1646 Synchronous Multiplexer (SM)
Release 2.3

Product Information and Planning Guide

3KC18077ADAATQZZA

Issue 8

October 2016

Conformance statements

Security statement

In rare instances, unauthorized individuals make connections to the telecommunications network through the use of remote access features. In such an event, applicable tariffs require that the customer pay all network charges for traffic. Nokia cannot be responsible for such charges and will not make any allowance or give any credit for charges that result from unauthorized access.

Limited warranty

Nokia provides a limited warranty for this product. For more information, consult your local Nokia customer support team.

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About this document

Purpose

The Product Information and Planning Guide provides information regarding features, applications, configurations, composition in terms of cards codes, position, notes, functional description, units description, technical specifications, and hardware settings for the 1646 Synchronous Multiplexer SM which is a part of the Nokia Optical Multiservice Node family.

This document provides the following information on the 1646 SM product:

- A general system description which includes:
  - Features
  - Physical configurations
  - Functional descriptions
  - Typical applications
  - Operation, administration, and maintenance functionality
  - Technical specifications
- Description of each physical component
- Product support information

What's new

This is Issue 8 of the 1646 SM Release 2.3 Product Information and Planning Guide.

The document changes for Release 2.3 are shown in the following table:

Table 1 Document changes for Issue 8, October 2016

Feature/enhancement	Description	Location
Rebranding	Rebranding to Nokia.	General
Updated DWDM SFPs	Electrical SFP support details added in the DWDM section.	“DWDM SFPs” (p. 4-15)

Table 1 Document changes for Issue 8, October 2016 (continued)

Feature/enhancement	Description	Location
Maximum access capacity for 1646 SM.	Updated the Maximum access capacity for *GE*.	"Equipment configuration" (p. 3-3)

Supported languages

The official language for composition of Nokia communications and technical documentation is United States English. This guide applies only to documents that are written in the English language.

Most of the standard content described in this document has been translated by the Nokia Central Information and Document (CID) Localization and Translation Services group. This translated content can be retrieved and inserted, in language, from the translation memory repositories that the Localization Services group maintains.

If you intend to translate a document that contains the standard content, CID recommends that you contact the Localization and Translation Services group for translation of the document. This group reuses the standard translated content when the standard English content appears in a document. By using this service, you reduce the costs and time for your project and help ensure consistency of the translated document.

For more information on translation services, see the OneDoc Toolbox Localization and Translation Services web page (http://onedoc.all.alcatel-lucent.com/toolbox/translations/). To submit a document for translation, use the Localization and Translation Services group Submit Translation Request tool (http://onedoc.all.alcatel-lucent.com/toolbox/translations/fileupload.shtml).

Intended audience

Network planners, analysts, managers, and engineers comprise the primary audience for this Product Information and Planning Guide. It provides general information about the application of the 1646 SM, and specific information about the features it supports. It is intended for systems and operations technicians who are required to operate, install, commission, or upgrade the 1646 SM product.

How to use this document

The following table lists the organization of information in this document:

Topic	Description
"About this document"	Contains general information as preliminary information, safety recommendation, handbook scope, history, related documents. Furthermore, it describes the handbook structure and the customer documentation.
Chapter 1, "Safety"	Contains general safety information.
Chapter 2, "Introduction"	Contains all the equipment's general introduction including its application in the telecommunication network
Chapter 3, "Physical configuration"	Contains the equipment composition, part lists with denomination, part numbers and quantity; the units front view are also displayed.
Chapter 4, "Technical specifications"	Contains technical data of the equipment, norms and standard references, detailed data of common parts present in all the various equipment configurations.
Chapter 5, "Functional description"	Contains system description with detailed equipment features.
Chapter 6, "Units description"	Provides detailed unit description with block diagrams of common parts present in all the various equipment configurations.
Chapter 7, "Maintenance"	Provides information to the user on the maintenance aspects.
Chapter 8, "Dismantling and recycling"	Contains information for subrack/units dismantling and recycling, list of hazardous materials and waste code.
Chapter 9, "Quality and reliability"	Contains information about the quality and reliability information for 1646 SM.
Appendix D, "Document issue history"	Contains the information about the updates made in the previous issues.
Appendix A, "Acronyms"	Contains the list of abbreviation used in this document.
Index	Contains a list of index references.

Safety information

For your safety, this document contains safety statements. Safety statements are given at points where risks of damage to personnel, equipment, and operation may exist. Failure to follow the directions in a safety statement may result in serious consequences.

Conventions used

The following table describes the typographical conventions used in this document:

Table 2 Conventions used

Appearance	Description
emphasis	Text that is emphasized
document titles	Titles of books or other documents
file or directory names	The names of files or directories
graphical user interface text	Text that is displayed in a graphical user interface
keyboard keys	The name of a key on the keyboard
`system input`	Text that the user types as input to a system
`system output`	Text that a system displays or prints
`variable`	A value or command-line parameter that the user provides
[ ]	Text or a value that is optional
submenu	The name of a second level submenu
submenu	The name of a third level submenu

Related information

The following table depicts all the documents related to this product:

Table 3 Related product information

Document Number	Document title and description
3KC18078ADAATQZZA	*1646 Synchronous Multiplexer (SM) Release 2.3 User Provisioning Guide*
	Provides general craft terminal information, screens description, and user provisioning procedures by means of the ZIC.
3KC18079ADAATQZZA	*1646 Synchronous Multiplexer (SM) Release 2.3 Installation and System Turn-Up Guide*
	Provides information on maintenance and trouble-clearing procedures.
3KC18080ADAATQZZA	*1646 Synchronous Multiplexer (SM) Release 2.3 Maintenance and Trouble-Clearing Guide*
	Provides information and safety guidelines to safeguard against personal injury and to prevent material damage to the equipment.

Table 3 Related product information (continued)

Document Number	Document title and description
3KC18082ADAATQZZA	*1646 Synchronous Multiplexer (SM) Release 2.3 TL1 User Provisioning Guide*
	Provides information on provisioning procedures by means of Translator Language 1 (TL1) commands
3KC18083ADAATQZZA	*1646 Synchronous Multiplexer (SM) Release 2.3 Safety Guide*
	Provides information and safety guidelines to safeguard against personal injury and to prevent material damage to the equipment.
3KC18081ADAATQZZA	*1646 Synchronous Multiplexer (SM) Release 2.3 TL1 Command Guide*
	Provides comprehensive resource to all Translator Language 1 (TL1) commands

Technical support

For technical support, contact your local customer support team. See the Support web site (http://www.alcatel-lucent.com/support/) for contact information.

How to order

To order Nokia documents, contact your local sales representative or use the Nokia Networks Online Services web site at https://online.networks.nokia.com (https://online.networks.nokia.com).

How to comment

To comment on this document, go to the Online Comment Form (http://infodoc.alcatel-lucent.com/comments/) or e-mail your comments to the Comments Hotline (comments@nokia.com).

1 Safety

Overview

Purpose

This chapter covers the critical information on the safety aspects of the 1646 Synchronous Multiplexer product.

Note: The user must operate the system only after having read and understood this chapter on safety and the parts of the documentation relevant to operation.

Contents

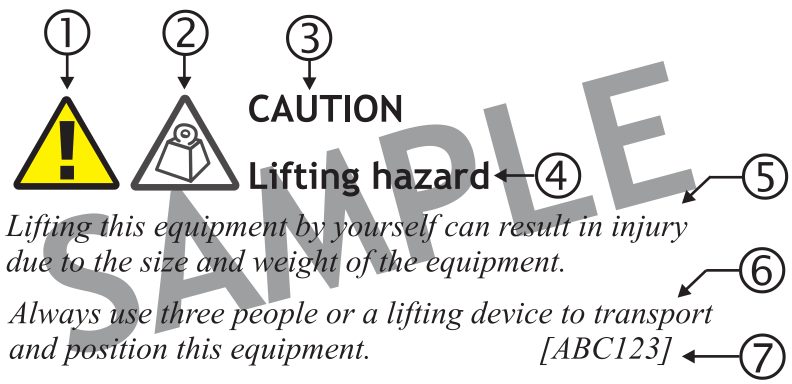
Structure of safety statements

Overview

This topic describes the components of safety statements that appear in this document.

General structure

Safety statements include the following structural elements:



Item	Structure element	Purpose
1	Safety alert symbol	Indicates the potential for personal injury (optional)
2	Safety symbol	Indicates hazard type (optional)
3	Signal word	Indicates the severity of the hazard
4	Hazard type	Describes the source of the risk of damage or injury
5	Safety message	Consequences if protective measures fail
6	Avoidance message	Protective measures to take to avoid the hazard
7	Identifier	The reference ID of the safety statement (optional)

Signal words

The signal words identify the hazard severity levels as follows:

Signal word	Meaning
DANGER	Indicates an extremely hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a hazardous situation not related to personal injury.

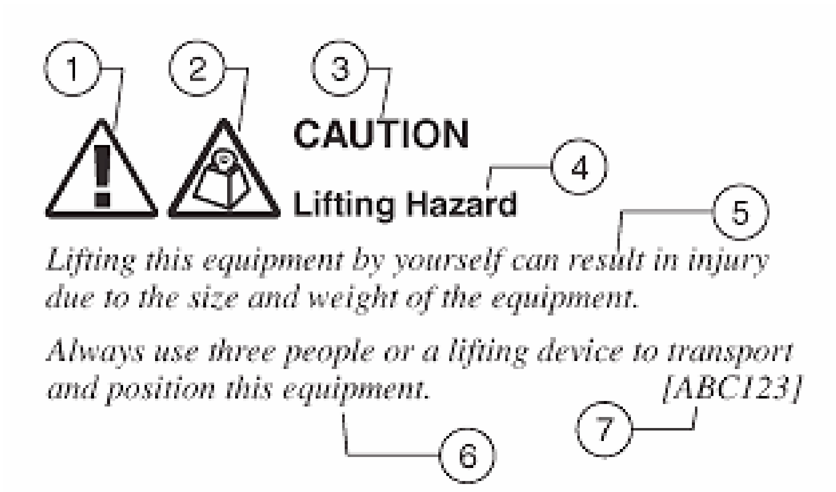
Basic safety aspects

Overview

This topic cover basic safety aspects relating to the 1646 Synchronous Multiplexer with which you must be familiar prior to installing or using the product.

For additional safety precautions, please see 3KC18083ADAATQZZA, *1646 Synchronous Multiplexer (SM) Release 2.3 Safety Guide*

Figure 1-1 Structure of safety statements



Item	Structure element	Purpose
1	Safety alert symbol	Indicates the potential for personal injury (optional)
2	Safety symbol	Indicates hazard type (optional)
3	Signal word	Indicates the severity of the hazard
4	Hazard type	Describes the source of the risk of damage or injury
5	Safety message	Consequences if protective measures fail
6	Avoidance message	Protective measures to take to avoid the hazard
7	Identifier	The reference ID of the hazard statement (optional)

General safety requirements

To reduce the risk of personal injury or damage to equipment, ensure that you read, understand, and follow the following general safety requirements prior to installing or using the 1646 SM:

- Ensure that transport, storage, installation. and operation of the system are conducted only under specified permissible conditions.
- Ensure that installation, configuration, and disassembly of the system are conducted only by suitably qualified personnel and with reference to the appropriate documentation.

  Due to the complexity of the system, the personnel requires special training.
- Ensure that the system is operated only by trained and authorized users.

  For complex systems, additional training is recommended. Any obligatory training for operating and service personnel must be carried out and documented.
- Follow all instructions marked on the product, including both general instructions and the stated methods for avoiding hazards.
- Do not operate the system unless safety is guaranteed. Any faults and errors that might affect safety must be reported immediately by the user to a person in responsibility.
- Operate the system only under the environmental conditions and with the connections described in the documentation.
- Ensure that modifications to any part of the system, including software, are conducted only by Nokia or by trained and qualified personnel authorized by Nokia. Unauthorized modifications will lead to a complete exemption from liability on the part of Nokia.
- Ensure that only components that are recommended by the manufacturer and are listed in the procurement documents are used.
- Avoid use of non-system software. The use or installation of non-system software can adversely affect the normal functioning of the system.
- Use only tested and virus-free data carriers, such as diskettes and tapes.
- Ensure that the removal or disabling of safety facilities, the clearance of faults, and the maintenance of equipment are carried out only by trained and qualified personnel and in conjunction with the appropriate documentation. Use only approved measuring and test equipment.
- Ensure that calibrations, special tests after repairs, and regular safety checks are conducted, documented, and archived.
- Use only specified chemicals or materials.
- Consult material safety data sheets (MSDSs) or the equivalent information when working with hazardous chemicals.
- Follow all applicable hazardous waste, electronic scrap, and take-back disposal procedures.

Personal safety

Observe the following safety instructions, which are of particular importance for your safety:

- Be familiar with evacuation plans and emergency telephone numbers.
- Ensure that first-aid kits are available.
- Wear appropriate personal protective equipment (PPE) such as safety glasses, hard hats, gloves and fall protection.
- Never wear jewelry (rings, bracelets, watches, and so on) when working on or near energized equipment.

Safety norms and labels

First Aid for electric shock

Do not touch the patient with bare hands until the circuit has been opened.

Open the circuit by switching off the line switches. If that is not possible, protect yourself with dry material and free the patient from the conductor.

Artificial respiration

It is important to start mouth to mouth resuscitation at once and seek medical help immediately.

Treatment of burns

This treatment should be used after the patient has regained consciousness. It can also be employed while the artificial respiration is being applied (in this case there should be at least two persons present).

Warning

- Do not attempt to remove his clothing from the burnt parts
- Apply dry gauze on the burns
- Do not apply ointments or other oily substances

Mouth to Mouth resuscitation method

Procedure

1	Lay the patient supine with his arms parallel with the body, if the patient is laying on an inclined plane, make sure that his stomach is slightly lower than his chest. Open the patient's mouth and check that there are no extraneous bodies in his mouth (dentures, chewing-gum etc.).
2	Kneel beside the patient level with his head. Put a hand under the patient's head and one under his neck (see fig.) **Lift the patient's head and let it recline backwards as far as possible** 
3	Shift the hand from the patient's neck to is chin: place your thumb between his chin and his mouth, the index along his jawbone, and keep the other fingers closed together (see fig.). While performing these operations take a good supply of oxygen by taking deep breaths with your mouth open. 
4	With your thumb between the patient's chin and mouth keep his lips together and blow into his nasal cavities (see fig.) 
5	While performing these operations observe if the patient's chest rises (see fig.) If not it is possible that his nose is blocked: in that case open the patient's mouth as much as possible by pressing on his chin with your hand, place your lips around his mouth and blow into his oral cavity. Observe if the patient's chest heaves. This second method can be used instead of the first even when the patient's nose is kept closed by pressing the nostrils together using the hand you were holding his head with. **The patient's head must be kept sloping backwards as much as possible.** 
6	Start with ten rapid expirations, hence continue at a rate of twelve/fifteen expirations per minute. Go on like this until the patient has regained consciousness, or until a doctor has ascertained his death.

End Of Steps

Safety rules

General rules

Before carrying out any installation, turn-up & commissioning, operation and maintenance operations carefully read the relevant Handbook and chapters.

Observe safety rules

When equipment is operating nobody is allowed to have access inside on the equipment parts which are protected with Cover Plate Shields removable with tools.

In case of absolute need to have access inside, on the equipment parts when it is operating this is allowed exclusively to service personnel, where for Service Personnel or Technical assistance is meant:

Personnel who have adequate Technical Knowledge and experience necessary to be aware of the danger that he might find in carrying out an operation and of the necessary measurements to reduce danger to minimum for him and for others.

The Service Personnel can only replace the faulty units with spare parts.

The Service Personnel is not allowed to repair: hence the access to the parts no specified is not permitted.

The keys and/or the tools used to open doors, hinged covers to remove parts which give access to compartments in which are present high dangerous voltages must belong exclusively to the service personnel.

For the eventual cleaning of the external parts of the equipment, absolutely do not use any inflammable substance or substances which in some way may alter the markings, inscriptions etc.

It is recommended to use a slightly wet cleaning cloth.

The Safety Rules stated in the handbook describe the operations and/or precautions to observe to safeguard service personnel during the working phases and to guarantee equipment safety, i.e., not exposing persons, animals, things to the risk of being injured/damaged.

Whenever the safety protection features have been impaired, REMOVE POWER.

To cut off power proceed to switch off the power supply units as well as cut off power station upstream (rack or station distribution frame).

