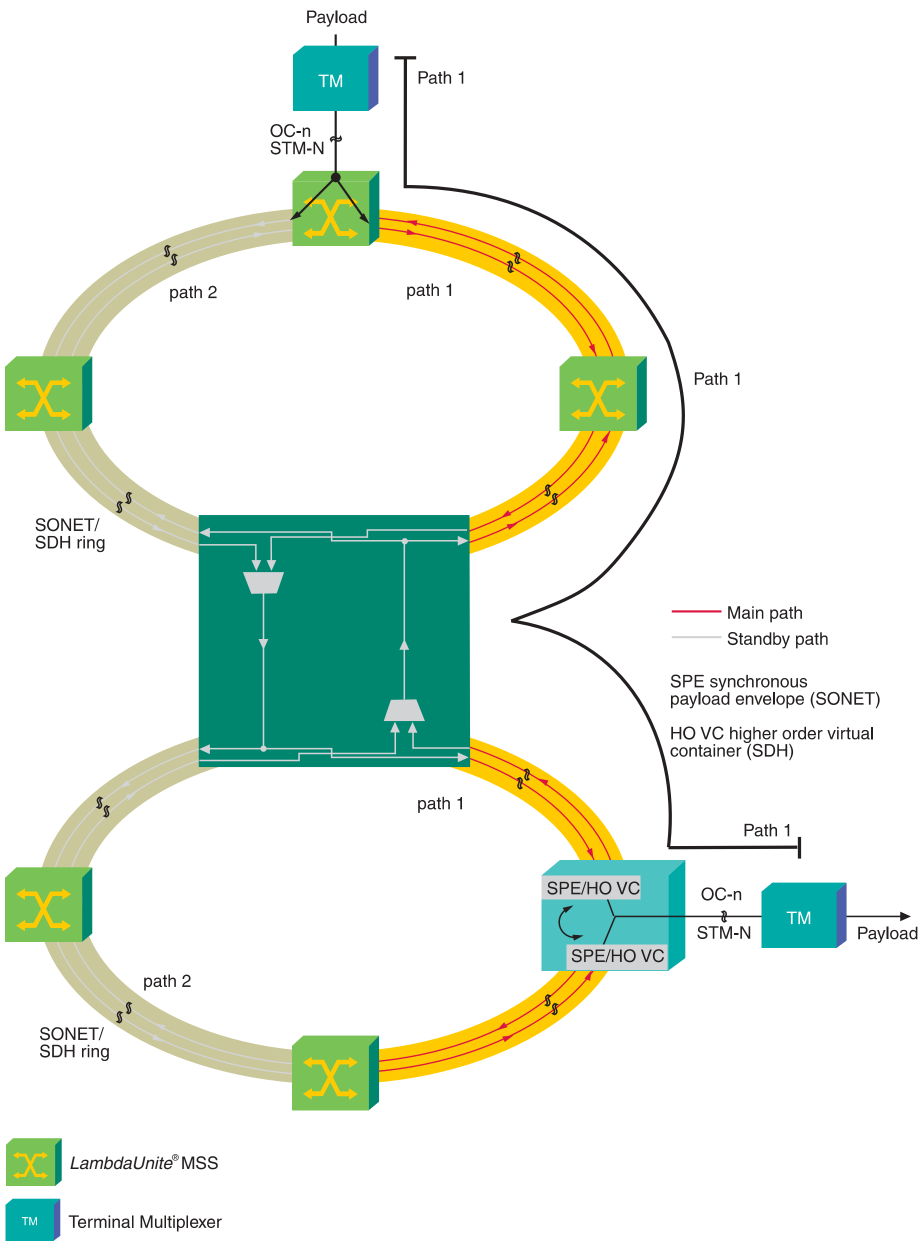
UPSR/SNCP configuration

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, 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 aring-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.



Important! Prerequisite for establishing path-protected cross-connections (UPSR/SNCP) is that both ports of the logical input tributaries are provisioned in fixed-mode. In other words, one or both inputs of a path-protected cross-connections must not be in adaptive-mode.

Manual switch

The following manual switching actions are possible with *WaveStar*® CIT, *Navis*® Optical MS 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.

□

Equipment features

Overview

Purpose

This section provides information about *LambdaUnite*® MSS equipment features concerning hardware protection, optical interface modules, and inventory and failure reports.

Contents

Equipment protection

1+1 redundancy

To enhance the reliability of *LambdaUnite*® MSS, for the following plug-in units non-revertive 1+1 equipment protection is supported:

- the switching units (XC160, XC320, XC640, and LOXC)
- the controller units (CTL) in ONNS applications; in traditional, non ONNS applications the redundancy is optional
- the electrical transmission units (EP155M and EP51, using the designated ECI paddle boards).

Besides automatic switching, manual and forced switching is supported to minimize operations interruption e.g. in maintenance scenarios (exchange of units).

Note that for the controller units the forced switch option is not available.

Power supply

The power feed is maintained duplicated throughout the system, applying "load sharing" in normal operation conditions.

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Optical interface modules

LambdaUnite® MSS supports optical port units consisting of a parent board which can be equipped with field-replaceable optical interface modules.

An optical interface module is a replaceable unit with a receiver and transmitter function providing the optical port. *LambdaUnite®* MSS optical interface modules are "hot pluggable" (field-replaceable), i.e. the interface modules can be inserted or removed while the parent board is in operation, without affecting the service of other interface modules on the same parent board.

Advantages of the optical interface modules

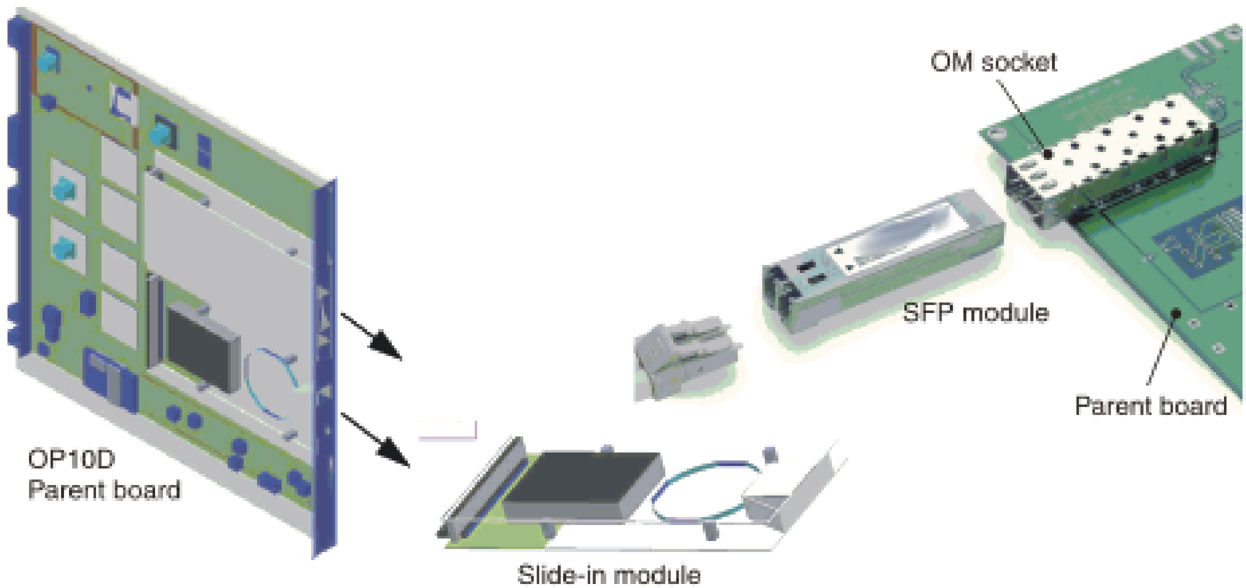
The *LambdaUnite®* MSS optical interface modules provide excellent pay-as-you-grow opportunities for smaller or start-up applications, as only the up-to-date required number of ports must be purchased. An additional advantage of this flexible interface lies in ease and cost reduction when it comes to maintenance and repair activities.

The number of modules inserted into the parent board can be varied flexibly between zero and the maximum number of sockets; the possibly unused sockets can be left empty.

Types of optical interface modules

There are two classes of optical interface modules, as shown in the figure below:

- on the left side the slide-in module and parent board (Lucent Technologies proprietary design)
- on the right side the Small Form Factor Pluggable module (SFPs), and a cut of an SFP parent board.



Please observe the configuration rules described in “Port location rules ” (p. 6-10).

The *LambdaUnite®* MSS SFPs are marked by the manufacturer, and they are checked upon insertion, in order to protect from accidental insertion of non *LambdaUnite®* MSS specific SFPs. Only for the *LambdaUnite®* MSS specific SFPs Lucent Technologies can guarantee the full functionality and warranty.

For further information please refer to the “Equipment provisioning concepts” chapter of the UOG.

□

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.

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Synchronization and timing

Overview

Purpose

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

Contents

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 DS1 (B8ZS) signals (SF or ESF) or 2,048 kHz, 2 Mbit/s (framed or unframed), or
  - One of up to six OC-n / STM-N input signals (choice of input is provisionable, maximum one per transmission unit).

  In locked mode, if all configured references fail, the internal clock will switch to the hold-over state.
- Free-running.

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.

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, etc. using the *WaveStar®* CIT, *Navis®* Optical MS or the *Navis®* Optical EMS.

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Timing protection

Timing unit protection

In *LambdaUnite®* MSS the timing functionality is physically located on the switching unit. Thus, 1+1 non-revertive protection of the timing functionality is provided (see "Equipment protection" (p. 2-43)).

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 *Telcordia*™ GR-253 for SONET timing and ETSI 300 417.1.1 / ITU-T Rec. G.781 for SDH timing. If all provisioned timing references fail or become unacceptable, the system will automatically switch over to the hold-over mode.

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Timing interface features

External timing outputs

LambdaUnite® MSS provides external timing output signals derived from the system clock or from the incoming line signals. These output ports support DS1 (B8ZS) signals (SF or ESF) or 2,048 kHz or 2 Mbit/s (framed or unframed) signals as per ITU-T Rec. G.812 and G.703.

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 all incoming and outgoing optical and electrical 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 with Bellcore TR-NWT-000499 and with the ITU-T Rec. G.704 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 tools, and about the monitoring and diagnostics features of *LambdaUnite*® MSS.

Contents

Interfaces

WaveStar® CIT, *Navis®* Optical EMS and *Navis®* OMS

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, *Navis®* OMS client and the *Navis®* Optical EMS client are customer-supplied 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, *Navis®* OMS and *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,*Navis®* OMS and *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, *Navis®* OMS 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, from the , *Navis®* OMS 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.

LAN interface

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

TCP/IP access

LambdaUnite® MSS provides TCP service for end-to-end communication with the management system via an IP network. Each LAN port of the NE can be provisioned with its own IP address and default router.

DCC interfaces

The *LambdaUnite®* MSS system supports operations via the standard 7-layer OSI protocol over Data Communications Channel (DCC). Up to 180 DCC terminations of section DCC (DCC_R) and line DCC (DCC_M) channels can be configured on 155-Mbit/s, 622-Mbit/s, 2.5-Gbit/s, 10-Gbit/s ports. DCC channel protection switching is supported in conjunction with line APS / MSP protection switching of the respective optical port ("slaving").

Transparent DCC

The *LambdaUnite®* MSS system supports transparent DCC connections, so called DCC cross connections, in addition to the standard DCCs. These transparent DCC connections pass through the DCC information between two ports (without D-byte termination).

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 and *Navis®* OMS, that provide 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 are supported on 10-Gbit/s- and 155-Mbit/s interfaces.

□

Optical Network Navigation System (ONNS)

ONNS features

The key drivers for the Optical Network Navigation System (ONNS) 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, ONNS comprises a set of capabilities that automates SONET/SDH connection set-up, fast restoration, and the automatic discovery of the topology in SONET/SDH networks. Compared to a classical SONET/SDH network, the ONNS can set-up or remove connections faster, using automated circuit design. Furthermore it provides automatic restoration in meshed topologies, automatic neighbor and topology discovery, and in a future release also dynamic network optimization.

The Optical Network Navigation System (ONNS) comprises the functionalities described in the ITU-T recommendations as Automatically Switched Transport Networks (ASTN, ITU-T Rec. G.8070/Y.1301), Network Topology Management (ITU-T Rec. G.7715), Link and Nodal Research Management (ITU-T Rec. G.7714) and Internal Network Node Interface (I-NNI, ITU-T Rec G.7713). For further information regarding Generalized Multi Protocol Label Switching (GMPLS) and Link Management Protocol (LMP) you can also refer to the relevant IETF documents.

LambdaUnite® MSS can be used as classical SONET/SDH network element, as ONNS network element, or the user can define port per port which standard to support. With this hybrid application *LambdaUnite®* MSS allows to integrate ONNS domains into existing classical SONET/SDH networks, hence *LambdaUnite®* MSS takes the role of a flexible link between the two standards, offering unique growth opportunities.

ONNS functional overview

ONNS shifts network functions like path routing and protection from the management systems to the network elements, gaining time, resources and flexibility, especially in complex structures like meshed network topologies.

The Optical Network Navigation System (ONNS) application basically subsumes the following functions:

- Automated path setup and tear down
  You insert in one network element only start- and end-point of a connection within the ONNS network. The system then performs automatically the connection set-up, a management system is not necessary. With a similar automatic function the path can be torn down via the ONNS.
- User defined network element exclusions
  You can choose to exclude certain network elements from the path. ONNS will not take them into consideration for setting up the path.
- Protection choices: 1+1 protection, automatic restoration or unprotected
  With ONNS you can choose to protect the path with 1+1 protection or with automatic restoration. In the latter case a protection path is calculated during setup, but it is not reserved. That means: no bandwidth is occupied by protection. In case of failure an up-to-the-minute restoration path is calculated and the traffic is restored on this path.
- Automatic topology and link state discovery
  The ONNS network elements exchange topology information and link state information continuously. For this purpose the neighbor discovery protocol, respectively the Link State Advertisements (LSA) are running over the Signaling Communications Network (SCN). With the resulting database every ONNS network element is able to perform the ONNS functions.

For further details and operations information concerning the ONNS feature please refer to the chapters “ONNS concepts” and “ONNS tasks” in the *LambdaUnite*® MSS Release 7.0 User Operations Guide.

ONNS prerequisites

To enable the ONNS functionality a specific *LambdaUnite*® MSS hardware configuration is required:

- controller unit CTL/2, CTL/3S or CTL/4S

Because of the extended importance of the controller unit in ONNS operations a protection controller unit (redundancy) is highly recommended.

Please note that the formerly available main switching unite XC320/- does not support ONNS.

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Monitoring and diagnostics features

Performance monitoring

LambdaUnite® MSS monitors performance parameters for 24-hour and 15-minute intervals on the synchronous and Ethernet transmission interfaces, so monitoring can be full-time for each signal. For further information please refer to "Performance monitoring" (p. 5-21).

Threshold reports

Additional to the common alarm status and normal/abnormal condition reports *LambdaUnite®* MSS supports threshold reports (TRs). A TR is generated when a performance monitoring parameter threshold is exceeded, that can be set individually by the user for 24-hour and 15-minute intervals. For further information please refer to "Performance monitoring" (p. 5-21).

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 and cross-connection loopbacks for testing and maintenance purposes. These loopbacks are available for each supported signal type, except the types that require the LOXC (VC-3 (lower order), VC-12 / VT1.5). Facility loopbacks are established electrically on port-level on a port unit, cross-connection loopbacks in the switching matrix. The available types are:

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

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

Note that on ONNS I-NNI ports loopbacks are not allowed and therefore blocked by the system.

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" (p. 2-46), is accessible via *WaveStar*® CIT, via *Navis*® OMS or via *Navis*® Optical EMS.

Self diagnostics (in-service)

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

Auto-recovery after input power interrupt

The system will 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, it will raise an alarm, and the configuration database can then be updated via the management system.

□

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)

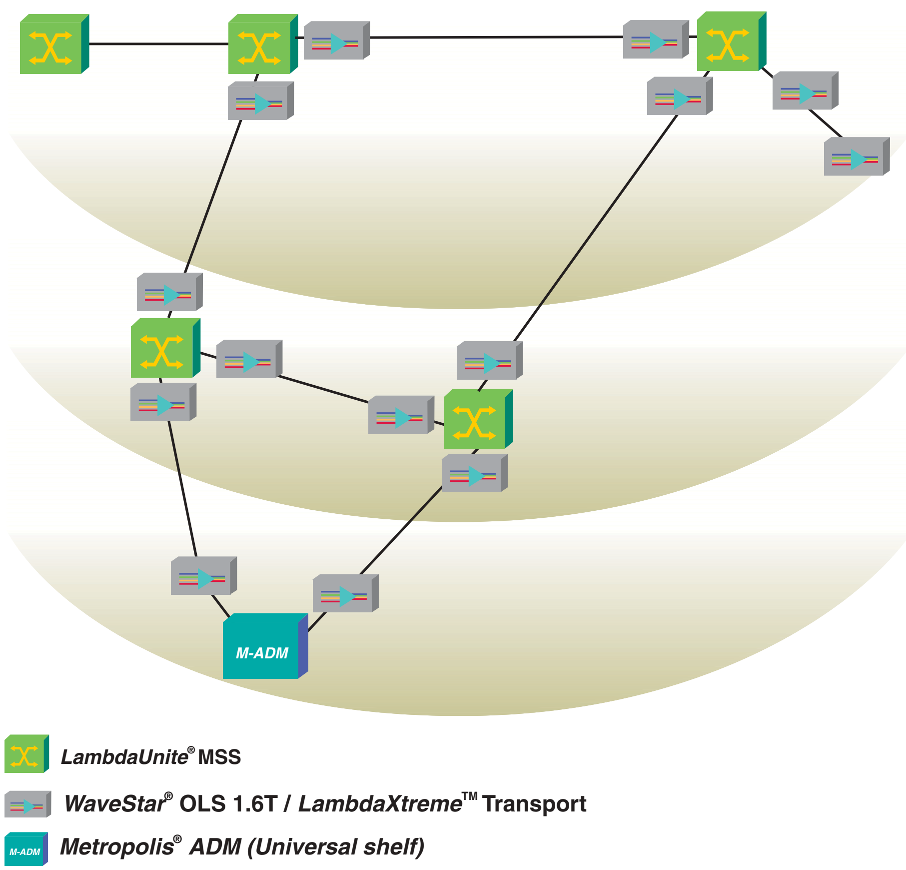
Contents

Classical backbones

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 *WaveStar®* BandWidth Manager and the *WaveStar®* 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, the Optical Network Navigation System (ONNS) will appear as a way to provision and protect services in the application above. *LambdaUnite®* MSS is already supporting this functionality.

As transparent high capacity services are becoming more important, *LambdaUnite®* MSS supports transparent DCC, and in future it will support further overhead transparent services. 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 provides 40-Gbit/s interfaces, 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

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 and 40 Gbit/s.

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, 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.

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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 (1.5-Mbit/s up to 10-Gbit/s services)
- Synchronous and data interfaces

Contents

Ring topologies

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.

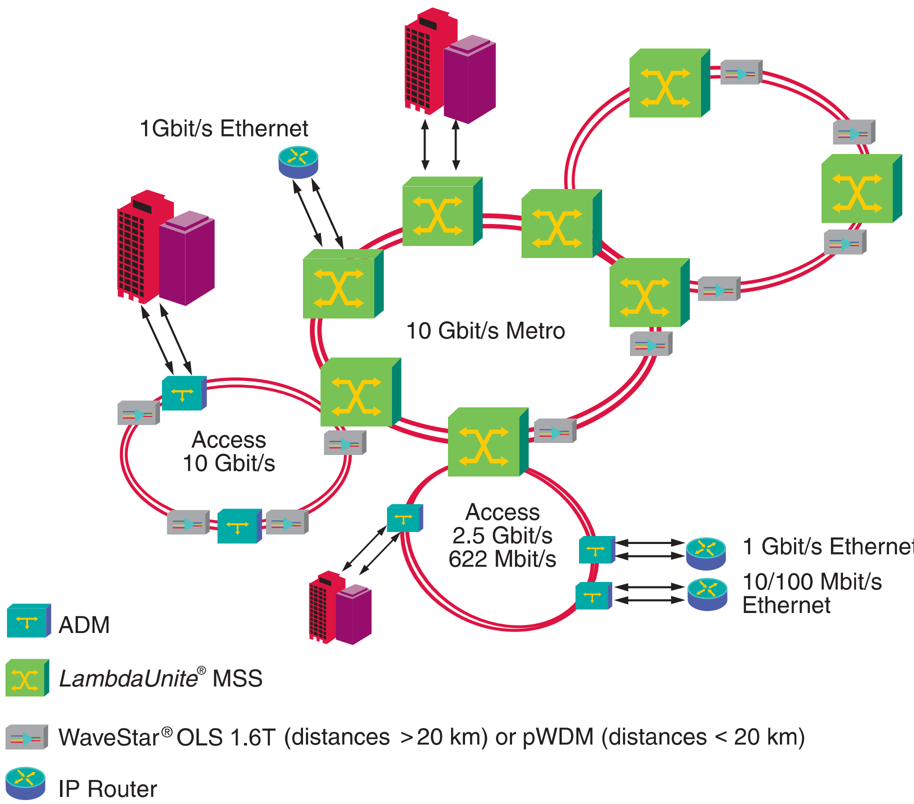
Due to the wide range of protection features supported by *LambdaUnite®* MSS, protection schemes can be chosen dependent on traffic pattern (hubbed versus more neighboring traffic) and the protection schemes supported by the nodes to interwork with on the same ring. A combination with DWDM or "passive" 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" (p. 3-32).



Clear channel topologies

In clear channel topologies the client signal is transparently transported over the carrier network. Especially in the SONET/SDH world this service boosts the flexibility of service providers. Actually, there is a strong market interest in clear channel transport services for all types of client signals. With its transparent optical SONET/SDH interfaces *LambdaUnite*® MSS extends its application range, fulfilling these market requests.

Typical non-transparent service model

SONET/SDH transport mechanisms require the termination of section/RS and line/MS layer information. The in-band OA&M channels associated with the section/RS and line/MS layers are terminated at the boundaries between two operator domains. Thus, important network management information such as data communication channels, parity bits etc. are terminated at the network boundaries.

In certain application topologies, however, the transparent transport of client SONET/SDH signals across a native SONET/SDH network can provide enormous advantages. Some examples for such applications are

- Transmission protections like BLSR/MS-SPRing
- Data Communications Networks
- ONNS domains.

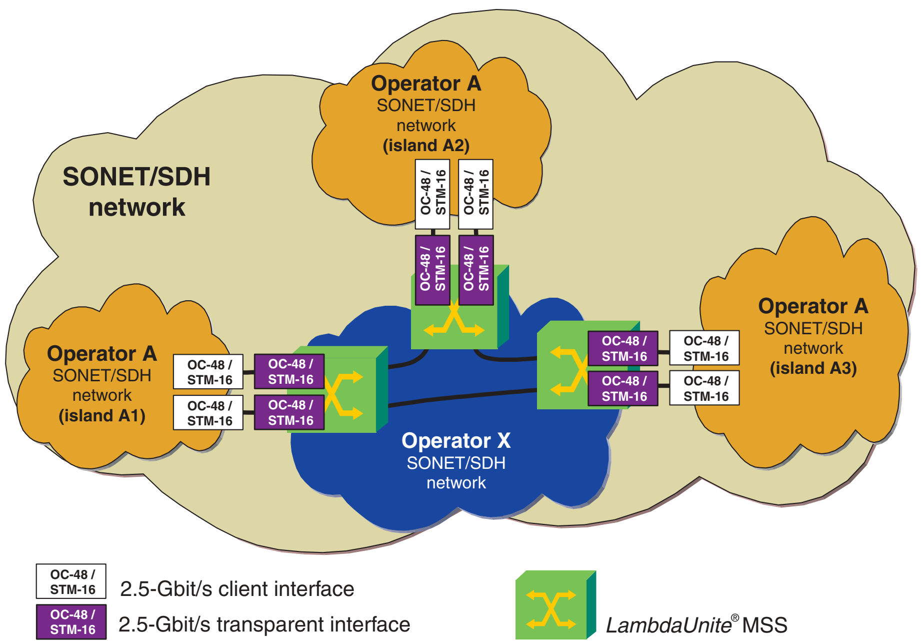
Transparent carrier's carrier application

One of the scenarios where a new service model is required is the "carrier's carrier" application, as shown in the figure below. Supposed that an operator or carrier (A) wants to extend the reach of his networking infrastructure over an area which is serviced by another SONET/SDH operator (X), for example by leasing transport capacity, he may ideally want each of the leased connections to behave as a virtual fiber.

With the transparent interfaces of *LambdaUnite*® MSS operator X can support, as shown in the following example, a BLSR/MS-SPRing application of carrier A, with nodes in the different location islands A1, A 2 and A3.

Carrier's carrier service example

The following figure shows the scheme of a carrier's carrier topology example, where operator X provides transparent connections to operator A. These so called clear channels are implemented by the *LambdaUnite*® MSS 2.5-Gbit/s transparent interfaces, here depicted in purple.



Transparent enterprise VPN (SONET/SDH) application

There are many institutions (large enterprises, government institutions, railway or energy companies) who also deploy private SONET/SDH networks with their own networking infrastructure. These enterprises often wish to extend the reach of their enterprise SONET/SDH networks by leasing circuits from the local operators. At the same time they want to become interconnected in a seamless fashion, allowing to operate and manage the contracted channels as "virtual fibers" in their network infrastructure.

This application can be modelled in the same way as the previous example, depicted in the preceding figure, substituting operator A by an enterprise. Note that the requirements for an enterprise OC-n/STM-N service may be significantly different from the requirements for a carrier's carrier OC-n/STM-N service. In particular, the requirements for timing transparency may be important for the carrier's carrier service, but less so for the enterprise service. *LambdaUnite*® MSS is able to cover both applications with its SONET/SDH transparency feature.

□

Meshed topologies

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

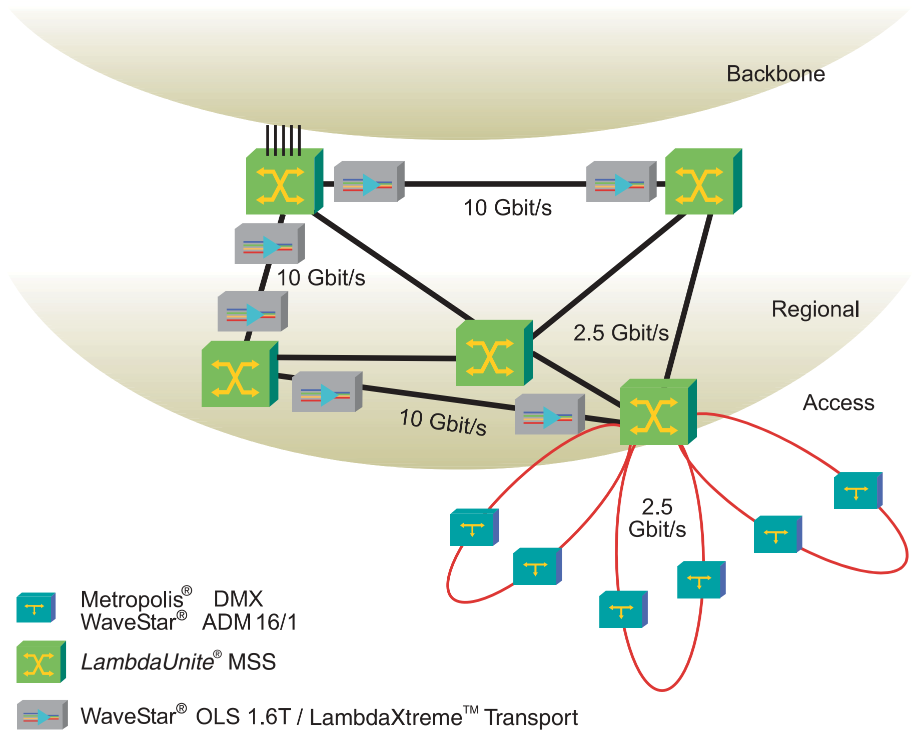
Due to the flexible architecture of *LambdaUnite®* MSS the creation and expansion of a meshed metro core topology is very easy. This can be combined with the ring closure capability towards the access network (the access network is still dominated by ring topologies due to its hubbed traffic pattern). 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. In this network type Optical Network Navigation System (ONNS) provides you with the highest flexibility of protection schemes and service activation methods. If ONNS is not used, the protection schemes used in the metro core network can be either BLSR/MS-SPRing or UPSR/SNCP, which supports meshed topologies more easily.

Service interfaces of the OEDs in the metro core network cover a wide range from 45 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.

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.



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Traffic hubbing

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.

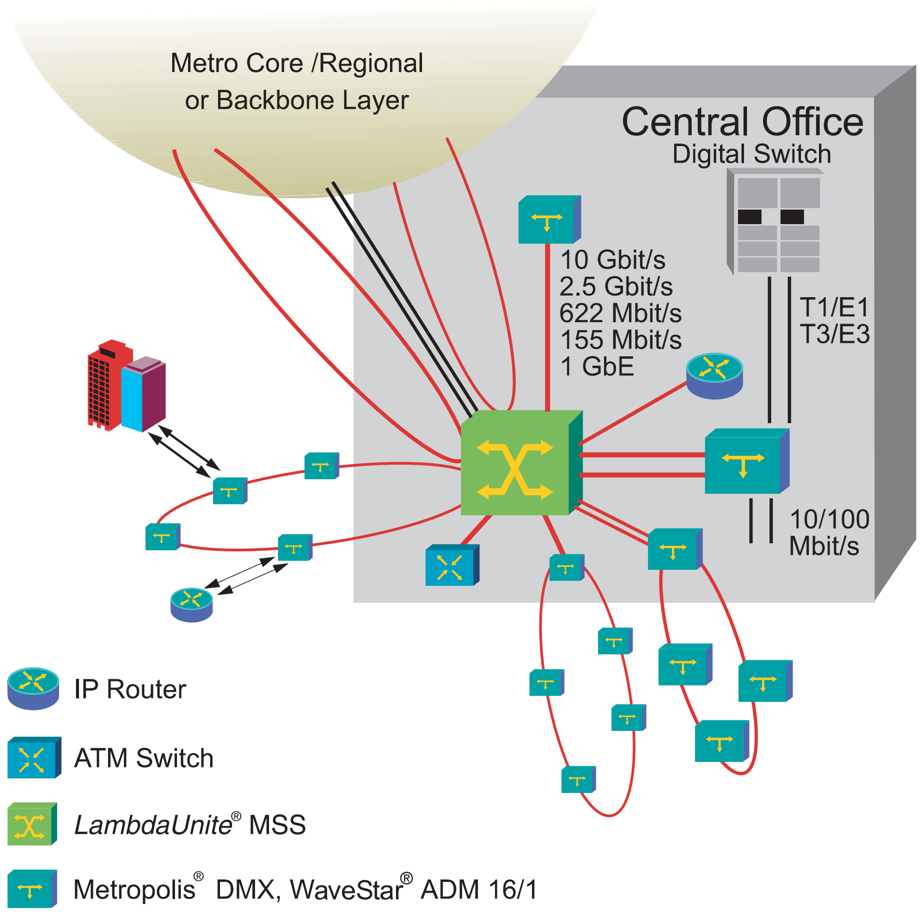
Metro core/regional hubbing example

In the 10-Gbit/s metro regional hub application *LambdaUnite®* MSS acts as multi-ring terminal, hubbing (see also “Remote hubbing ” (p. 3-24)) the traffic from several lower rate access rings (see also “Closing rings” (p. 3-26)) 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 and 4-fiber rings are supported, also in combinations with DWDM or “passive” WDM; see also “Growing demand for extra capacity” (p. 3-32).