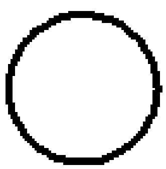
The safety rules described at the beginning of the handbook are distinguished by the following symbol and statement:

SAFETY RULES

Labels Indicating Danger, Forbiddance, Command

It is of utmost importance to follow the instructions printed on the labels affixed to the units and assemblies.

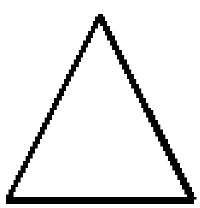
The labels are fully compliant with International Norms ISO 3846-1984. The symbols or statements are enclosed in geometric shapes: ISO 3864-1984.



CONTAINS A SYMBOL STATEMENT

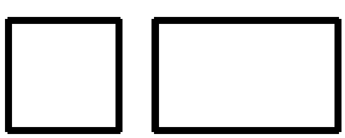
INDICATES FORBIDDANCE (WHITE BACKGROUND WHIT RED RIM-BLACK SYMBOL OR STATEMENT)

IT IS A COMMAND (BLUE BACKGROUND-WHITE SYMBOL OR STATEMENT).



CONTAINS A SYMBOL

INDICATES WARNING OR DANGER (YELLOW BACKGROUND-BLACK SYMBOL AND RIM)



CONTAINS A STATEMENT PROVIDING INFORMATION OR INSTRUCTION.

(YELLOW BACKGROUND-BLACK STATEMENT AND RIM)

The labels have been affixed to indicate a dangerous condition. They may contain any standard-known symbol or any statement necessary to safeguard users and service personnel against the most common ones, specifically:

- dangerous electrical voltages
- harmful optical signals
- risk of explosion
- moving mechanical parts
- heat-radiating mechanical parts

Pay attention to the information stated in the following, and proceed as instructed

Important! The symbols presented in the following paragraphs are all the possible symbols that could be present on Nokia equipment, but are not all necessarily present on the equipment.

Dangerous electrical voltages

Labeling

The following warning label is affixed next to dangerous voltages (>42.4 Vp; >60 Vdc).

If it is a Class 1 equipment connected to mains, then the label associated to it will state that the equipment will have to be grounded before connecting it to the power supply voltage, For example:

Electrical safety: general rules

Danger

Possibility of personal injury: carefully observe the specific procedures for installation/turn-up and commissioning/maintenance of equipment parts where AC or DC power is present, described in the relevant installation/turn-up and commissioning/maintenance documents and the following general rules:

1. a. Personal injury can be caused by -48 V DC (or by 220 V AC) if envisaged in the equipment). Avoid touching powered terminals with any exposed part of your body.
2. b. Short circuiting, low–voltage, low–impedance, DC circuits can cause severe arcing that can result in burns and/or eye damage. Remove rings, watches, and other metal jewelry before working with primary circuits. Exercise caution to avoid shorting power input terminals.

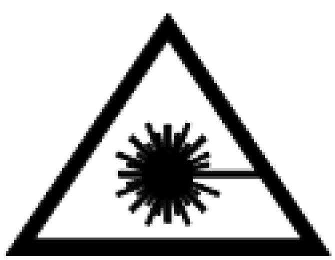
Electrical safety: equipment specific data

Refer to Electrical safety.

Harmful optical signals

Labeling

If the assembly or unit is fitted with a LASER, the labels must comply with the IEC 60825-1 and -2 International Norms.

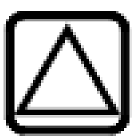


The symbol indicates the presence of a LASER beam. Danger level is stated within a rectangular label:

If the LASER is a Hazard Level 1, 1M product, the label depicting the symbol within a triangle is not compulsory.

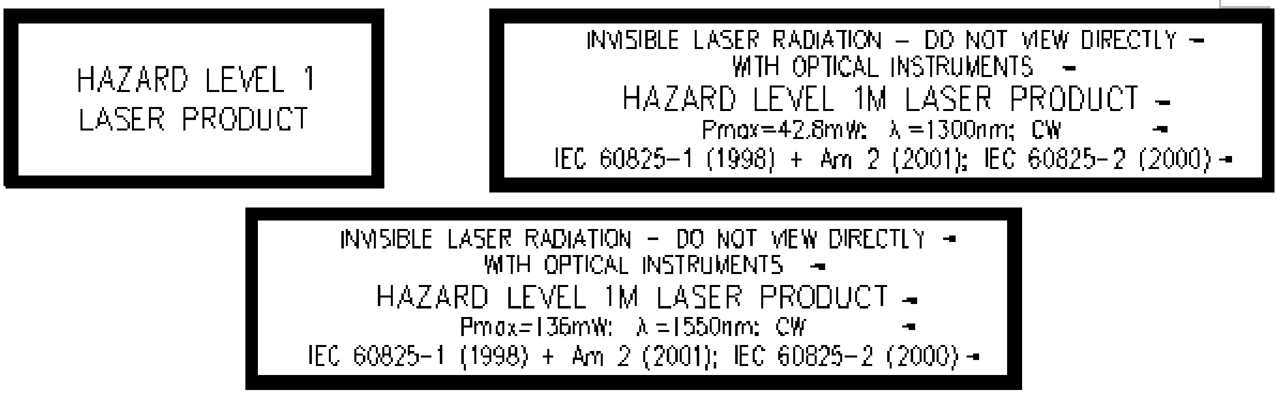
If the LASER is a Hazard Level 3A product, the label depicting the symbol within a triangle is compulsory.

Note: The equipment may be provided with labels of a type other than the illustrated one (reason: previous standard).



The rectangular shaped label bears all the information needed, i.e.:

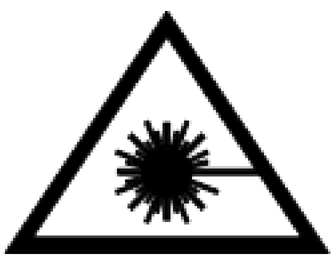
- LASER class
- Power emitted
- Wavelength
- Ref. Norm
- Precautionary measures taken depend on LASER class
- Indications given on openings, panels and safety interlockers



exemple of power and lenght values

Optical safety: general rules

On handling optical equipments or units or cables always check that laser labels are properly affixed and that the system complies with applicable optical standards.



Danger

Possibility of eyes damage: invisible infrared radiations emitted by the fiber optic transmitters can cause eyes damages. Carefully observe the specific procedures for installation/turn-up and commissioning/maintenance of units containing laser devices or cables transporting optical signals, described in the relevant installation/turn-up and commissioning/maintenance documents and the following general rules.

Laser radiation is not visible by the naked eye or with laser safety glasses. Although it cannot be seen, laser radiation may be present.

The general rules are:

1. Never look directly into an un-terminated fiber optic connector or into a broken optical fiber cable, unless it is absolutely known that no laser radiation is present.
2. Never look at an optical fiber splice, cable or connector, unless it is absolutely known that no laser radiation is present.
3. All optical connectors, terminating either fibers or transmitters/receivers, are provided with protective covers that must always be used, as soon as possible, when any optical link is disconnected for installation/test/maintenance purposes or whatever operation.
4. Never look directly into an un-terminated fiber optic connector or into a broken optical fiber cable by means of magnifiers/microscopes, unless it is absolutely known that no laser radiation is present. A magnifier/microscope greatly increases the damage hazard to the eyes.
5. Never point an un-terminated optical fiber splice, cable or connector to other persons, unless it is absolutely known that no laser radiation is present.
6. Always remove electrical power from near and far optical transmitters before disconnecting optical links between the transmitter and the receiver.
7. Wearing of laser safety goggles or eyes shields is recommended for every person working on optical devices, whenever the above listed rules cannot be followed.

Optical safety: equipment specific data

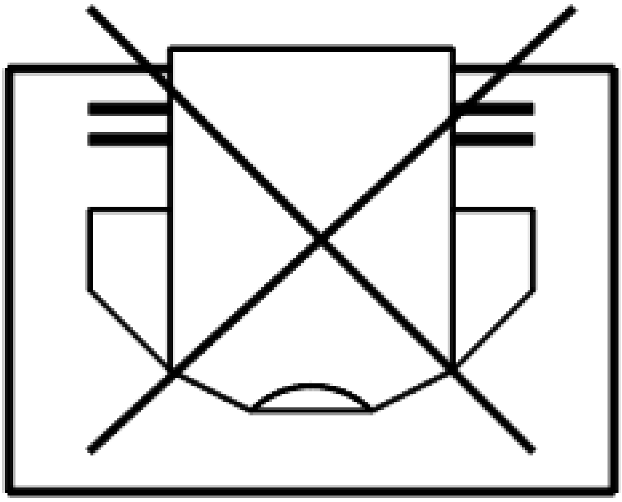
Refer to “Optical Safety”

Risks of explosions

Labeling and safety instructions

This risk is present when batteries are used, and it is signaled by the following label:

Therefore, slits or apertures are made to let air circulate freely and allow dangerous gases to down flow (battery-emitted hydrogen). A 417-IEC-5641 Norm. Compliant label is affixed next to it indicating that the openings must not be covered up.



Moving mechanical parts

The following warning label is affixed next to fans or other moving mechanical parts:

Before carrying out any maintenance operation see that all the moving mechanical parts have been stopped.

Heat-radiating Mechanical Parts

The presence of heat-radiating mechanical parts is indicated by the following warning label in compliancy with IEC 417 Norm, Fig.5041:

As stated by IEC 950 Norm., para.1.4.7 mechanical parts which carry the above pictured label and that could inadvertently be touched, have a temperature T established by the following formula:

(T-Tamb) ≤ (•Tmax + 25º - Tmra)

Where:

Table 1-1 Description of formula

T	Temperature of the mechanical part measured at ambient temperature Tamb.
Tamb	Ambient temperature during the test
DTmax	Value defined by IEC 60950 Norm, Table 16 part 2a, para.5.1, and specified in the table below.
Tmra	The maximum room ambient temperature permitted by the equipment specification or 25ºC, whichever is greater.

Table 1-2 IEC 950 -Table 16: Over temperature limits, Part 2

Operator-accessible parts	Maximum over temperature (˚C)		
	Metal	**Glass, porcelain**	**Plastic, rubber**
Handle knob, etc., held or touched for short periods	35	45	60
Handles, knobs, etc., regularly held	30	40	50
Outer surface of the equipment that can be touched	45	55	70
Inner surface of the equipment that can be touched	45	55	70

Danger

Possibility of personal injury: carefully observe the specific procedures for installation / turn-up and commissioning / maintenance of equipment parts where heat-radiating mechanical parts are present, described in the relevant installation / turn-up and commissioning / maintenance documents and the following general rule:

Personal injury can be caused by heat. Avoid touching powered terminals with any exposed part of your body.

Specific safety rules in this handbook

The safety rules are specified in the following chapters:

- General Safety Rules

Other norms and labels

Overview

Purpose

This section provides the information of the norms and labels.

Contents

This chapter covers the these topics

Electromagnetic Compatibility
Electrostatic Dischargers (ESD)
Suggestions, Notes and Cautions
Labels affixed to the Equipment

Electromagnetic compatibility

The equipment's EMC norms depend on the type of installation being carried out (cable termination, grounding etc.,) and on the operating conditions (equipment, setting options of the electrical/electronic units, presence of dummy covers, etc.).

Before starting any installation, turn-up & commissioning, operation and maintenance work refer to the relevant Handbook and chapters.

The norms set down to guarantee EMC compatibility, are distinguished inside this handbook by the symbol and term:

ATTENTION **EMC NORMS.**

General Norms - installation

All connections (towards the external source of the equipment) made with shielded cables use only cables and connectors suggested in this technical handbook or in the relevant Plant Documentation, or those specified in the Customer's “Installation Norms.” (or similar documents)

1. Shielded cables must be suitably terminated.
2. Install filters outside the equipment as required

3. Ground connects the equipment utilizing a conductor with proper dia. and impedance
4. Mount shields (if utilized), previously positioned during the installation phase, but not before having cleaned and degreased it.
5. Before inserting the shielded unit proceeds to clean and degrease all peripheral surfaces (contact springs and connection points, etc.)
6. Screw fastens the units to the subrack.
7. To correctly install EMC compatible equipment follows the instructions given.

General Norms - Turn-up & commissioning, operation

The general norms are:

1. Preset the electrical units as required to guarantee EMC compatibility.
2. Check that the equipment is operating with all the shields properly positioned (dummy covers, ESD connector protections, etc.).
3. To properly use EMC compatible equipment observes the information given.

General Norms - maintenance

The general norms are:

1. Before inserting the shielded unit, which will replace the faulty or modified unit, proceed to clean and degrease all peripheral surfaces (contact springs and connection points, etc.)
2. Clean the dummy covers of the spare units as well.
3. Screw fastens the units to the subrack.

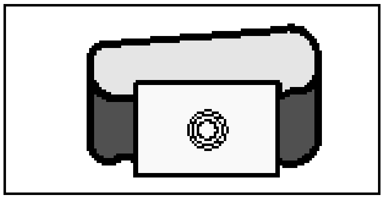
Electrostatic Dischargers (ESD)

Before removing the ESD protections from the monitors, connectors etc., observe the precautionary measures stated. Make sure that the ESD protections have been replaced and after having terminated the maintenance and monitoring operations.

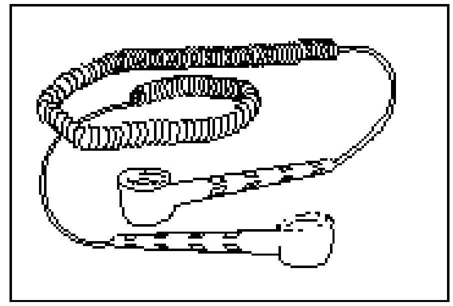
Most electronic devices are sensitive to electrostatic dischargers; to this concern the following warning labels have been affixed:

Observe the precautionary measures stated when having to touch the electronic parts during the installation/maintenance phases.

Workers are supplied with antistatic protection devices consisting of:



ELASTICIZED BAND



COILED CORD

an elasticized band worn around the wrist

A coiled cord connected to the elasticized band and to the stud on the subrack.

Suggestions, notes and cautions

Suggestions and special notes are marked by the following symbol:

> **Note:** Cautions to avoid possible equipment damage are marked by the following symbol:
>
> **Note:** TITLE... (Caution to avoid equipment damage)

Statement....

Labels affixed to the equipment

This chapter indicates the positions and the information contained on the identification and serial labels affixed to the equipment.

Figure 1-2, "Subrack label" (p. 1-22) through' Figure 1-4, "Back panels internal label" (p. 1-24) Illustrate the most common positions of the labels on the units, modules and subracks.

Figure 1-5, "Label specifying item not on catalogue (P/N. and serial number)" (p. 1-25) through' Figure 1-10, "WEEE label" (p. 1-27) illustrate the information (e.g., identification and serial No.) printed on the labels.

The table below relates the ref. numbers stated on the figures to the labels used.

Important! Labeling depicted hereafter is for indicative purposes and could be changed without any notice.

Table 1-3 Label references

Ref. No.	Name of Label
1	Label specifying item not on catalogue (P/N. and serial number). Refer to Figure 1-5, "Label specifying item not on catalogue (P/N. and serial number)" (p. 1-25)
2	Label specifying item on catalogue (P/N. and serial number). Refer to Figure 1-6, "Label specifying item on catalogue (P/N. and serial number" (p. 1-25)
3	Item identification label – item on catalog. Refer to Figure 1-7, "Item identification labels - item on catalog" (p. 1-26)
4	Label identifying the equipment. Refer to Figure 1-8, "Label identifying the equipment (example)" (p. 1-26)
5	Label identifying compliancy with CE and WEEE Directives. Refer to Figure Figure 1-9, "CE label" (p. 1-27) and Figure 1-10, "WEEE label" (p. 1-27)

On contract basis, customized labels can be affixed to the equipment.

Standard labels can be affixed to any position on the equipment, as required by the Customer. However, for each of the above are applied the rules defined by each individual Customer.