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



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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

Contents

Tier 1 applications

Although *LambdaUnite*® MultiService Switch (MSS) with its 160-Gbit/s, 320-Gbit/s, or 640-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.

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Application details

Overview

Purpose

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

Contents

Ethernet applications

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:

- Ethernet service types
- Inter-PoP (Point-of-Presence) services
- Corporate LAN interconnections

Ethernet service types

An Ethernet end-to-end transport service is the service that a service provider or operator delivers to an end-user, in which multiple access points of that customer are interconnected via physical Ethernet interfaces. The end-user Ethernet frames are transported transparently to the proper destination. A second type of Ethernet transport service is not really end-to-end, but is a back-hauling service whereby the end-user traffic is collected via a physical Ethernet access interface and handed-off at a central location to a service node (most likely an IP edge router). In this case Ethernet provides a transport function for services at the IP layer.

These service types are grouped in three applications based on Ethernet network topology:

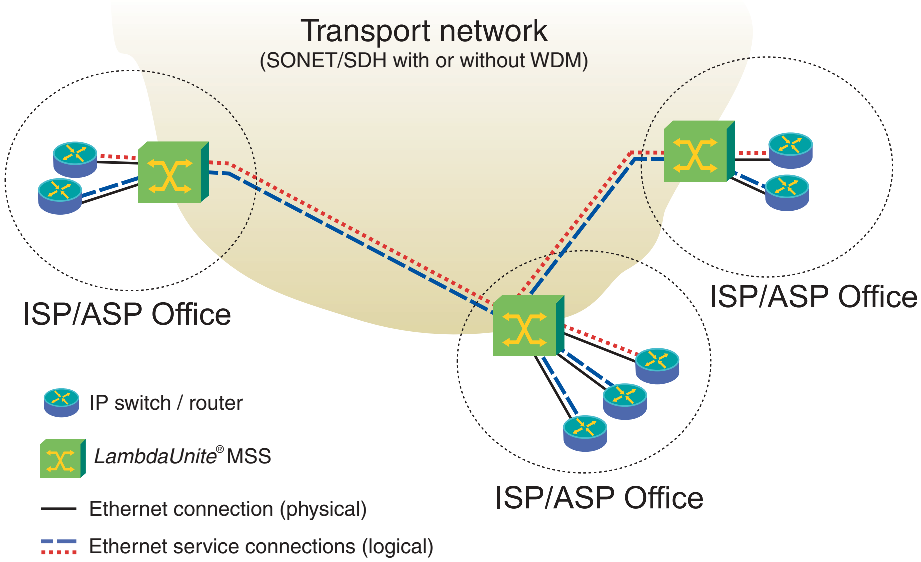
- point-to-point applications, see the first example of “Corporate LAN interconnections”
- multi-point applications, see the first example of “Inter-PoP services”
- trunking applications, see the second example of “Corporate LAN interconnections”.

For further information please refer to “Ethernet features” (p. 2-14) and to the chapter “Traffic provisioning concepts” of the *LambdaUnite*® MSS User Operations Guide.

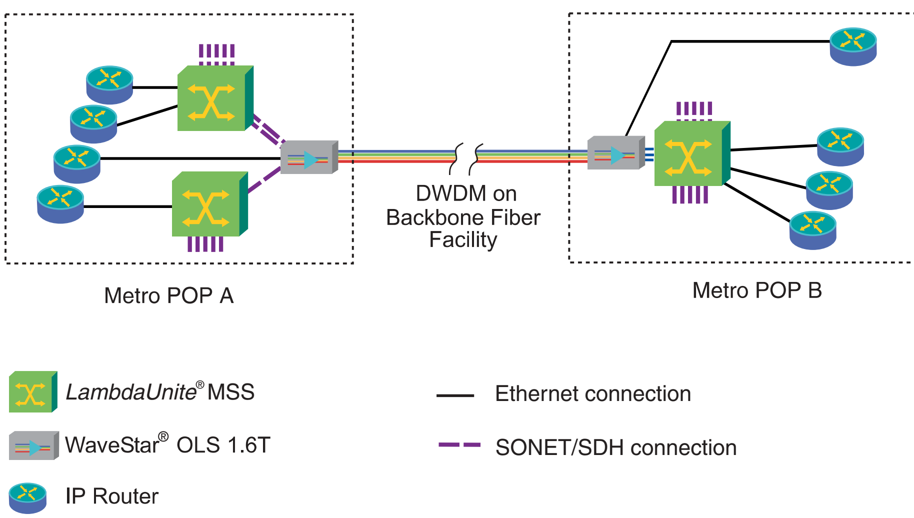
Inter-PoP services

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 multi-point application example given in the following figure.



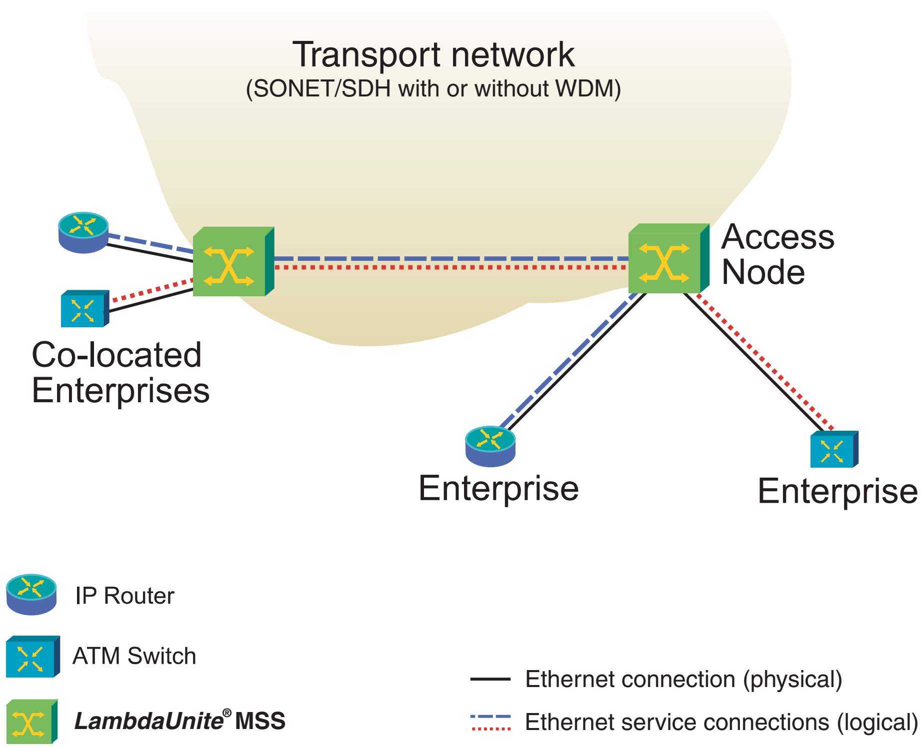
A specific option for high bandwidth between distant Metro POPs is to transport Gigabit Ethernet (GbE) traffic with Hybrid Transport over *LambdaUnite*® MSS and *WaveStar*® OLS 1.6T, based on SONET/SDH and Dense Wavelength Division Multiplexing (DWDM) solutions, as shown in the example given in the following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



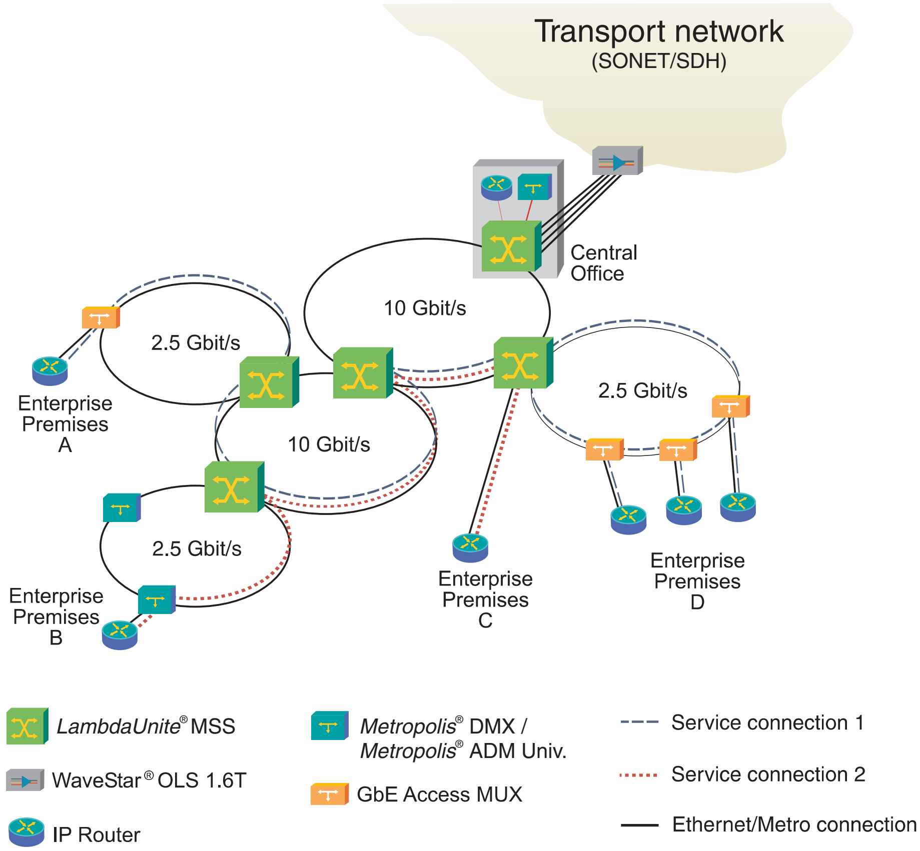
Corporate LAN interconnections

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 point-to-point 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 or 10 Gbit/s WANPHY. 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 transport network. In this figure also VLAN trunking is shown, for example in enterprise premises D.



□

Broadband transport

Broadband Services

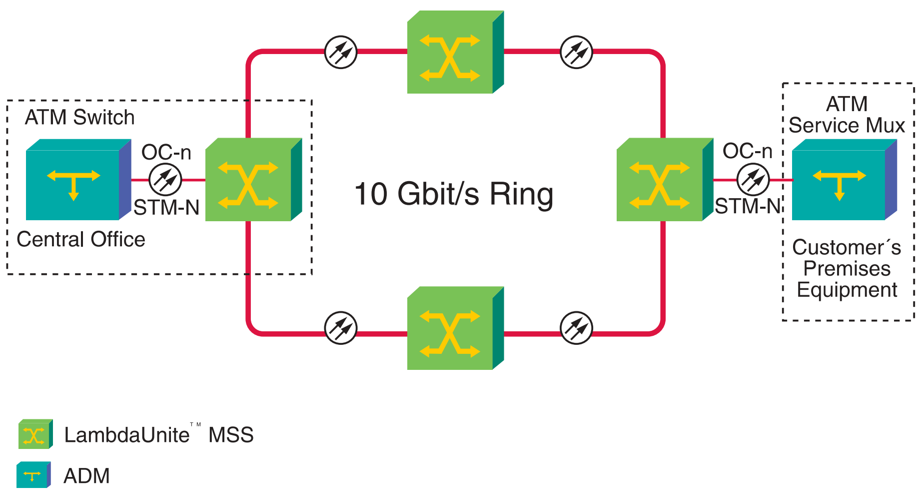
Broadband services that can be handled with *LambdaUnite*® MultiService Switch (MSS) include:

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

These services can be conveniently switched by *LambdaUnite*® MSS, for example as concatenated payloads (STS-3c/VC-4, STS-12c/VC-4-4c, STS-48c/VC-4-16c or STS-192c/VC-4-64c) - except LAN - over all available line interfaces; for LAN interconnection the special Gigabit Ethernet interfaces can be used.

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

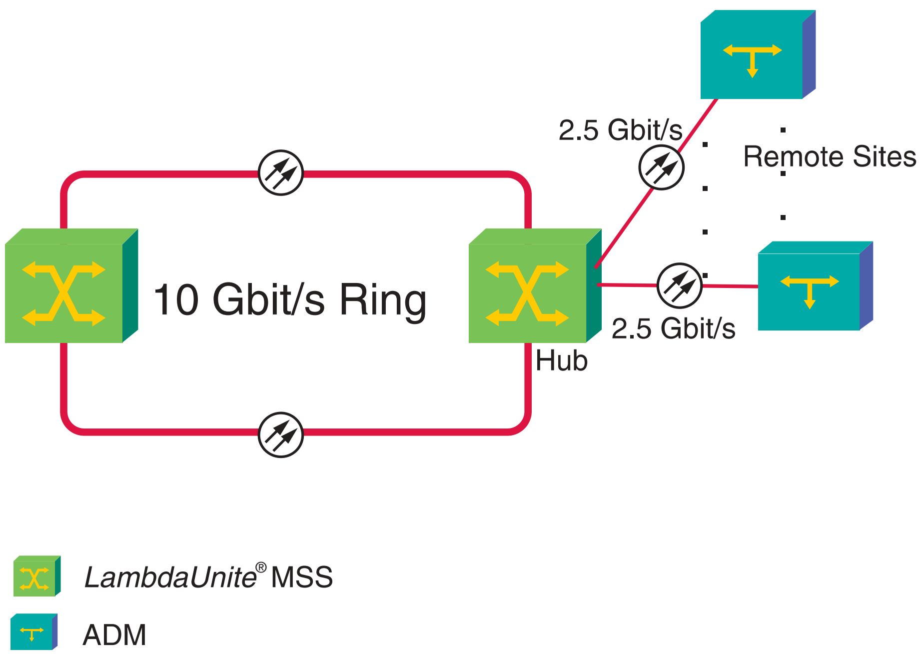
What is remote hubbing?

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.

LambdaUnite® MSS can perform 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

An example is shown in the following figure where a *LambdaUnite*® MSS 10-Gbit/s ring serves a cluster of 2.5-Gbit/s multiplexers located at remote sites.



Remote hubbing ring networks

In some situations the traffic volume of a route does not justify 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" (p. 3-26)).

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 or a 40-Gbit/s ring, see also "Ring topologies" (p. 3-26).

☐

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.

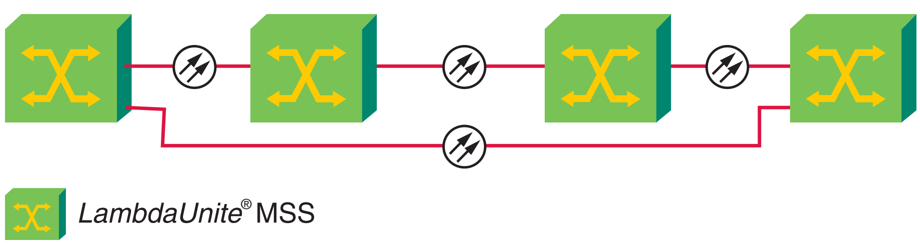
In many cases, a network starts out as a linear add/drop chain because of short-term service needs between some of the nodes. Later, it evolves into a ring when there is a need for service and fiber facilities to other nodes in the network. It is easier to evolve the linear add/drop network into a full 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

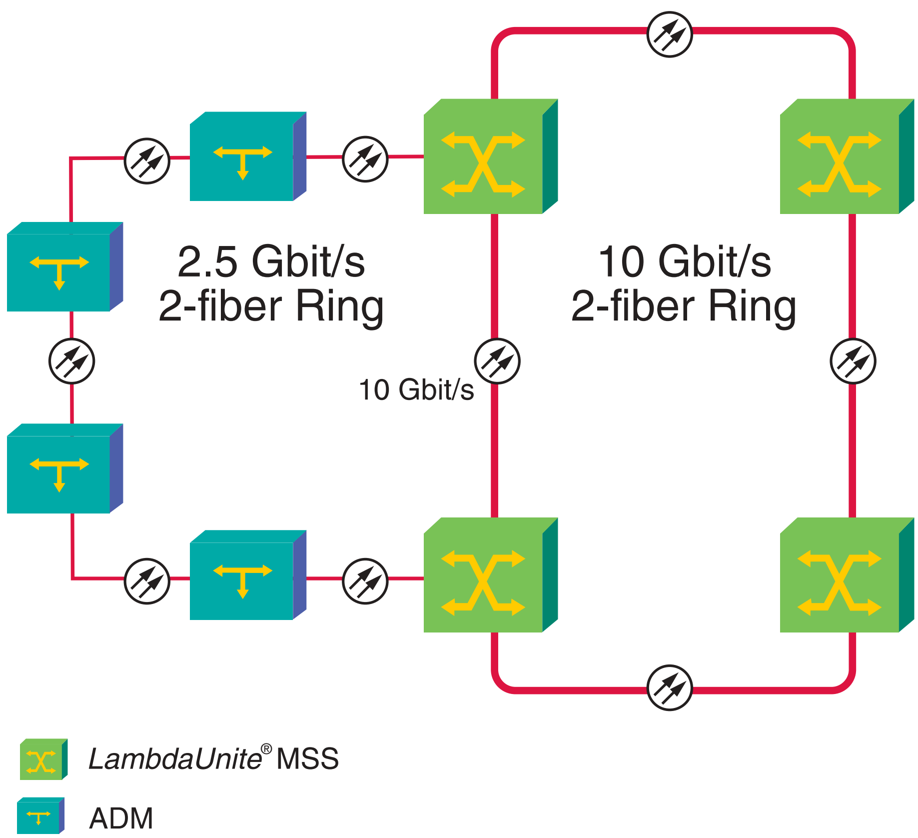
If a linear network is geographically close enough to a backbone system, then the linear network can be upgraded to a ring network by connecting both ends to the backbone. Traffic from the newly-formed ring can be transported by the backbone system, thereby closing the ring. This is referred to as closing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



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, like in this example.

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.

Note that MS-SPRing can be implemented in the given example only in the 10-Gbit/s ring.

Multiple ring closure

LambdaUnite® 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, 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®* MSS. For all rings BLSR/MS-SPRing protection can be configured.

Low rate grooming and protection

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

- grooming
- path protection

on traffic rates below the STS-1 or HO-VC-3 level. This can be done by connecting an additional lower rate ADM to *LambdaUnite®* MSS, as shown in "Metro core/regional hubbing example" (p. 3-15). In this example *LambdaUnite®* MSS is used as a hub in the central office with two *Metropolis®*DMX or *Metropolis®* ADM universal connected to it as grooming devices.

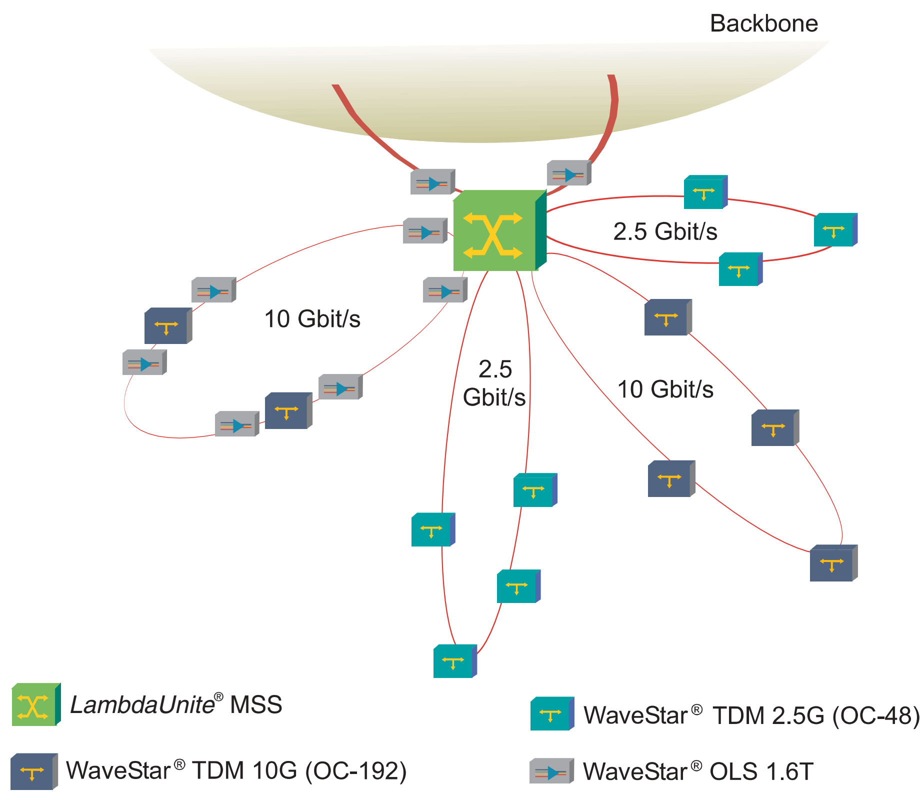
□

Interworking with *WaveStar*® TDM 10G/2.5G and *Metropolis*® ADM universal

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 *Metropolis*® ADM universal.

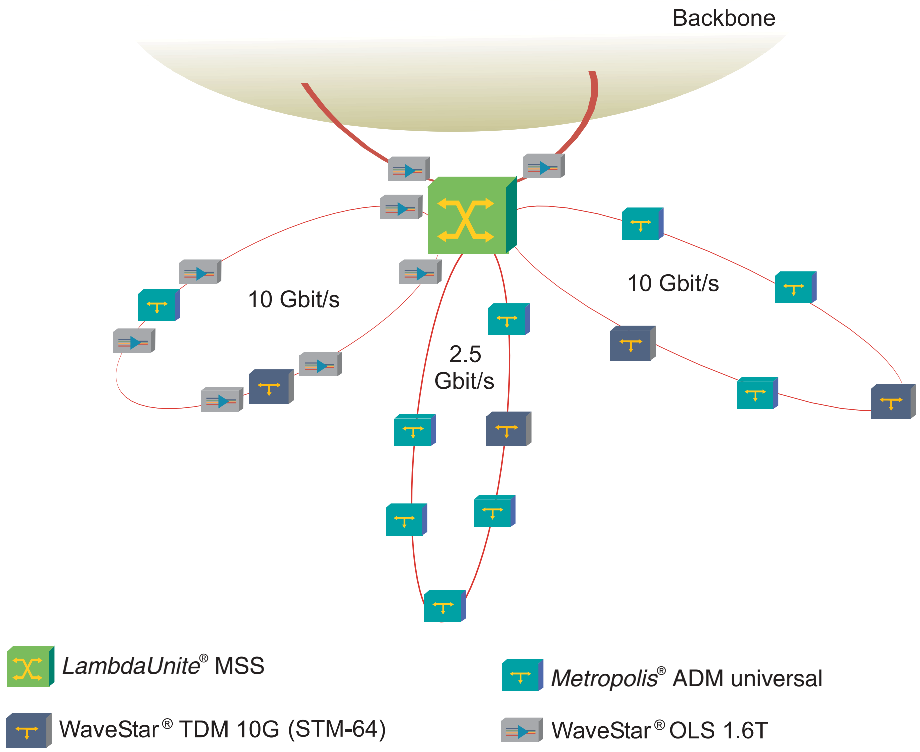
Interworking with *WaveStar*® TDM 10G (OC-192) and *WaveStar*® TDM 2.5G (OC-48)

The following figure shows an application example of *LambdaUnite*® MSS acting 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 *Metropolis*® ADM universal

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 *Metropolis*® ADM universal systems.



□

Interworking with *WaveStar*® BandWidth Manager

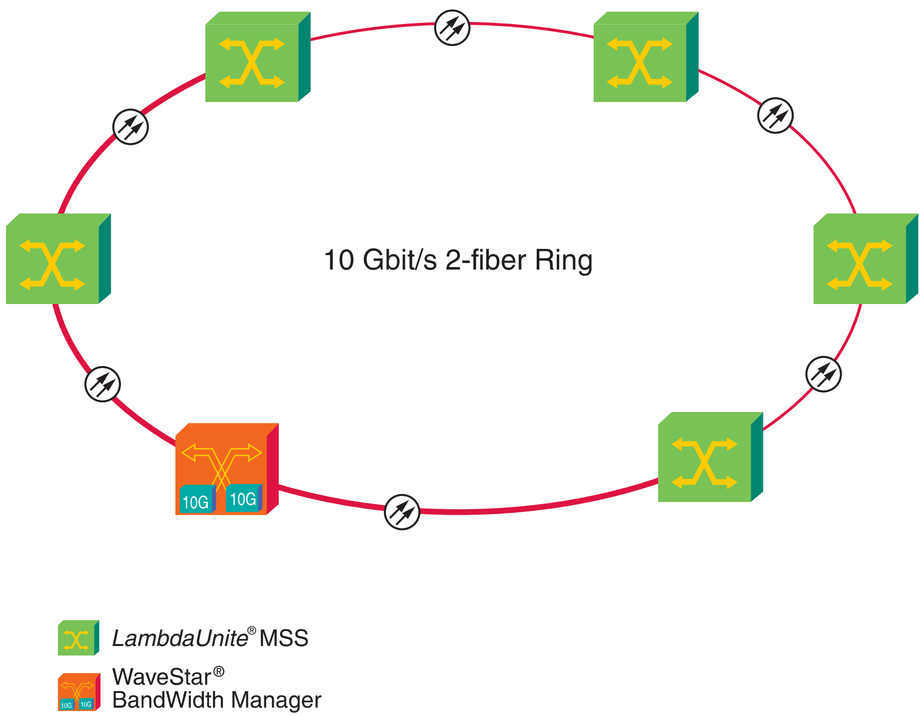
What is *WaveStar*® BandWidth Manager?

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 unit 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, via 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s or 155-Mbit/s interfaces to *LambdaUnite*® MSS.

□

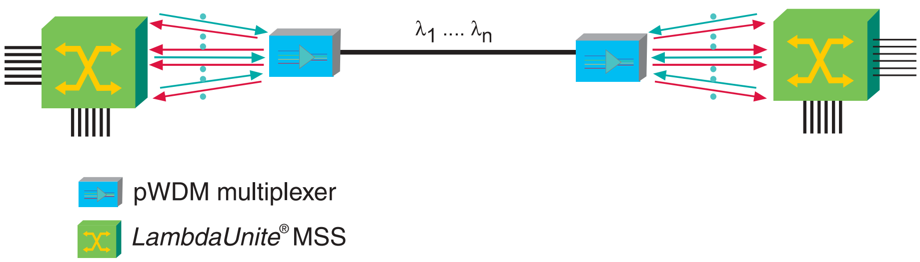
Interworking with Wavelength Division Multiplexing

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

Via the pWDM interfaces *LambdaUnite*® MSS can interwork with the particular Original Equipment Manufacturer (OEM) pWDM multiplexer, as illustrated in the following figure. Up to 32 different 10-Gbit/s or 2.5-Gbit/s signals can be passively multiplexed into a single fiber and transported cost-efficiently over short and intermediate distances this way.



For further information about the OEM pWDM multiplexer please refer to the Appendix D of the *LambdaUnite*® MSS Installation Guide.

The *LambdaUnite*® MSS interfaces for pWDM applications are:

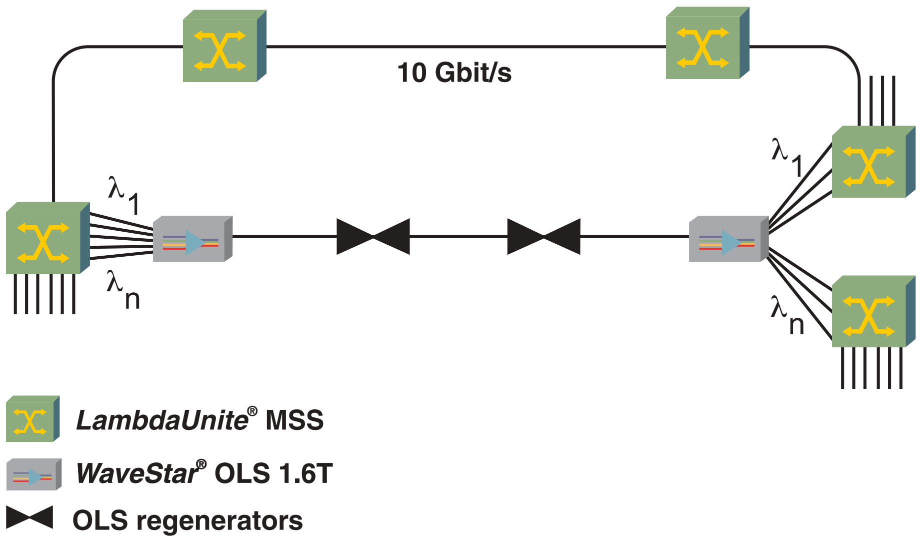
- 10-Gbit/s intermediate reach / short haul interface, 1550 nm, pWDM compatible, 16 wavelengths
- 2.5-Gbit/s pWDM compatible interface (parent board with optical modules), 32 wavelengths.

Dense WDM

Dense Wavelength Division Multiplexing (DWDM) systems can be used with the *LambdaUnite*® MSS for cost-efficient data transport over long and intermediate distances:

- *LambdaXtreme*™ Transport
- *WaveStar*® Optical Line System (OLS) 1.6T
- *Metropolis*® Enhanced Optical Networking (EON).

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.



LambdaXtreme™ Transport

With *LambdaXtreme*™ Transport the traffic of up to 64 different 40-Gbit/s signals can be transmitted via one single optical fiber. Using special lasers ("colored laser") in the *LambdaUnite®* MSS system, which all have their individual wavelengths, it is possible to connect the 40-Gbit/s interfaces of *LambdaUnite®* MSS directly to *LambdaXtreme*™ Transport.

Alternatively, Optical Translators (OTs) can be used to translate the out-coming wavelength of the 40-Gbit/s interfaces and 10-Gbit/s interface to wavelengths specified for DWDM systems.

Distances of up to 4000 km can be bridged by using *LambdaXtreme*™ Transport together with *LambdaUnite®* MSS.

WaveStar® OLS 1.6T and *Metropolis®* EON

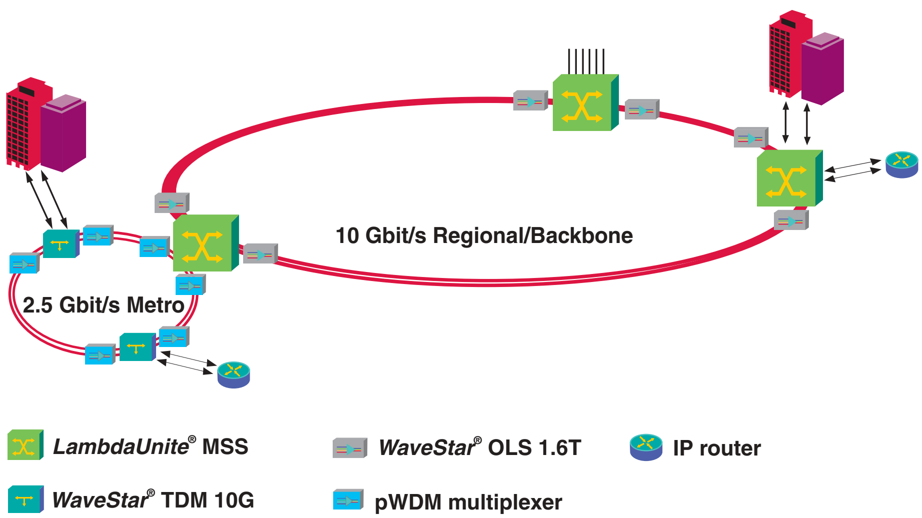
Using the *WaveStar®* OLS 1.6T, the traffic of up to 80 different 10-Gbit/s signals, with the *Metropolis®* EON up to 32 different 10-Gbit/s signals can be transmitted via one single optical line. Using special lasers ("colored laser") in the *LambdaUnite®* MSS system, which all have their individual wavelengths, it is possible to connect the 10-Gbit/s interfaces of *LambdaUnite®* MSS directly to *WaveStar®* OLS 1.6T.

With *Metropolis®* EON and *WaveStar®* OLS 1.6T Optical Translator Units (OTUs) can be used to translate the out-coming wavelength of the 10-Gbit/s and 2.5-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 together with *LambdaUnite*® MSS, and for the *Metropolis*® EON distances up to 640 km can be bridged together with *LambdaUnite*® MSS.

Combined interworking with DWDM and PWDM

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



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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

The *LambdaUnite®* MSS system architecture is based on a full non-blocking switch matrix with STS-1/VC-3 granularity. In the present release main switching units with the following capacities are available: 160-Gbit/s, 320-Gbit/s, and 640-Gbit/s. The granularity range can be extended down to VT1.5/VC-12 with a specific lower-order switching matrix.

LambdaUnite® MSS provides 32 universal slots, which can be flexible configured in 320-Gbit/s configurations with 40-Gbit/s, 10-Gbit/s (synchronous and Ethernet WANPHY), 2.5-Gbit/s, 622-Mbit/s, 155-Mbit/s and 1-Gbit/s Ethernet optical interface circuit packs , as well as 155-Mbit/s STM-1 and 45 Mbit/s DS3 electrical interface circuit packs. In 160-Gbit/s configurations the lower row is not operative, but the upper row can be flexible configured like mentioned above.

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

For further information about configuration and location rules please refer to "Port location rules " (p. 6-10).

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-connection 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).

With the Optical Network Navigation System (ONNS) *LambdaUnite®* MSS provides automatic connection set-up and removal, automatic restoration and automatic topology discovery in meshed topologies. Due to the flexible architecture *LambdaUnite®* MSS allows to integrate ONNS domains into existing classical networks. For further information please refer to "Optical Network Navigation System (ONNS)" (p. 2-54).

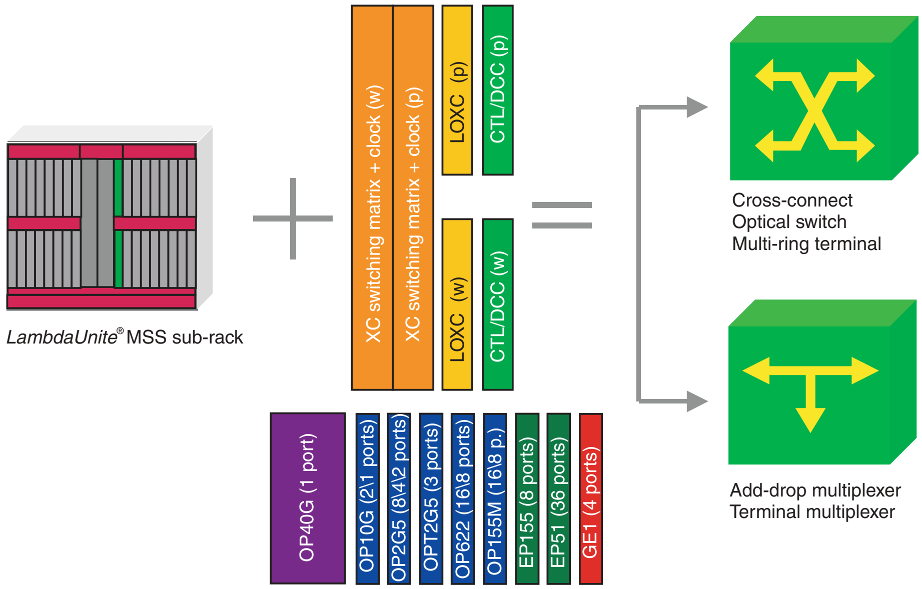
Halogen free cables

LambdaUnite® MSS systems can be ordered with halogen-free internal and external cabling.

Basic architecture

The basic *LambdaUnite®* MSS architecture as outlined here covers the network element as a whole. The required number of the different plug-in units will be discussed later in this chapter.

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



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Transmission architecture

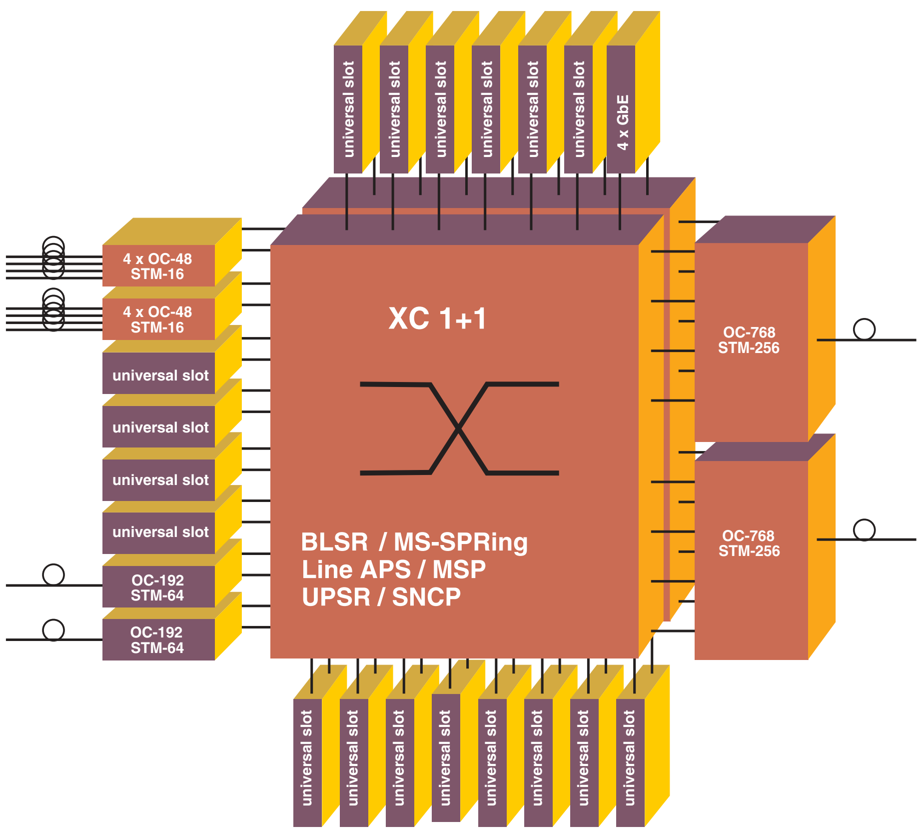
The *LambdaUnite*® MSS transmission architecture is based on a centralized switching unit which is 1+1 protected. All traffic from/to the ports is fed to the central switch.

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 to one of three LAN ports, or remotely via DCC channels.

Block diagram

The following figure shows a block diagram of the transmission architecture of the *LambdaUnite*® MSS shelf, operating the 320-Gbit/s switching units.



□

Switch function

All traffic from/to port units is fed from/to the main switching unit (XC160, XC320 or XC640).

Switching capabilities

The total fully-non-blocking switching capacity is 160 Gbit/s (3072 STS-1 / 1024 VC-4), respectively 320 Gbit/s (6144 STS-1 / 2048 VC-4), or 640 Gbit/s (12288 STS-1 / 4096 VC-4). 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 unit.

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 2.5-Gbit/s transmission lines, the so called TXI (Transmission Exchange Interface) channels on the backplane directly towards the switch; the switch execution is done in hardware. Therefore, no interaction with the 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 units are 1+1 equipment protected (c.f. “Block diagram” (p. 4-4) on the previous pages).

☐

Shelf configurations

This section provides information about the different elements of *LambdaUnite*® MSS and its configurations.

Shelf overview

The *LambdaUnite*® MSS shelf provides the facilities to house the circuit packs. It consists of the mechanics, a backplane, a user panel and interface paddle boards (see "Interface paddle boards" (p. 4-10)) for the connections to the customer's infrastructure.

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

Optical interfaces

All optical ports bear LC connectors and are located on the front side of the subrack. If *LambdaUnite*® MSS is mounted in a rack with doors you must use fiber connectors with angled boots.

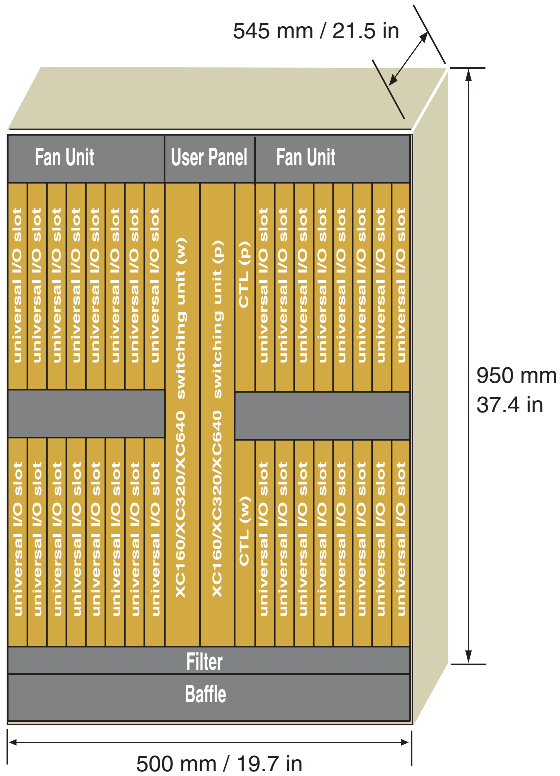
Electrical interfaces

All electrical transmission ports are located on electrical connection interfaces (ECIs) that can be inserted on the rear side of the subrack. The electrical transmission unit however is to be inserted on the front side of the subrack in the upper unit row. The ECIs are inserted on the rear side corresponding to the respective circuit pack positions. For further information about the ECIs please refer to "Interface paddle boards" (p. 4-10).

Important! For electrical transmission interfaces the use of rack extensions is recommended.

Shelf layout

The following figure depicts the *LambdaUnite*® MSS shelf slots.



Circuit pack slots

The following table identifies the circuit pack slots of the *LambdaUnite*® MSS shelf. For additional information about the transmission units please refer to Chapter 10, "Technical specifications".

Slot designation	Slot equipage
Universal slots (32)	Any mix of transmission interface circuit packs: • 40-Gbit/s port units • 10-Gbit/s synchronous and Ethernet WANPHY port units • 2.5-Gbit/s port units • 622-Mbit/s port units • optical 155-Mbit/s port units • electrical 155-Mbit/s port units (can be inserted only into the upper 16 universal slots) • electrical 45- /51-Mbit/s port units (can be inserted only into the upper 16 universal slots) • 1-Gigabit Ethernet interface
Controller slot (working)	Working CTL unit. System controller including non-volatile memory and DCC controller for the whole network element.
Controller slot (protection)	Protection CTL unit. Redundant system controller including non-volatile memory and DCC controller for the whole network element. After initial power up of the system one of the two CTLs is in standby mode.
XCW (switching unit working)	The switching circuit pack in this slot is paired with XCP switching unit (protection) in a 1+1 non-revertive protection mode configuration. Furthermore, this circuit pack contains the timing generator function for the NE.
XCP (switching unit protection)	The switching circuit pack in this slot is paired with XCW switching unit (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 one of the two XCs is in standby mode.

Minimum configuration of plug-in units

The minimum recommended complement of plug-in units required for an operational *LambdaUnite®* MSS shelf is

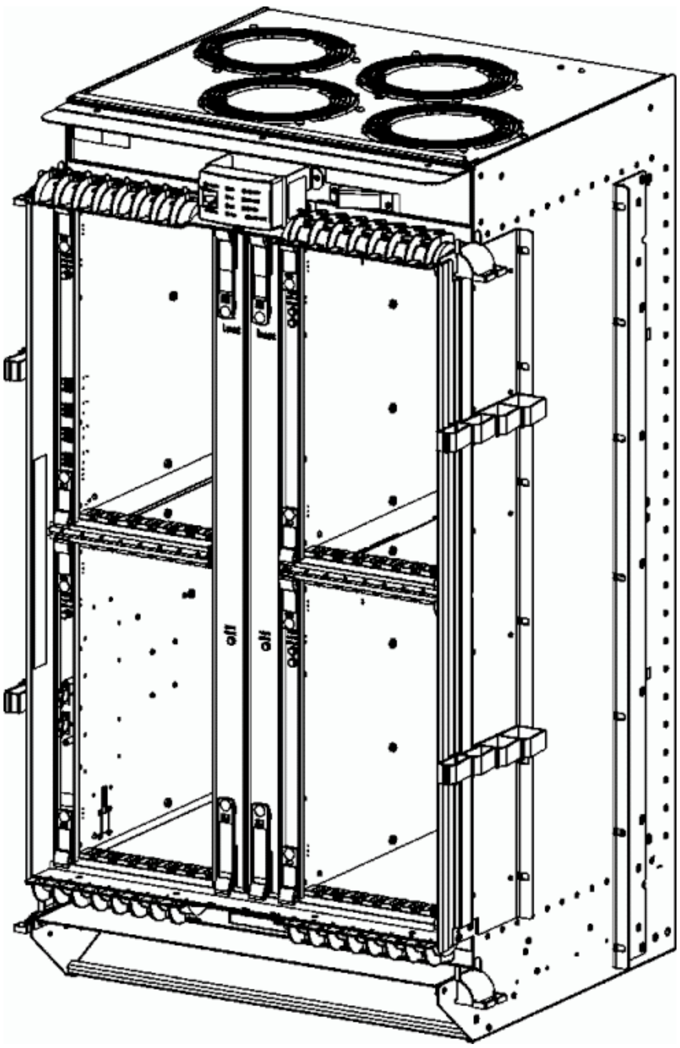
- two switching units, one working and one protection
- one controller unit (traditional applications) or two controller units, one working and one protection (ONNS functionality)
- the required transmission units in the universal slots.

A shelf equipped with these circuit packs would be fully functional. If ONNS applications are not used, the CTL redundancy is not required.

Other essential parts of the system are the User Panel, the Power Interfaces (PI), the fan unit, and the Controller Interface (CI-CTL); these parts are subsumed in the core assembly kits, delivered already mounted in the subrack.

Front view of *LambdaUnite®* MSS sub-rack

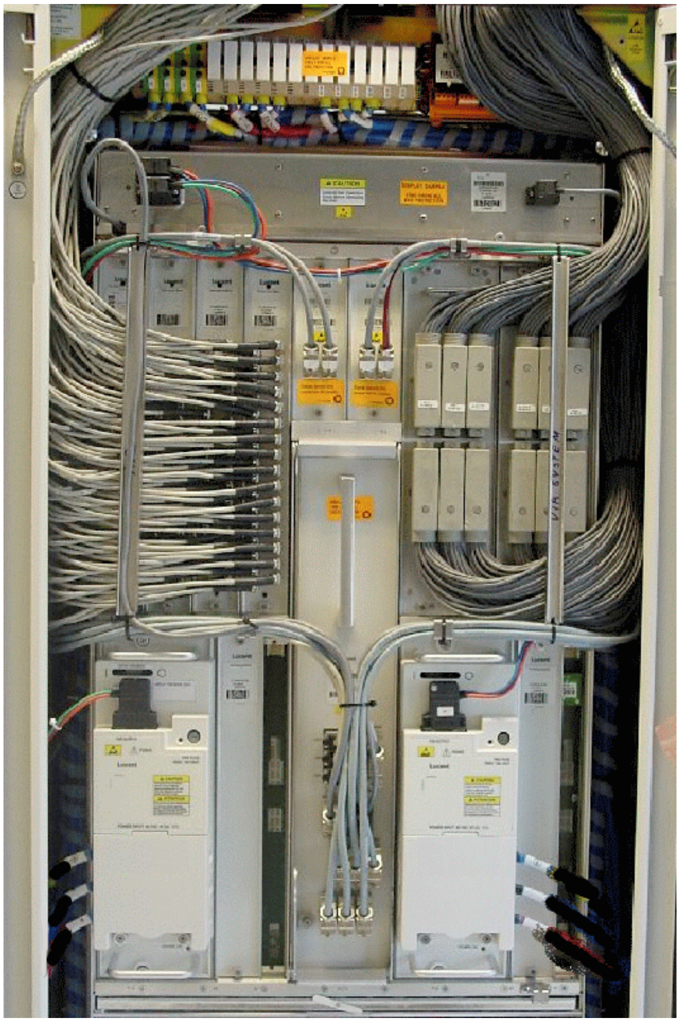
In the following figure a front view of a *LambdaUnite®* MSS sub-rack is shown, with a partial equipage.



The sub-rack is equipped with two controller units, one 2.5-Gbit/s interface, one 10-Gbit/s interface, and two blank face plates in the XCW/XCP slots; for operation these blank face plates must be replaced by XC packs, and the empty slots must be covered by blank face plates. We can also distinguish the four fans of the fan unit on top of the sub-rack, the user panel in front of the fan unit, and the fiber trays next to the subrack, at the sides and at the bottom of it.

Rear view of *LambdaUnite*® MSS sub-rack

The following figure shows a rear view of a *LambdaUnite*® MSS sub-rack with the different interface paddle boards as listed below.



Interface paddle boards

A variety of interface paddle boards provide connection between customer cabling and the backplane. All the universal slots for transmission units are located on the front of the subrack, whereas all the interface paddle boards are inserted at the rear side of the subrack.

The following interface paddle boards can be inserted into the *LambdaUnite®* MSS shelf:

- Two Timing Interfaces (TI) in the upper center part, providing external timing inputs/outputs
- One Controller Interface (CI-CTL) in the center, provides the external LAN interface, station alarm interface, MDI/MDO interface, user byte interface and interface for cables to User Panel and Fan Unit.
- Two Power Interfaces (PI) in the lower part of the back plane.
- Up to eight ECIs for EP155 operation (upper right part of the figure), two-slots wide, for the electrical 155-Mbit/s transmission units. The ECIs are inserted into the upper row of the back plane, corresponding to the circuit pack positions.

  There are two types of ECI for the electrical EP155 circuit packs:
  - ECI 155ME8 with 32 coax connectors (16 ports), providing connection for two unprotected 155-Mbit/s electrical transmission units , and
  - ECI 155MP8 with 16 coax connectors (8 ports), providing connection for one 155-Mbit/s electrical 1+1 protection pair: one worker unit and one protection unit.
- Up to four ECIs for EP51 operation (upper left part of the figure), four-slots wide, for the electrical 51- and 45-Mbit/s transmission units. The ECIs are inserted into the upper row of the back plane, corresponding to the circuit pack positions.

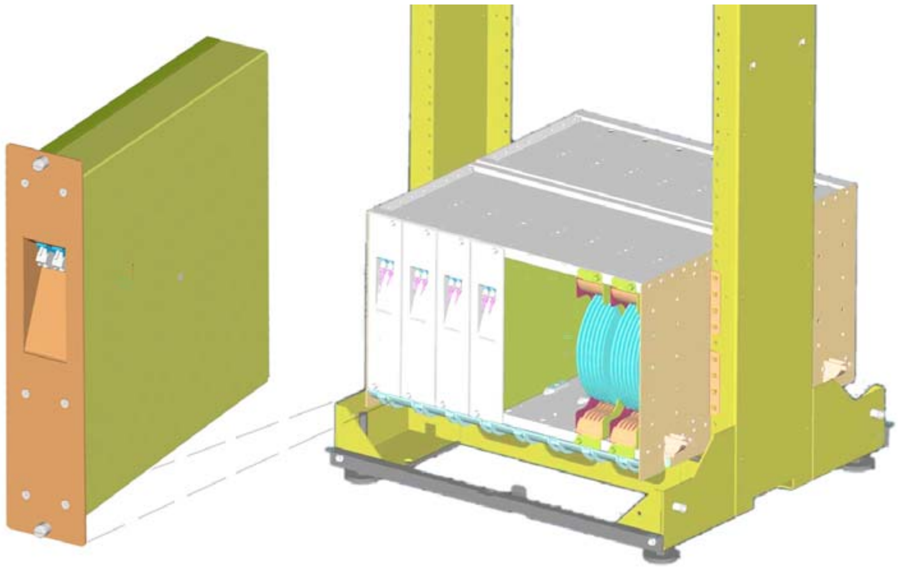
  This ECI bears 72 ports, providing connection
  - for up to two unprotected 45- /51-Mbit/s electrical transmission units, or
  - for up to two 45- /51-Mbit/s electrical 1+1 protection pairs, one worker unit and one protection unit each.

  Please note that for the transport of electrical signals the use of rack extensions is recommended, see also “Rack extensions” (p. 6-15).
  For more information about the configuration please refer to “Port location rules ” (p. 6-10).

LambdaUnite® MSS storage subrack

For the storage of Dispersion Compensation Modules (DCM) and overlength fiber *LambdaUnite®* MSS offers a special storage subrack. Up to eight DCM-s or overlength reels fit into one storage subrack, and the storage subracks can be mounted in the *LambdaUnite®* MSS rack, also in a back-to-back configuration.

The following figure shows a DCM and two *LambdaUnite®* MSS storage subracks, mounted back-to-back in a bottom position of the rack. In this drawing the storage subrack in the front is partially equipped with four DCM-s on the left hand side, and with two fiber overlength storage boxes on the right hand side; two slots in between are left empty.



□

Circuit packs

The circuit packs supported by *LambdaUnite*® MSS can be divided in two groups:

- *prime plug-in units*, inserted directly into the slots of the sub-rack (refer to "Circuit pack slots " (p. 4-7))
- *optical interface modules*, hosted by special prime plug-in units, so called *parent boards*.

Types of prime plug-in units supported by *LambdaUnite*® MSS:

Short Name	Function	Ports per pack	Max. units per shelf	Max. ports per shelf
OP40	optical I/O pack OC-768 / STM-256	1	8	8
OP10	optical I/O pack OC-192 / STM-64 / PWDM / 10-Gbit/s Ethernet WANPHY	1	32	32
OP10D/PAR2	optical I/O parent board for OC-192 / STM-64 optical interface modules	2	32	64
OP2G5	optical I/O pack OC-48 / STM-16	4	32	128
OP2G5/PARENT	optical I/O parent board with OC-48 / STM-16 PWDM modules	2	32	64
OP2G5D/PAR8	optical I/O parent board for OC-48 / STM-16 optical SFP interface modules	8	32	256
OPT2G5/PAR4	transparent optical I/O parent board for OC-48 / STM-16 optical SFP interface modules	4	32	128
OPT2G5/PAR3	transparent optical I/O parent board for OC-48 / STM-16 optical SFP interface modules	3	32	96
OPLB/PAR8	optical I/O parent board for OC-12 / STM-4 or OC-3 / STM-1 optical SFP interface modules	8	32	256
OP622	optical I/O pack OC-12 / STM-4	16	32	512
OP155M	optical I/O pack OC-3 / STM-1	16	32	512
EP155	electrical I/O pack STM-1	8	16	128
EP51	electrical I/O pack DS3/EC1	36	16	288
GE1	1-Gigabit Ethernet optical I/O pack	4	32	128

Short Name	Function	Ports per pack	Max. units per shelf	Max. ports per shelf
XC160	XC with 160 Gbit/s capacity (switching matrix incl. timing generator, ONNS capable, 1+1 protection recommended, upgradable)	n/a	2	n/a
XC320/B	XC with 320 Gbit/s capacity (switching matrix incl. timing generator, ONNS capable, 1+1 protection recommended, upgradable)	n/a	2	n/a
XC640	XC with 640 Gbit/s capacity (switching matrix incl. timing generator, ONNS capable, 1+1 protection recommended)	n/a	2	n/a
LOXC	lower-order cross-connection unit (switching matrix for VC-3 lower-order, for VC-12, and for VT1.5 traffic; 1+1 protection recommended, upgradable to a higher capacity LOXC in a future release)	n/a	2	n/a
CTL/	system controller and DCC controller unit (1+1 protection optional)	n/a	2	n/a
CTL/2	system controller and DCC controller unit ONNS capable (1+1 protection for ONNS recommended)	n/a	2	n/a
CTL/3T	system controller and DCC controller unit with enhanced performance (no ONNS capability)	n/a	2	n/a
CTL/3S	system controller and DCC controller unit with enhanced performance, ONNS capable (1+1 protection for ONNS recommended)	n/a	2	n/a
CTL/4T	system controller and DCC controller unit (no ONNS capability)	n/a	2	n/a
CTL/4S	system controller and DCC controller unit, ONNS capable (1+1 protection for ONNS recommended)	n/a	2	n/a

Types of optical interface modules supported by *LambdaUnite®* MSS:

Short Name	Function	Parent board	Max. ports per board	Max. ports per shelf
OM10	optical interface module OC-912 / STM-64	OP10D/ PAR2	2	64
OM2G5/PWDM	optical PWDM interface module OC-48 / STM-16; factory mounted in	OP2G5/ PARENT	2	64
OM2G5	optical SFP interface module OC-48 / STM-16	OP2G5D/ PAR8 and OPT2G5/ PAR3	8	256
OM622	optical SFP interface module OC-12 / STM-4	OPLB/PAR8	8	256
OM155	optical SFP interface module OC-3 / STM-1			

All these circuit packs can be inserted into *LambdaUnite®* MSS with a high flexibility. For details please refer to "Port location rules " (p. 6-10).

For the optical I/O packs, there is a second level of identification (qualifier) which carries information about reach, wavelength and other variants, e.g.: OP10/1.5LR1, or OP40/1.3IOR1 (see Chapter 10, "Technical specifications").

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

Optical transmission units OP40

For interfacing to optical 40-Gbit/s signals, *LambdaUnite®* MSS can be equipped with the OP40 circuit pack which is available in the present release in the following variants:

- 40-Gbit/s long reach interface (80 km), 1550 nm, with provisionable out-of-band FEC
- 40-Gbit/s intra-office interface (2 km), 1300 nm
- 40-Gbit/s interface for direct *LambdaXtreme™* Transport interworking, 64 colors, with provisionable out-of-band FEC.

The electrical-to-optical and optical-to-electrical conversion is provided by the optics module(s) of these circuit packs. Different 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 4 x 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 4 x 16 times 622-Mbit/s TXI interfaces. The pointer processor itself provides the interface to the backplane with 16 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 (XC160, XC320, or XC640) 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 transmission units OP10

For interfacing to optical 10-Gbit/s signals, *LambdaUnite®* MSS can be equipped with the OP10 circuit pack which is available in the following variants:

- 10-Gbit/s long reach interface (80 km), 1550 nm
- 10-Gbit/s intermediate reach / short haul and WANPHY Ethernet interface (40 km), 1550 nm
- 10-Gbit/s long reach / long haul hot-pluggable optical interface module (80 km), 1550 nm
- 10-Gbit/s intermediate reach / short haul hot-pluggable optical interface module (40 km), 1550 nm
- 10-Gbit/s intra-office hot-pluggable optical interface module (600 m), 1310 nm
- 10-Gbit/s intra-office interface (600 m), 1310 nm
- 10-Gbit/s interface for direct OLS 1.6T interworking, 80 colors, with provisionable out-of-band FEC
- 10-Gbit/s intermediate reach / short haul interface circuit pack (36 km), 1.5 µm, pWDM compatible, 16 wavelengths

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 (XC160, XC320, or XC640) 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).

The 40 km interface supports besides the SONET/SDH protocol also the 10-Gbit/s Ethernet WANPHY protocol. It is not fully compliant to IEEE 802.3ae but interworkable, accepting some limitations:

- No support for transparent loop setting
- Different K1/K2 default value
- No support for jitter test mode.

Optical transmission units OP2G5

For interfacing to optical 2.5-Gbit/s signals, *LambdaUnite®* MSS can be equipped with OP2G5 circuit packs respectively the Small Form Factor Pluggable (SFP) parent board or the pWDM parent board, available in the current release in the following variants:

- 2.5-Gbit/s long reach interface (80 km), 1550 nm, 4 ports
- 2.5-Gbit/s long reach interface (40 km), 1310 nm, 4 port.
- 2.5-Gbit/s intra-office interface (2 km), 1310 nm, 4 ports
- 2.5-Gbit/s long reach optical Small Form Factor Pluggable (SFP) interface module (80 km), 1550 nm
- 2.5-Gbit/s long reach optical Small Form Factor Pluggable (SFP) interface module (40 km), 1310 nm
- 2.5-Gbit/s short reach / intra-office optical SFP interface module (2 km), 1310 nm
- 2.5-Gbit/s long reach interface module (40 km), 1,5 µm, pWDM compatible, 32 wavelengths; two are factory-mounted in the pWDM parent board (OP2G5/PARENT).

For the SFP parent board and the respective optical interface modules please observe the configuration rules described in “Port location rules ” (p. 6-10).

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 (XC160, XC320, or XC640) 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).

Transparent optical transmission units OPT2G5/PAR3

For transparently transporting optical 2.5-Gbit/s signals, *LambdaUnite*® MSS can be equipped with OPT2G5/PAR3 circuit packs, each bearing three sockets for the following SFP modules:

- 2.5-Gbit/s long reach optical Small Form Factor Pluggable (SFP) interface module (80 km), 1550 nm
- 2.5-Gbit/s long reach optical Small Form Factor Pluggable (SFP) interface module (40 km), 1310 nm
- 2.5-Gbit/s short reach / intra-office optical SFP interface module (2 km), 1310 nm

For the SFP parent board and the respective optical interface modules please observe the configuration rules described in “Port location rules ” (p. 6-10).

The optical specifications depend on the SFP used; please refer to the specifications of the single SFP.

The main features of the OPT2G5/PAR3 are

- 3 port OC-48 or STM-16
- optical SFP modules as used on other 2.5-Gbit/s circuit packs in *LambdaUnite*® MSS
- hot pluggability for optical modules
- virtual concatenation, mapping into STS-3c-17v / VC-4-17v
- differential delay compensation for VCG members up to 32 ms (measured between the fastest and slowest VCG member)
- client signal SONET/SDH section/RS non-intrusive monitoring on ingress and egress
- consequent action configurable on egress: (generic AIS) OR (MS-AIS) OR (Laser OFF) upon diverse defects, such as LOF, path defects, VC group defects, mapping defects; ingress consequent action generic AIS
- ingress/egress fixed position/sequence of VC group per port

The electrical-to-optical and optical-to-electrical conversion is provided by the SFP module.

The MUX/DEMUX devices interface to the byte and pointer processor device by 5 times 622-Mbit/s interfaces each.

The byte and pointer processor provides the interface to the backplane by mapping the five 622-Mbit/s streams per port into the 2.5-Gbit/s TXI interfaces. The TXIs are doubled at the byte and pointer processor, connecting to the working or the protection switch circuit pack (XC160, XC320, or XC640) 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).

Optical transmission unit OP622

For interfacing to sixteen optical 622-Mbit/s signals, *LambdaUnite®* MSS can be equipped with the OP622 circuit pack which is available in the current release in the following variant:

- 622-Mbit/s long reach / long haul optical SFP interface module (80 km), 1530 nm
- 622-Mbit/s long reach / long haul optical SFP interface module (40 km), 1310 nm
- 622-Mbit/s intermediate reach / short haul optical SFP interface module (15 km), 1310 nm
- 622-Mbit/s intermediate reach interface (15 km), 1310 nm, 16 ports.

The electrical-to-optical and optical-to-electrical conversion is provided by the optical transceiver, which interfaces to a MUX/DEMUX device.

The MUX/DEMUX devices interface to the byte and pointer processor device by one 622-Mbit/s interface.

The byte and pointer processor provides the interface to the backplane with a 2.5-Gbit/s TXI interface. The 2.5-Gbit/s TXIs are doubled at the byte and pointer processor, connecting to the working or the protection switch circuit pack (XC160, XC320, or XC640) 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).

Important! For this transmission unit only so called optical break-out cables (bundles of 12 single mode fibers) should be used.