Figure 1-2 Subrack label

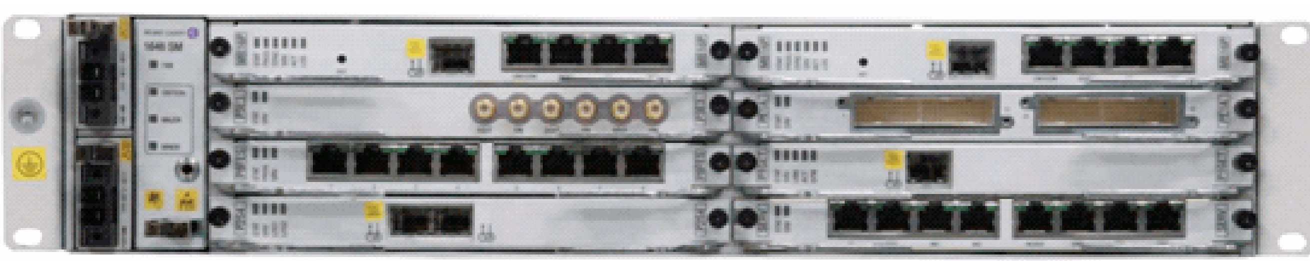


Figure 1-3 Internal label for Printed Board Assembly

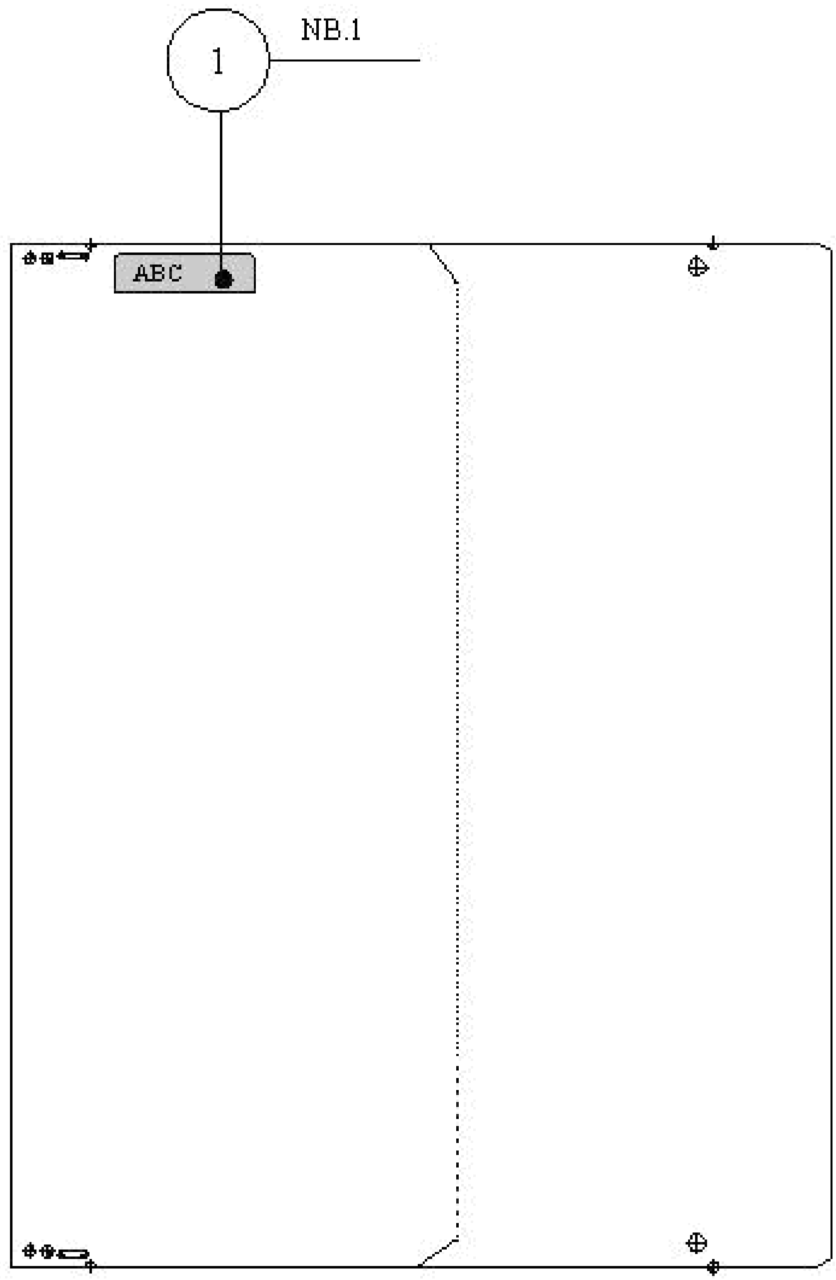
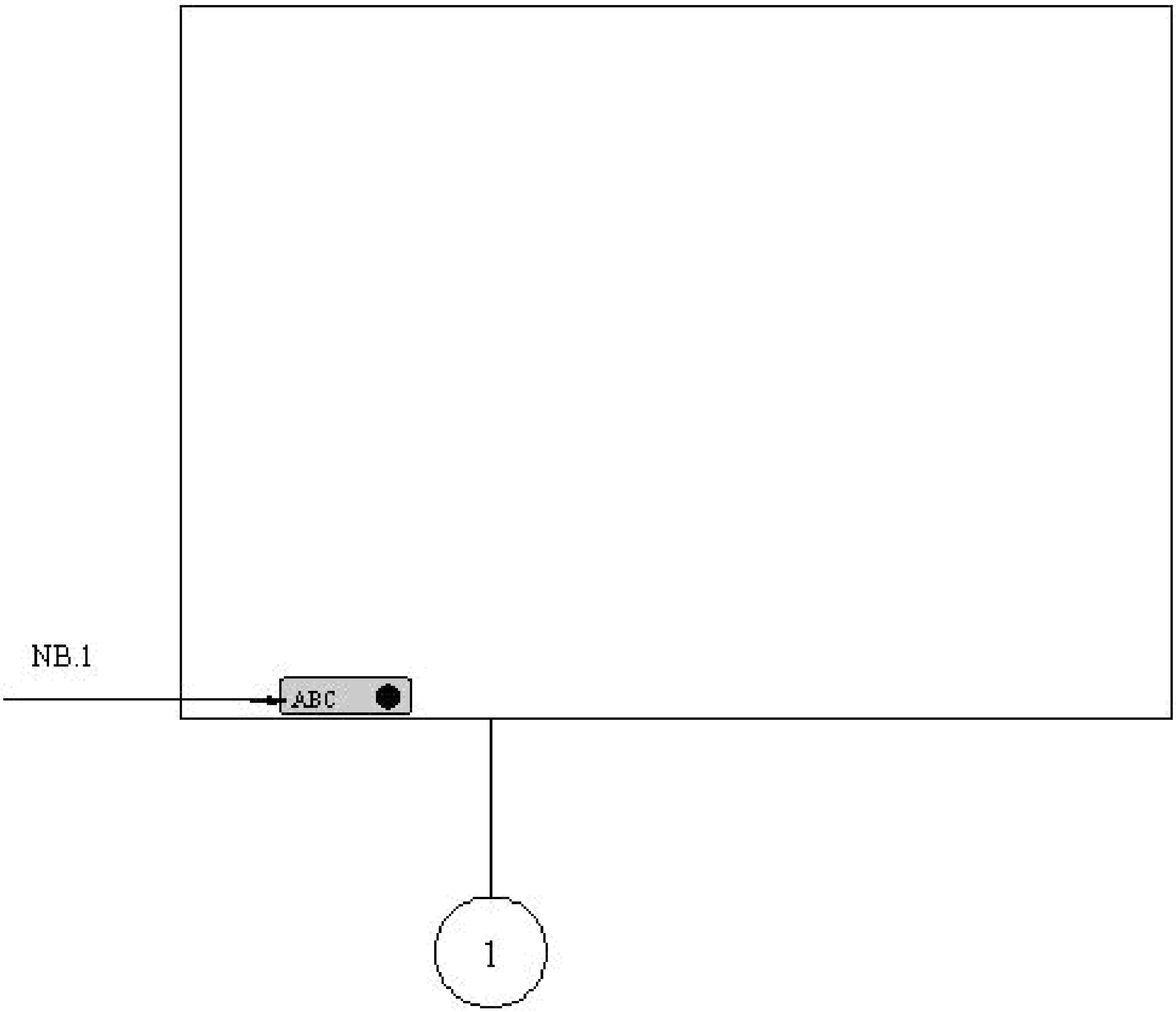


Figure 1-4 Back panels internal label



Note: The label is present on p.c.s.components side or rear side on the empty spaces.

Figure 1-5 Label specifying item not on catalogue (P/N. and serial number)

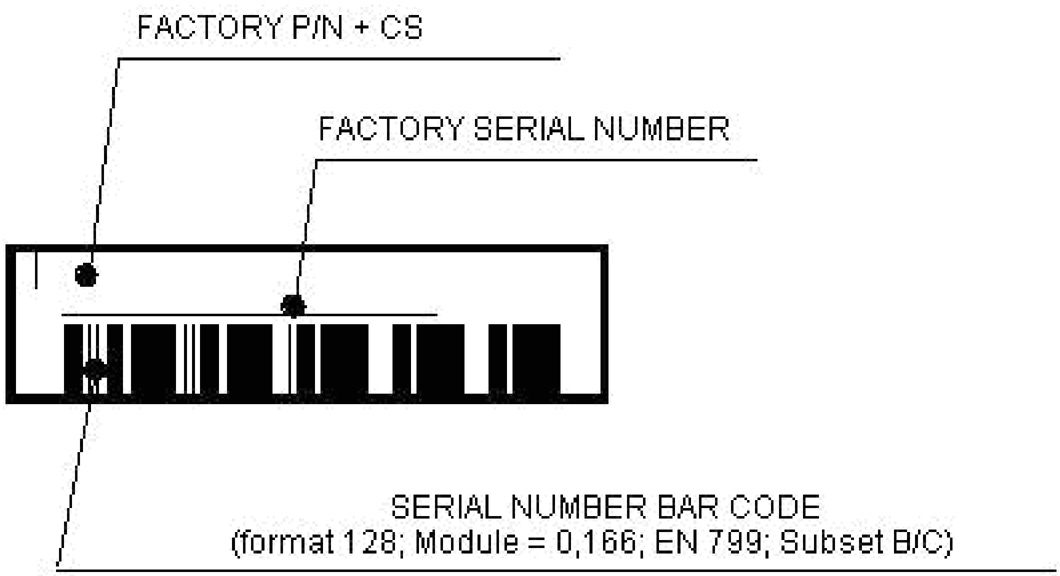


Figure 1-6 Label specifying item on catalogue (P/N. and serial number

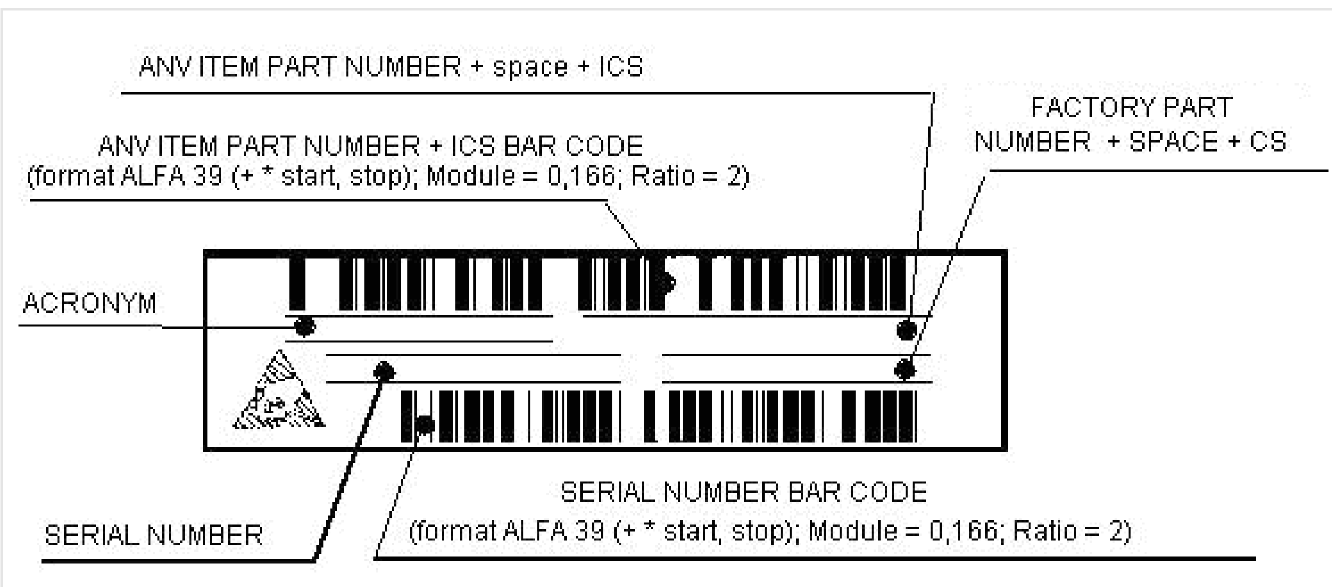


Figure 1-7 Item identification labels - item on catalog

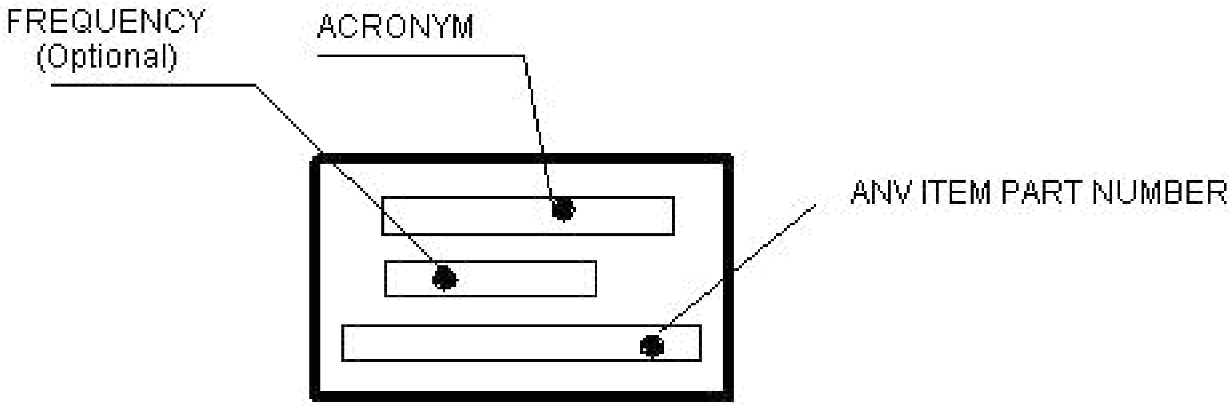


Figure 1-8 Label identifying the equipment (example)

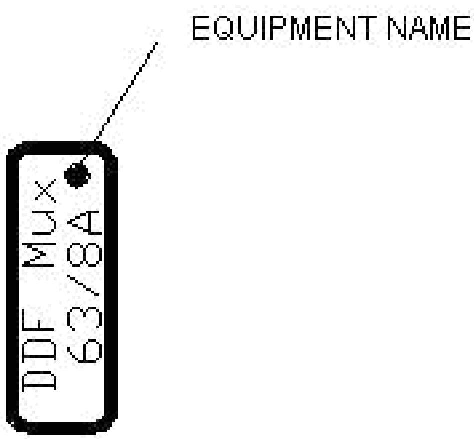


Figure 1-9 CE label

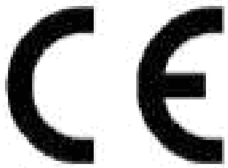


Figure 1-10 WEEE label

Handbook structure and configuration check

Overview

The following procedures have been issued and must be observed when unpacking the equipment. The reciprocal operation must be done for repacking. In such case it is recommended to use the original packing material.

The following sturdy outer packing material is utilized in order to protect the equipment against mechanical and climatic stresses to which they are subjected:

Wooden crates for transport by ship, air, on road for periods longer than 60 days

Ply-wood crates for transport by ship, air, on road for periods of 30 to 60 days

Cardboard boxes for transport by air or on road for periods of less than 30 days

General Information

Warning

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Handbook applicability

This handbook applies to the following product releases:

Product			ANV P/N	Factory P/N
1646 SM			3KC18077ADAATQZZA	--.--.--
Product	**Release**	**Version**	**ANV P/N**	**Factory P/N**
1646 SM	2.2		3KC18077ADAATQZZA	--.--.--

Warehousing

If having to store the packed material, the following requirements must be met:

- The cardboard boxes must be placed indoor in airy rooms
- The wooden or plywood cases can be placed outdoors provided they are protected against rain and direct sunlight

Product-release handbooks

The list of handbooks given here below is valid on the issue date of this Handbook and can be changed without any obligation for Nokia to update it in this Handbook.

Some of the handbooks listed here below may not be available on the issue date of this Handbook.