Optical transmission unit OP155M

For interfacing to sixteen optical 155-Mbit/s signals, *LambdaUnite®* MSS can be equipped with the OP155M circuit pack which is available in the current release in the following variant:

- 155-Mbit/s intermediate reach interface (15 km), 1310 nm, 16 ports.
- 155-Mbit/s long reach / long haul optical SFP interface module (80 km), 1530 nm

- 155-Mbit/s long reach / long haul optical SFP interface module (40 km), 1310 nm
- 155-Mbit/s intermediate reach / short haul optical SFP interface module (15 km), 1310 nm

The electrical-to-optical and optical-to-electrical conversion is provided by the optical transceiver, which interfaces to a MUX/DEMUX device.

The MUX/DEMUX devices interface to the byte and pointer processor device by a 622-Mbit/s interface.

The byte and pointer processor provides the interface to the backplane with a 2.5-Gbit/s TXI interface. The 2.5-Gbit/s TXIs are doubled at the byte and pointer processor, connecting to the working or the protection switch circuit pack (XC160, XC320, or XC640) 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).

Important! For this transmission unit only so called optical break-out cables (bundles of 12 single mode fibers) should be used.

Electrical transmission unit EP155

For interfacing to eight electrical 155-Mbit/s signals, *LambdaUnite*® MSS can be equipped with the EP155 circuit pack which is available in the current release in the following variant:

- 155-Mbit/s intra-office electrical interface for STM-1 signals, 8 ports.

The MUX/DEMUX devices interface to the byte and pointer processor device by a 622-Mbit/s interface.

The byte and pointer processor provides the interface to the backplane with a 2.5-Gbit/s TXI interface. The 2.5-Gbit/s TXIs are doubled at the byte and pointer processor, connecting to the working or the protection switch circuit pack (XC160, XC320, or XC640) 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).

Important! For this transmission unit the use of rack extensions is recommended, see also “Rack extensions” (p. 6-15).

Electrical transmission unit EP51

For interfacing to 36 electrical DS3/EC1 signals, *LambdaUnite®* MSS can be equipped with the EP51 circuit pack which is available in the current release in the following variant:

- 45- /51-Mbit/s intra-office electrical interface for DS3/EC1 signals, 36 ports.

The EP51 supports the following formats:

- EC1
- DS3 M23
- DS3 C-bit
- DS3 unframed or “clear channel.”

The DS3/EC1 signal is transported transparently through the SONET/SDH network, that means no change of DS3/EC1 data takes place. (exception the P- bit used for parity calculation can be inserted newly).

To perform the electrical conversion and to detect LOS so called LIU (Line Interface Unit) devices are used. Each of them supports 12 DS3/EC1 channels.

In case of DS3 it performs all relevant fault and performance functions, performs the mapping demapping to/from STS-1 and terminates the STS-1 path. In case of EC-1 it performs all relevant SONET functions (line/section termination / path monitoring, clock adaptation via pointer processing). Subsequently the 12 STS-1 channels are multiplexed into a TXI622 channel. These TXI622 channels are then adapted to the system internal TXI2G5 interfaces (only one out of 4 TXI2G5 is used), and broadcast respectively selected to and from the working and protection TXI2G5.

The timing function 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.

Note that the card cannot be used as a timing source. (the device is able to monitor the S1 byte (timing marker) but there is no reference clock output available).

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

> **Important!** For this transmission unit the use of rack extensions is recommended, see also “Rack extensions” (p. 6-15).

Gigabit Ethernet transmission unit GE1

For interfacing to four optical 1-Gbit/s Ethernet signals, *LambdaUnite®* MSS can be equipped with the GE1/SX4 or with the GE1/LX4 circuit pack. Each port provides a 1000Base-SX / 1000Base-LX optical Ethernet interface.

The Ethernet ports consist of an external optical LAN port that is connected to an internal synchronous WAN port via a crossbar device. An internal function controller is used for on-board control and supervision purposes.

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

The internal 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 internal function controller is built around an MPC860 processor. The asset uses 4 MB of Flash memory and 16 MB 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.

Main switching unit

There are three types of the main switching unit (XC) available: the XC160, the XC320, and the XC640. They are connected with the interface units via the backplane bus (TXI). The main switching unit is a bit-sliced switching matrix for up to 3072 STS-1 or 1024 VC-4 (XC160), respectively 6144 STS-1 or 2048 VC-4 (XC320), respectively 12288 STS-1 or 4096 VC-4 (XC640) level signals. The bit-sliced data is generated in the data converter device, it will be desliced in the data converter after the XC. MS-SPRing/BLSR, 1+1 line APS / 1+1 MSP and SNCP/UPSR switching is supported on the switching unit.

The main switching unit 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 switching matrix device. In the switching 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 switching matrix devices is collected and desliced in the data converter devices before it leaves the main switching unit.

Timing generator function

The timing generator function in the *LambdaUnite®* MSS network element is physically implemented on the cross-connection circuit pack (XC160, XC320, and XC640). 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).

The available timing modes are:

- Free running
- Hold-over (entered automatically if all configured references fail)
- Locked with reference to:
  - one of the external synchronization inputs
  - one of all of the OC-N / STM-N input signals.

LambdaUnite® MSS provides 1+1 equipment protection for the timing function as part of the XC.

For more information on the timing architecture, please refer to "Synchronization" (p. 4-26).

Lower-order cross-connection unit

The lower-order cross-connection unit (LOXC) is designed to cross-connect lower-order traffic with a capacity of 15 Gbit/s in total (288 x 288 VC-3 (lower order), 6048 x 6048 VC-12 or 8064 x 8064 VT1.5). It is to be used in addition to the main switching units. In a future release lower-order cross-connects with higher capacities will be available.

The handling is user-friendly, employing a single-step approach: the user establishes only the port-to-port connection (client connection), while the internal connections between the XC and the LOXC (server connections) are provided accordingly, automatically by the NE.

The LOXC provides a non-blocking lower-order switching matrix. 15 Gbit/s switching capacity can be reached by cross-connecting lower-order traffic out of contiguously filled higher-order tributaries (288 STS-1 / 96 VC-4).

LambdaUnite® MSS provides 1+1 equipment protection for the LOXC units, that works independently from the XC protection.

A seamless upgrade to LOXC applications, implying the upgrade from either

- CTL/- to CTL/3T or
- CTL/2 to CTL/3S

is supported.

Controller unit

The controller unit (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.

Four different types of the controller unit are available, offering different functionalities:

Controller type	traditional SONET/SDH support	ONNS support	LOXC support
CTL/-	+	-	-
CTL/2	+	+	-
CTL/3T	+	-	+
CTL/3S	+	+	+
CTL/4T	+	-	-
CTL/4S	+	+	-

Note: The ONNS controllers support the additional Signalling Communication Network (SCN) to support the intelligent control plane. This control plane can be established by dedicated SCN DCC- channels for in-band signalling or by enabling the LAN port(s) for an out-of-band signalling channel.

The CTL maintains system configuration data and system software on an exchangeable *CompactFlash*® card of the following capacities:

- 256 MB for CTL/-
- 512 MB for CTL/2
- 1 GB for CTL/3T and CTL/3S.
- 256 MB for CTL/4T
- 512 MB for CTL/4S.

CompactFlash® cards can be ordered separately and have a own comcode:

- *CompactFlash*® card 256MB can be ordered via the comcode: 109197137
- *CompactFlash*® card 512MB can be ordered via the comcode: 109449710
- *CompactFlash*® card 1024MB can be ordered via the comcode: 109558544

A further 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.

The different controller units have different DCC capacities::

- CTL/- and CTL/2 support a maximum of
  - 64 regular section or line DCC links, respectively DCC_r or DCC_m links, and
  - 25 bidirectional (...50 unidirectional) transparent DCC links that cross-connect the DCC information transparently through the system from one port to another (without D-byte termination).

  The usage of regular DCCs does not interfere with the number of available transparent DCCs or vice versa.
- CTL/4T and CTL/4S support a maximum of 64 DCC terminations simultaneously. CTL/3T and CTL/3S support a maximum of 180 DCC terminations simultaneously.

  These DC channels can be
  - regular section or line DCC links, respectively DCC_r or DCC_m links
  - transparent DCC links that cross-connect the DCC information transparently through the system from one port to another (without D-byte termination).

  The number of available DCC terminations can be calculated using the formula: `(number of regular DCCs + 2 x (number of transparent DCCs)) ≤ maximum number of DCCs.`
  You can see that one transparent DCC equals two regular DCCs.

With the DCC slaving feature you can choose to switch the concerned DC channels together with line APS / MSP protection switching.

LambdaUnite® MSS provides 1+1 equipment protection for the controller unit.

Because of the extended importance of the controller unit in ONNS operations the 1+1 protection of the controller unit (redundancy) is highly recommended.

For further information please refer to “Optical Network Navigation System (ONNS)” (p. 2-54).

A further description of the control architecture can be found on “Control” (p. 4-31).

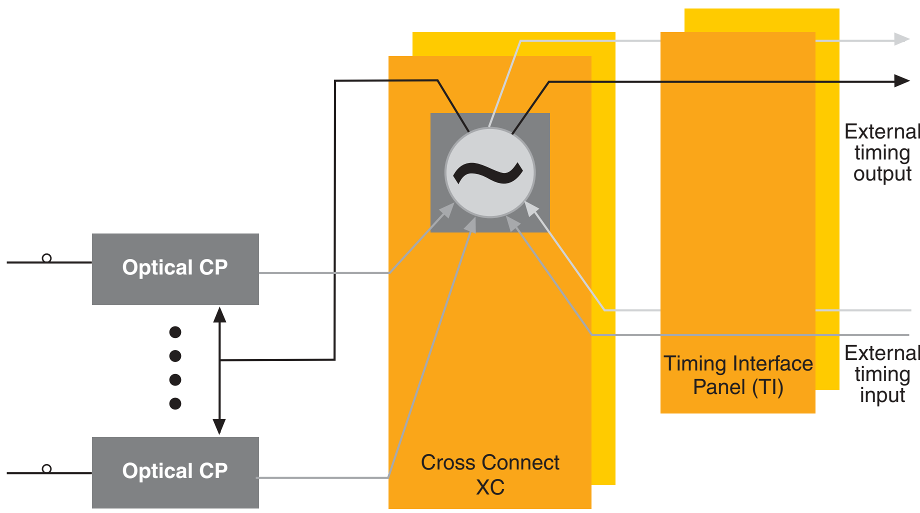
□

Synchronization

LambdaUnite® MSS synchronizes add, drop and through signals by using one timing source for all transmission. The system timing generator is normally locked to an external reference signal, such as a Primary Reference Source / Clock (PRS / PRC) or a line timing source. In the *LambdaUnite®* MSS shelf, the timing function is physically located on the switching circuit pack (XC160, XC320, and XC640). If two XC circuit packs are present in the NE, 1+1 non-revertive protection of the timing sources is provided.

Timing function on the XC 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

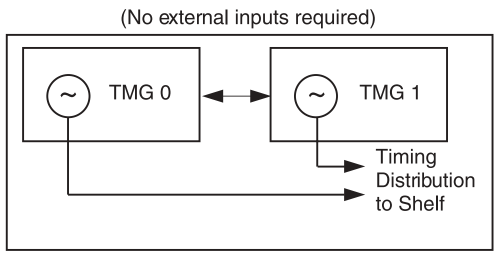
LambdaUnite® MSS runs in one of these synchronization modes:

- Free-running operation (Stratum 3 / SEC)
- Hold-over mode (entered automatically if all configured references fail; deviation from the last source max. 4.6 ppm in two weeks)
- Locked mode, with the internal Equipment Clock (Stratum 3 / SEC) locked to:
  - One of the two external netclock inputs; each of them is configurable for DS1, 2.048-MHz or 2-Mbit/s signals
  - One of up to six of the OC-n/STM-N input signals (choice of input is provisionable, maximum one per transmission unit).

Free running mode

In the free running mode, the timing generator on the active switching unit 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 switching unit.



Locked mode

In the locked mode, the timing functions on the switching units can be provisioned to accept a timing reference signal with a specified priority from

- synchronous line timing, one out of six, or
- external netclock timing, one out of two.

Only one of these reference signals can be active at a time. 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.

The timing function on the active switching unit synchronizes its internal Stratum 3 clock to the reference signal. The timing function on the standby XC 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.

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

Synchronous line timing

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

External netclock timing

Another possibility for the locked mode is to receive external reference timing. In this case the timing function on the active XC circuit pack receives a DS1 *Telcordia*™ (B8ZS, SF and ESF format; if in ESF format SSM is supported) or a 2.048-MHz, 2-Mbit/s ITU-T reference signal from the external netclock inputs.

Timing protection

LambdaUnite® MSS uses non-revertive 1+1 protection switching to protect its timing function. If the active XC 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, but the timing protection switching can be done manually.

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.

Holdover mode

The active timing generator enters the holdover mode if all configured 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 XC160/XC320/XC640 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.

Timing provisioning

The *LambdaUnite*® MSS synchronization features can be provisioned by using *WaveStar*® CIT or *Navis*® Optical EMS. 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.

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 synchronous signals is coded in the timing marker (also known as Synchronization Status Message, SSM) as per *Telcordia*™ GR-1244-CORE respectively ITU-T Rec. G.783 and G.707, located in four bits of the S1 byte. The S1 byte is located in the first STM-N frame (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.813	–
1100	–	–
1110	–	–
1111	Do Not Use for synchronization (DNU)	Do not Use for Synchronization (DUS)

The quality level "DNU/DUS" is inserted if AIS (Alarm Indication Signal), LOS (Loss Of Signal) or LOF (Loss Of Frame) 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 *Telcordia*™ DS1, 2.048-MHz or 2-Mbit/s signals. The external timing outputs will be squelched if the available timing quality drops below a configurable threshold.

The external timing outputs can be configured

- in SONET mode: external timing output 1 on line 1, external timing output 2 on line 2
- in SDH mode: it is possible either to use the system timing reference (derived from internal oscillator) or a timing reference independent from the system timing reference; in the latter case both external timing output are synchronized together on one of up to six configured line signals.

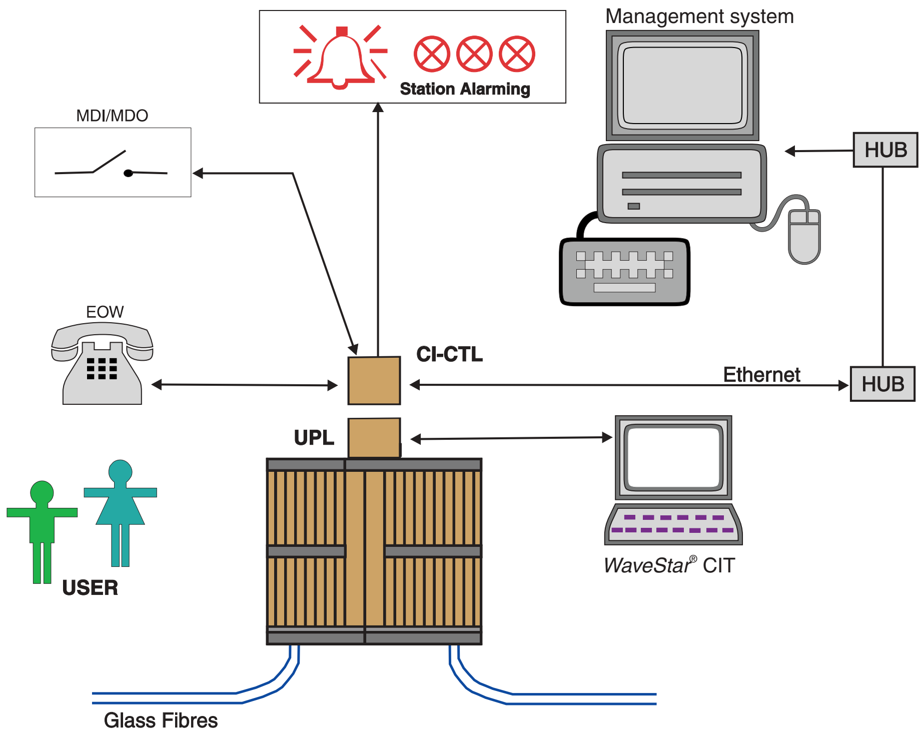
□

Control

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). The other circuit packs (OP40, OP10, OP2G5, OP622, OP155M, EP155, EP51, GE1 and XC160/XC320/XC640) 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 Protocol (EMP) control function is responsible for inventory data access, reset lines and equipment sensing (check physical availability of circuit packs).

In case of Data Communications Network (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 Craft Interface Terminal (CIT) at LAN ports forwarded via Controller Interface Protocol (CIP) to the DCF on CTL
- from the XC160/XC320/XC640 circuit pack where line DCC (DCCr) and section DCC (DCCm) are terminated via OverHead Interface (OHI) to the DCF on CTL.

Furthermore, the CTL is involved in user byte processing. The user bytes (E1, E2, F1) which are physically made available as 64-kbit/s channels at the Control Interface (CI), are fed to this interface via the XC160/XC320/XC640 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 XC160/XC320/XC640 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).

For further information about the controller features and capacities please refer to “Controller unit” (p. 4-24).

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Power

LambdaUnite® MSS uses a distributed powering system, rather than bulk power supplies. To maintain high availability the power interface is duplicated. The system power supply is able to provide 3500 W power in the range -40 V to -72 V DC, respectively -48 V to -60 V DC nominal. Each circuit pack uses its own onboard power converter to derive the necessary operating voltages.

For detailed information about the power consumption please refer to "System power consumption" (p. 6-3) and to "Weight and power consumption" (p. 10-31).

Power interfaces

The office power supply is filtered and protected by circuit breakers on the power interfaces (PI/100) at the input to the shelf - except when the special "breaker-less" power interface version is used. To each power feeder one power interface is assigned. After that, the power 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 power interfaces are supervised individually by the system controller circuit pack (CTL). A green LED on every Power Interface indicates that an appropriate input voltage is available, that means it is in the range between –40.5 VDC and –72 VDC. Once the input voltage out of this range, an alarm message will be sent to the CTL.

Circuit breaker specifications

The circuit breaker located on the regular power interface (not on the special "breaker-less" power interface version) is designed to support a maximum rated current of 100 A with a BS characteristic (medium delay). It provides protection according to the EN 60950 in the power range up to 3500 W, in particular in the range of 87.5 - 48.6 A at 40 - 72 V.

Power indicator

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

□

Cooling

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 with air filter is integrated in the lower part of the subrack to prevent the intake of particles or exhaust air from below.

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 system controller.

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

Air filter

The air filter, located below the subrack, must be replaced or cleaned under regular conditions (e.g. with Eurovent EU6 filters used in the HVAC) once every 3 months to ensure the proper cooling, as described in the User Operations Guide (UOG) chapter "Periodic activities" or as part of a trouble clearing procedure as described in the Alarm Messages And Trouble Clearing Guide (AMTCG).

☐

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*® Craft Interface Terminal (CIT)
- Operations interfaces

Please note that administration, maintenance, and provisioning activities via *Navis*® Optical Element Management System (EMS) respectively via the *Navis*® Optical Management System (OMS) are described in the separate *Navis*® Optical EMS respectively in the *Navis*® OMS 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

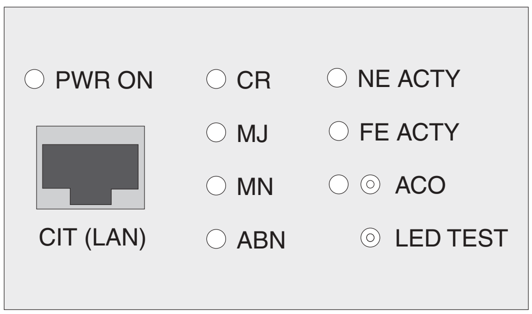
Visible alarm indicators

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)
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.

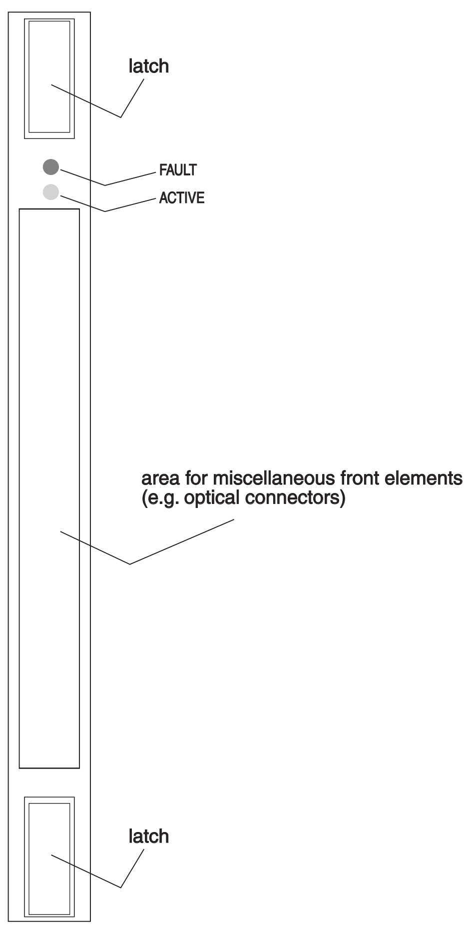
Controls and connectors

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 an Activity 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 during the boot process, for example after inserting a circuit pack into the shelf.

Gigabit Ethernet port LEDs

In addition to the circuit pack indicators the GE1 transmission unit bears two LEDs for each external Ethernet port, providing the following information:

- one green LED, indicating the link integrity
- one yellow LED, indicating transceived data.

SFP parent board LEDs

In addition to the circuit pack indicators the SFP parent board bears one red LED for each SFP socket, providing information about the status of the inserted plug-in module and the related port.

Further reading

For further information please refer to “Circuit pack status indicators” in the “Alarm management concepts” chapter of the *LambdaUnite®* MSS User Operations Guide.

□

WaveStar® CIT

LambdaUnite® MSS is shipped with a GUI that runs on a customer-furnished desktop or laptop computer that fulfills the requirements below. The *WaveStar®* CIT is always part of the respective NE software.

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®* processor with 800 MHz
- 512 MB RAM
- 2 GB of free hard drive space
- CD-ROM drive (16X)
- *CompactFlash®* card device
- SVGA monitor set with 1024x768 pixel resolution
- 100BaseT LAN interface, installed and working
- *Microsoft® Windows®* NT 4.0 service pack 6, *Windows®* 2000 service pack 2 or *Windows®* XP operating system
- *Adobe®Acrobat®* Reader for *Windows®* 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.

A shielded 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-connection 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

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, allow an Operations System (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

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, *Navis®* Optical Element Management System (EMS) and *Navis®* Optical Management System (OMS). The latter is a type of network-level OS element manager and network manager. It is able to collect the responses and autonomous messages from the Network Elements. The information it receives is used to perform fault correlation and diagnose problems in the network. The *Navis®* OMS concentrates the data links to/from NEs and directly addresses and manages the NEs, 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 *LambdaUnite*® MSS provides for secure system access by means of a two-tier security mechanism.

Contents

Security

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

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 *LambdaUnite*® MSS are stored and made available to be reported, on demand, through the *WaveStar*® CIT. In addition, a history of the 12000 most recent alarm events, of the 22000 most recent state change events and of the 2000 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

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.

Note that on ONNS I-NNI ports loopbacks are not allowed and therefore blocked by the system.

Software-initiated loopbacks

LambdaUnite® MSS can perform software-initiated facility loopbacks within the port units (near-end or in-loopbacks and far-end or out-loopbacks), as well as software-initiated cross-connection loopbacks. Active loopbacks are indicated by the abnormal (ABN) LED on the user panel.

Remote test access

The *LambdaUnite®* MSS remote test access feature provides the possibility to access and survey specific traffic for testing purposes. You can select individual tributaries on different tributary rate levels and in different test access modes, depending on the configuration and cross connection type you want to observe.

Further reading

For further information about the remote test access feature please refer to the chapter 17, “Alarm management concepts” of the *LambdaUnite®* MSS User Operations Guide.

Power on self-test

A Power ON Self Test (POST) is executed automatically after power up to verify correct system operation. This test consists of random access memory tests, of checksum tests and of specific tests for the hardware of the concerned unit they are performed in, such as controller pack, switching unit or transmission unit.

Additional diagnostic tests are performed for fault isolation, like for example bus, communication, temperature and voltage surveillance. 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 is identified by LEDs on the unit and by the alarm information displayed on the management software.

Circuit pack self-test

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

□

Protection switching

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, uni-directional and bi-directional, non-revertive and revertive , on all 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s optical port types, compliant with ANSI T1.105.01
- 1+1 Multiplex Section Protection (MSP), uni-directional and bi-directional, non-revertive and revertive , on all 10-Gbit/s optical port types, in a future release also on all 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s optical port types, compliant with ITU-T Rec. G.841
- 1+1 Multiplex Section Protection (MSP), optimized bi-directional, non-revertive, on all 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s optical port types, compliant with ITU-T Rec. G.841 including Annex B
- 1:1 Multiplex Section Protection (MSP), bi-directional, revertive, on all 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s optical port types
- Bidirectional Line Switched Ring (BLSR), compliant with ANSI T1.105.01
- Multiplex Section Shared Protection Ring (MS-SPRing), compliant with ITU-T Rec. G.841
- Transoceanic Protocol on 4-fiber MS-SPRing
- Uni-directional Path Switched Ring (UPSR) on all supported cross connection types, compliant with *Telcordia*™ GR-1400-CORE
- Sub-Network Connection Protection (SNCP) on all supported cross connection types, compliant with ETS 300417 and ITU-T Rec. G.783
- Mesh path protection (ONNS restoration), compliant with ITU-T Rec G.8070/Y.1301
- 1+1 redundancy for the electrical 155-Mbit/s interfaces is supported
- 1+1 redundancy for the electrical 45- /51-Mbit/s interfaces is supported
- 1+1 redundancy for the main switching unit with integrated timing generator (XC)
- 1+1 redundancy for the lower-order cross-connection unit (LOXC)
- 1+1 redundancy for the controller unit (Duplex CTL)
- 1+1 redundancy for the power feed throughout the system (load sharing mode)
- DCC protection in combination with port protection (slaving) is supported.

Please note that the described transmission protection types are not applicable to ports configured as ONNS ports.

1+1 Line APS (SONET), 1+1 MSP and 1:1 MSP (SDH)

One physical working connection is protected by one physical stand-by connection. For the supported switching protocols refer to "Line protection" (p. 2-35).

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.

Note that in the current release BLSR/MS-SPRing is not supported on the LOXC-switched transmission rates VT1.5, VC-12 and VC-3 (lower order).

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.

UPSR/SNCP is supported on all available cross-connection rates: from 1.5 Mbit/s up to 10 Gbit/s.

Mesh path protection (restoration)

Mesh path protection: ONNS enables end to end path protection. In case of a failure the "A" node, the node where the path set up was requested, starts a real time routing calculation to find an alternate route to restore the path. The routing is based on the availability of I-NNI ports. Once an alternate route is found ONNS establish the route and the traffic is restored.

Note that in the current release ONNS is not supported on the LOXC-switched transmission rates VT1.5, VC-12 and VC-3 (lower order).

Redundant switching unit

The switching matrix and the synchronization unit are located on the XC160/XC320/XC640 pack which is redundancy protected.

Duplex controller

The controller unit (CTL) is redundancy protected by a second CTL in the reserved CTL-P slot of the subrack (duplex CTL). The software and the configuration data is automatically distributed to the protection CTL, providing a memory back up.

Duplicated power feed

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

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Performance monitoring

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)

The following performance parameters are available to estimate the performance of a data connection (Ethernet):

- OR (number of Octets Received)
- OS (number of Octets Sent)
- IEPD (number of Incoming Errored Packets Dropped).

Enabling performance measurement points

Performance measurement points can be enabled via the management systems *Navis*® Optical EMS, *Navis*® OMS and via the *WaveStar*® CIT. Please refer to the *LambdaUnite*® MSS *User Operations Guide* or the respective management system documentation.

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	32	8 hours
24 hours	1	1 day

Data retrieval

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

Reports

Via *Navis*® OMS and *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.

Threshold reports

LambdaUnite® MSS supports threshold reports (TRs), also called threshold crossing alerts (TCAs). If the counter value of a performance monitoring parameter exceeds the threshold, a report can be generated and displayed on *Navis®* OMS, *Navis®* Optical EMS and *WaveStar®* CIT. This feature complies with *Telcordia*™ GR253-CORE (2000) and ITU-T G.784 and G.826.

For further information please refer to "Thresholding" in the chapter "Performance Monitoring Concepts" in the User Operations Guide.

Fault localization

Performance alarms give only 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 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.

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Reports

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.

Additionally the status “abnormal condition” is displayed on the user panel and by the *WaveStar®* CIT, if at least one of the following is true:

- the system is in maintenance condition
- the system timing is set to free running
- there is a loop back active
- there is forced switch active.

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.

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.

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Maintenance condition

Explanation of maintenance condition

The maintenance condition (or "maintenance mode") is an exceptional mode of operation characterized as follows:

- The internal communication between the Controller and the function controllers on circuit packs is disabled. Transmission services are *not* affected, and management communication, for example a *WaveStar*® CIT session, is still possible.
- A software download from the Controller to the function controllers on circuit packs is *not* possible.
- Only those autonomous state change events (i.e. also notifications) that do not change the active configuration database are allowed.
- Only a limited set of operations is allowed:
  - Changing the NE name (*only* possible in maintenance mode).
  - Setting the NE's date and time.
  - Changing the default value for the NE's synchronization mode (*only* possible in maintenance mode).
  - Changing the default value for the optical interface standard.
  - Changing the default value for the tributary operation mode.
  - Performing a database download (*only* possible in maintenance mode).
  - Setting an IP address, both for IP access on LAN, and for the SCN (*only* possible in maintenance mode).
  - Setting the IP default router address and LAN port (*only* possible in maintenance mode).
  - Setting the T-TD raw mode and length value port.
  - Setting the LAN status (general, OSI, IP), designated router, osinode, and TARP LAN storm suppression (TLSS) of LANs.
  - Retrieving data from the active configuration database.
  - Leaving (terminating) the maintenance mode (*only* possible in maintenance mode).
- Write access to the active configuration database is restricted to those data related to the limited set of operations that are allowed in maintenance mode.

The maintenance mode can either be entered manually to perform operations that are only possible in maintenance mode, such as changing the NE name (TID) for example, or autonomously by the system when an exceptional situation occurred.

Reasons for autonomously entering the maintenance mode

The following description lists the possible reasons why a *LambdaUnite*® MSS system autonomously enters the maintenance mode:

1. An empty database is detected on the NVM during startup.
2. A new or different database is detected on the NVM during startup.
3. A Controller of type CTL/-, CTL/3T or CTL/4T is present, and during startup it is detected that the **Cross-Connect Application** is set to **ONNS**.
   The CTL/-, the CTL/3T and the CTL/4T controller variants do not support ONNS applications. For ONNS applications the CTL/2, the CTL/3S or the CTL/4S controller variants are mandatory.

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Orderwire

This section provides information about orderwire.

Description

Engineering Orderwire (EOW) provides voice or data communications for maintenance personnel to perform facility maintenance. *LambdaUnite*® MultiService Switch (MSS) provides three channels of 64-kbit/s (E1, E2 and F1) on the 10-Gbit/s- and 155-Mbit/s interfaces for orderwire applications, for example:

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

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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.

Contents

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 and SFPs

To simplify circuit pack installation, parameters can be provisioned before inserting the corresponding circuit pack or SFP. The appropriate parameters are automatically downloaded when the corresponding circuit pack or SFP 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.

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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

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".

Intended use

This equipment shall be used only in accordance with intended use, corresponding installation and maintenance statements as specified in this documentation. Any other use or modification is prohibited.