The standard Customer Documentation in the English language for the equipment whose product–release–version is stated in Handbook Applicability consists of the handbooks listed in Table 3, “Related product information” (p. xx)

Handbook structure

This handbook has been edited according to the Nokia standardized “drawing-up guides” complying with such suggestion.

This handbook is divided into the following main topics as described in the table of contents:

Handbook guide:	It contains general information on safety norms, EMC and type of labels that might be affixed to the equipment. Furthermore, it describes the handbook structure and the customer documentation. The abbreviation list is supplied too.
Introduction:	It contains all the equipment's general and detailed system features including its application in the telecommunication network. Furthermore, it supplies the equipment description and specifications (i.e., system, mechanical, electrical and/or optical).
Physical configuration	It contains the physical structure, layout and composition, coding and partition of the equipment and fans subrack.
Technical specifications	It covers the technical specifications of the equipment.
Functional description	It gives a general description of the main subsystems and the related features
Units description	It provides a detailed description of all the units in 1646 Synchronous Multiplexer (SM).

Maintenance:	It contains all the details for periodic checks, fault location and repair procedures and restore to normal operation through the withdrawal of faulty units and their replacement with spares (*)
Hardware settings	It encloses the documents related to unit hardware setting operations, if envisaged.
Dismantling & recyling	It contains information for subrack/units dismantling and recycling, list of hazardous materials and waste code.
Appendices:	Section envisaged (but not necessarily included) to describe possible alternative unit.
Annexes:	Section envisaged (but not necessarily included) containing additional documentation or general information on other topics not inherent to the chapters making up the handbook.

Important!(*) If the equipment is software integrated and man-machine interfaced (through a PCD, PC, Work Station or other external processing/displaying system) the maintenance carried out with such system is described in the Operator's Handbook.

2 Introduction

Overview

Purpose

This chapter introduces the user to the 1646 Synchronous Multiplexer product.

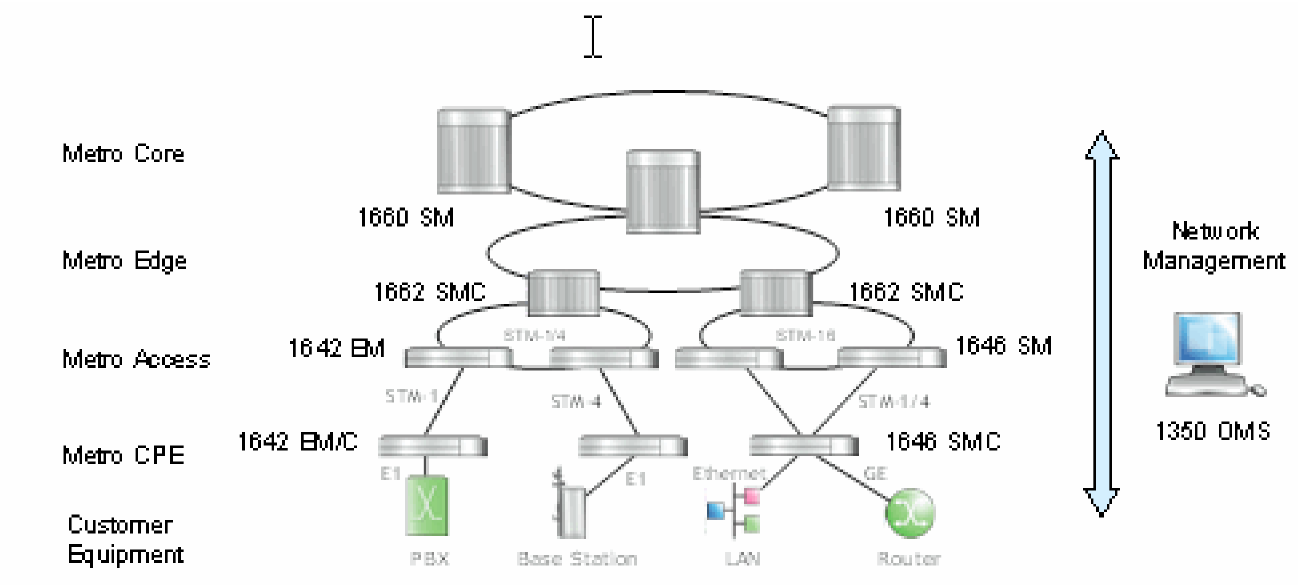
Contents

1646 SM portfolio

Description

The 1646 Synchronous Multiplexer SM is a part of the Nokia Optical Multiservice Node (OMSN) family. See Figure 2-1, "Example of 1646 SM as part of the OMSN family" (p. 2-2)

Figure 2-1 Example of 1646 SM as part of the OMSN family



The 1646 SM is an ideal customer premises equipment (CPE) for the delivery of the simultaneous TDM and Ethernet services. It extends services to the customer premises for fixed and wireless service providers and enterprise customers with rapid payback on investment. It is a compact SDH CPE solution providing large capacity, high port density, and low power consumption per Mb/s.

Features

The following features are supported in the 1646 SM:

- Supports E1, STM-1/4/16, and 10/100/1000M Ethernet compliant to ETSI standards
- High capacity super-impact 2U design for customer premises deployment
- Ultra high-port density for a CPE device with up to 252 E1 ports and/or 48 FE ports per chassis
- Layer 2 and QoS Ethernet features
- E-Line and E-LAN services

- SDH protection with subnetwork connection protections (SNCP/I and SNCP/N), linear multiplex section protection (MSP 1+1)
- MS-SPRING: Multiplex section shared protection for RING
- Leverages installed SDH networks to offer next-generation data services
- CWDM and DWDM Small Form Factor Pluggable (SFP)
- Ethernet ring protection (G.8032) and Ethernet line protection (G.8031)
- Mainboard redundancy

Customer benefits

The following is a list of benefits that a customer can derive from the 1646 SM:

- Offers high-margin Ethernet service along with reliable leased-line services
- Support for always-on, mission critical applications
- CAPEX optimization due to latest ASICs Integrated technologies
- Reduced OPEX with fan-less design, less power consumption, small footprint, remote manageable
- End-to-end, across MSPP, PTN, and WDM, and manageable by Nokia 1350 Optical Management System (OMS)
- Faster time-to-market with rapid rollout of new services into mainstream product portfolio, accelerating the return on investment (ROI)
- Provides rich data-services set for Carrier-Ethernet, mobility-backhaul, video, and broadband-aggregation application
- Nokia OMSN systems are Metro Ethernet Forum (MEF) compliant

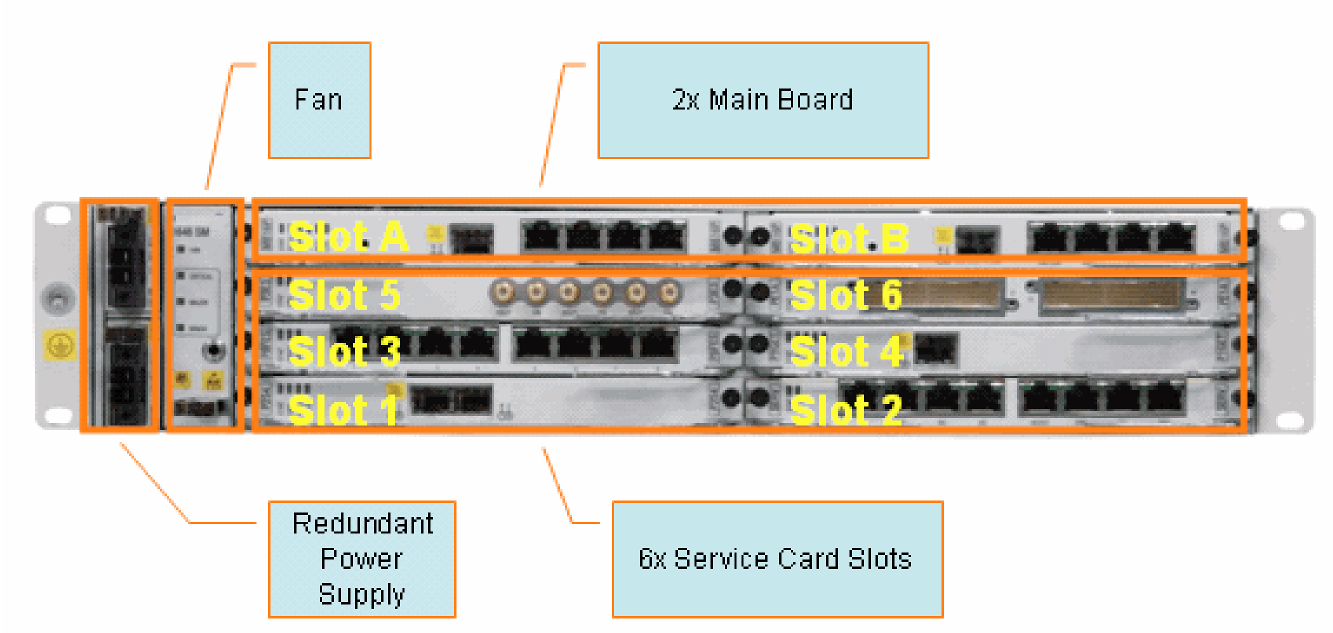
1646 SM

Overview

The 1646 SM is designed for access and metro applications. The Nokia MSPPs offer powerful solutions for building intelligent optical networks that achieve a balance between new services, future-oriented service offerings, and traditional services that generate revenues.

Figure 2-2 1646 SM front panel view

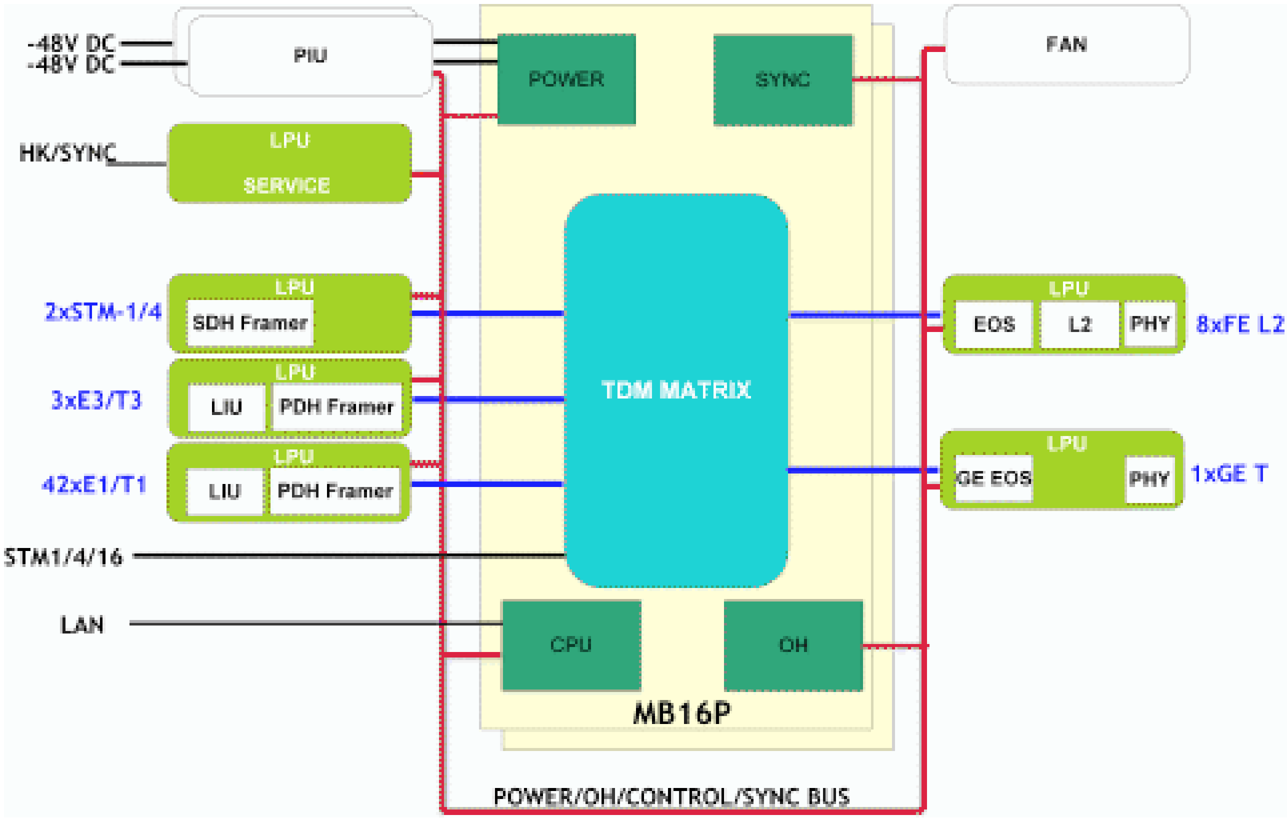
Figure 2-3 1646 SM expansion slots



One multiservice provisioning platform integrates carrier-grade, next-generation SDH functionality, and TDM transport with advanced Layer 2 packet-switching features, such as Ethernet.

These features allow service providers to support new broadband services, such as Ethernet virtual private networks (VPNs), high-speed Internet access, and 3G mobile aggregation services. It will also support business services such as TDM leased lines and storage area network (SAN) extension, plus wavelength services, over a single platform.

Figure 2-4 1646 SM system architecture



The 1646 SM is an ideal Customer Premises Equipment (CPE) for the delivery of simultaneous TDM and Ethernet services. The 1646 SM can be used in numerous scenarios, such as mobile back-haul, enterprise data service and fixed broadband aggregation. It extends services to the customer with rapid payback on investment.

Nokia is dominating the evolution of multiservice transport technology. The 1646 SM solves the scalability issues encountered with the traditional MSPP when data traffic is increasing.

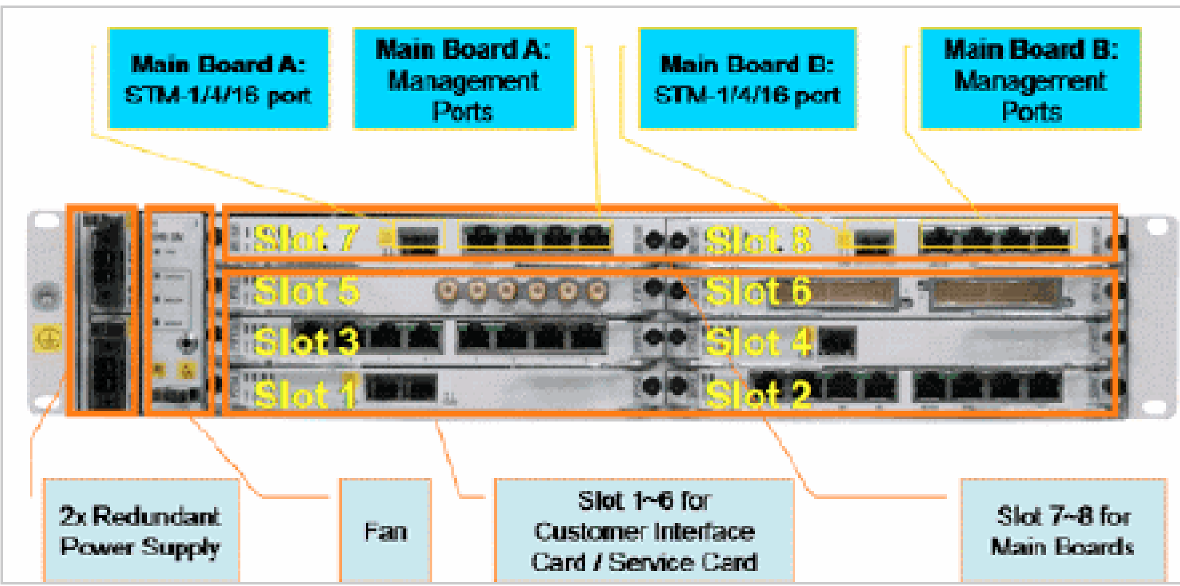
System design

Overview

The 1646 family implements a modular design. The 1646 SM has eight slots, two for main boards and six for line cards. The multi-speed network interfaces are built into main board. Users can choose line rate from STM-1, STM-4 or STM-16, just by configuration. The 1646 SM and 1646 SMC variants share the same set of line cards that provide service interfaces to customer. The customer service interfaces that 1646 SM can provide include STM-1/4/16, E1, E3/T3, Fast Ethernet, and Gigabit Ethernet. All the cards and modules of the 1646 family are designed to be in front panel for easy access.

The 2U high 1646 SM chassis has eight card slots. Figure 2-5, "1646 SM chassis layout" (p. 2-7) shows the front panel of a fully loaded 1646 SM.

Figure 2-5 1646 SM chassis layout



The 1646 SM chassis layout is described as follows:

- Slot 1 through 6 are for line cards or optional service cards.
- Slot 7 and 8 can hold two main boards which protect each other.
- The 1646 SM chassis has two redundant DC power supply modules and one replaceable fan module.

Main features

The following are the main features of the 1646 SM:

- Compact chassis: 2RU for 1646 SM
- Low power consumption
- High speed interfaces, upto STM-16 and Gigabit Ethernet
- High port density line cards
- Network protection: MSP 1+1, SNCP, MS-SPRing (1646 SM)
- Ethernet linear path protection (ITU G.8031)
- Ethernet ring protection (ITU G.8032v2)
- Network management by the Nokia 1350 Optical Management System (OMS)

Applications and configurations

Overview

System features and applications such as SDH and Data are discussed in this section.

The 1646 SM equipment perform multi-service integration of SDH Data.

By combining SDH ADM, multiservice data switching and aggregation capabilities in one NE, the 1646 SM allows network operators to easily enhance functionality and improve network performance by leveraging on current infrastructures.

SDH network configuration

The equipment is compliant with SDH ITU-T Recommendations.

The 1646 SM be used in metropolitan networks configured for standard plesiochronous or synchronous systems.

The 1646 SM supports linear, ring, and hub networks and is on protected or unprotected line links.

The equipment applications depend on the different types of networks available. Configuration options are discussed below:

• *Terminal multiplexer configuration*

In terminal multiplexer configurations, the NE is provided with a STM-N (with N=1, 4, 16) station interface (eventually stand-by) to be connected to a digital electronic cross-connect or to a higher hierarchical line system.

• *Add/Drop Multiplexer configuration*

In add/drop multiplexer configurations, the NE can be programmed to drop (insert) signals from (into) the STM-N (with N=1 to 16) stream, with signal pass-through between the line sides as shown in Side A and Side B (see next figure)

• *"HUB" configuration*

With HUB configurations, STM-N tributaries are dropped/added into a multiple stream and then split off in HUB structures.

• *Mixed Configuration*

The NE handles all the previously-discussed configurations in one node simultaneously in mixed configurations.

SDH applications

Each of the SDH configurations support a variety of network topologies including:

- Point to Point
- Linear
- Ring and multi-ring
- Meshed

• Point-to-point links

In this case, the NE is connected to another multiplexer through the line, as shown in the next figure

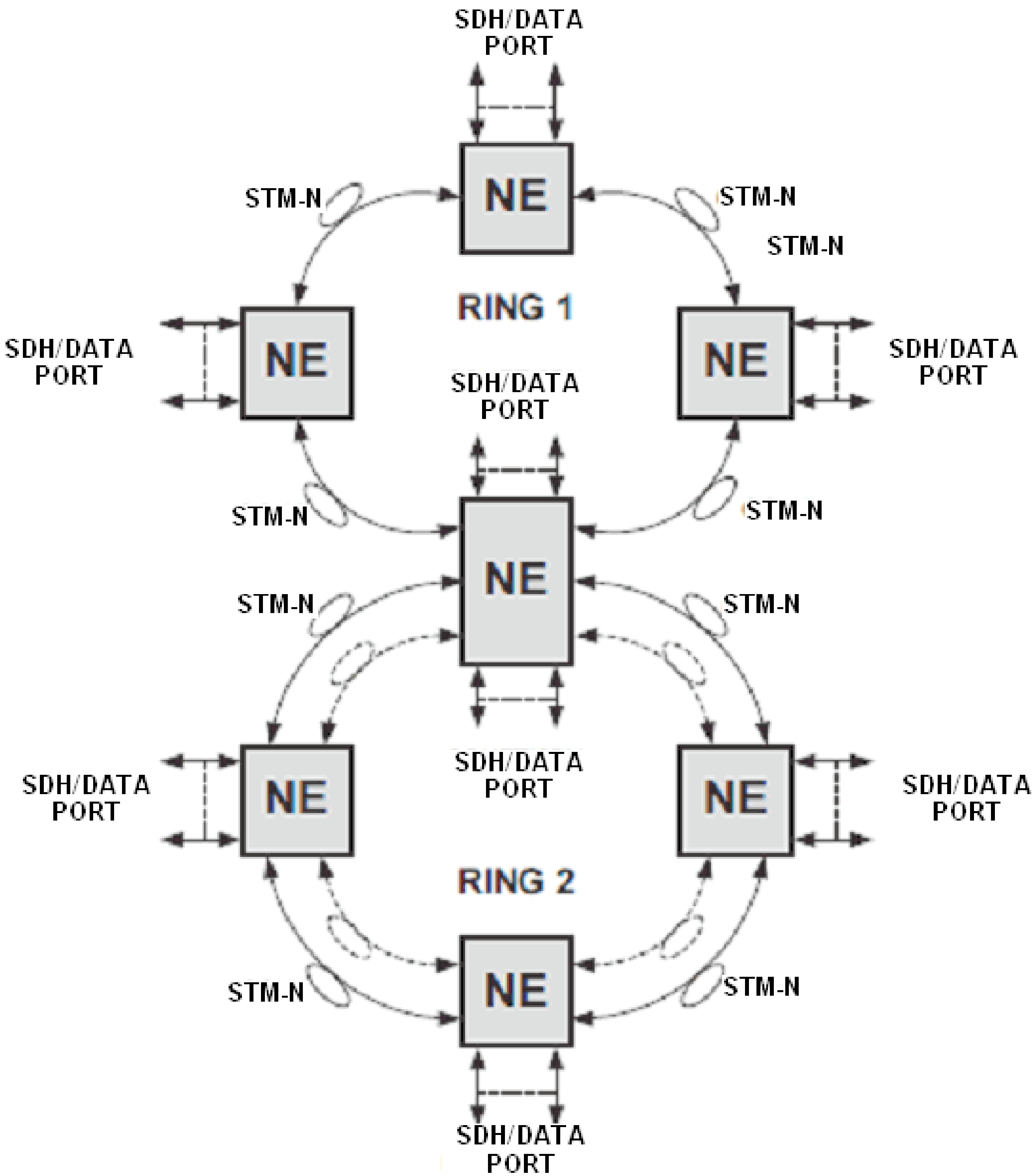
• Linear Drop-insert

The NE is configured to drop (insert) SDH ports from (into) the STM-N (with N=1 to 16) stream

• Ring structure

Because of the drop-add function, large ring networks can be created in ring topologies. In this configuration, the VC is automatically rerouted in the event of a signal or node failure.

Figure 2-6 Ring structure



- **Meshed topology**

Generally, meshed topology is used when there is a need to combine traffic from peripheral nodes or at customer sites. In this configuration, 1+1 line protection may be used to protect against line failure or node failure. Dual hub topology may also be used for protection. The mini digital cross-connect system is very useful in meshed technology; Subnetwork Connection Protection Inherent (SNCP/I) is also used.

Switching capacity

The following table shows the reported switch capacity.

Table 2-1 1646 SM reported switch capacity

HO SDH	LO SDH
21.25G	5G

Matrix connections

The 1646 SM can manage and configure several types of connections at different layers. Refer to the appropriate section(s) in the following list for more information on a given layer:

- SDH HO
- SDH LO

System management

With the extensive introduction of SDH in the transport network, centralized and integrated network management is mandatory for Network Operators to realize the potential cost saving and required quality of service.

Nokia provides a comprehensive range of Network Management Applications compliant with the ANSI/ITU-T Telecommunication management Network Principles.

The ZIC (Zero-Installation Craft terminal) is a an application embedded in NE Equipment controller SW based on a Web Browser Interface. It is in charge of the *local* management of single network elements from different Nokia SDH products, providing ANSI/ITU compliant Information Model Interface to the Network Element.

The ZIC manages all Gateway or Remote Network Elements in the Nokia Transmission catalogue, except for the Cross-Connect (DXC).

The ZIC can be integrated to products in charge of the management of *networks* and network elements.

The ZIC uses a state-of-the-art platform for providing an advanced and integrated *Management*.

Internal bus includes:

- CPU bus: point to point from MB16P to LPU slot, for configuration and alarm/PM management
- I2C bus: From MB16P to LPU/BP/FAN/PIU slot, for Remote Inventory, and temperature monitoring
- JTAG bus: From MB16P to LPU slot, for CPLD upgrade and boundry scan

For the controller sub-system the following buses are defined

External interfaces toward Craft Terminal, OS and Mediation Device

M interface: This is a TMN-related communication interface based on the use of the Embedded Communication Channels. Through the QECC interface, the system can exchange management messages with a remote OS.

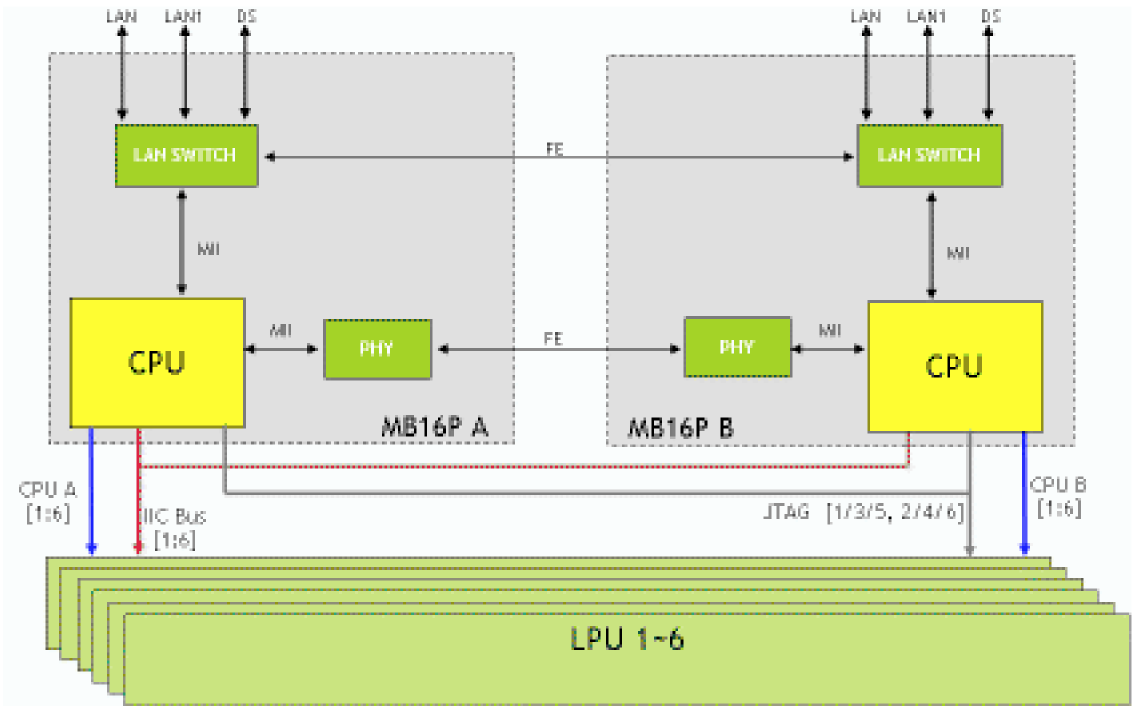
In the 1646 SM, one of the following ECC channels can be terminated from each SDH interface: one DCC_M at 576 kbit/s or one DCC_R at 192 kbit/s.

RE / HK interface : This interface consists of parallel I/O signals used for remote alarms and for housekeeping signals. The relevant electrical interfaces are placed on SERVICE card, including six input and two output.

Examples of network management architecture are reported in Figure 2-8, “Example of network management architecture” (p. 2-18) and Figure 2-9, “Example of management of a SDH and DATA network” (p. 2-19).

In these figures, any generic SDH equipment (Add / Drop Multiplexer, Cross-connect, Regenerator, etc.) inserted in the network is indicated by the acronym NE (network element).

Figure 2-7 Control subsystem



Network management interfaces

The SDH equipment provides physical interfaces for management functions like the M interface. This interface can be connected to the manager computer, which can be:

- Operating system (OS) Workstations utilized for the TMN (Telecommunications Management Network): They are connected through the M interface for network management

The 1646 SM User Provisioning Guide deals with the management achieved by means of the first type of computer, i.e,. the ZIC. For the Telecommunications Management Network description, refer to the documents of the various Operation Systems.

The management can be realized in *local* or *remote* mode:

- In the *local mode*, the managed equipment are directly connected to the computer
- In the *remote mode* (Type 1), the managed equipments are indirectly connected via the OSI Network which can include both DCCM / DCCR protocol.

- In the *remote mode* (Type 2), the managed equipments are indirectly connected via an IP network using a tunnel over IP.
- In the *remote mode* (Type 3), the managed equipments are indirectly connected via external modem.

The software runs on the Windows XP in a Windows environment. User familiarity with this operating environment is, therefore, highly recommended.

Management

Management of the 1646 SM includes the following functions:

- Alarm (fault) management - For real time alarm reporting and subsequent fault localization and correction.
- System management - for example:
  - Configuration management - For handling operational data of the Network Element
  - Performance monitoring management - To set up, collect, log, and display performance data associated with the managed NE according to the ITU-T G.826 recommendations.
- NE access according to the user profile.

The management functions on the 1646 SM are available for all the NEs - local or remote.

Figure 2-8 Example of network management architecture

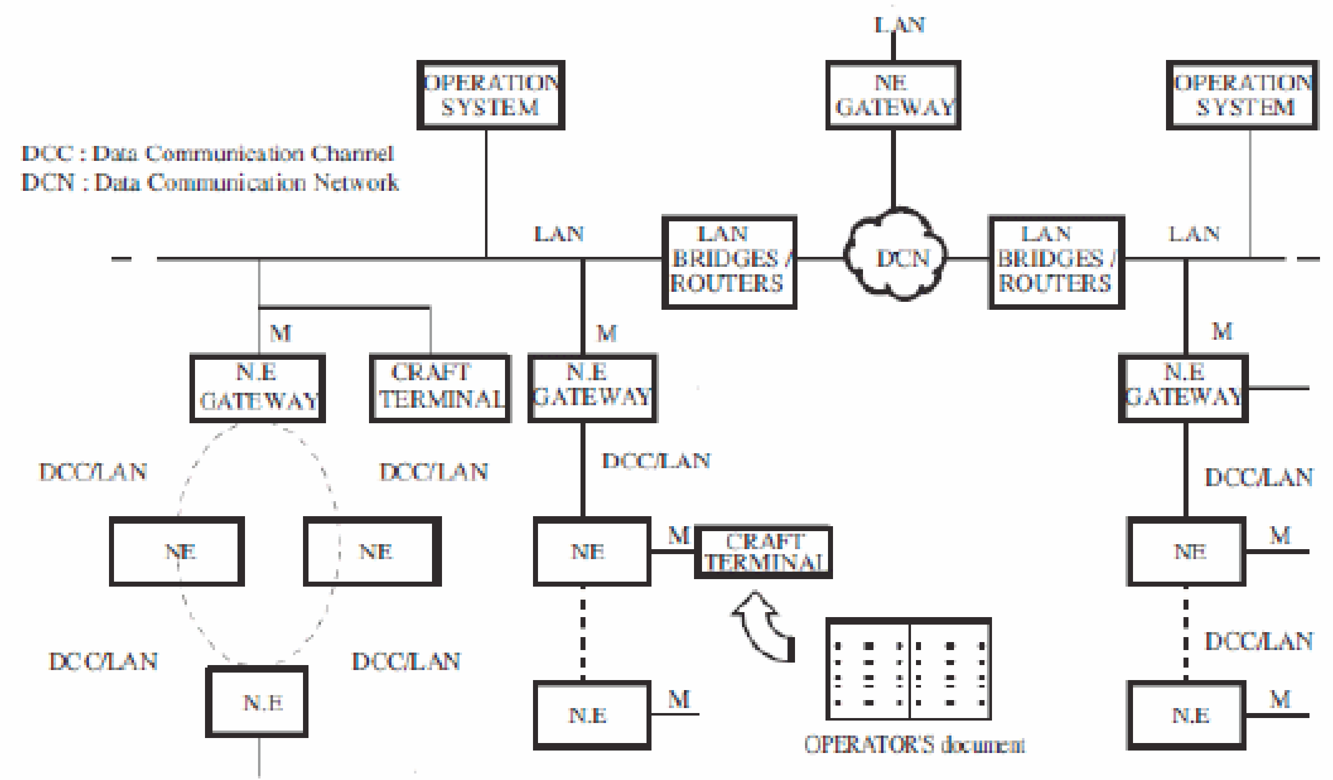
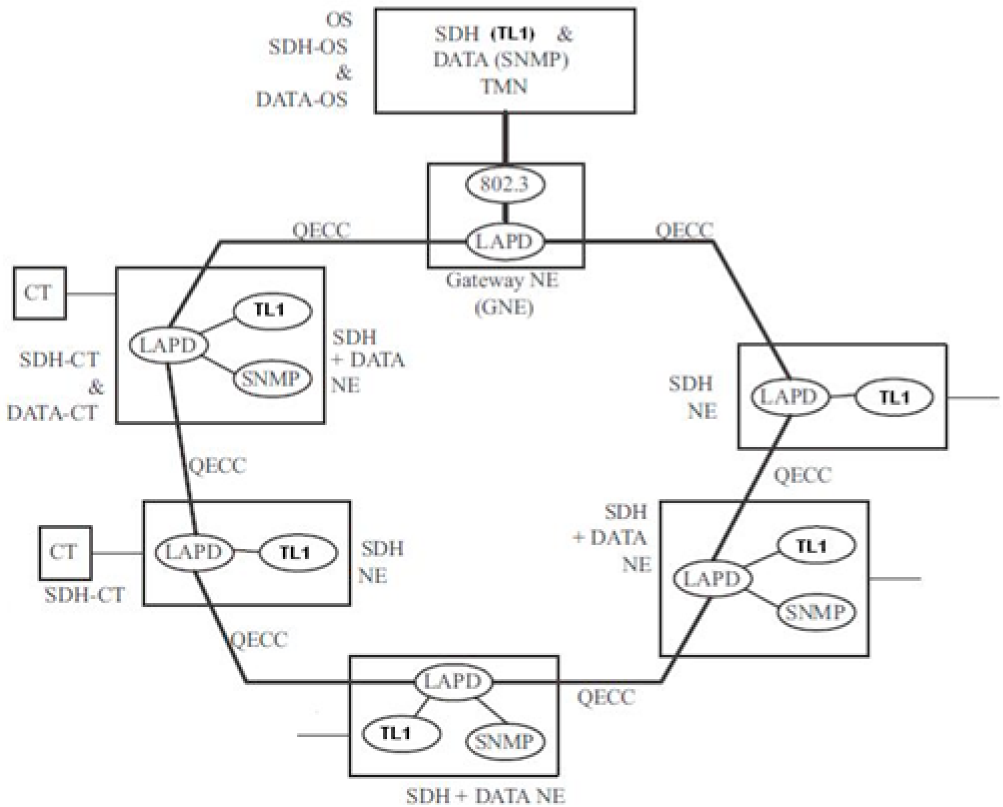