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Power planning

This section provides general power planning information for *LambdaUnite*® MSS.

System power consumption

The power consumption of *LambdaUnite*® MSS depends on its configuration (160-Gbit/s, 320-Gbit/s, or 640-Gbit/s configuration) and on its equipage.

The maximum power consumption (fully equipped with the most consuming cards) is as follows:

- 1900 W for the 160-Gbit/s configuration
- 3345 W for the 320-Gbit/s configuration
- 3500 W for the 640-Gbit/s configuration.

For more information about power consumption of the individual circuit packs, refer to "Weight and power consumption" (p. 10-31).

For equipment heat release information, please refer to "Heat release" (p. 6-5).

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 subrack.

The subrack uses a distributed powering system, rather than bulk power supplies. The system power supply is able to provide 3500 W power in the range -40 V to -72 V DC, respectively -48 V to -60 V DC nominal. 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 and B are filtered and protected by circuit breakers at the input to the subrack. 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 circuit breaker located in the PI is used.

The circuit breaker specification depends on the power interface type:

- 63 A for the core assembly kit 1 power interface (PI - PBH1)
- 100 A for the core assembly kit 2 power interface (PI/100 - PBH3)

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.

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.

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Cooling equipment

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

Fan units

Cooling is done by fans. 4 fans are located in the fan unit above the upper row of boards in the Dual Unit Row (DUR) subrack. They aspirate air through a filter located below the lower row of boards and force the air through the subrack from bottom to top.

Air flow baffle

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

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

Heat release

Important! As *LambdaUnite®* MSS is a highly integrated system, the heat release may exceed the objective values recommended by NEBS GR-63-core, Sec. 4.1.4, depending on the system equipage and on the rack configuration.

Note: To cope with high heat release, aisle spacings may be increased and/or restriction to 1 NE per rack has to be taken into consideration. In the case of excessive heat release special equipment room cooling may be required.

References

For more information about cooling, please refer to “Cooling” (p. 4-34) and to the Alarm Messages and Trouble Clearing Guide.

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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

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.

For equipment heat release information, please refer to "Heat release" (p. 6-5).

Transmission capacity

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

Capacity

The *LambdaUnite®* MSS Dual Unit Row sub-rack (DUR) provides 160 Gbit/s, 320-Gbit/s respectively 640 Gbit/s switching capacity, depending on the switching units applied. This allows you to equip the subrack with the following circuit packs:

- 40-Gbit/s synchronous
- 10-Gbit/s synchronous / Ethernet WANPHY
- 2.5-Gbit/s synchronous and transparent
- 622-Mbit/s synchronous
- 155-Mbit/s synchronous
- 45- /51-Mbit/s synchronous
- 1-Gbit/s Ethernet.

Circuit pack capacities

The following table lists the transmission capacity provided by each port and per circuit pack.

Circuit pack	max. STS-1 equivs. per port	max. STS-1 equivs. per circuit pack	max. STM-1 equivs. per port	max. STM-1 equivs. per circuit pack
40-Gbit/s synchronous (1 port per unit)	768	768	256	256
10-Gbit/s synchronous and Ethernet WANPHY (2 or 1 port per unit)	192	384	64	128
2.5-Gbit/s synchronous (8, 4 or 2 ports per synchronous, 3 ports per transparent unit)	48	384	16	128
622-Mbit/s synchronous (16 or 8 ports per unit)	12	192	4	64
155-Mbit/s synchronous (16 or 8 ports per OP155M, 8 ports per EP155)	3	48	1	16
45- /51-Mbit/s synchronous (36 ports per EP51)	1	36	(1/3)	(12)

Circuit pack	max. STS-1 equivs. per port	max. STS-1 equivs. per circuit pack	max. STM-1 equivs. per port	max. STM-1 equivs. per circuit pack
1-Gbit/s Ethernet (4 ports per unit)	21	84	7	28

References

For more information about transmission capacity, please refer to Chapter 4, “Product description”.

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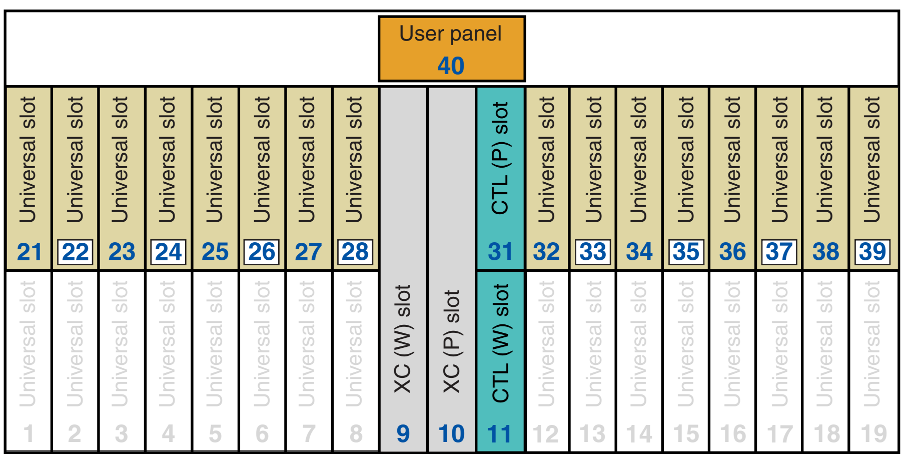
Port location rules

This section provides an overview of configuration restrictions and recommendations about using circuit packs and slots efficiently. For more detailed information please refer to the chapters "Equipment provisioning concepts" and "Transmission provisioning concepts" of the *LambdaUnite®* MSS User Operations Guide.

160-Gbit/s configuration

In 160-Gbit/s configurations the following rules and guidelines apply:

1. Port units can only be used in the upper row of the DUR shelf, i.e. in the universal slots 21 … 28 and 32 … 39.
   When a port unit is installed in any of the remaining universal slots, then the green activity LED of that port unit will be flashing, and a `Circuit Pack Type Mismatch` alarm will be reported. An attempt to preprovision a port unit for any of these slots will be denied.
2. Port units with a transmission capacity of 20 Gbit/s (for example an OP2G5D/PAR8 parent board, equipped with 8 optical modules) can only be used in the universal slots 22, 24, 26, 28, 33, 35, 37, and 39. The slot left to a slot where such a port unit is installed has to remain unequipped. Please also refer to the diagram subsequent to this list.

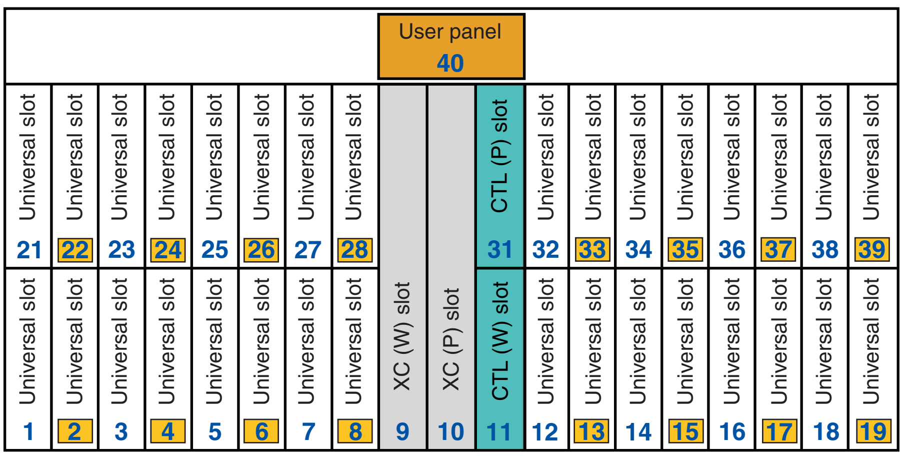


front view

320-Gbit/s configuration

In 320-Gbit/s configurations the following rules and guidelines apply:

1. Port units can be used in *all* universal slots.
   However, port units with a transmission capacity of 20 Gbit/s (for example an OP2G5D/PAR8 parent board, equipped with 8 optical modules) can only be used in the universal slots 2, 4, 6, 8, 13, 15, 17, 19, 22, 24, 26, 28, 33, 35, 37, and 39. The slot left to a slot where such a port unit is installed has to remain unequipped. Please also refer to the diagram subsequent to this list.
2. Only XC320 switching units can be provisioned in slot 9 and slot 10.
   When an XC160 switching unit is installed in slot 9 or slot 10, then the green activity LED of that XC160 will be flashing, and a `Circuit Pack Type Mismatch` alarm will be reported.



front view

LOXC circuit packs

If lower-order traffic (VC-3 (lower-order), VC-12, or VT1.5) is to be switched, the lower-order cross-connection unit (LOXC) must be installed in dedicated universal slots or slot combinations.

Moreover, which universal slots or slot combinations support the lower order cross-connection functionality also depends on the maximum switching capacity (XC…) of the system:

These are the supported slot combinations for the usage of LOXCs ((W): worker; (P): protection):

Max. switching capacity		Slot assignment		
		LOXC (W)	LOXC (P)	Remarks and additional equipage guidelines
XC160		37	39	The slots 36 and 38 must remain empty.
XC320	Option 1[(1)]	4	19	The slots 3 and 18 must remain empty. The slots 2 and 17 are reserved, i.e. may be used in case a future in-service upgrade is planned towards LOXC units which occupy 2 or 3 slots, respectively.
	Option 2	17	19	Alternative equipage if slot 4 is occupied. The slots 16 and 18 must remain empty.
	Option 3[(2)]	37	39	The slots 36 and 38 must remain empty.
XC640	Option 1[1]	4	19	The slots 3 and 18 are reserved, i.e. may be used in case a future in-service upgrade is planned towards LOXC units which occupy 2 slots.
	Option 2[(3)]	17	19	The slots 16 and 18 are reserved, i.e. may be used in case a future in-service upgrade is planned towards LOXC units which occupy 2 slots.
	Option 3[(4)]	18	19	–
	Option 4[(5)]	37	39	The slots 36 and 38 are reserved, i.e. may be used in case a future in-service upgrade is planned towards LOXC units which occupy 2 slots.

Notes:

1. Option 1 is the preferred option.
2. XC320, option 3, is the preferred option for a seamless upgrade from XC160 to XC320.
3. XC640, option 2, is the preferred option for a seamless upgrade from XC320 to XC640.
4. XC640, option 3, is the preferred option for maximized automatic I/O slot usage by *Telcordia®* Technologies.
5. XC640, option 4, is the preferred option for a seamless upgrade from XC160 to XC640.

Important! There may be at most *one active* LOXC. A second LOXC may be configured for protection purposes. This implies that at most one LOXC equipment protection group may be used.

40-Gbit/s circuit packs

40-Gbit/s circuit packs require four universal slots, and they are supported only in every forth slot (in slot number 4, 8, 15, 19, 24, 28, 35, 39, or in other words either on the left or on the right edge of a subrack quadrant).

10-Gbit/s parent board with slide-in modules

The OP10D/PAR2 parent board can be equipped with up to 2 opt. interface modules (ports), each having a transmission capacity of 10 Gbit/s. Thus, the transmission capacity of a fully equipped OP10D/PAR2 port unit is 20 Gbit/s. In other configurations than the 640-Gbit/s configuration of this so called double density card must be inserted according to the following rules.

In 160-Gbit/s configurations is supported only in every second slot (in slot number 22, 24, 26, 28, 33, 35, 37, 39), and the slot on the left side next to it must be left empty.

In 320-Gbit/s configurations is supported only in every second slot (in slot number 2, 4, 6, 8, 13, 15, 17, 19, 22, 24, 26, 28, 33, 35, 37, 39), and the slot on the left side next to it must be left empty.

For the 10-Gbit/s optical interface modules, slide-in modules with a Lucent Technologies proprietary design are used.

2.5-Gbit/s SFP parent board

The 2.5-Gbit/s Small Form Factor Pluggable (SFP) parent board (OP2G5D/PAR8) is a double density card, using the full 20-Gbit/s capacity of the universal slot. In other configurations than the 640-Gbit/s configuration the following rules are to observe.

In 160-Gbit/s configurations is supported only in every second slot (in slot number 22, 24, 26, 28, 33, 35, 37, 39), and the slot on the left side next to it must be left empty.

In 320-Gbit/s configurations is supported only in every second slot (in slot number 2, 4, 6, 8, 13, 15, 17, 19, 22, 24, 26, 28, 33, 35, 37, 39), and the slot on the left side next to it must be left empty.

Low bandwidth SFP parent board

The 622-Mbit/s / 155-Mbit/s Small Form Factor Pluggable (SFP) parent board (OPLB/PAR8) supports up to eight SFPs.

The parent board is provisioned entirely for one transmission rate:

- 622-Mbit/s or
- 155-Mbit/s.

SFP modules

The optical plug-in modules for the OPx/PARy parent boards and for the transparent parent board OPT2G5 are so called Small Form Factor Pluggable units (SFPs). They can be inserted and removed in a live system (“hot pluggable”).

The number of inserted SFPs can be configured flexibly between 0 and the maximum number (3, 6 or 8). The remaining SFP slots can be left empty and should be covered by a faceplate.

The *LambdaUnite®* MSS SFPs are marked by the manufacturer and checked upon insertion, in order to protect from accidental insertion of non *LambdaUnite®* MSS specific SFPs.

EP155 electrical circuit packs

The electrical 155-Mbit/s units (EP155) can be inserted in the upper slot row only, thus up to 16 circuit packs fit into one *LambdaUnite®* MSS subrack. In case of 1+1 protection of these circuit packs adjacent slot pairs odd/even are used, for example slot 21 and 22.

The combination of EP155 and EP51 is possible, taking into account the slot coverage of the respective connection interfaces (ECIs), .

For more details refer to *LambdaUnite®* MSS User Operations Guide, chapter "Equipment provisioning concepts".

EP51 electrical circuit packs

The electrical DS3/EC1 units (EP51) can be inserted in the upper slot row only, thus up to 16 circuit packs fit into one *LambdaUnite®* MSS subrack in case of 1+1 protection; the protected circuit packs are inserted into adjacent slot pairs odd/even, for example slot 21 and 22.

The maximum number of active circuit packs (no matter if protected or not) is limited to eight, due to physical constraints.

The combination of EP51 and EP155 is possible, taking into account the slot coverage of the respective connection interfaces (ECIs).

For more details refer to *LambdaUnite®* MSS User Operations Guide, chapter "Equipment provisioning concepts".

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.

Further reading

For more information about port location rules and subrack configuration, please refer to the chapters "Equipment provisioning concepts" and "Transmission provisioning concepts" of the *LambdaUnite®* MSS User Operations Guide.

□

Floor plan layout

This section gives information about the space needed to mount *LambdaUnite*® MSS subracks and racks.

Rack dimensions

The regular 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 (83.6 in) and a seismic rack (2.0 m (78.7 in) height) are possible depending on customer requirements (not standard delivery).

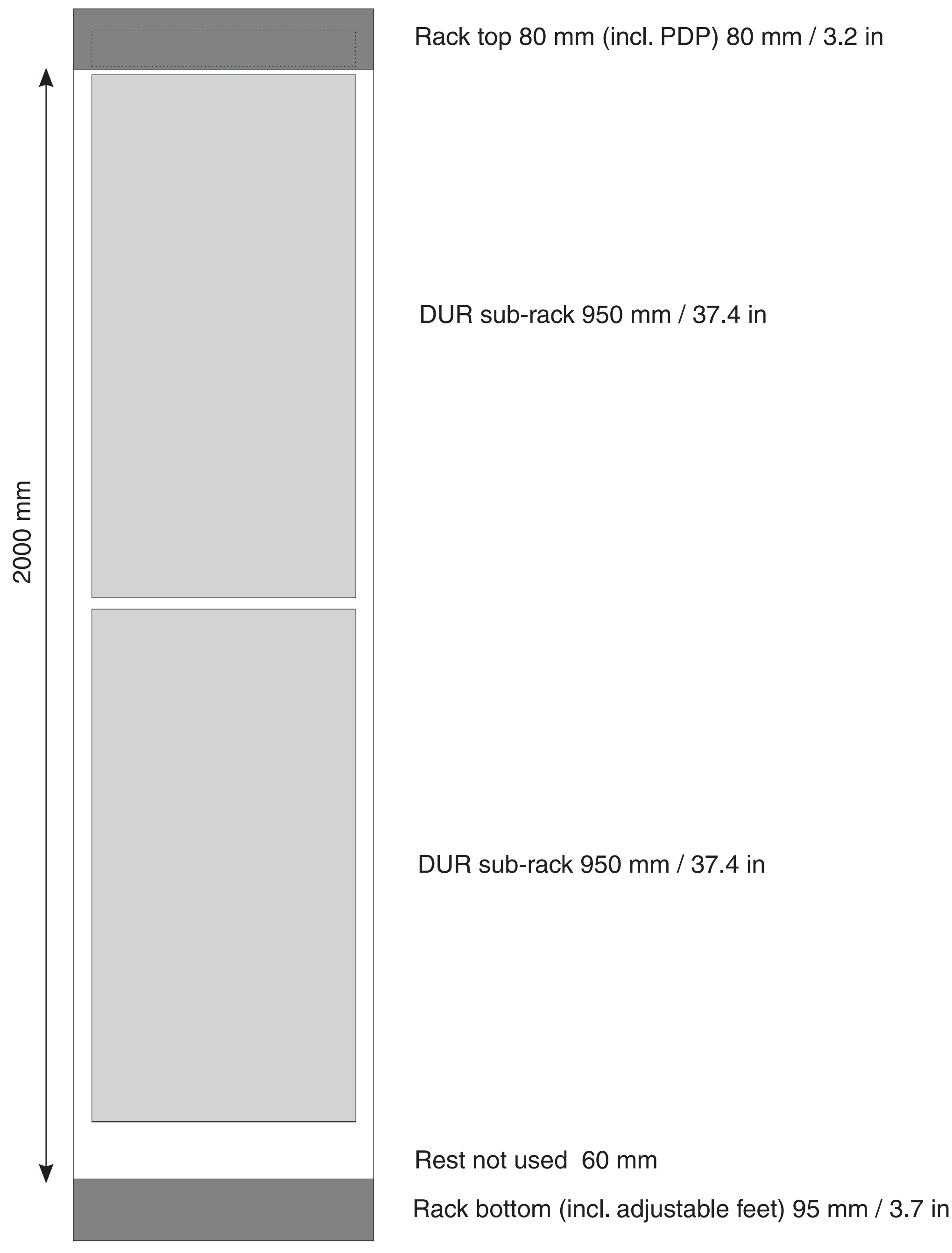
For equipment heat release information, please refer to “Heat release” (p. 6-5).

Rack extensions

For the transport of electrical signals the use of rack extensions is recommended. The width of the regular rack is increased by these extensions, to ease cable handling and guidance. These rack extensions are mounted on both sides of the regular rack, providing an extra width of 75 mm (2.9 in) on either side; the side plates of the rack can be mounted on the rack extensions, resulting in a total rack width of 750 mm (29.5 in).

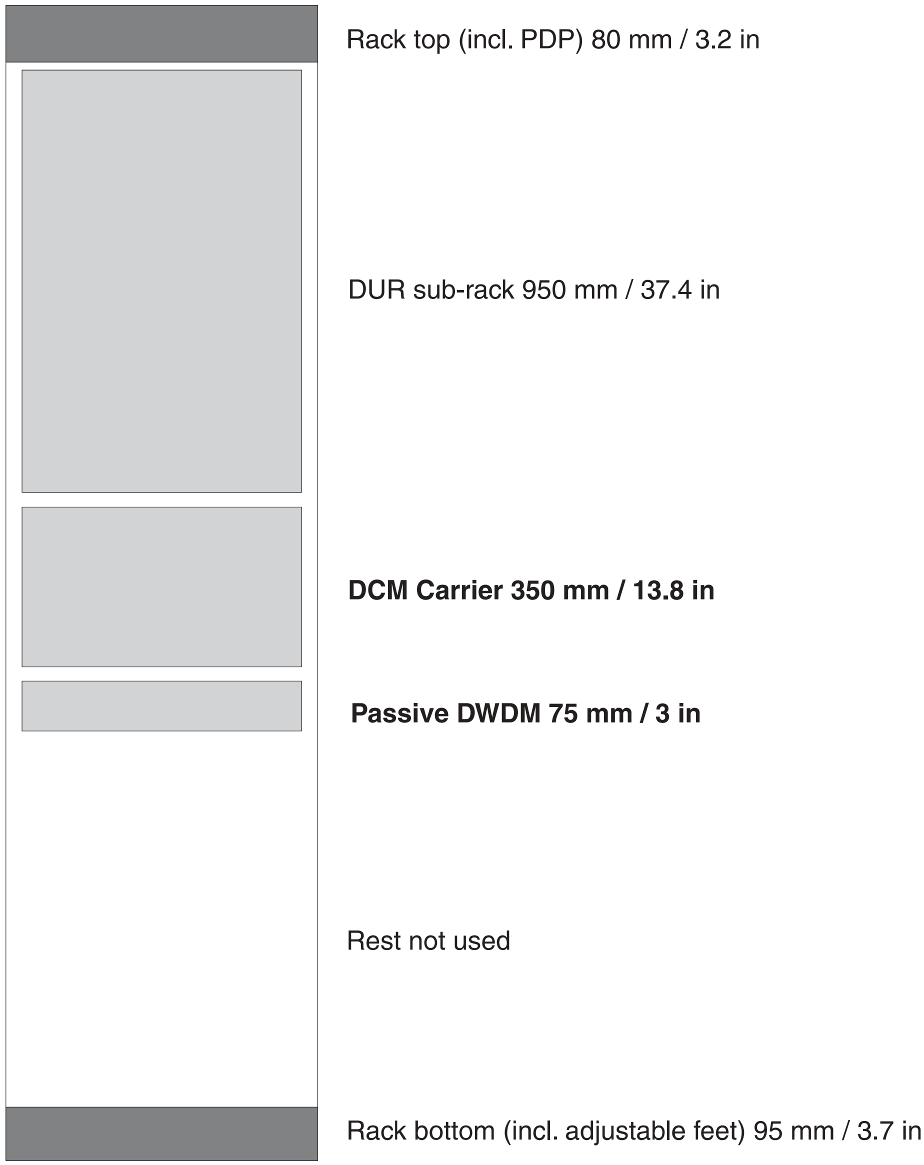
Rack equipping

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.



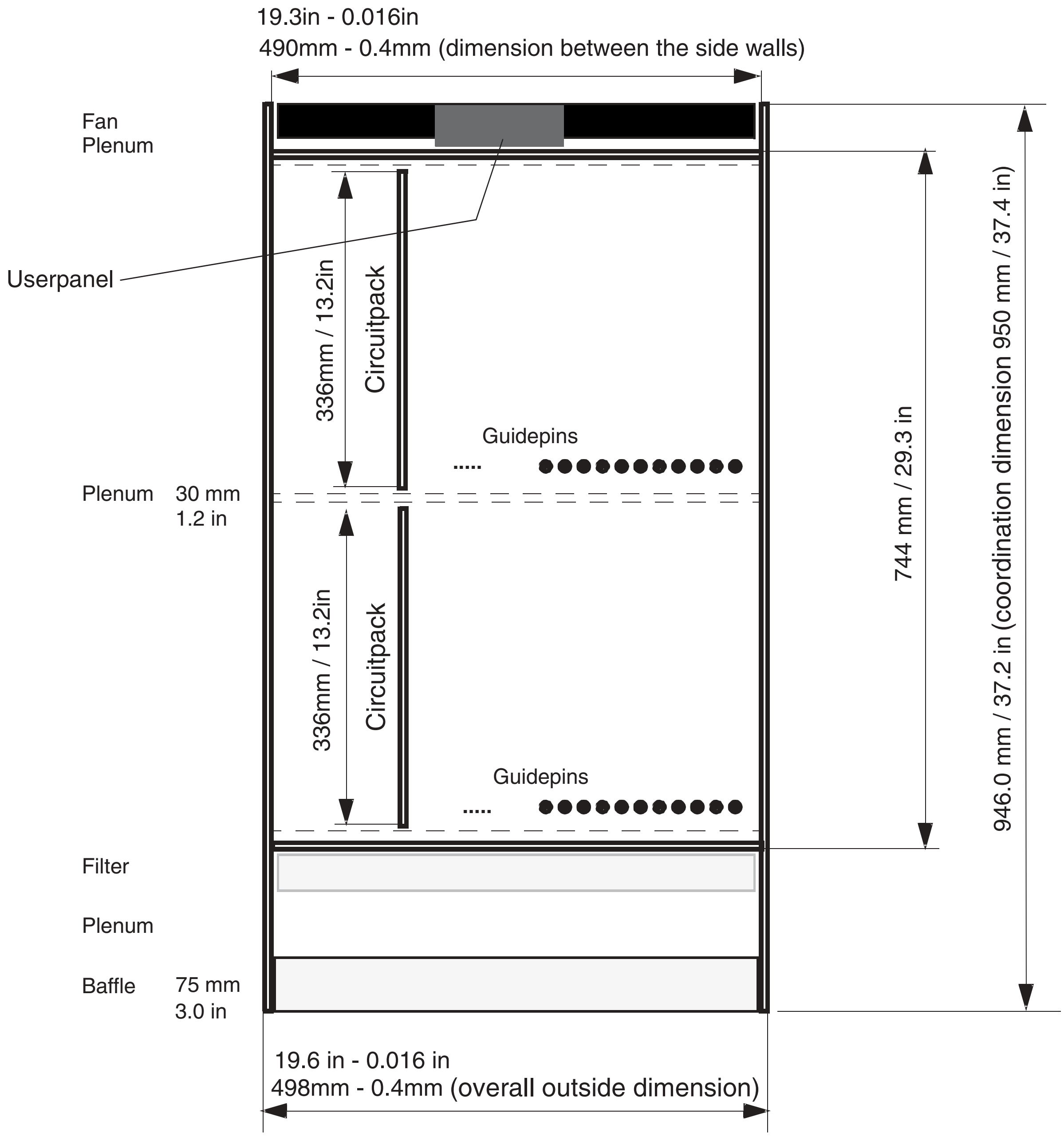
In the following figure a carrier for Dispersion Compensation Modules (DCM) and a passive WDM box have been mounted in the rack. DCMs are required only with

40-Gbit/s applications without DWDM interfacing. The passive WDM box is an OEM product. In this case, only one DUR subrack fits in a 2.2 m (86.6 in) rack (*LambdaUnite*® MSS specific rack). Instead of a DCM unit there is also the possibility to insert a storage box for fiber overlength.



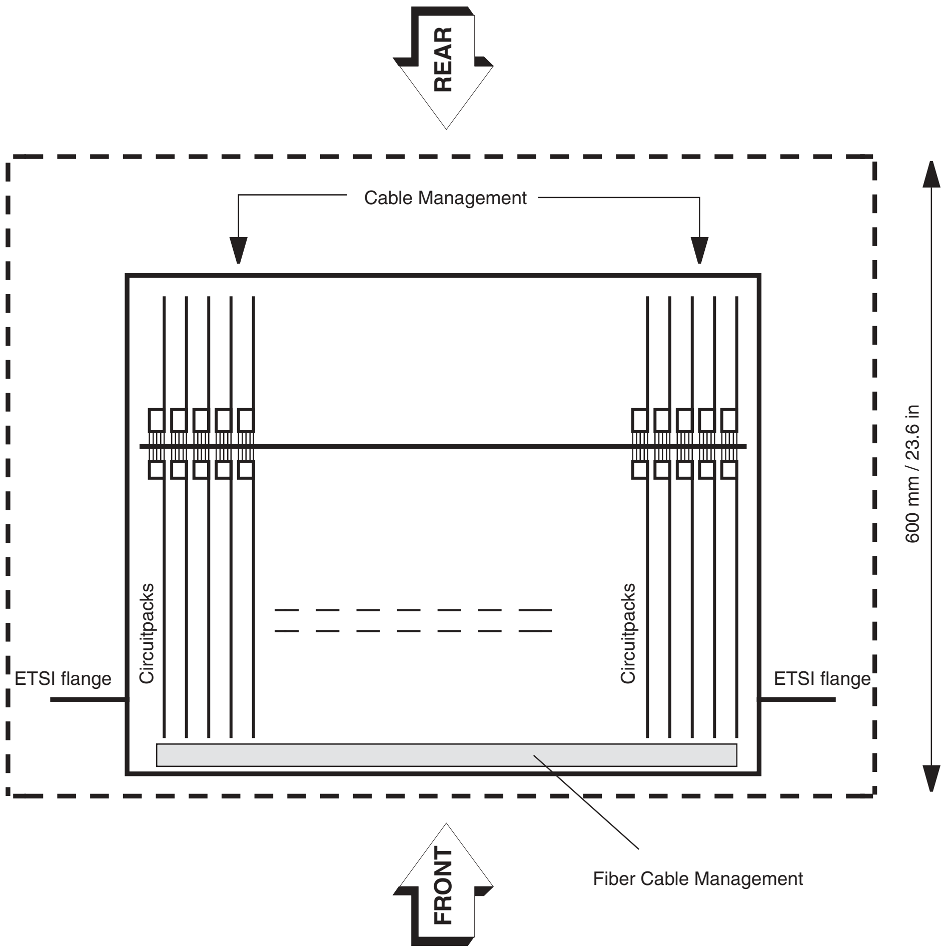
Subrack dimensions

The size of the DUR subrack 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 subrack 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 and for the arrangements/rearrangements of the electrical transmission cables (STM-1 and DS3/EC1).



□

Equipment interconnection

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. If *LambdaUnite*® MSS is mounted in a rack with doors you must use fiber connectors with angled boots.

The following figure illustrates the LC connectors and straight fiber connectors.

LBOs

If required, *LambdaUnite*® MSS provides optical attenuation using lightguide build-outs (LBOs) on the optical ports. All optical interfaces are factory-equipped with 0-dB LC-type connectors. The optical attenuation can be changed by replacing the LBO.For a complete list of items and comcodes please refer to the *LambdaUnite*® MSS engineering drawing ED8C948-10, described in "Engineering Drawing" (p. 7-2).

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	D-Sub shielded - filtered
LAN 1 (on User Panel)	RJ 45 crossed - shielded
LAN2, LAN3, LAN4	RJ 45 crossed - shielded
Racktop (alarm lamps)	D-Sub shielded - filtered

Interface Function	Connector Type
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	D-Sub shielded
STM-1 electrical	1.6 / 5.6 coax connector

□

7 Ordering

Overview

Purpose

This chapter provides an overview of the ordering process and the current software & licence ordering information for *LambdaUnite*® MultiService Switch (MSS).

Contents

Ordering information

LambdaUnite® MSS has been carefully engineered and all equipment kitted to simplify the ordering process. In this chapter the current software and licence items are shown, as available on the issue date of this document. For a complete and up-to-date list of all orderable items please refer to the Engineering Drawings described below.

Contact and further information

For all questions concerning ordering of *LambdaUnite*® MSS, for any information about 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.

Engineering Drawing

For a complete list of the orderable items with the respective comcodes please refer to the Engineering Drawing *LambdaUnite*® MSS "Engineering and Ordering Information" that you can

- find appended at the end of this document, up to date of the printing date (if it was ordered at the Customer Information Center (CIC))
- order in the latest version at CIC under http://www.cic.lucent.com/drawings.html with the order code *ED8C948-10*.

Software & licence items

The following table lists the ordering information concerning the current software and licence items for *LambdaUnite*® MSS.