Figure 2-9 Example of management of a SDH and DATA network



The management function is performed using one of two interfaces: ZIC and TL1/SNMP. Supported signals and interfaces are listed in Table 2-2, "1646 SM interfaces" (p. 2-19).

Table 2-2 1646 SM interfaces

Managed Signals	ZIC	TL1	SNMP
SDH	X	X	
DATA	X		X

The Translation Language level 1 (TL1) consists of input commands (TID, AID, CTAG, General Delayed Activation, Positional, Keyword Parameter Block, State Parameter Blocks), command output response (successful and unsuccessful) messages, acknowledgement output messages, and autonomous output messages.

It uses a Telnet session with TCP/IP connectivity between the host from which the Telnet session is opened and the 1646 SM.

Control architecture

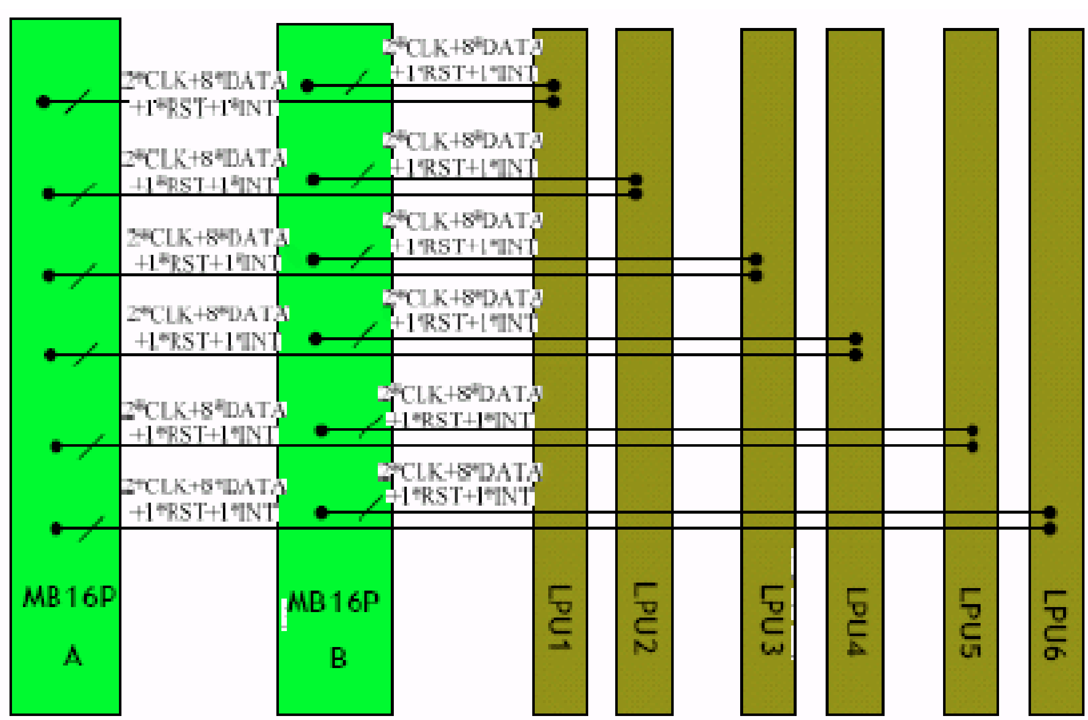
CPU control link

CPU control bus is point to point structure. Each main-board has one group CPU control bus to each LPU, which includes two 66MHz CPU clock, eight 66M CPU data, one INT signal and one RST signal. Two 66MHz CPU clock can sample data on both rising and falling edge.

Internal bus includes:

- CPU bus: point to point from MB16 to LPU slot, for configuration and alarm/PM management
- I2C bus: From MB16 to LPU/BP/FAN/PIU slot, for Remote Inventory, and temperature monitoring
- JTAG bus: From MB16 to LPU slot, for CPLD upgrade and boundry scan

Figure 2-10 CPU control Link on 1646 SM



For 1646 SM, both MB16P will send CPU control link to six LPU, but no CPU link between both MB16P. So for MB16P, no matter what role it is, master or slave, it will take charge of itself configuration.

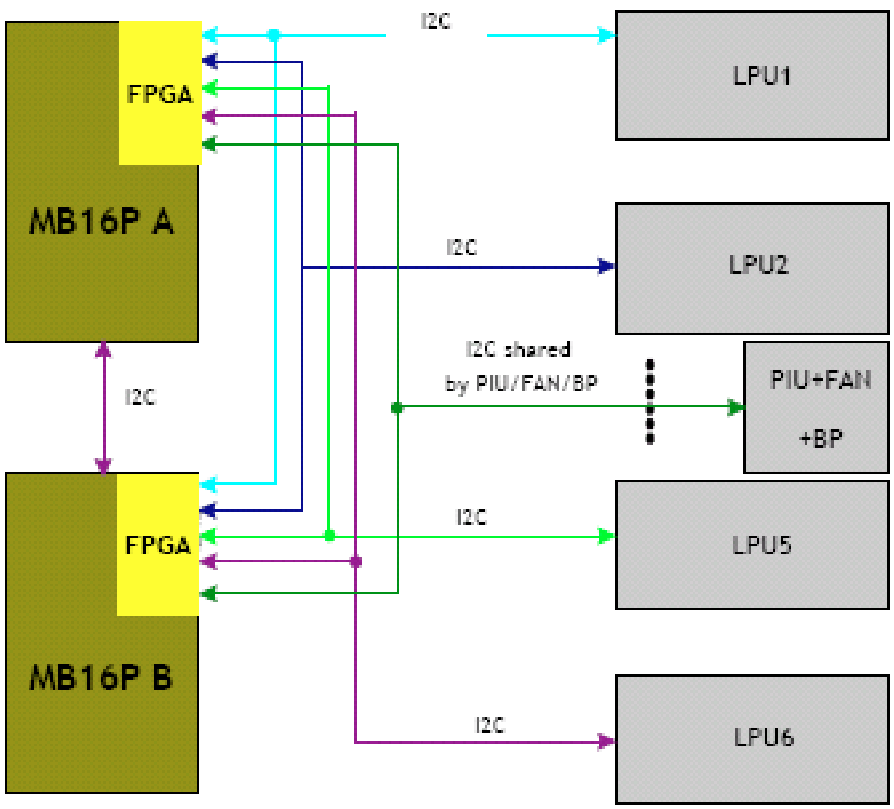
I²C BUS

I²C (Inter Integrated Circuits bus) is a two wired BUS, including serial data (SDA) and serial clock (SCL). Multi-slave can be connected to one I²C BUS. It is originated from CPU control BUS by FPGA.

I²C BUS is used to read manufacture information and board type. For 1646SM, both main-boards share one I2C BUS to each LPU slot and one of I²C BUS is shared by FAN, PIU and BP.

- Point to point structure from main-board to LPU
- BP provide E2PROM to save manufacture information and BP type.
- I2C to LPU slot can read manufacture information and board type, also temperature and power on/off control, and so on.

Figure 2-11 I²C BUS structure on 1646 SM

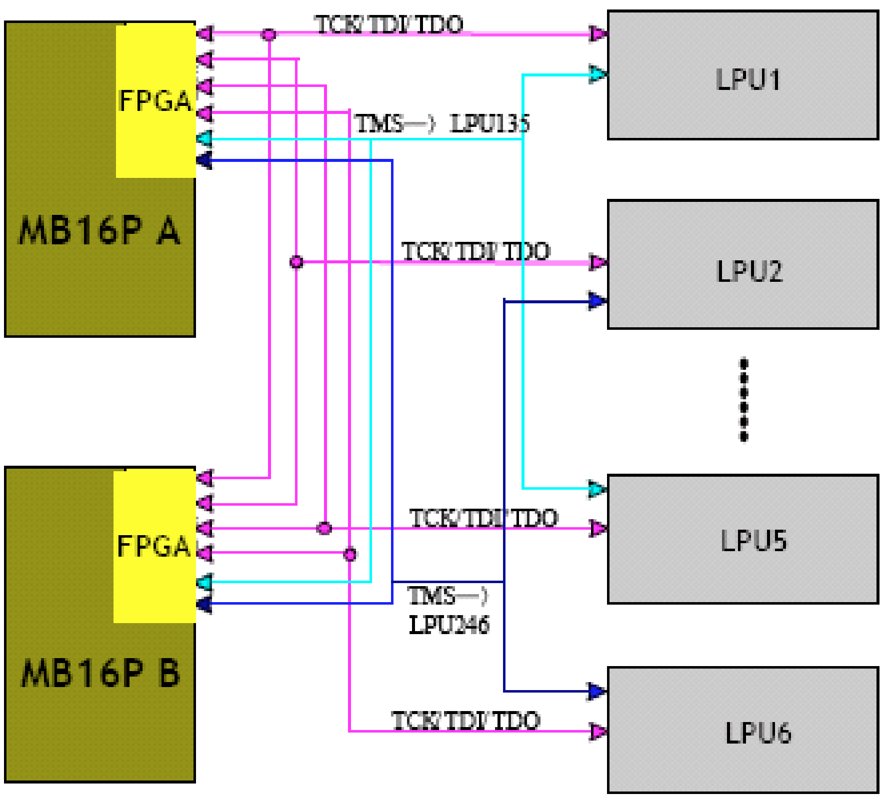


JTAG BUS

JTAG (Joint Test Action Group) can be used as boundary scan for PCB testing. Several ASIC can be connected together by daisy chain mode. It includes five signals:

- TDI: test data IN
- TDO: test data OUT
- TCK: test clock
- TMS: test mode selection
- TRST: test reset (optional signal)

Figure 2-12 JTAG BUS structure on 1646 SM



For 1646SM, TCK, TDO and TDI are driven by two MB16P to one LPU slot. TMS is driven by two MB16P, shared by three LPU slot. (MB16P A+ MB16P B to LPU1/3/5 and LPU2/4/6)

FAN management

The 1646 SM has one FAN card and supports six fan units.

They are:

- I^2C BUS

I2C BUS is used to read manufacture information, temperature and control indication LED and so on.

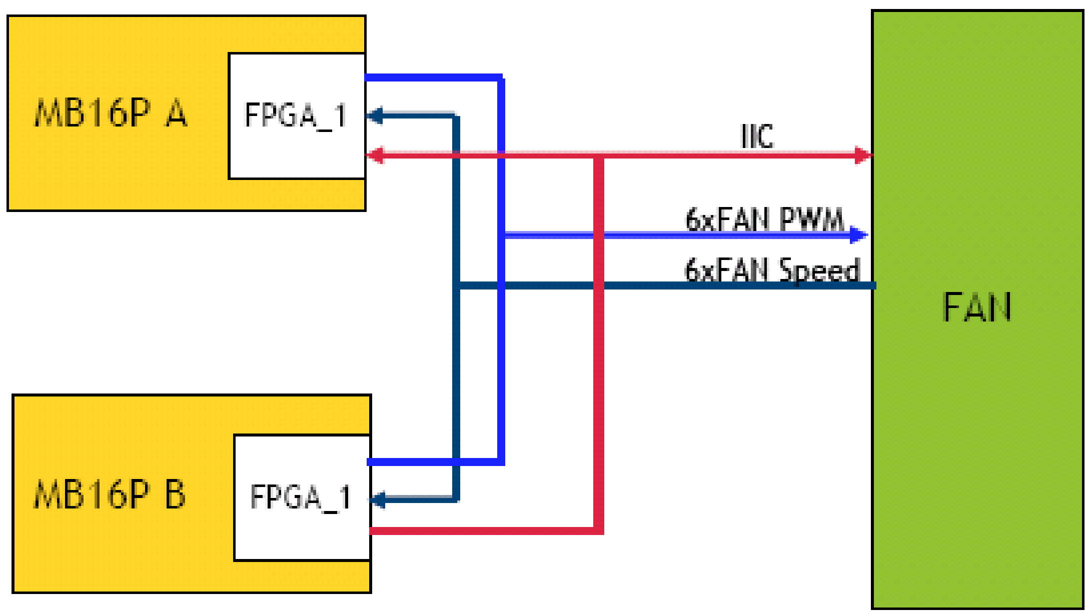
- Speed_FAN

  FAN speed signals are frequency signal and used to report all FAN units speed status.

- PWM

  Pulse Width Modulation is used to adjust FAN speed. For 1646SM, there are six PWM_SCA_FAN[1:6] signals from MB16P A/B to FAN.

Figure 2-13 FAN management on 1646 SM



Others control signals

They are:

- LAMP_TEST

  LAMP test signal is driven by FAN and shared by all LPU slot and MB16P A/B, except PIU A/B. LAMP_TEST button is located on FAN.

- INT_PIU

  Power card PIU interrupt signals.

- Reserved signals:

  Single ended point-to-point signals between each main-board and each LPU

  Two groups bus to all LPU slot: driven by two MB16 A/B or one MB16.

Main-board protection

There are two main-boards (MB16P A and MB16P B) on the 1646SM. One is an *Active* board and the other is a *Standby*. When the *Active* board detects failure, the *Standby* board becomes the active board to process services to ensure normal operation. This switchover process is called an active and standby switchover.