Description	Functional Name	ITEM CODE	COMCODE
LambdaUnite® MSS Upgrade License, → R7.0	Upgrade License → R6.1.x	SBA570	109572412
LambdaUnite® MSS Upgrade SW CD R5.0.x → R6.1.1	Upgrade SW CD ROM R5.0.x → R6.1.1	SCA151B	109556001
LambdaUnite® MSS Upgrade SW CD R6.0.0 → R6.1.1	Upgrade SW CD ROM R6.0.0 → R6.1.1	SCA163	109537753
LambdaUnite® MSS Upgrade SW CD , → R7.0	Upgrade SW CD ROM , → R7.0	SCA172	109572404

Description	Functional Name	ITEM CODE	COMCODE
LambdaUnite® MSS Release 7.0 NE SW (incl. EMS agent) + CIT SW + license + 3rd party license and full Release Letter	NE SW & LI R7.0 CD-Rom	SCA171	109572396

Documentation items

For the order codes of the current *LambdaUnite*® MSS documentation please refer to "Related documentation" (p. xv).

□

8 Product support

Overview

Purpose

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

Contents

Installation services

This section describes the installation services available to support *LambdaUnite®* MSS.

Lucent Technologies offers Installation Services focused on providing the technical support and resources needed to efficiently and cost-effectively install your network equipment. Lucent Technologies Installation Services provide unparalleled network implementation expertise to help install your wire line and wireless networks. We use state-of-the-art tools and technology, and highly skilled technicians to install your equipment and help to ensure the timely and complete implementation of your network solution. By relying on our installation experts, we can rapidly build or expand your network, help manage the complexity of implementing new technologies, reduce operational costs, and help improve your competitive position by enabling your staff to focus on the core aspects of your business rather than focusing on infrastructure details.

Description

Within Lucent Technologies' overall Installation Services portfolio, Basic Equipment Installation and Site Supplemental Installation are the two services most closely linked to the initial deployment of Lucent Technologies' *LambdaUnite®* MSS product into your network.

Basic Equipment Installation

Provides the resources, experience and tools necessary to install the *LambdaUnite®* MSS product into your network. We assemble, cable and wire, and test the *LambdaUnite®* MSS, helping to ensure it is fully functioning as engineered and specified.

Site Supplemental Installation

Enhances the Basic Equipment Installation service by performing supplemental work that is unique to your specific site location, configuration, or working requirements. Includes installation of material other than the main footprint product (such as earthquake bracing); provision of services unique to your site (such as, hauling and hoisting, multi-floor cabling, rental and local purchases) or as may be required by your operations (such as, overtime to meet your compressed schedules, night work requested by you, abnormal travel expenses, abnormal transportation or warehousing); and any other additional effort or charges associated with your environment.

Benefits

When implementing our Installation Services, Lucent Technologies becomes a strategic partner in helping you realize your long-term strategies and achieve your business and technological goals. We combine our state-of-the-art technical background, high-quality processes, expertise in the latest technologies, knowledge of revolutionary equipment breakthroughs, and feature-rich project management tools to get your network up and running - quickly, efficiently, and reliably. With Lucent Technologies, you can concentrate on your core business, while we apply our years of knowledge and experience to installing your network.

Our Installation Services let you:

- *Rapidly expand your network* — by turning hardware into working systems, with the capability to deploy multiple networks in parallel rollouts
- *Reduce operational expense* — of recruiting, training, and retaining skilled installation personnel
- *Leverage Lucent Technologies' resources and expertise* — by utilizing our team of knowledgeable and fully equipped experts that implement projects of any size, anywhere around the world
- *Implement quality assurance* — through our total quality management approach
- *Reduce operational expenses* — by avoiding the purchase of the necessary state-of-the-art tools, test equipment, specialized test software, and spare parts that Lucent Technologies Installation Services utilize
- *Ensure high-quality support* — with Lucent Technologies' extensive support structure, including proven methods and procedures, mechanized tools, professional training, technical support, and access to Bell Labs.

Reference

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

□

Engineering services

This section describes the engineering services available to support *LambdaUnite®* MSS.

Lucent Technologies Worldwide Services (LWS) offers Engineering Services focused on providing the technical support and resources needed to efficiently and cost-effectively engineer your network equipment. We provide the best, most economical equipment solution by ensuring your network equipment is configured correctly, works as specified, and is ready for installation upon delivery. With our proven, end-to-end solutions and experienced network engineering staff, Lucent Technologies Worldwide Services is the ideal partner to help service providers engineer and implement the technology that supports their business.

Description

Within Lucent Technologies' overall Engineering Services portfolio, Site Survey, Basic Equipment Engineering, Site Engineering, and Site Records are the four services most closely linked to the initial deployment of *LambdaUnite®* MSS into your network; each is described below.

Site Survey

A Site Survey may be required to collect your site requirements needed for proper equipment engineering. If adequate site requirements and records are not available up front, a site survey would be performed to collect information required for configuration of the equipment and integration of the equipment into the site.

Basic Equipment Engineering

Ensures that the correct footprint hardware is ordered and that the ordered equipment is configured for optimal performance in the network for the customer. Lucent Technologies Engineering configures equipment requirements based on inputs from the customer order, completed questionnaires, and/or site survey data. The decisions as to specific equipment needs are based on each component's functionality and capacity, and the application of engineering rules associated with each component.

Site Engineering

Ensures that the correct site material is ordered and that the optimal equipment layout for the installation of the ordered equipment in the customer's site is determined. Site Engineering will be used in assisting the customer with determining the necessary site conditions, layout and equipment required to properly install/integrate the footprint hardware components into a specific location.

Site Records

Site Records Service provides detailed record keeping which accurately documents the physical placement and configuration of specified customer equipment. Depending on the customer request, this can involve the initial creation of site records, updating of existing records, or ongoing maintenance of the customer's records.

Benefits

When implementing our Engineering Services, Lucent Technologies becomes a strategic partner in helping you realize your long-term strategies and achieve your business and technological goals. Our Engineering Services portfolio delivers quick, responsive support, with state-of-the-art tools, top technicians and end-to-end services to help you engineer an optimal network solution. Whether you are looking to outsource your total engineering effort or simply supplement basic coverage gaps, our portfolio of services provides the flexible level of support you need. With Lucent Technologies, you can concentrate on your core business while we apply our years of knowledge and experience in engineering your equipment solutions.

Our Engineering Services let you:

- *Rapidly expand your network* — by turning products into working systems, with the capability to deploy multiple networks in parallel rollouts
- *Reduce costs* — by determining the most cost-effective network configuration and optimal use of office space when planning and providing an equipment solution
- *Reduce operational expense* — of recruiting, training, and retaining skilled engineering personnel
- *Leverage Lucent Technologies' resources and expertise* — by utilizing our team of knowledgeable and fully equipped experts that can plan, design, and implement projects of any size, anywhere around the world
- *Implement quality assurance* — through our total quality management approach and use of ISO-certified processes
- *Provide one–stop shopping* with a globally deployed engineering workforce, saving the time, delays and coordination challenges of dealing with multiple equipment vendors and service providers
- *Keep pace with rapidly changing technology* — by supporting the latest technologies and equipment breakthroughs, including Lucent Technologies' and other vendor's products
- *Ensure high-quality support* — with Lucent Technologies' extensive support structure, including proven methods and procedures, mechanized tools, professional training, technical support, and access to Bell Labs
- *Maintain and track vital office records* — keep track of equipment locations and connections.

Reference

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

□

Maintenance services

This section describes the maintenance services available to support *LambdaUnite*® MSS.

Description

Maintenance Services is composed of three primary services to support your maintenance needs. The services are

- Remote Technical Support Service (RTS)
- On-site Technical Support Service (OTS)
- Repair and Exchange Services (RES)

Remote Technical Support Service (RTS)

RTS provides telephone and web-based access to remote engineers and tools for product information, network diagnostics, and trouble resolution and restoration for all Lucent products.

On-site Technical Support (OTS)

OTS provide network trouble resolution and restoration, at the customer's location, for all Lucent products and selected OEM equipment.

Repair and Exchange Services (RES)

RES provides advanced exchange or return for repair services for defective hardware, eliminating the need for you to purchase and maintain a costly spares inventory.

Contact

For maintenance service contact information please refer to "Technical support" (p. 8-7).

□

Technical support

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

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.

Technical support groups

Technical support is available through

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

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 north and south America (NAR and CALA)	Customer Technical Assistance Management (CTAM): • +1 866 Lucent8 (prompt#1) • +1 630 224 4672 (from outside the United States)
for Europe, Africa, Asia and the pacific region (EMEA and APAC)	International Customer Management Centre (ICMC): • +353 1 692 4579 (toll number) • 00 800 00Lucent (toll free number in most EMEA countries)

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 Technical Support Service (TSS) teams in Merrimack Valley, USA or Nuremberg, Germany.

Technical Support Service

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

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

Technical support platform

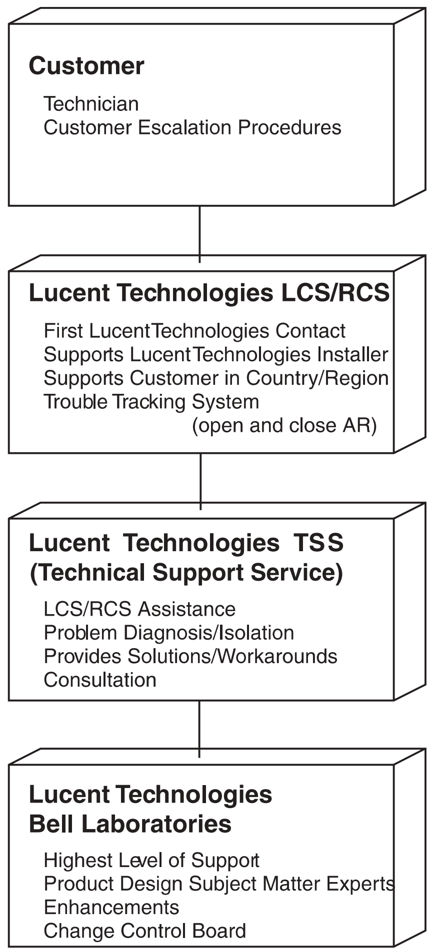
A global online trouble tracking system is used by all support teams to track customer assistance requests. The system communicates details about product bulletins, troubleshooting procedures, and other critical information to customers. All details of a request are entered into this database until closure. 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

The Lucent Technologies documentation organization provides comprehensive product documentation tailored to the needs of the different audiences. An overview of the documentation set can be found at "Related documentation" (p. xv).

Customer comment

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

To comment on this information product, go to the Online Comment Form (http://www.lucent-info.com/comments/enus/) or email your comments to the Comments Hotline (comments@lucent.com).

□

Training support

To complement your product needs, the Lucent IP&T organization offers a formal training package, with the single training courses scheduled regularly at Lucent Technologies' corporate training centers or to be arranged as on-site trainings at your facility.

Registering for a course or arranging an on-site training

To enroll in a training course at one of the Lucent Technologies corporate training centers or to arrange an on-site training at your facility (suitcasing), please contact:

Asia, Pacific, and China	Training Center Singapore, Singapore voice: +65 6240 8394 fax: +65 6240 8017
Central America and Latin America	Training Center Mexico City, Mexico voice: +52 55 527 87187 fax: +52 55 527 87185
Europe, Middle East, and Africa	Training Center Nuremberg, Germany voice: +49 911 526 3831 fax: +49 911 526 6142
North American Region	Training Center Altamonte Springs, USA voice: +1-888-582-3688 - prompt 2 (+1-888-LUCENT8 - prompt 2).

To review the available courses, to enroll for a training course at one of Lucent Technologies' corporate training centers, or to obtain contact information please visit:

- https://training.lucent.com.

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 Technologies ´ commitment to quality and reliability and how quality is ensured.

Contents

Lucent Technologies' commitment to quality and reliability

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

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

□

Conformity statements

CE conformity

Hereby, Lucent Technologies declares that the Lucent Technologies product

LambdaUnite® MultiService Switch (MSS), Release 7.0

is in compliance with the essential requirements and other relevant provisions of the following Directive:

Directive 1999/5/EC of 9 March 1999 on Radio and Telecommunication Terminal Equipment of the European Parliament and of the Council

is tested and conforms with the essential requirements for protection of health and the safety of the user and any other person and Electromagnetic Compatibility. Conformity is indicated by the CE mark affixed to the product. For more information regarding CE marking and Declaration of Conformity (DoC), please contact your local Lucent Technologies Customer Service Organization.

This product is in conformity with Article 3, Paragraph 3 of the R&TTE Directive and interworks in networks with other equipment connected to the optical telecommunication network. Conformance with specifications of optical interfaces is granted as stated in the Official Journal of the European Union.

Compliance statement in other European languages

English

Hereby, Lucent Technologies, declares that this *LambdaUnite®* MSS is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Finnish

Lucent Technologies vakuuttaa täten että *LambdaUnite®* MSS tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.

Dutch

Hierbij verklaart Lucent Technologies dat het toestel *LambdaUnite®* MSS in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.

Bij deze verklaart Lucent Technologies dat deze *LambdaUnite®* MSS voldoet aan de essentiële eisen en aan de overige relevante bepalingen van Richtlijn 1999/5/EC.

French

Par la présente Lucent Technologies déclare que l’appareil *LambdaUnite®* MSS est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.

Par la présente, Lucent Technologies déclare que ce *LambdaUnite*® MSS est conforme aux exigences essentielles et aux autres dispositions de la directive 1999/5/CE qui lui sont applicables.

Swedish

Härmed intygar Lucent Technologies att denna *LambdaUnite*® MSS står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.

Danish

Undertegnede Lucent Technologies erklærer herved, at følgende udstyr *LambdaUnite*® MSS overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.

German

Hiermit erklärt Lucent Technologies, dass sich dieses *LambdaUnite*® MSS in Übereinstimmung mit den grundlegenden Anforderungen und den anderen relevanten Vorschriften der Richtlinie 1999/5/EG befindet (BMWi), und dass es mit den grundlegenden Anforderungen und den anderen relevanten Festlegungen der Richtlinie 1999/5/EG (Wien) übereinstimmt.

Greek

ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ Lucent Technologies ΔΗΛΩΝΕΙ ΟΤΙ *LambdaUnite*® MSS ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗ⌐ΙΑΣ 1999/5/ΕΚ.

Italian

Con la presente Lucent Technologies dichiara che questo *LambdaUnite*® MSS è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.

Spanish

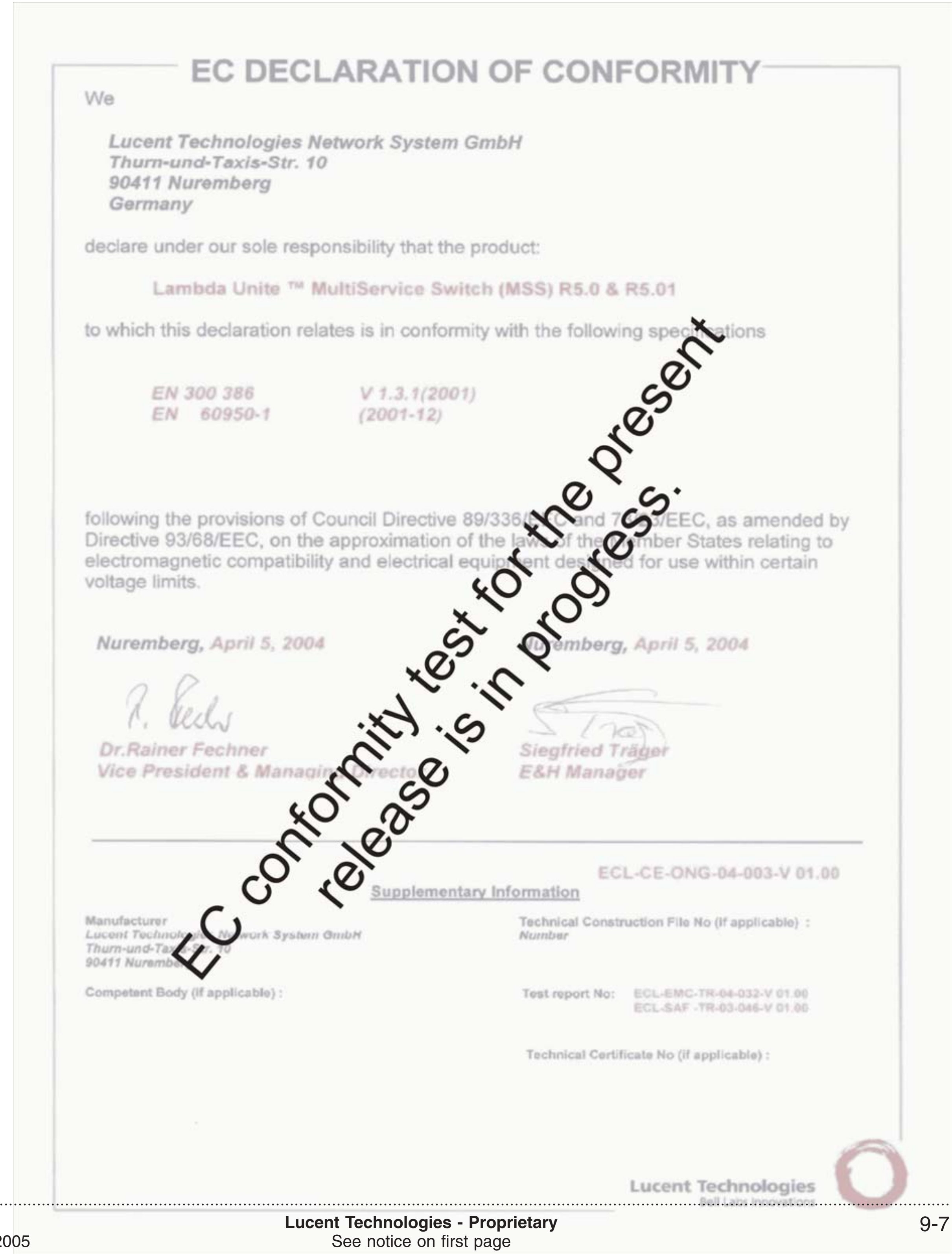
Por medio de la presente Lucent Technologies declara que el *LambdaUnite*® MSS cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.

Portuguese

Lucent Technologies declara que este *LambdaUnite*® MSS está conforme com os requisitos essenciais e outras provisões da Directiva 1999/5/CE.

EC conformity declaration

The EC Declaration of Conformity (DoC) for *LambdaUnite®* MSS Release 7.0 is shown in the following figure, as available upon issue, or at: http://www.lucent.de/ecl, selecting "**Produkte mit CE**", upon issue.



EC DECLARATION OF CONFORMITY

We

Lucent Technologies Network System GmbH
Thurn-und-Taxis-Str. 10
90411 Nuremberg
Germany

declare under our sole responsibility that the product:

Lambda Unite ™ MultiService Switch (MSS) R5.0 & R5.01

to which this declaration relates is in conformity with the following specifications

EN 300 386 V 1.3.1(2001)
EN 60950-1 (2001-12)

following the provisions of Council Directive 89/336/EEC and 73/23/EEC, as amended by Directive 93/68/EEC, on the approximation of the laws of the Member States relating to electromagnetic compatibility and electrical equipment designed for use within certain voltage limits.

Nuremberg, April 5, 2004 *Nuremberg, April 5, 2004*

Dr.Rainer Fechner
Vice President & Managing Director

Siegfried Träger
E&H Manager

ECL-CE-ONG-04-003-V 01.00

Supplementary Information

Manufacturer
Lucent Technologies Network System GmbH
Thurn-und-Taxis-Str. 10
90411 Nuremberg

Technical Construction File No (if applicable) :
Number

Competent Body (if applicable) :

Test report No: ECL-EMC-TR-04-032-V 01.00
ECL-SAF -TR-03-046-V 01.00

Technical Certificate No (if applicable) :

Lucent Technologies

EC conformity test for the present release is in progress.

Eco-environmental statements

The statements that follow are the eco-environmental statements that apply to the *Waste from Electrical and Electronic Equipment (WEEE) directive*.

Packaging collection and recovery requirements

Countries, states, localities, or other jurisdictions may require that systems be established for the return and/or collection of packaging waste from the consumer, or other end user, or from the waste stream. Additionally, reuse, recovery, and/or recycling targets for the return and/or collection of the packaging waste may be established.

For more information regarding collection and recovery of packaging and packaging waste within specific jurisdictions, please contact the Lucent Technologies Field Services / Installation - Environmental Health and Safety organization.

For installations not performed by Lucent Technologies, please contact the Lucent Customer Support Center at::

Technical Support Services, Lucent Technologies.

Within the United States: 1 866 LUCENT8 (866 582 3688), prompt 1

From all other countries: +1 630 224 4672, prompt 2

Recycling / take-back / disposal of product

Electronic products bearing or referencing the symbol shown below when put on the market within the European Union, shall be collected and treated at the end of their useful life, in compliance with applicable European Union and local legislation. They shall not be disposed of as part of unsorted municipal waste. Due to materials that may be contained in the product, such as heavy metals or batteries, the environment and human health may be negatively impacted as a result of inappropriate disposal.

Note: In the European Union, a solid bar under the crossed-out wheeled bin indicates that the product was put on the market after 13 August 2005.

Moreover, in compliance with legal requirements and contractual agreements, where applicable, Lucent Technologies will offer to provide for the collection and treatment of Lucent Technologies products at the end of their useful life, or products displaced by Lucent Technologies equipment offers.

For information regarding take-back of equipment by Lucent Technologies, or for more information regarding the requirements for recycling/disposal of product, please contact your Lucent Account Manager or Lucent Takeback Support at takeback@lucent.com.

Technical documentation

The technical documentation as required by the Conformity Assessment procedure is kept at Lucent Technologies location which is responsible for this product. For more information please contact your local Lucent Technologies representative.

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Reliability

Overview

Purpose

This section describes how reliability is specified.

Contents

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General reliability specifications

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

Mean Time Between Failures

The Mean Time Between Failures (MTBF) for the whole *LambdaUnite®* MSS depends on the equipage of the system and on the specific hw FIT rates, refer to "*LambdaUnite®* MSS failure-in-time rates" (p. 9-13). For further information please contact your Customer Team.

Mean time to repair

The mean time to repair for *LambdaUnite®* MSS is assumed to be 2 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 estimation of the *LambdaUnite®* MSS circuit pack reliability is based on an infant mortality factor (IMF) smaller than 2.5. That means the first year failure rate (or infant mortality rate [IMR]) is assumed to be <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 and the *CompactFlash®* card. The fan unit design life and the and the *CompactFlash®* card design life are 7 years.

CompactFlash® cards can be ordered separately and have a own comcode:

- *CompactFlash®* card 256MB can be ordered via the comcode: 109197137
- *CompactFlash®* card 512MB can be ordered via the comcode: 109449710
- *CompactFlash®* card 1024MB can be ordered via the comcode: 109558544

Maintainability specifications

HW items that need maintenance activities:

- The air filter, located below the subrack, must be replaced or cleaned under regular conditions (e.g. with Eurovent EU6 filters used in the HVAC) once every 3 months to ensure the proper cooling, as described in the User Operations Guide (UOG) chapter "Periodic activities" or as part of a trouble clearing procedure as described in the Alarm Messages And Trouble Clearing Guide (AMTCG).
- The *CompactFlash®* card, located in the controller circuit pack, is strongly recommended to be replaced once every seven years; the respective procedure is described in the Alarm Messages and Trouble Clearing Guide (AMTCG) in the chapter "Supporting procedures".

LambdaUnite® MSS does not require periodic electronic equipment maintenance activities, except the *CompactFlash®* card replacement. Continuous performance monitoring enables the system to detect conditions before they become service-affecting.

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LambdaUnite® MSS failure-in-time rates

This section provides failure-in-time (FIT) rates for *LambdaUnite®* MSS components, the calculated number of failures in 10^9 hours of operation.

FIT rates of core units

Unit suite	unit description	apparatus code	FIT rate
Subrack	shelf	–	150
	FAN unit	–	2765
	PI (power interface 63A)	PBH1	203
	PI100 (power interface 100A)	PBH3	110
	UPL (user panel)	–	193
	CI-CTL (controller interface)	PBJ1	1366
	TI (E1/DS1 timing interface)	PBI1	100
CTL	controller CTL/- (w/o ONNS support, w/o LOXC support)	KFA1	6000
	controller CTL/2 (w/ ONNS support, w/o LOXC support)	KFA531	9545
	controller CTL/3T (w/o ONNS support, w/ LOXC support)	KFA536	6644
	controller CTL/3S (w/ ONNS support, w/ LOXC support)	KFA537	6644
	controller CTL/4T (w/o ONNS support, w/o LOXC support)	KFA538	6114
	controller CTL/4S (w/ ONNS support, w/o LOXC support)	KFA539	6114
XC	switching unit XC160 (w/ ONNS support)	KFD3	7523
	switching unit XC320/B (w/ ONNS support)	KFD1B	11289
	switching unit XC640 (w/ ONNS support)	KFD2	11063
	low order cross-connection matrix LOXC	KFA700	5776

FIT rates of transmission units

Unit suite	unit description	apparatus code	FIT rate
OP40	OP40/1.3IOR1, 2 km	KFA202	8576
	OP40/1.5LR1O, 80 km	KFA3	11602
	OP40/9280…8650XT	KFA290…*	8974
OP10	OP10/1.3IOR1, 600 m	KFA7	4100
	OP10/1.5IR1, 40 km	KFA14	4517
	OP10/1.5LR1, 80 km	KFA6	5517
	OP10/01…80/800G	KFA9, KFA81…*	5347
	OP10/9285…8650	KFA210…*	5674
	OP10/01…16/PWDM	KFA11, KFA61…*	5435
OP10D	OP10D/PAR2 (20-Gbit/s per slot parent board)	KFA630	6500
	OM10 (600m slide-in module)	OM10G7	2200
	OM10 (40km slide-in module)	OM10G14	2617
	OM10 (80km slide-in module)	OM10G6	2800
OP2G5	OP2G5/1.5LR4, 80 km	KFA204	6011
	OP2G5/1.3LR4, 40 km	KFA203	6011
	OP2G5/1.3SR4, 2 km	KFA12	6011
	OP2G5 pWDM (sum of below)	–	4504
	OP2G5 parent	KFA20	2665
	OM2G5/921…*PWDM	OM2G5A921…*	1839
OP2G5D	OP2G5/PAR8 (parent board for eight SFP modules)	KFA620	5952
	OM2G5 SFP module 2 km	OM2G5A12	300
	OM2G5 SFP module 40 km	OM2G5A203	300
	OM2G5 SFP module 80 km	OM2G5A204	300
OP2G5/PAR4	OC48/STM16, Parent board for 4 SFP modules(without SFP modules)	KFA621	3482
OPT	OPT2G5/PAR3 (transparent 2.5-Gbit/s parent board for three SFP modules)	KFA540	4667
GE1	GE1/SX4	KFA13	4270
	GE1/LX4	KFA532	4270
OP622	OP622 w/16 ports, 15 km	KFA17	8737

Unit suite	unit description	apparatus code	FIT rate
OP155M	OP155M w/16 ports, 15 km	KFA18	8737
OPLB	OPLB/PAR8 (622/155M parent board for 8 SFPs)	KFA180	5632
	OM622 SFP module, 80 km	OM622A180	235
	OM622 SFP module, 40 km	OM622A181	300
	OM622 SFP module, 15 km	OM622A182	300
	OM155 SFP module, 80 km	OM155A185	300
	OM155 SFP module, 40 km	OM115A183	300
	OM155 SFP module, 15 km	OM115A184	232
EP 155	EP155/EL8 (electrical STM-1 pack, 8 signals)	KFA533	2139
	ECI/155ME8 (paddle board w/16 ports)	PBK1	147
	ECI/155MP8 (protection paddle board w/8 ports)	PBK2	417
EP 51	EP51/EL36 (electrical DS3/EC1 pack, 36 signals)	KFA535	4406
	EP51/EL36B (electrical DS3/EC1 pack, 36 signals)	KFA535B	4406
	ECI51/MP72 (protection paddle board w/72 ports)	PBK4	925

For the fields marked with “n.a.” data was *n*ot *a*vailable on the issue date.

*: For the complete apparatus code list and the respective comcodes please refer to “Engineering Drawing” (p. 7-2).

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10 Technical specifications

Overview

Purpose

This chapter provides the technical specifications for *LambdaUnite*® MultiService Switch (MSS). These data are necessary for planning the application 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	Ethernet
General	ANSI T1.105-1191, T1.1066-1988	ITU-T Rec. G.707, G.703	IEEE 802.3-2000
Equipment		ITU-T Rec. G.781, G.782, G.783, G.784, G.813	
Physical interface	Bellcore GR-253 SR-1	ITU-T Rec. G.957, G.691, G.692, G.693, G.959.1	IEEE 802.3-2000 clause 38
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 "Transmission parameters " (p. 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 coded by the pins used
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 coded by the pins used
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 discrete interfaces

The system supports 8 MDI and 8 MDO ports. 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.

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Transmission parameters

Planning data

Data for planning a transmission route with the signal 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. The abbreviations used are explained at the end of this section, see "Port unit designation" (p. 10-22) and following.

Connector type

In *LambdaUnite*® MSS all optical connections are provided by LC connectors. Please refer also to "Equipment interconnection" (p. 6-20).

40-Gbit/s single color and DWDM direct optics circuit packs

The following table lists some parameters and the end of life power budget of the single channel optical interfaces for 40-Gbit/s signals, and of the dense WDM compatible optical interfaces for 40-Gbit/s signals; for the spectral parameters please refer to "Engineering Drawing" (p. 7-2).

Application code	**(Unit)**	**L-256.2/3/5 (Similar to P1L1-7A2/3/5 in G.959.1.)**	**VSR2000-3R1 (G.693)**	***LambdaXtreme*™ Transport compatible**
Functional name		OP40/1.5LR1O	OP40/1.3IOR1	OP40/9280XT ... 8650XT
Apparatus code		KFA3	KFA202	KFA290 … 353
SONET level / SDH level		OC-768 / STM-256	OC-768 / STM-256	OC-768 / STM-256
Transmission rate	kbit/s	42 478 433 (with FEC)	39 813 120	42 478 433 (with FEC)
Transmission code		RZ, 33%	NRZ	RZ, 67%,
Wavelength	nm	1555.75 +/- 0.02	1311 +/- 2	1555 … 1607 (64 colors)
Transmitter at reference point S and MPI-S (acc. G.959.1 or G.693) respectively				
Source type		SLM	SLM	SLM
Max. spectral RMS width	nm	—	n/a	—
Min. side mode suppression	dB	35	n/a	n/a

Application code	(Unit)	L-256.2/3/5 (Similar to P1L1-7A2/3/5 in G.959.1.)	VSR2000-3R1 (G.693)	*LambdaXtreme*™ Transport compatible
Mean launched power range	dBm	10 … 13 (class IIIb/1M)	5 ... 7 (class 1)	–5 … –3 (class 1)
Minimum Extinction ratio	dB	10	10	12
Receiver at reference point R and MPI-R (acc.G.959.1 or G.693) respectively				
Receiver type		PIN	PIN	PIN
Min. optical sensitivity (BER $=10^{-12}$)	dBm	–14	–2	–10.5
Max. optical path penalty	dB	2	1 (G.652)	2
Overload limit	dBm	+2	+4	–0.5
Maximum reflectance of receiver	dB	–27	–27	–27
Optical path between S and R				
Minimum optical return loss of cable at point S (incl. any connectors)	dB	n/a	n/a	n/a
Maximum discrete reflectance between S and R	dB	–27	–27	–27
Maximum chromatic dispersion	ps/nm	0 ... 1600 (G.652), 50 ... 280 (G.653), 50 ... 480 (G.655)	0 ... 36 (G.652)	–300 ... –700
Maximum tolerable differential group delay	ps	11.5	2	9
Optical attenuation range	dB	11 ... 22	3 … 6	3 … 11
Nominal target distance	km	80	2	n/a

10-Gbit/s single color circuit packs and modules

The following table lists some parameters and the end of life power budget of the single channel optical interfaces for 10-Gbit/s signals.

Application code	(Unit)	VSR600-2R1 (G.693)	S-64.2b/3b IR-2/3	L-64.2b/3 LR-2b/3	P1L1-2D2 (G.659.1)
Functional name		OP10/1.3IOR1 and OM10/1.3IOR1	OP10/1.5IR1 and OM10/1.5IR1	OP10/1.5LR1	OM10/1.5LR1
Apparatus code		KFA7 and OM10G7	KFA14 and OM10G14	KFA6	OM10G6
SONET level / SDH level		OC-192 / STM-64	OC-192 / STM-64	OC-192 / STM-64	OC-192 / STM-64
Type of plug-in unit		OP101.3Ir	OP101.5SH	OP101.5LH	OM101.5LH
Transmission rate	kbit/s	9 953 280	9 953 280	9 953 280	9 953 280
Transmission code		NRZ	NRZ	NRZ	NRZ
Wavelength	nm	1260 … 1360; the receiver also supports 1.5 μ signals with slight span length restrictions; for further information please contact your local customer service.	1530 … 1565; the receiver also supports 1.3 μ signals with slight span length restrictions; for further information please contact your local customer service.	1530 … 1565; the receiver also supports 1.3 μ signals with slight span length restrictions; for further information please contact your local customer service.	1530 … 1565; the receiver also supports 1.3 μ signals with slight span length restrictions; for further information please contact your local customer service.
Transmitter at reference point S and MPI-S (acc. G.691 or G.693) respectively					
Source type		MLM	DFB	DFB	SLM
Max. spectral RMS width	nm	3	—	—	—
Min. side mode suppression	dB	—	30	30	30
Mean launched power range	dBm	– 6… – 1 (class 1)	– 1 … + 2 (class 1)	+ 10 … + 13 (class IIIb/1M)	+ 0 … + 4 (class 1)

Application code	**(Unit)**	**VSR600-2R1 (G.693)**	**S-64.2b/3b IR-2/3**	**L-64.2b/3 LR-2b/3**	**P1L1-2D2 (G.659.1)**
Minimum Extinction ratio	dB	6	8.2	8.2	9
Receiver at reference point R and MPI-R (acc.G.691) respectively					
Receiver type		PIN	PIN	PIN	APD
Min. optical sensitivity (BER $=10^{-12}$)	dBm	– 11	– 14	– 16	– 24
Max. optical path penalty	dB	1	2 (SSMF), 1 (DSF and NZ-DSF)	2 (SSMF), 1 (DSF and NZ-DSF)	2
Overload limit	dBm	– 1	– 1	– 1	– 7
Maximum reflectance of receiver	dB	– 14	– 27	– 27	– 27
Optical path between S and R					
Minimum optical return loss of cable at point S (incl. any connectors)	dB	14	24	24	24
Maximum discrete reflectance between S and R	dB	– 27	– 27	– 27	– 27
Maximum chromatic dispersion	ps/nm	3.8	800	1600	1600
Maximum tolerable differential group delay	ps	30	30	30	30
Optical attenuation range (10*12)	dB	0 ... 4	3 ... 11	16 ... 22	11 ... 22
Nominal target distance	km	0.6	40	80	80

10-Gbit/s WDM direct optics circuit packs

The following table lists the End of Life power budget of the dense and passive WDM compatible optical interfaces for 10-Gbit/s signals. For the spectral parameters please refer to "Engineering Drawing" (p. 7-2).

Application code	**(Unit)**	***WaveStar*® OLS 1.6T compatible**	**passive WDM compatible**
Functional name/qualifier		OP10/01...80/800G	OP10-1...16-PWDM
Apparatus code		KFA9 / KFA81-159	KFA11 / KFA61-75
SONET level / SDH level		OC-192 / STM-64	OC-192 / STM-64
Transmission rate	kbit/s	9 953 280 with strong FEC: 10 619 608	9 953 280
Transmission code		NRZ	RZ
Frequencies	THz	191.9 … 195.8 (80 colors); the receiver also supports 1.3 μ signals with slight span length restrictions; for further information please contact your local customer service.	192.1 … 195.9 (16 colors); the receiver also supports 1.3 μ signals with slight span length restrictions; for further information please contact your local customer service.
Transmitter at reference point S and MPI-S (acc. G.691) respectively			
Max. spectral width (-20dB)	nm	—	1
Min. side mode suppression	dB	35	35
Mean launched power range	dBm	–6.2 … –3.8 (class 1)	–1 … 2 (class 1)
Minimum Extinction ratio	dB	12	8.2
Receiver at reference point R and MPI-R (acc.G.691) respectively			
Receiver type		APD	APD
Input power range (BER $=10^{-12}$)	dBm	–20...–13	–21...–8
Maximum input power	dBm	–13	–8
Max. optical path penalty due to chromatic dispersion	dB	2	2
Maximum OSNR (BER $=10^{-12}$)	dB	19.5	n/a
Maximum reflectance of receiver	dB	–27	–27

Application code	(Unit)	*WaveStar*® OLS 1.6T compatible	passive WDM compatible
Optical path between S and R			
Minimum optical return loss of cable at point S (incl. any connectors)	dB	n/a	24
Maximum discrete reflectance between S and R	dB	n/a	-27
Maximum chromatic dispersion	ps/nm	1000	1000 (G.652), 500 (G.655)
Maximum tolerable differential group delay	ps	30	30
Optical attenuation range (10*12)	dB	n/a	10 ... 18
Nominal target distance	km	n/a	36

2.5-Gbit/s single color interfaces

The following table lists some parameters and the end of life 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/qualifier		OP2G5/1.3SR4 and OM2G5/1.3SR1	OP2G5/1.3LR4 and OM2G5/1.3LR1	OP2G5/1.5LR4 and OM2G5/1.5LR1
Apparatus code		KFA12 and OM2G5A12	KFA203 and OM2G5A203	KFA204 and OM2G5A204
SONET level / SDH level		OC-48 / STM-16	OC-48 / STM-16	OC-48 / STM-16
Transmission rate	kbit/s	2488,320	2488,320	2488,320
Transmission code		NRZ	NRZ	NRZ

Application code	**(Unit)**	**I-16** **SR**	**L-16.1** **LR-1**	**L-16.2** **LR-2**
Wavelength	nm	1266 … 1360	1280 … 1335	1530 … 1560; the receiver also supports 1.3 µ signals with slight span length restrictions; for further information please contact your local customer service.
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 (class 1)	-2 … +2 (class 1)	-2 … +2 (class 1)
Minimum Extinction ratio	dB	8.2	8.2	8.2
Receiver at reference point R and MPI-R (acc.G.957 and G.959.1) respectively				
Receiver type		PIN	APD	APD
Min. optical sensitivity (BER $=10^{-10}$)	dBm	–18	–27	–28
Max. optical path penalty	dB	1	1	2 / 1 (L-16.3)
Overload limit	dBm	–3	–8	–8
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	24	24	24

Application code	(Unit)	I-16 SR	L-16.1 LR-1	L-16.2 LR-2
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

2.5-Gbit/s optical pWDM modules

The following table lists some parameters and the End of Life power budget of the pWDM optical interfaces for 2.5-Gbit/s signals. For the spectral parameters please refer to "Engineering Drawing" (p. 7-2).

Application code	(Unit)	optical modules for OP2G5/PARENT pWDM board
Functional name/qualifier		OM2G5-921 ... 959
Apparatus code		OM2G5-921 … 959
SONET level / SDH level		OC-48 / STM-16
Transmission rate	kbit/s	2488320
Transmission code		NRZ
Wavelength	nm	1530...1560 (32 wavelengths); the receiver also supports 1.3 µ signals with slight span length restrictions; for further information please contact your local customer service.
Transmitter at reference point S and MPI-S (acc. G.957) respectively		
Source type		SLM
Max. spectral RMS width	nm	n/a
Spectral width at –20 dB	nm	1
Min. side mode suppression ratio	dB	30
Mean launched power range	dBm	–3 … 0 (class 1)

Application code	(Unit)	optical modules for OP2G5/PARENT pWDM board
Minimum Extinction ratio	dB	8.2
Receiver at reference point R and MPI-R (acc.G.957) respectively		
Receiver type		APD
Min. optical sensitivity (BER $=10^{-10}$)	dBm	–28
Max. optical path penalty	dB	2 (G.652 fiber) / 1 (G.655 fiber)
Overload limit	dBm	–8
Maximum reflectance of receiver	dB	–27
Optical path between S and R		
Minimum optical return loss of cable at point S (incl. any connectors)	dB	n/a
Maximum discrete reflectance between S and R	dB	n/a
Maximum chromatic dispersion	ps/nm	2400 (G.652 fiber) / 600 (G.655 fiber)
Optical attenuation range (BER $=10^{-12}$)	dB	8...21.5 (G.652 fiber) / 8...22.5 (G.655 fiber)
Nominal target distance	km	40

622-Mbit/s optical interfaces

The following table lists some parameters and the End of Life power budget of the 622-Mbit/s optical interface units.

Application code	(Unit)	S-4.1 / IR-1	L-4.2/ L-4.3 (LR-2 / LR-3)	L-4.1 / LR-1
Functional name/qualifier		OP622/1.3IR16 and OM622/1.3IR1	OM622/1.5LR1	OM622/1.3LR1
Apparatus code		KFA17 and OM622A182	OM622A180	OM622A181
SONET level / SDH level		OC-12 / STM-4	OC-12 / STM-4	OC-12 / STM-4

Application code	(Unit)	S-4.1 / IR-1	L-4.2/ L-4.3 (LR-2 / LR-3)	L-4.1 / LR-1
Transmission rate	kbit/s	622080	155520	622080
Transmission code		NRZ	NRZ	NRZ
Wavelength	nm	1274 … 1356	1480 …1580	1280 … 1335
Transmitter at reference point S and MPI-S (acc. G.957) respectively				
Source type		MLM	SLM	SLM
Max. spectral RMS width	nm	2.5	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	–15 … –8 (class 1)	–3 … +2 (class 1)	–3 … +2 (class 1)
Minimum Extinction ratio	dB	8.2	10	10
Receiver at reference point R and MPI-R (acc.G.957) respectively				
Receiver type		n/a	n/a	n/a
Min. optical sensitivity (BER $=10^{-10}$)	dBm	–28	-34	–28
Max. optical path penalty	dB	1	1	1
Overload limit	dBm	–8	-10	–8
Maximum reflectance of receiver	dB	n/a	-25	14
Optical path between S and R				
Minimum optical return loss of cable at point S (incl. any connectors)	dB	n/a	n/a	n/a

Application code	(Unit)	S-4.1 / IR-1	L-4.2/ L-4.3 (LR-2 / LR-3)	L-4.1 / LR-1
Maximum discrete reflectance between S and R	dB	n/a	n/a	n/a
Maximum chromatic dispersion	ps/nm	74	n/a	172
Optical attenuation range	dB	0 … 12	10 … 28	10 … 24
Nominal target distance	km	15	80	40

155-Mbit/s optical interfaces

The following table lists some parameters and the End of Life power budget of the 155-Mbit/s optical interface units.

Application code	(Unit)	S-1.1 / IR-1	L-1.2/ L-1.3 (LR-2 / LR-3)	L-1.1 / LR-1
Functional name/qualifier		OP155M/1.3IR16, and OM155/1.3IR1	OM155/1.5LR1	OM155/1.3LR1
Apparatus code		OM155A184 and KFA18	OM155A185	OM155A183
SONET level / SDH level		OC-3 / STM-1	OC-3 / STM-1	OC-3 / STM-1
Transmission rate	kbit/s	155520	622080	155520
Transmission code		NRZ	NRZ	NRZ
Wavelength	nm	1261 … 1360	1480 …1580	1280 … 1335
Transmitter at reference point S and MPI-S (acc. G.957) respectively				
Source type		MLM	SLM	SLM
Max. spectral RMS width	nm	7.7	n/a	n/a
Spectral width at –20 dB	nm	n/a	1	1

Application code	(Unit)	S-1.1 / IR-1	L-1.2/ L-1.3 (LR-2 / LR-3)	L-1.1 / LR-1
Min. side mode suppression ratio	dB	n/a	30	30
Mean launched power range	dBm	–15 … –8 (class 1)	–5 … 0 (class 1)	–5 … 0 (class 1)
Minimum Extinction ratio	dB	8.2	10	10
Receiver at reference point R and MPI-R (acc.G.957) respectively				
Receiver type		n/a	n/a	n/a
Min. optical sensitivity (BER $=10^{-10}$)	dBm	–28	-34	–28
Max. optical path penalty	dB	1	1	1
Overload limit	dBm	–8	-10	–8
Maximum reflectance of receiver	dB	n/a	-25	14
Optical path between S and R				
Minimum optical return loss of cable at point S (incl. any connectors)	dB	n/a	n/a	n/a
Maximum discrete reflectance between S and R	dB	n/a	n/a	n/a
Maximum chromatic dispersion	ps/nm	96	n/a	172
Optical attenuation range	dB	0 … 12	10 … 28	10 … 24
Nominal target distance	km	15	80	40

EP155 electrical circuit packs

The following table lists some parameters and the End of Life power budget of the 155-Mbit/s electrical interface units.

Application	(Unit)	intra-office
Functional name/qualifier		EP155/EL8
Apparatus code		KFA533
SDH Level	type	STM-1
Transmission rate	kbit/s	155,520 ± 20 ppm
Line coding	type	Bipolar with Coded Mark Inversion (CMI, G.703-12)
Return Loss (8 ... 240 MHz.)	dB	15
Maximum cable attenuation (78 MHz)	dB	12.7

EP51 electrical circuit packs

The following table lists some parameters and the End of Life power budget of the EP51 electrical interface units.

Application	(Unit)	intra-office
Functional name/qualifier		EP51/EL36
Apparatus code		KFA535
SONET/SDH Level	type	DS3/EC1
Transmission rate	kbit/s	44,736 ±20 ppm respectively 51,840 ±20 ppm
Line coding	type	Bipolar with 3 Zero Substitution (B3ZS)
Return Loss	dB	18 in the range 2,24 … 44,736 kHz 14 in the range 44,736 … 67,104 kHz
Maximum cable attenuation (10 MHz)	dB/100 ft	0.8 for WE 728/734 cables 1.7 for WE 735 cables

Gigabit Ethernet short reach circuit pack

The GE1/SX4 port unit supports 4 fully independent bidirectional ports. Ethernet frames received from a GE1/SX4 port are mapped into STS-1s or VC-4s using Virtual Concatenation. The number of STS1s/VC-4s per virtual concatenated signal can be user provisioned 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 1/1 according to FDA/CDRH - 21 CFR 1010 & 1040 / 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**	
Apparatus code		KFA13
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

Description	Unit	
RMS spectral width (max)	nm	0.85
Average launch power (max)	dBm	-4.
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	–12.5	
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

Description	Unit	62.5 µm MMF	50 µm MMF
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
Link power budget	dB	7.5	7.5	7.5	7.5
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

Gigabit Ethernet long reach circuit pack

The GE1/LX4 port unit supports 4 fully independent bidirectional ports. Ethernet frames received from a GE1/LX4 port are mapped into STS-1s or VC-4s using Virtual Concatenation. The number of STS1s/VC-4s per virtual concatenated signal can be user provisioned 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/LX4 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/LX4 port unit uses a Low Power Laser (laser class 1/1 according to FDA/CDRH - 21 CFR 1010 & 1040 / IEC 60825).

The GE1/LX4 port unit complies with IEEE 802.3-2000 Clause 38.

The table below describes the various operating ranges for the GE1/LX4 port unit over each optical fiber type.

Fiber Type	Modal Bandwidth @ 1300 nm (min. overfilled launch) (MHz*km)	Minimum range (meters)
62.5 µm MMF	500	2 to 550
50 µm MMF	400	2 to 550
50 µm MMF	500	2 to 550
10 µm SMF	N/A	2 to 5000

The following table lists the specific transmission characteristics for a GE1/LX4 port unit.

Description	Unit	
Apparatus code		KFA532
Transmitter type		Longwave Laser
Signaling speed (range)	GBd	1.25 ± 100 ppm
Wavelength (range)	nm	1270 to 1335
T_{rise}/T_{fall} (max, 20–80%)	ns	0.26
RMS spectral width (max)	nm	4
Average launch power (max)	dBm	-3
Average launch power (min)	dBm	-11.5 (62.5 µm and 50 µm MMF) / -11 (10 µm SMF)
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

Description	Unit	
RIN (max)	dB/Hz	-120
Coupled Power Ratio (CPR) (radial overfilled launches, while they meet CPR ranges, should be avoided)	dB	28 < CPR < 40 (62.5 µm MMF) / 12 < CPR < 20 (50 µm MMF) / N/A (10 µm SMF)

The following table lists the specific receive characteristics for a GE1/LX4 port unit.

Description	Unit	
Signaling speed (range)	GBd	1.25 ± 100 ppm
Wavelength (range)	nm	1270 to 1335
Average receive power (max)	dBm	-3
Receive sensitivity	dBm	-19
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	-14.4
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
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/LX4 port unit. Link penalties are used for link budget calculations.

Description	Unit	62.5 µm MMF	50 µm MMF		10 µm SMF
Modal bandwidth as measured at 1300 nm (minimum, overfilled launch)	MHz*km	500	400	500	N/A
Link power budget	dB	8.5	8.5	8.5	9

Description	Unit	62.5 µm MMF	50 µm MMF		10 µm SMF
Operating distance	m	550	550	550	5000
Channel insertion loss (a wavelength of 1270 nm is used to calculate the values)	dB	2.35	2.35	2.35	4.57
Link power penalties (a wavelength of 1270 nm is used to calculate the values)	dB	3.48	5.08	3.96	3.27
Unallocated margin in link power budget (a wavelength of 1270 nm is used to calculate the values)	dB	2.67	1.07	2.19	1.16

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.

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

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

OC / STM level

The OC level can be 3, 12, 48, 192 and 768. The STM level can be 1, 4, 16, 64 and 256.

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.

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Bandwidth management

Specifications

The following specifications apply to *LambdaUnite®* MSS Release 7.0 with regard to bandwidth management:

- System switching capacity: 160 Gbit/s, 320 Gbit/s, or 640 Gbit/s in total (for details please refer to Chapter 4, "Product description")
- VT1.5/VC-12 cross-connection granularity base with LOXC; STS-1/VC-3 (higher-order) without LOXC
- 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) for Gigabit Ethernet applications
- Unidirectional and bidirectional virtual concatenated cross-connections STS-3c-17v / VC-4-17v for transparent applications
- STS-3c, STS-12c, STS-48c unidirectional and bidirectional pipe mode cross-connections
- Uni-directional drop & continue
- Switching matrix capacity: 3072 x 3072 STS-1 /1024 x 1024 VC-4s (XC160), 6144 x 6144 STS-1s / 2048 x 2048 VC-4s (XC320), or 12288 x 12288 STS-1 / 4096 x 4096 VC-4 (XC640)
- Bridging and rolling commands for in-service rearrangement of circuits, except for the LOXC-handled traffic.

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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

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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.
- Q-LAN interface to connect to *WaveStar*® CIT
- Q-LAN interfaces to connect to *Navis*® Optical EMS or other Network Elements
- Floating station alarm interface outputs
- Miscellaneous discrete inputs and outputs

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Timing and synchronization

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 optical inputs
Automatic ref. signal switching	compliant with ETSI ETS 300 417–6
Support of Sync. Status Message (SSM)	OC-M / STM-N ports

OAM & P

Specifications

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

- Testing
  - Power On Self Test after start up and recovery
  - LAN interface self test
  - LED self test
  - Facility loopbacks and cross-connection loopbacks for interface testing
- Recovery
  Auto recovery after input power failure
- Local O & M via faceplate LEDs, buttons on User Panel, *WaveStar*® 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
- Self-diagnostics
- Local workstation (*WaveStar*® CIT)
- Auto-provisioning by the insertion of a circuit pack

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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 *Navis*® Optical EMS interface: TL1 message protocol / 1000BaseT interface
- *WaveStar*® CIT for small network management: RJ-45 CIT interface / 1000BaseT interface

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Physical design

Specifications overview

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

Subrack dimensions	DUR subrack: 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
DUR subrack weight	27 kg (without: Fan unit, UPL, internal cabling, blanks). For more detailed weight information, please refer to "Weight and power consumption" (p. 10-31).
Rack types	NEBS-2000 or ETSI-2 rack
Rack weight	NEBS-2000: 90.5 kg (rack with PDP and rack cabling + 2x door-set) ETSI-2 rack: 92.3 kg (rack with PDP and rack cabling + 2x door-set). For more detailed weight information, please refer to "Weight and power consumption" (p. 10-31).
Connectors optical	LC connectors on all optical interfaces
Connectors electrical	1.6/5.6 coax on STM-1 electrical interface SUB-D on Alarm, Timing, User Byte IF Western RJ45 on LAN interfaces
Station power input (battery)	-48 V / -60 VDC (max. range: -40 ... -72 VDC)
Power consumption	1500 W for a typical configuration, 3500 W maximum. For more detailed power consumption information, please refer to "System power consumption" (p. 6-3) and to "Weight and power consumption" (p. 10-31).

Transmission Fibers

LambdaUnite® MSS supports the following transmission fiber types:

- 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.

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Weight and power consumption

Weight and power consumption specifications

The following specifications apply to *LambdaUnite*® MSS with regard to weight and typical power consumption of the individual parts/circuit packs. The values for the worst case power consumption are roughly 20% higher.

Component	App.-Code	Weight [kg]	Typical power consumption [W]
UNITE Rack ETSI-2 (incl. rack top lamps, doors and side plates)	-	120	-
ETSI-2 rack extension (width), for both sides	-	12.5	-
UNITE Rack NEBS-2000 (incl. rack top lamps, doors and side plates)	-	116	-
NEBS-2000 rack extension (width), for both sides	-	12.2	-
Rack extension (height), 600 mm	-	27.4	-
Rack extension (height), 750 mm	-	27.6	-
DUR/2 with rear faceplates and complete mounting brackets +	-	51	307
incl. 1 x Controller Interface (CI-CTL)	PBJ1		
incl. 2 x Power Interface (PI/100)	PBH3		
incl. 1 x Fan Unit			
incl. 1 x User Panel (UPL)			
incl. 2 x Timing Interface (TI)	PBI1		
Controller (CTL/-)	KFA1	1.47	26
Controller (CTL/2)	KFA531	1.47	26
Controller (CTL/3)	KFA536/7	1.4	28
Controller (CTL/4)	KFA538/9	1.39	18
XC640 (switching unit 640G)	KFD2	7.1	248
XC320/B (switching unit 320G)	KFD1B	6.38	200
XC160 (switching unit 160G)	KFD3	5.49	99

Component	App.-Code	Weight [kg]	Typical power consumption [W]
LOXC (low order switching unit)	KFA700	1.52	64
OP40/1.5LR1/OFC	KFA3	6.84	125
OP40/1.3IOR1	KFA202	4.82	100
OP40/9280-8650/XT	KFA290-353	5.99	120
OP10D/PAR2 with Slide In OM10/xxx	KFA630 +	2.38	51
OP10D/PAR2 without Slide In OM10/xxx	KFA630	1.29	34
OM10/1.3IOR1	OM10G7	0.55	8
OM10/1.5IR1	OM10G14	0.55	9
OM10/1.5LR1	OM10G6	0.55	9
OP10/1.5LR1	KFA6	1.95	47
OP10/1.3IOR1	KFA7	1.6	43
OP10/1.5IR1	KFA14	1.7	40
OP10/1-16/PWDM	KFA11	2.29	46
	KFA61-75		
OP10/01-80/800G	KFA9	2.22	56
	KFA81-159		
OP2G5D/PAR8 without SFP	KFA620	1.56	31
OP2G5/PAR4 without SFP	KFA621	1.245	21
OM2G5/1.3SR1	OM2G5A12	0.02	0.9
OM2G5/1.3LR1	OM2G5A203	0.02	0.9
OM2G5/1.5LR1	OM2G5A204	0.02	0.9
OP2G5D/PAR8 (with 8 modules OM2G5/xxx)	KFA620 +	1.72	38
OP2G5/1.3SR4	KFA12	1.35	22
OP2G5/1.3LR4	KFA203	1.63	39
OP2G5/1.5LR4	KFA204	1.69	39
OP2G5/921-959/PWDM	KFA20 + OM2G5-921...-959	1.96	41
OPT2G5/PAR3 (without SFPs)	KFA540	1.68	48

Component	App.-Code	Weight [kg]	Typical power consumption [W]
OPLB/PAR8 (without SFPs)	KFA180	1.48	28
OM622/1.3IR1	OM622A182	0.02	0.8
OM622/1.3LR1	OM622A181	0.02	0.8
OM622/1.5LR1	OM622A180	0.02	0.8
OM155/1.3IR1	OM155A184	0.02	0.8
OM155/1.3LR1	OM155A183	0.02	0.8
OM155/1.5LR1	OM155A185	0.02	0.8
OPLB/PAR8 (with 8 modules OM622/xxx or OM155/xxx)	KFA180+	1.64	34
OP622/1.3IR16	KFA17	1.6	39
OP155M/1.3IR16	KFA18	1.67	39
GE1/SX4	KFA13	1.46	76
GE1/LX4	KFA532	1.46	76
EP155/EL8	KFA533	1.25	23
ECI/E8	PBK1	0.44	1.1
ECI/P8	PBK2	0.35	1.1
EP51/EL36	KFA535	1.52	36
EP51/EL36B	KFA535B	1.52	36
ECI/51MP72	PBK4	0.75	n.a.
DCM CARRIER CPL (ETSI - 2/NEBS - 2000 RACK)	-	8.84	-
DCM/LC CPL DK-S (15 km SSMF)	-	2.47	-
DCM/LC CPL DK-30,0	-	2.06	-
Front blank (faceplate)	-	0.52	-

For the fields marked with “n.a.” data was *n*ot *a*vailable on the issue date.

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Spare part information

Recommended spare parts

The following table indicates how many plug-in units, paddle boards and sub-racks are required for the customer's substitution spare stock; the calculation for all parts is based on a lead time of 26 week days, except for the 40-Gbit/s- and the 10-Gbit/s colored optics transmission units which have longer lead times. For more specific information please contact your Lucent Technologies local customer team.

Type	Apparatus code	1 pack used	up to 10 packs used	up to 100 packs used	up to 1000 packs used	up to 10000 packs used
Subrack DUR	-	1	1	1	2	5
Fan unit	-	1	1	2	5	21
PI/100 power interface	PBH3	1	1	1	2	4
User panel	-	1	1	1	2	6
TI/E1/DS1 timing interface	PBI1	1	1	1	2	4
CI controller interface	PBJ1	1	1	2	5	19
CTL/- controller	KFA1	1	1	3	11	58
CTL/2 controller	KFA531	1	2	4	15	85
CTL/3 controller (/3T and /3S)	KFA536/KFA537	1	1	3	12	63
CTL/4 controller (/4T and /4S)	KFA538/KFA539	1	1	3	11	59
XC160 switching unit	KFD3	1	2	4	13	69
XC320 switching unit	KFD1B	1	2	4	17	101
XC640 switching unit	KFD2	1	2	4	16	96
LOXC switching unit	KFA700	1	1	3	11	56
OP40 long reach 1.5 µm	KFA3	2	4	13	70	n.a.
OP40 intra-office 1.3 µm	KFA202	1	3	9	46	n.a.
OP40 *LambdaXtreme*™ Transport compatible (preferred \ not preferred colors)	KFA290…*	1 \ 2	3 \ 4	11 \ 15	58 \ 73	n.a.
OP10 intra-office 1.3 µm	KFA7	1	2	4	15	88
OP10 colored optics *WaveStar*® OLS 1.6T and pWDM compatible) (preferred \ not preferred colors)	KFA9, KFA81…*	1 \ 1	2 \ 2	6 \ 7	24 \ 29	n.a.
OP10 long reach 1.5 µm	KFA6	1	2	4	17	101
OP10 intermediate reach 1.5 µm	KFA14	1	2	4	16	91
OP10D OC-192/STM-64 double density parent board for two optical modules	KFA630	1	1	3	12	62

Type	Apparatus code	1 pack used	up to 10 packs used	up to 100 packs used	up to 1000 packs used	up to 10000 packs used
OM10 (OC-192/STM-64 hot pluggable optical LR/LH modules) 80 km	OM10G6	1	1	2	7	34
OM10 (OC-192/STM-64 hot pluggable optical IR/SH modules) 40 km	OM10G14	1	1	2	7	30
OM10 (OC-192/STM-64 hot pluggable optical IOR module) 600 m	OM10G7	1	1	2	6	26
OP2G5 long reach 1.5 µm / 1.3 µm	KFA204 / KFA203	1	1	3	11	59
OP2G5 short reach 1.3 µm	KFA12	1	1	3	12	64
OP2G5D/PAR8 (SFP parent board)	KFA620	1	2	4	13	73
OP2G5/PAR4 (SFP parent board)	KFA621	1	1	3	8	37
OPT2G5/PAR3 (transparent SFP parent board)	KFA540	1	1	3	9	47
OM2G5/1.5LR SFP optical modules	OM2G5A204	1	1	1	3	9
OM2G5/1.3LR SFP optical modules	OM2G5A203	1	1.	1	3	9
OM2G5/1.3SR SFP optical modules	OM2G5A12	1	1	1	3	9
OP2G5 pWDM parent board	KFA20	1	1	3	8	36
OM2G5 pWDM optical modules	OM2G5A291…*	1	1	3	8	35
OP622 intermediate reach 1.3 µm	KFA17	1	2	4	14	79
OP155M intermediate reach 1.3 µm	KFA18	1	2	4	14	79
OPLB (OC-3&OC-12 /STM-1&STM-4 parent board for eight SFP modules)	KFA180	1	1	3	10	52
OM622 (OC-12/STM-4 SFP modules for LR/LH applications) 40 km	OM622A181	1	1	1	2	7
OM622 (OC-12/STM-4 SFP modules for IR/SH applications) 15 km	OM622A182	1	1	1	2	7
OM622 (OC-12/STM-4 SFP modules for LR/LH applications) 80 km	OM622A180	1	1	1	2	6
OM155 (OC-3/STM-1 SFP modules for LR/LH applications) 40 km	OM155A183	1	1	1	2	7
OM155 (OC-3/STM-1 SFP modules for IR/SH applications) 15 km	OM155A184	1	1	1	2	7
OM155 (OC-3/STM-1 SFP modules for LR/LH applications) 80 km	OM155A185	1	1	1	2	6
EP155 electrical STM-1 interface unit	KFA533	1	1	3	8	40
ECI/155ME8 electrical comm. interface with 16 ports	PBK1	1	1	1	2	4

Type	Apparatus code	1 pack used	up to 10 packs used	up to 100 packs used	up to 1000 packs used	up to 10000 packs used
ECI/155MP8 electrical comm. interface with protection	PBK2	1	1	1	2	6
EP51 electrical DS3 interface unit	KFA535	1	1	3	9	45
EP51 electrical DS3 interface unit	KFA535B	1	1	3	9	45
ECI51/MP72 electrical comm. interface with protection	PBK4	1	1	2	4	14
GE1/LX4 Ethernet Interface	KFA532	1	1	3	10	51
GE1/SX4 Ethernet Interface	KFA13	1	1	3	10	51

For the fields marked with "n.a." data was *n*ot *a*vailable on the issue date.

*: For the complete apparatus code list and the respective comcodes please refer to "Engineering Drawing" (p. 7-2).