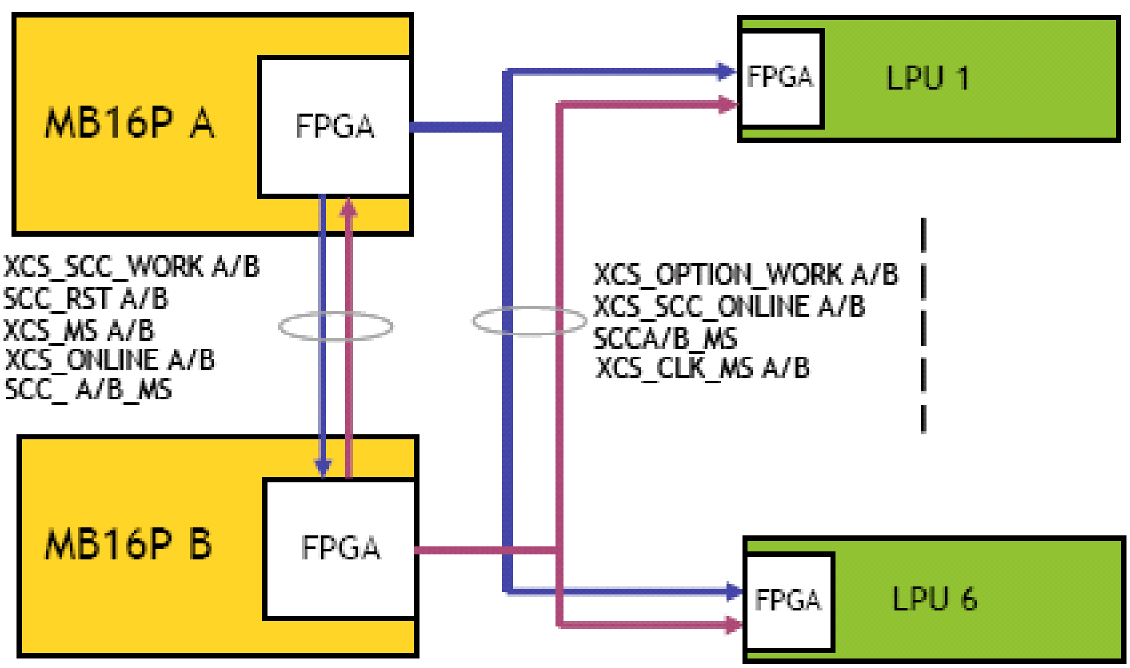
MB16P is an integration board, that involves several main functional blocks, such as Fabric, SYNC, Controller, and Power. These blocks will be protected as a whole. Failure of any one of the functional blocks will cause all others to switch together. The switch is based on the board level.

Note: Active/Standby are same as the Master/Slave.

Protection status signals

Active/Standby Protection signals are shown as Figure 2-14, "Active/Standby Protection signals of 1646SM" (p. 2-24).

Figure 2-14 Active/Standby Protection signals of 1646SM



Active/Standby protection switch includes two parts, one is MB16P A/B and the other is LPU.

MB16P A/B

MB16P A/B will contend for the Active/Standby roles.

There are five status signals between both MB16P FPGA, which are sent to each other:

- XCS_SCC_WORK: Fabric and Controller work well or not, *0 = work* and *1 = failure*
- SCC_RST: Soft reset signal, *0 = reset* and *1 = not reset*
- XCS_ONLINE: Fabric and Controller online or not, *0 = online* and *1 = offline*
- SCC_MS: Controller Active/Standby status, *0 = Active* and *1 = Standby*

According to these signals, MB16P A/B will decide weather it is an Active or Standby switch.

These signals are controlled by FPGA and a switch table for role decision, Master or Slave, is shown in Table 2-3, "Switch table of MB16P" (p. 2-25).

Table 2-3 Switch table of MB16P

RST	En-able	Manual	online		work		MS	A
			A	B	A	B	B	result
0	*	*	*	*	*	*	*	S
1	1	*	*	*	*	*	*	S
1	0	1	*	*	*	*	*	M
1	0	0	0	1	*	*	*	M
1	0	0	1	0	*	*	*	S
1	0	0	0	0	0	1	*	M
1	0	0	0	0	1	0	*	S
1	0	0	0	0	0	0	0	S
1	0	0	0	0	0	0	1	M
1	0	0	0	0	1	1	0	S
1	0	0	0	0	1	1	1	M
1	0	0	1	1	0	1	*	M
1	0	0	1	1	1	0	*	S
1	0	0	1	1	0	0	0	S
1	0	0	1	1	0	0	1	M
1	0	0	1	1	1	1	0	S
1	0	0	1	1	1	1	1	M

Notes:

1. *RST:0* denotes *RESET*.
2. *Enable : 0* denotes *switch enable*, *1* denotes switch disable.
3. *Manual : 1* denotes *force to master*. *0* denotes nothing.
4. *online : 0* denotes *online*, *1* denotes *offline*
5. *work : 0* denotes *Work*, *1* denotes *Failure*
6. *MS : 0* denotes *master*, *1* denotes *slave*
7. *A* denotes *local Fabric*
8. *B* denotes *remote Fabric*

EPS switch priority: **RST > Enable> Manual> Online > Work > MS**

LPU

LPU decides to choose signals, such as CPU bus, SYNC, and Payload, from the main-boards, MB16P A or B. These signals are chosen independently, according to status signals from MB16P A/B and also based on the received signal quality of SYNC and Payload, which are traffic related.

The status signals form MB16P A/B include:

- XCS_OPTION_WORK: Fabric work or failure, *0 = Work* and *1 = Failure*
  - LPU slot, an *8K signal* denotes *work*, *0* denotes *failure*
  - 38M and 2K FP are also detected to decide *work or failure*
- XCS_SCC_ONLINE: Fabric and Controller online or offline, *0 = Online* and *1 = Offline*
- SCC _MS: Controller is Active or Standby, *0 = Active* and *1 = Standby*
- XCS_CLK_MS: Fabric and SYNC are Active or Standby, *0 = Active* and *1 = Standby*

Table 2-4 Controller Switch Table of LPU

FS	online		clk check		MS		Controller
	A	B	A	B	A	B	
0	*	*	*	*	*	*	A
1	1	1	*	*	*	*	hold
1	0	1	*	*	*	*	A
1	1	0	*	*	*	*	B
1	0	0	bad	bad	*	*	hold
1	0	0	ok	bad	*	*	A
1	0	0	bad	ok	*	*	B

Table 2-4 Controller Switch Table of LPU (continued)

1	0	0	ok	ok	0	0	hold
1	0	0	ok	ok	0	1	A
1	0	0	ok	ok	1	0	B
1	0	0	ok	ok	1	1	hold

There are also similar switch tables for Fabric, which are controlled by FPGA on LPU.

LPU can select controller on master MB16P, but fabric can be selected on master or slave MB16P.

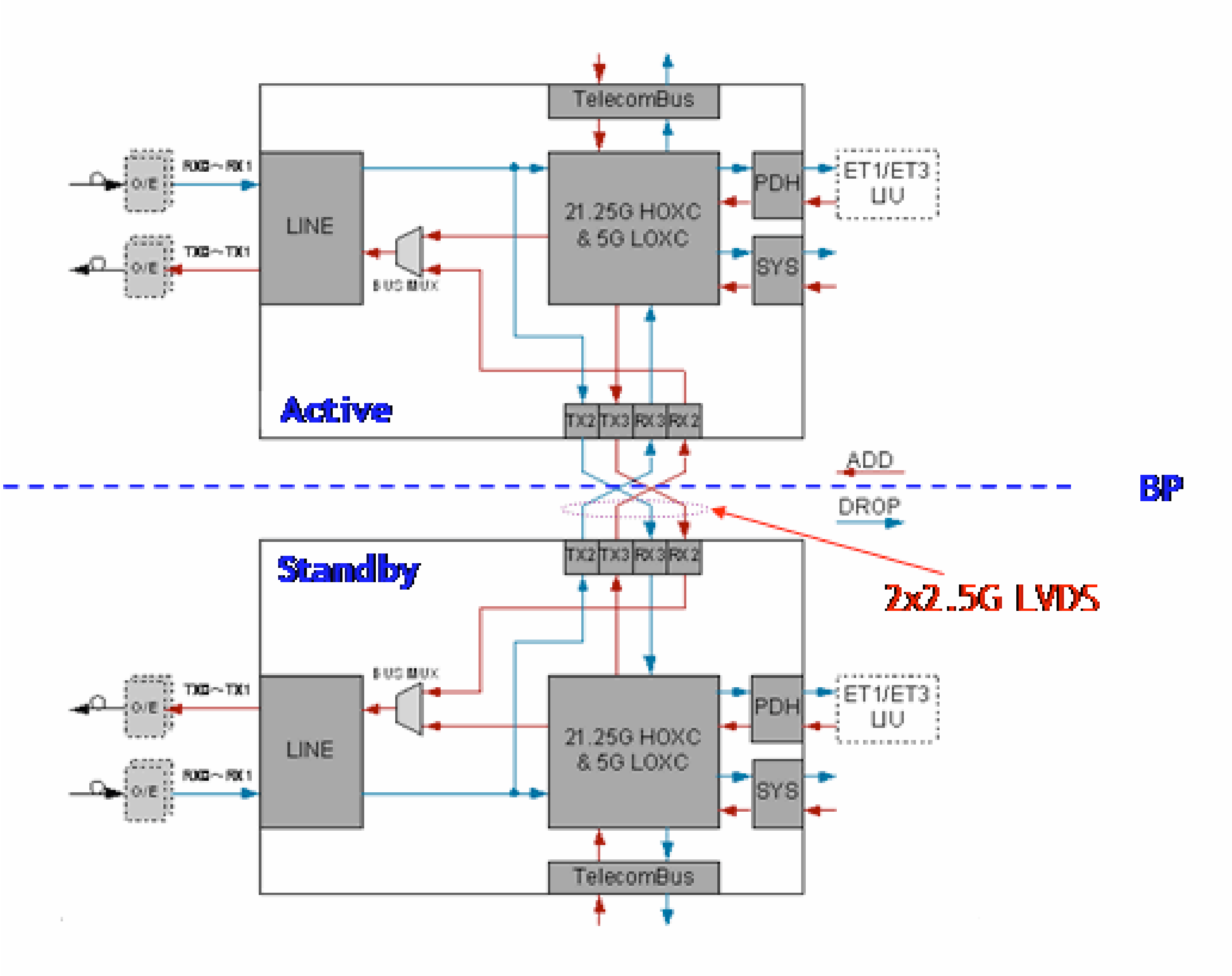
If slave MB16P fabric is selected by LPU due to bus error detection on master MB16P, then MB16P Master/Slave switch will be triggered. If master MB16P detects bus error from LPU, but slave MB16P is OK, switch will still be triggered.

Protection payload links

MB16P has Fabric and STM-N line interface at the same time. Hence, when MB16P works on Standby mode, the STM-N line interface has to send and receive payload from the remote Fabric.

Fabric chip on MB16P is an integration solution, which includes 4x STM-N line interfaces, HO/LO Fabric, PDH mapper and TELECOM/LVDS interfaces. One STM-N interfaces is used as STM1/4/16 line interface on Front Panel, two are used as protection interfaces to connect with BP 2.5G LVDS protection links. A BUS MUX is used for Active/Standby switch: for Active, line interfaces will select Local Fabric payload and for Standby, Remote Fabric payload are selected, which pass through RX2.

Figure 2-15 2x2.5G LVDS protection links



Active/Standby switch rules

General Active/Standby switch rules:

- When the power is *ON*, both are on Standby and the switch is disabled. When the switch is enables by software, various *Software enable* timing is set to prevent both becoming Active, depending on the SLOT ID.
- When another board is detected as offline, switch to Active. If it is offline by default, switch to Standby.
- When bus error, hardware failure, power, and PLL failure is detected, sets self to failure condition (unable to work), switch is triggered.

- When main power supply is lower than the threshold, switch occurs at once without software process. Traffic related power failure will trigger switch.
- Any operation on Slave will not cause switch.
- Force switch is supported in FPGA.
- SCC/XCS/SYNC hard reset and FPGA NIOS reset will result in switch. Software reset and front panel reset button will not cause switch.

Active/Standby switch trigger

Active/Standby switch is caused due to various conditions like power supply failure, loss of clock, LOP of PLL, ASIC read/write cycle failure, BUS error. Remote MB16P status such as offline, failure or Active/Standby status change will also trigger switch.

Following are the detailed conditions under which a switch will occur:

1. Power detection
   - 3.3V power module output failure
   - 2.5V, 1.5V and 1.2V power module output failure
2. Clock detection
   - 38M/77M system clock loss
   - Two channels external timing loss, including 2MHz and 2Mbit/s
   - 38M/77M system clock source frequency offset is out of range, SA8000 loss of lock.
   - External timing loss of lock, 2MHz and 2Mbit/s
3. Traffic detection
   - Fabric chip detects traffic signal alarm, but remote fabric is normal
   - Traffic LOS/LOF/B1 detection and alarm report, which will cause switch
4. Local MB16P status detection
   - Read/write abnormal on main ASIC, such as Fabric
   - Local FPGA abnormal
   - Offline
5. Remote MB16P status detection
   - Online status signal: Offline
   - Work status signal: Failure
   - Active/Standby status signal: Change

3 Physical configuration

Overview

Purpose

This chapter provides information on the physical configuration of the 1646 SM. This chapter illustrates the physical structure, layout and composition, coding and partition of the equipment and fans subrack.

Contents

Subrack overview

1646 SM support multi-service interface, including PDH, SDH and ETH. It is located at edge or access layer of network and cooperate with others OMSN products, such as Nokia 1662SM/SMC and 1646 SM series. It has similar system architecture with different access capacity. 1646 SM is a 2RU height equipment, which supports two main-board (MB16P A/B for protection), six option boards (LPU1~LPU6), one FAN and two power PIU. Option boards LPU can be shared by both equipments.

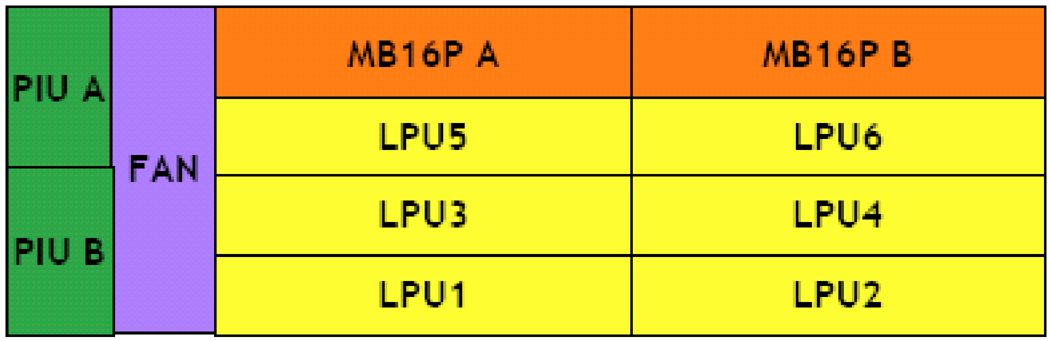
Figure 3-1 Subrack overview

Equipment configuration

Overview

1646 SM is a 2 RU height equipment, which supports two main-board (MB16P A/B for EPS protection), six option boards (LPU1~LPU6), one FAN and two power PIU.

Figure 3-2 1646 SM shelf layout



Equipment capability

The 1646 SM can provide SDH/PDH/ETH service interface and have core TDM cross-connect capability of 21.25G HO and 5G LO, which is concentrated cross-connect and located on the main-board.

Service access capacity

Multi-service interfaces are supported, such as E1, E3, STM-1/4/16, FE and GE. The maximum access capacity is shown in the following table:

Table 3-1 Maximum access capacity- 1646 SM

Service Interface type	Maximum No.	Interface Description
E1	252	E1 75/120 Ohm
E3/T3	18	E3/T3 75 Ohm
STM-1	26	Electrical SFP Support
STM-4	14	
STM-16	2	Only supported by main-board
FE	48	10/100 BASE-T
FX	24	100 Base-FX/LX
GE	4	1000 BASE-SX/LX

Management and auxiliary interfaces

Management and auxiliary interfaces include: NM LAN, Housekeeping, Synchronization, Auxiliary, and Power.

Table 3-2 Management and auxiliary interfaces- 1646 SM

Interface name	Description	Location
NM LAN	Network management	MB16P A/B
Housekeeping	Environment and external equipment input/output	SERVICE
AUX	19.2K RS-232 and 64K G.703 auxiliary interfaces	SERVICE
Synchronization	External timing: 2MHz or 2Mbit/s	SERVICE
Power	AC power input	No AC
	DC power input	PWDC2

Protection

1646 SM supports equipment and network protection as follows:

- For power, 1+1 protection is supported. The 1646SM has two power cards: PWDC2 with -48V input on each, which can support 1+1 power card protection.
- For traffic, network protection is supported: 1+1 Linear MSP, MS-SPRING (supported only on STM-16 interface), and SNCP
- For Ethernet traffic, 1:1 Linear and Ring protection are supported
- E3 EPS is not supported
- Two types of external 1+1 E1 EPS BOX (75/120 Ohm) are supported, which can be used to support maximum three groups 42xE1 1+1 EPS protection.