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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

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" (p. 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

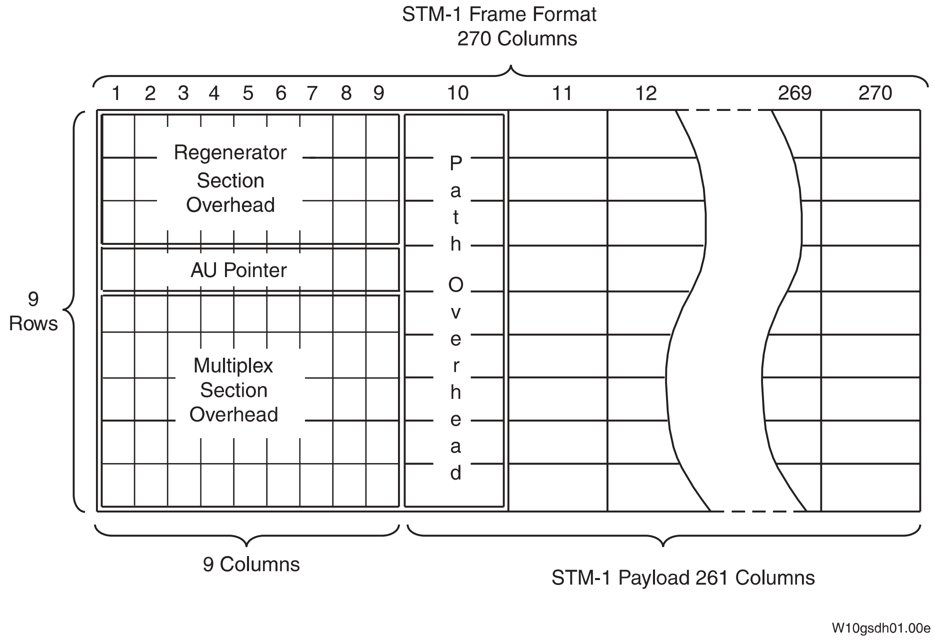
The STM-1 frame (STM = Synchronous Transport Module) is transmitted serially starting from the left with row 1 column 1 through column 270, then row 2 column 1 through 270, continuing on, row-by-row, until all 2430 bytes (9x270) of the STM-1 frame have been transmitted. Because each STM-1 frame consists 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

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

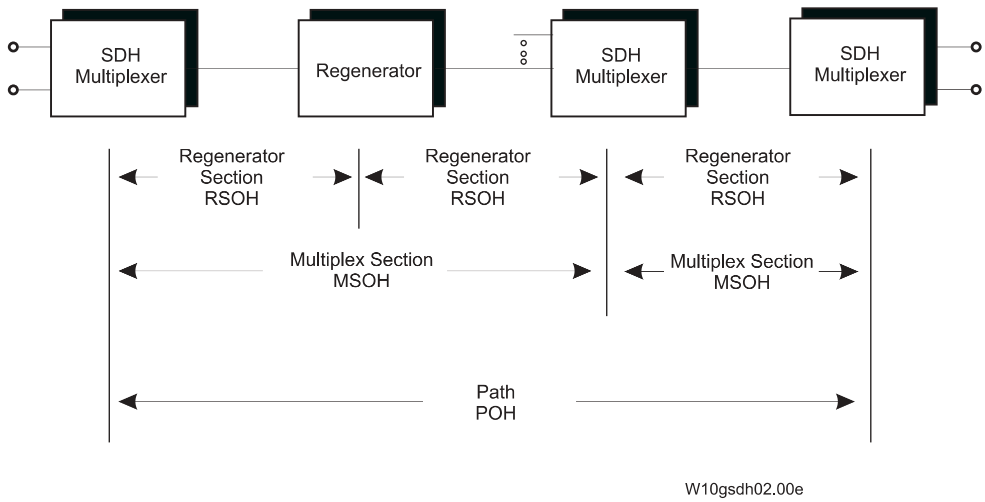
Equipment layers

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.



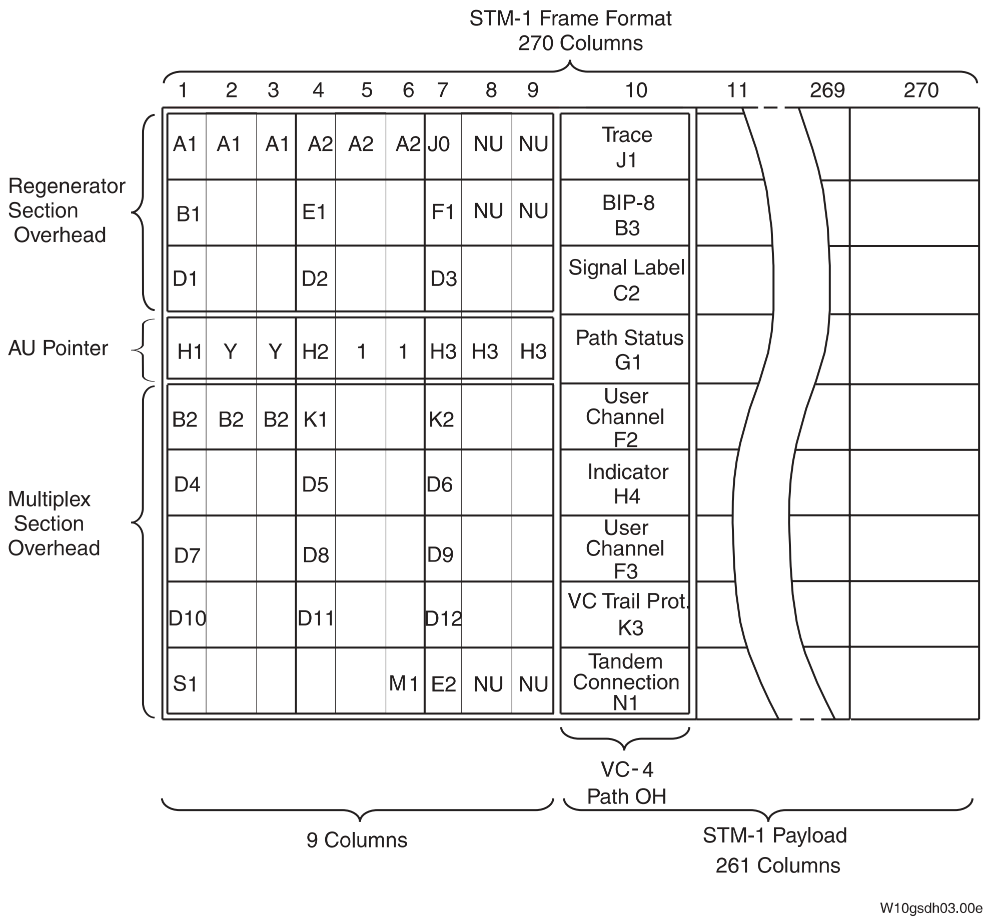
Overhead bytes

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

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

RS/MS overhead

The following table identifies the location and function of each Regenerator Section and Multiplex 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
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 higher order POH bytes and their functions.

Byte	Function
J1	Path trace identifier
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.
N1	Tandem Connection Monitoring (TCM)

The following table shows the lower order POH bytes and their functions.

Byte	Function
V5	Error checking (b1 + b2 = BIP2), signal label (bit 5…7), and path status (b3 = REI, b4 = RFI, b8 = RDI)
J2	Path trace identifier
N2	Network operator byte (for TCM)
K4	higher order APS (b1…b4) and optional (b5…b7).

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.

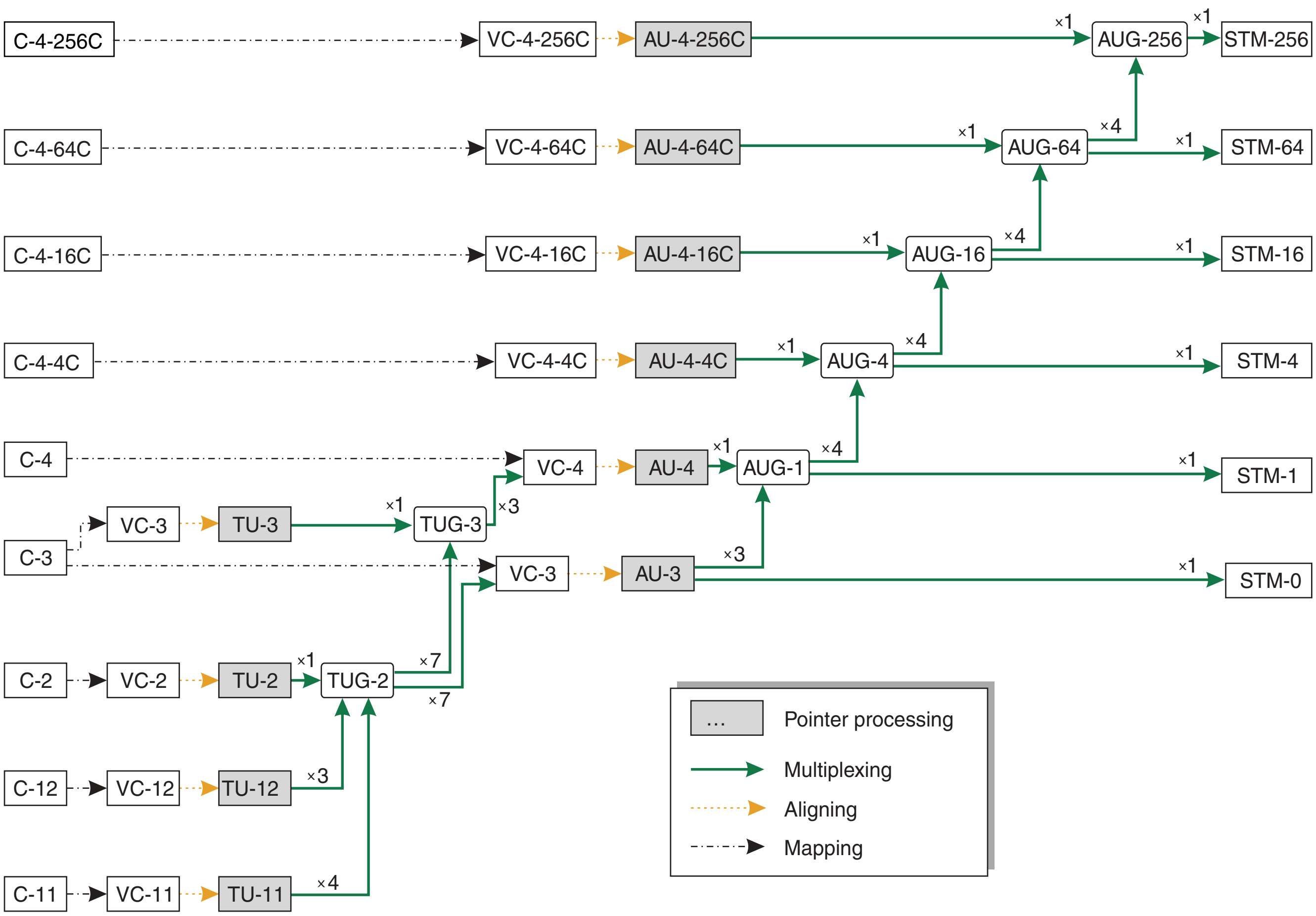
□

SDH digital multiplexing

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 the STM frames.



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 STM payloads. There are various sizes of VCs: VC-11, VC-12, VC-2, VC-3, VC-4, VC-4-4C, VC-4-16C, VC-4-64C and VC-4-256C.

Table

The following table shows the mapping possibilities of some digital signals into 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

□

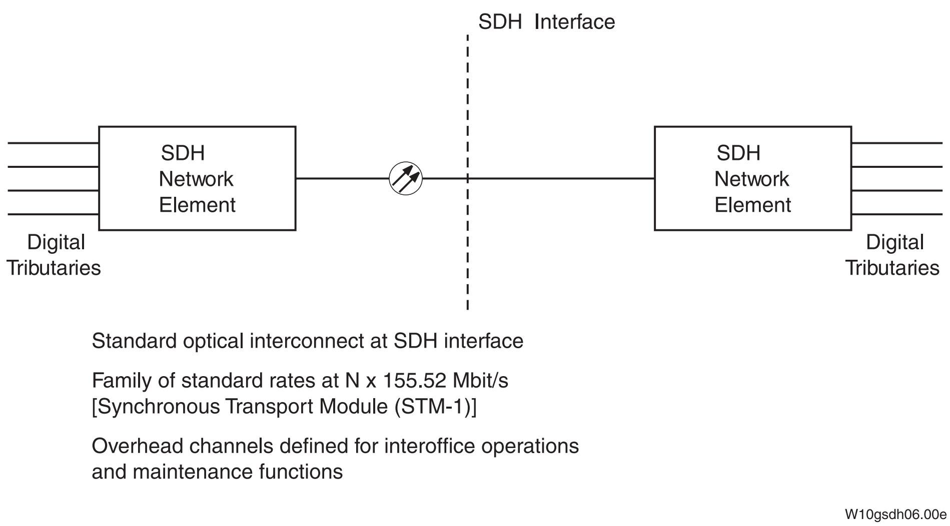
SDH interface

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

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" (p. 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

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" (p. 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

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

Contents

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" (p. 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:

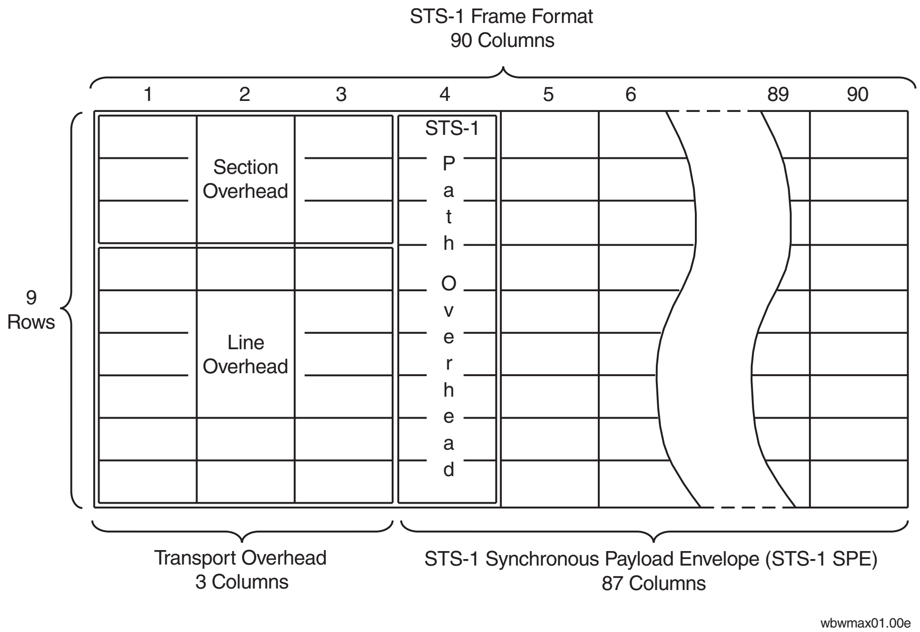
- 90 columns
- 9 rows

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:

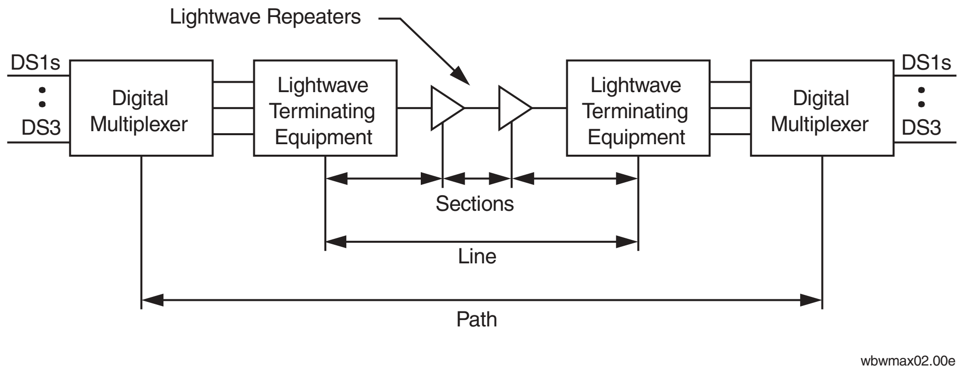
- Equipment that reflects the natural divisions in network spans
- Bytes that carry information used by various network elements

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.



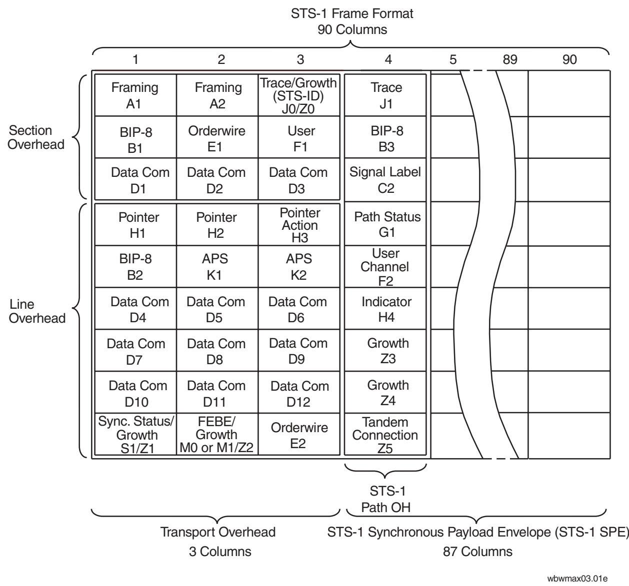
Overhead byte layers

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
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

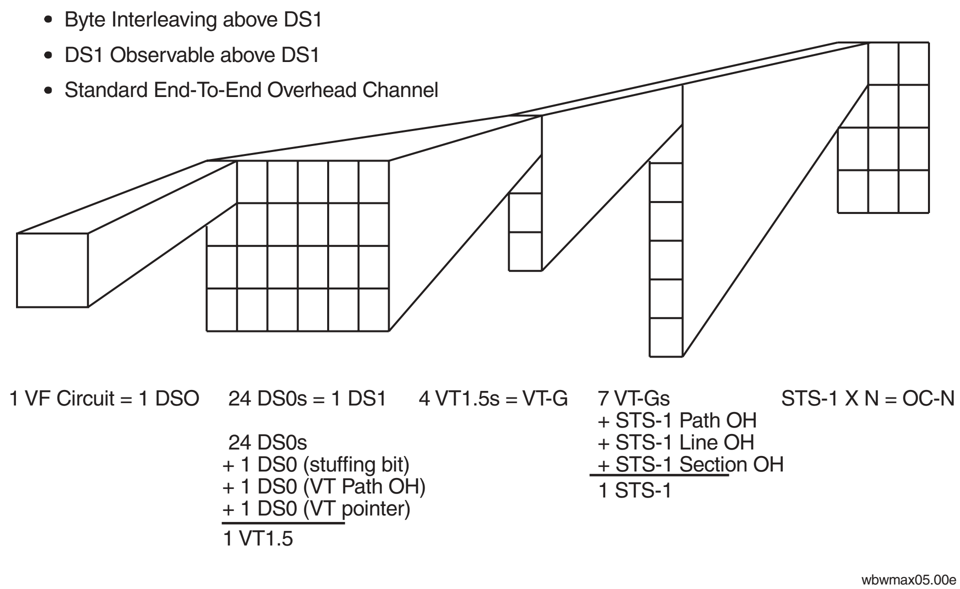
When using an M23 format, identification of DS0s contained in any DS-N signal is complex, and DS0s cannot be directly extracted. An asynchronous DS3 signal must be demultiplexed down to the DS1 level to access and cross-connect DS0 and DS1 signals. In addition, the M23 format does not provide an end-to-end 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
DS4NA	2016 DS0s	139.264 Mbit/s	STS-3c	155.520 Mbit/s

Input Tributary	Voice Channels (DS0s)	Rate	SONET Signal	Rate
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

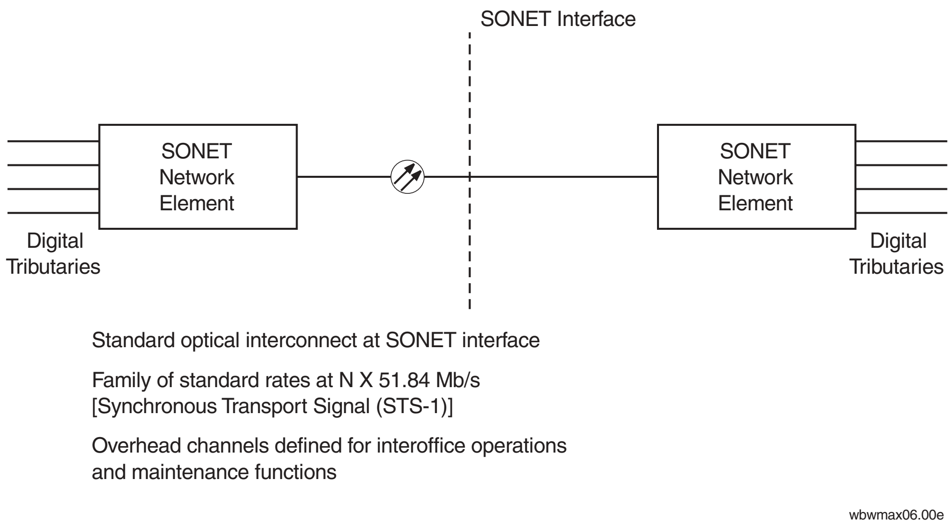
Introduction

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.

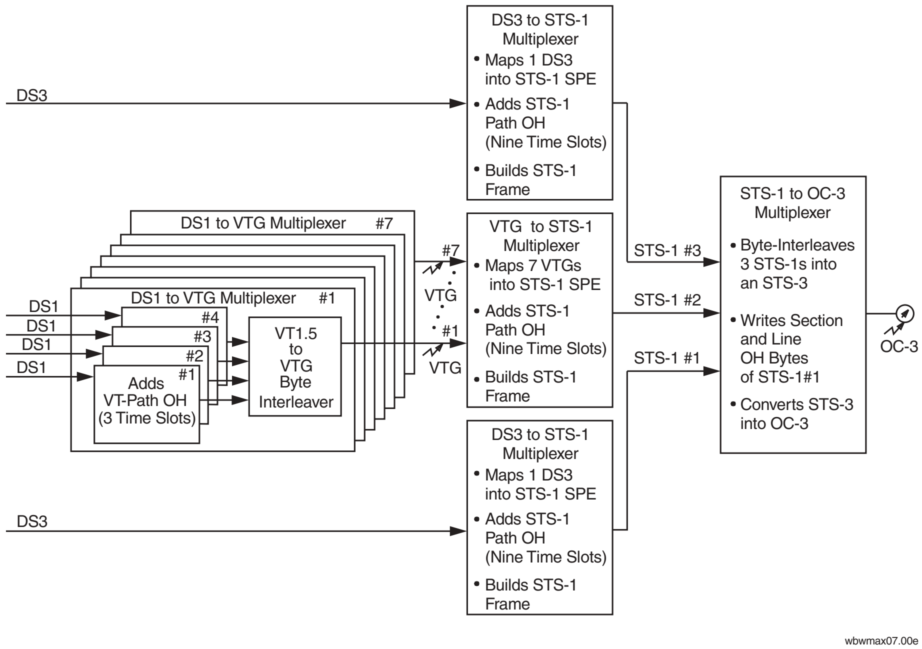
- Each VT1.5 carries a single DS1 payload.
- Four VT1.5s are bundled into a VT group (VT-G).
- Seven VT-Gs are byte interleaved into an STS-1 frame.

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.

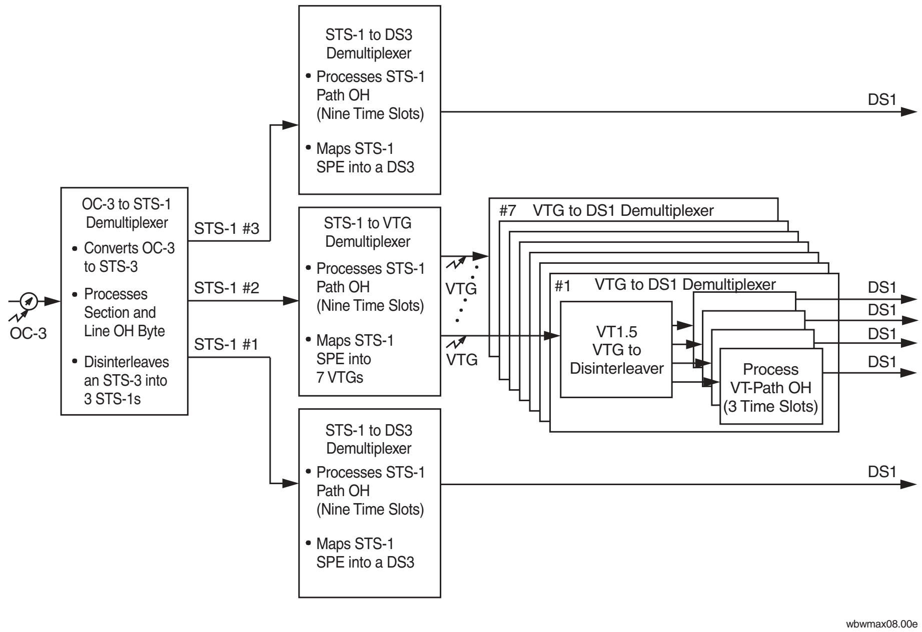
Key points

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.

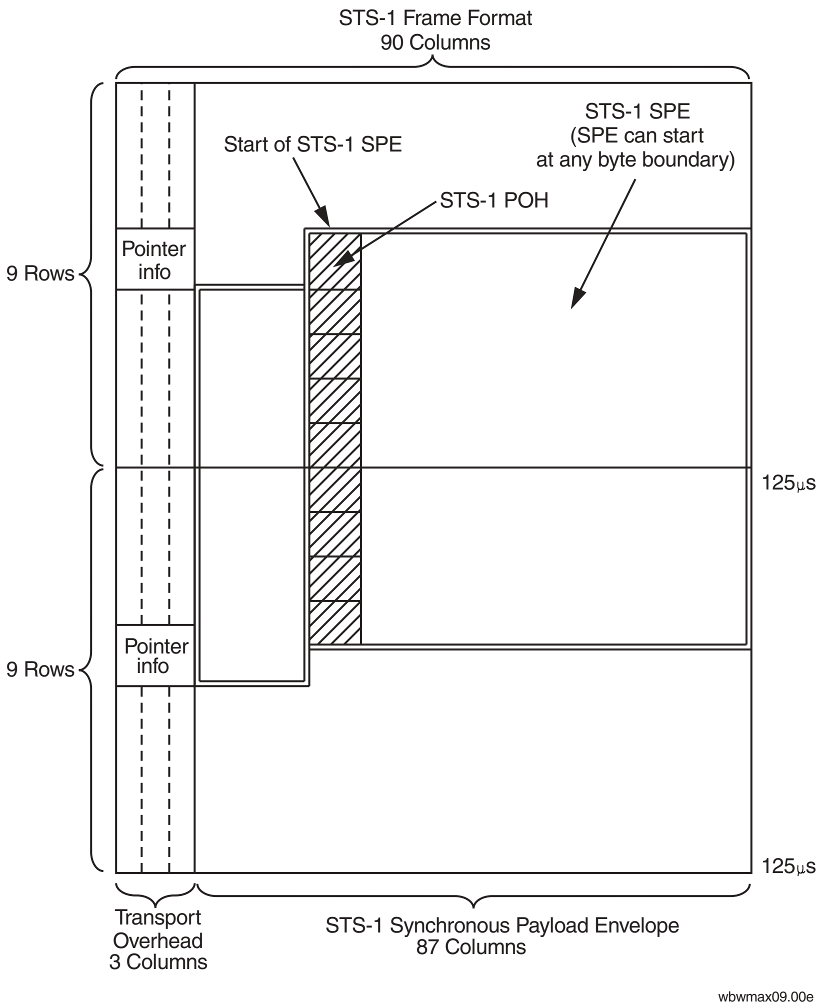
  Important! SONET STS pointers are used to locate the SPE relative to the transport overhead.

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

Symbols

µ

Microns

µm

Micrometer

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

Apparatus code (app. code , item code)
A unique string composed of letters and numbers to identify a piece of hardware.

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.

ASTN (Automatically Switched Transport Networks)

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

Break-out cable

Bundle of several, typically 12, rather thin optical fibers.

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-connection 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

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, VC-12, VC-3 or VC-4 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

GARP

Generic Attribute Registration Protocol

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.

GMPLS
Generalized Multi Protocol Label Switching

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.

GVRP
Generic VLAN Registration Protocol

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
Higher 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-NNI
Internal Network Node Interface

I/O
Input/Output

IAO LAN
Intraoffice Local Area Network

ID
Identifier

IEC
International Electro-Technical Commission

IEEE
Institute of Electrical and Electronics Engineers

IETF
Internet Engineering Task Force

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.

ip&t (Information products and training)

Former Lucent Learning, respectively CTIP.

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)

LMP
Link Management Protocol

LO
Lower 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).

LOXC (Lower-order cross-connection unit)
Optional circuit pack for cross-connections on lower-order signal levels: VT1.5, VC-12 and VC-3 (lower order).

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 **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

MPLS

Multi Protocol Label Switching

MS

Multiplexer Section

ms
Millisecond

MS-SPRING (Multiplexer Section Shared Protection Ring)
A protection method used in Add-Drop Multiplexer Network Elements.

MSA
Multisource Agreement

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.

NTP
Network Time Protocol

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.

OIF

Optical Internetworking Forum

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

PDU (Protocol Data Unit)

A packet of information that is delivered as a unit between peer entities of a network and that may contain control information.

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.

SFF (Small Form Factor)

Fiber-optical connector, designed to be both small and low-cost.

SFP (Small Form Factor Pluggable)
A new generation of optical modular transceivers, designed for use with small form factor (SFF) connectors, offering high speed and physical compactness. They are hot-swappable.

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.

Stratum (Synchronization quality level)
Stratum is a measure for synchronization quality. Opposed to jitter or delay, Stratum is a more static measure. Basically (and from the perspective from a client) it is the number of servers to a reference clock. So a reference clock itself appears at Stratum 0, while the closest servers are at Stratum 1. On the network there is no valid NTP message with Stratum 0. A server synchronized to a Stratum n server will be running at Stratum n + 1. The upper limit for Stratum is 15. The purpose of Stratum is to avoid synchronization loops by preferring servers with a lower Stratum.

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.

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.

TMN
Telecommunications Management Network

Transmit-Direction
The direction outwards from the Network Element.

Tributary
A signal of a specific rate (e.g. 2 Mbit/s, 34 Mbit/s, 140 Mbit/s, VC-12, VC-3, VC-4, 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

TSS

Technical Support Service within Lucent Technologies

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

UNI
User Network Interface

UNITE
UNIversal high speed TDM Equipment

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.

VC-12
Virtual Container 1 2 (SDH payload; 2 Mbit/s capacity)

VC-3
Virtual Container 3 (SDH payload; 34 or 45 Mbit/s capacity)

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.

VLAN

Virtual Local Area 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.

VT1.5

Virtual Tributary at the 1.5 level (SONET payload, 1.728 Mbit/s capacity).

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.

WANPHY (Wide Area Network Physical layer)

An OSI layer 1 WAN Ethernet interface type.

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-connection and timing unit; , main switching unit)

A circuit pack basically consisting of the system switching matrix and the system internal timing source; available switching capacities: 160, 320, or 640 Gbit/s.

Z **Zero Code Suppression**

A technique used to reduce the number of consecutive zeros in a line-coded signal (B3ZS, B8ZS).

Index