ETH characteristic

ETH service supports layered protection, including SDH layer protection and Ethernet layer protection. EPL, EVPL, EPLAN and EVPLAN are supported and also OAM.

Three option cards can provide ETH interfaces: P4FXS, P8FES, and P1GET.

Payload link

Payload links include 622M LVDS BUS and 2.5G LVDS. For each LPU slot on 1646 SM, payload link will come from two main-boards and two 622M LVDS from each main-board. Two more 2.5G LVDS links are for STM-16 Line interface protection between the two main-boards.

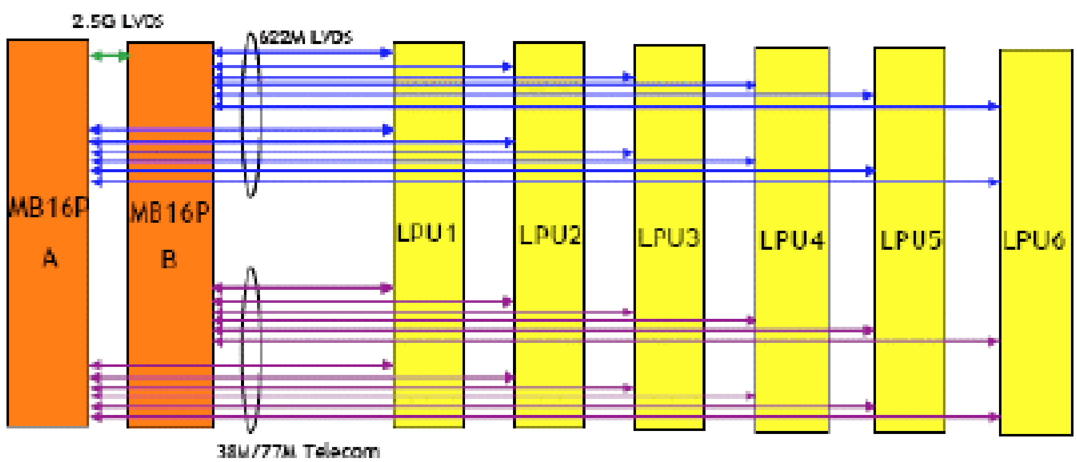
Note: Three groups E3/T3 signals (CLK/DATA/LOS) are only supported on LPU2 but are not used. Telecom BUS is not used anymore.

For each LPU slot on 1646 SM, payload link will come from two main-boards MB16P as EPS backup and selection will be done by LPU as follows:

- From each main-board (MB16P), 38M/77M LVTTL Telecom BUS has only one group, which has one C1J1SPE and four data link on each direction, which can support VC-4 capacity (38M mode) or 2x VC-4 (77M mode).
- From each main-board (MB16P), two 622M LVDS are also available by reusing four data links of another group Telecom BUS link(1).

For two MB16P slot on 1646 SM, there are two more 2.5G LVDS links for STM-16 Line interface protection.

Figure 3-3 1646 SM payload link



Note: Telecom bus is not used.

Parts list

Purpose

Parts list for the 1646 SM are listed in the following table:

Table 3-3 1646 SM parts list- 1646SM

Type	Alias	Description	Slot
Power	PWDC2	DC power -38.4VDC~-72VDC, 550W[2]	PIU A/B
FAN	FAN	FAN	FAN
Main Board LPU	MB16P	Main board with protection (only 1xSTM1/4/16)	MB16A/B
	P2S1	2x STM-1	LPU
	P2S4	2x STM-4	LPU
	P4S1	4x STM-1	LPU
	PE1A	42x E1, 120 Ohm	LPU
	PE1B	42x E1, 75 Ohm	LPU
	P3E3	3x E3/T3, 75 Ohm	LPU
	P1GET	1x GE Transparent	LPU
	P8FES	8x FE L2 Switch	LPU
	P4FXS	4x FX L2 Switch	LPU
	SERVICE	Auxiliary interface, such as Housekeeping and SYNC	LPU
Attachment	HK BOX	12 HK input external BOX	NA
	E1A EPS BOX	External 42xE1 (120 Ohm) 1+1 EPS protection BOX	NA
	E1B EPS BOX	External 42xE1 (75 Ohm) 1+1 EPS protection BOX	NA

Legend:

(1): √ means supported by this system.

(2): Power consumption is at its maximum value (value depends on system configuration).

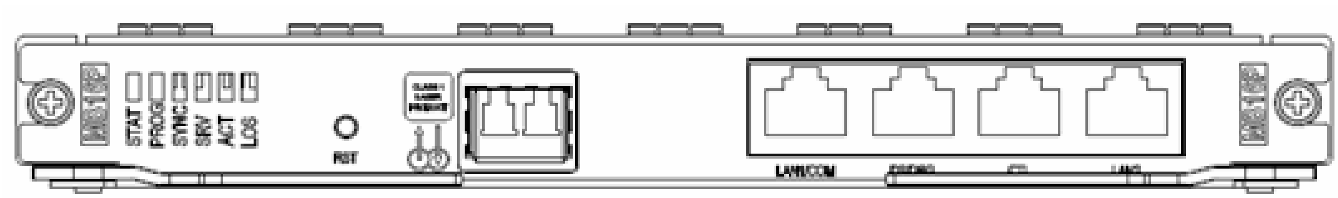
Units front view

Overview

The following section shows the access points (LEDs, connectors, switches, etc.) present on each unit with legends explaining the components.

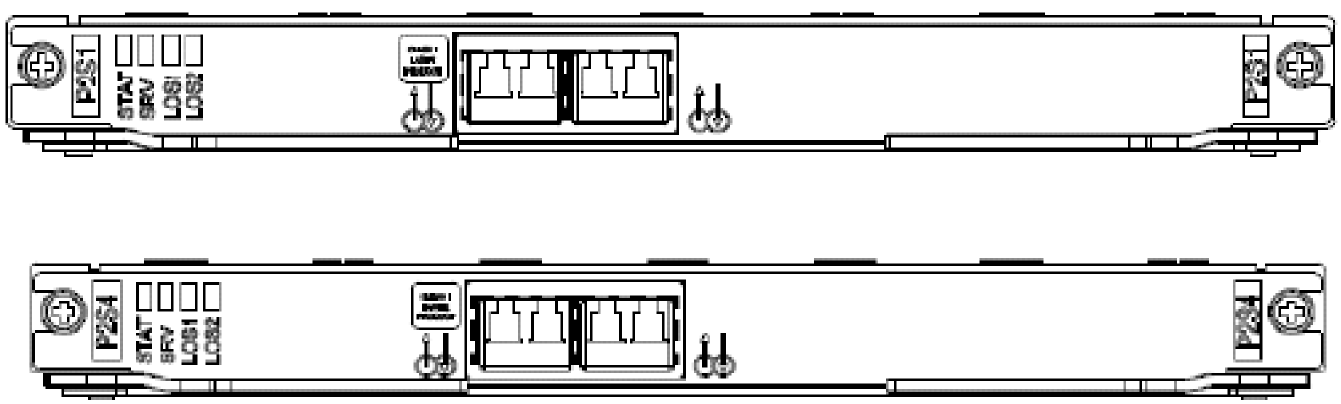
MB16P front panel

Figure 3-4 MB16P front panel



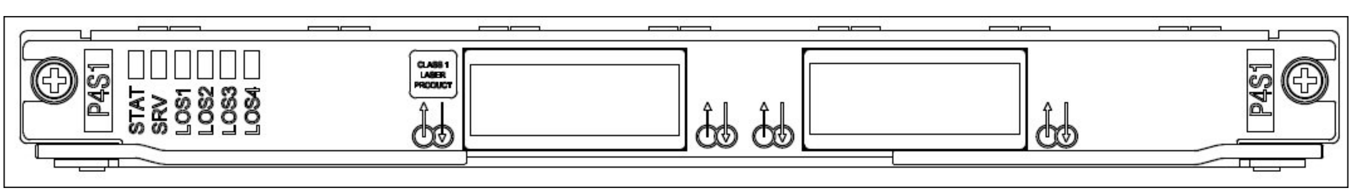
P2S1/P2S4 front panel

Figure 3-5 P2S1/P2S4 front panel



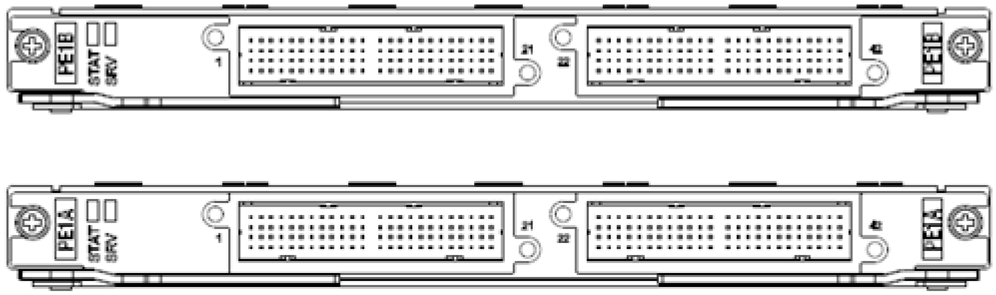
P4S1 front panel

Figure 3-6 P4S1 front panel



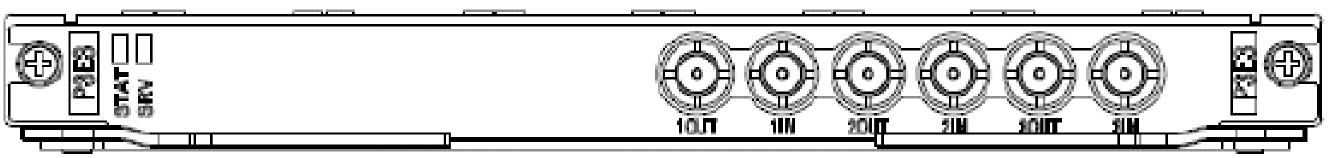
PE1A/PE1B front panel

Figure 3-7 PE1A/PE1B front panel



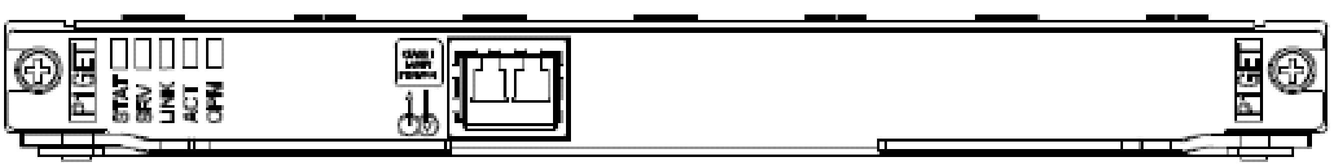
P3E3 front panel

Figure 3-8 P3E3 front panel



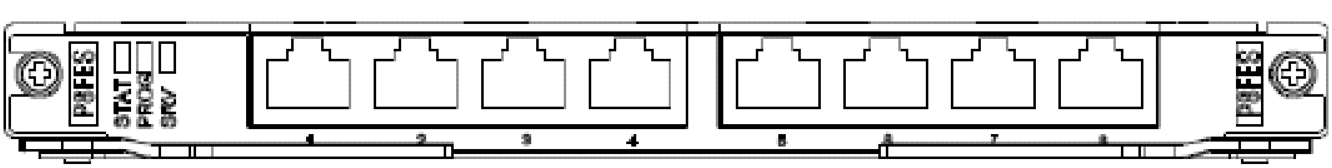
P1GET front panel

Figure 3-9 P1GET front panel



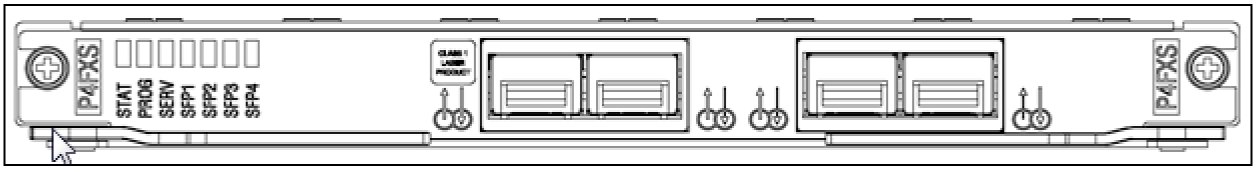
P8FES front panel

Figure 3-10 P8FES front panel



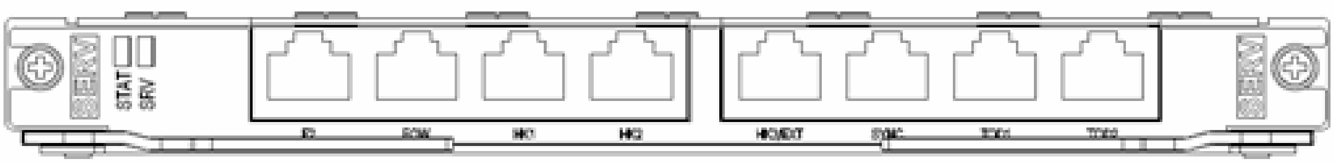
P4FXS front panel

Figure 3-11 P4FXS front panel



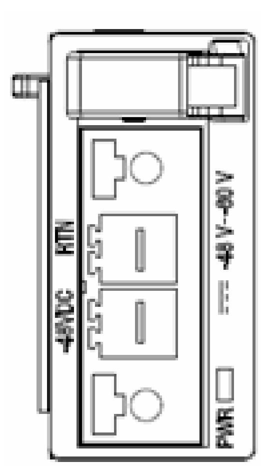
SERVICE front panel

Figure 3-12 SERVICE front panel



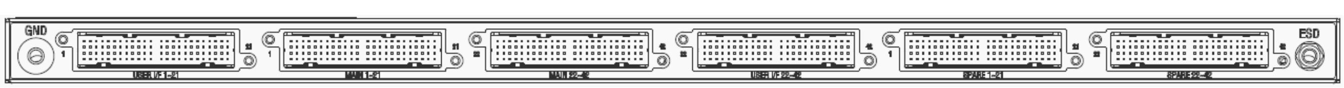
PWDC2 front panel

Figure 3-13 PWDC2 front panel



E1 EPS BOX front panel

Figure 3-14 E1 EPS BOX front panel



4 Technical specifications

Overview

Purpose

This chapter covers the technical specifications of the 1646 Synchronous Multiplexer.

Contents

General characteristics

Table 4-1 General characteristics

Application types		
Any combination of: • Terminal Multiplexer (TM) • ADM in protected and unprotected linear links and rings • Ethernet switch		
SDH subsystem optical bit rate		*Unit*
155.520 Mbps 622.080 Mbps 2.488.320 Gbps	STM-1 STM-4 STM-16	STM-1 unit is P2S1 STM-4 unit is P2S4 STM-16 unit is MB16P
DATA subsystem optical bit rate		*Unit*
1.250 Gbps	1 Gigabit Ethernet	P1GET
125 Mbps	100 Megabit Ethernet	P4FXS
Type of optical fiber		
• 50/125-µm MMF for 1000Base-S, 1000Base-L • 62.5/125-µm MMF for 1000Base-S, 1000Base-L • 9/125-µm SMF for all the other interfaces according to ITU-T G.652, G.653, G.654, G.655 **Note**: 1000Base-L SFP supports both MMF and SMF fibers		
Applied standards		
SDH	ITU-T G.703 for electrical interfaces ITU-T G.707 for SDH frame and multiplexing structure ITU-T G.957, G.958, G.691, G.693, G.959.1 for optical interfaces ITU-T G.821 and G.826 for transmission quality ITU-T G813 for synchronization ITU-T G.783 and G.841 for network protection architectures ITU-T G.784 and G.774 for system management functions ITU-T G.662 and G.663 for optical amplification ITU-T G.812 for timing requirements	

Table 4-1 General characteristics (continued)

Application types	
DATA	IEEE 802.3 IEEE 802.1D, 802.1Q, 802.1AD IEEE 802.1s, 802.1w0. ITU-T 8011x MEF 6, MEF 10

Add-drop and cross-connect features		
1646 SM Cross-Connections capacity	21.25 Gbps - HO TDM	
	5 Gbps - LO TDM	
Transmission delay		
125-µs maximum for any traffic pathway		
Protections		
Network protection	*SDH protection*: • APS 1+1 (MSP 1+1) • MS-SPRING • SNCP/I, SNCP/N *DATA protection*: • Link aggregation • Ethernet Linear and Ring protection • Ethernet protection through STP protocols	

Management interface		
Local:	Craft Interface/CLI (Personal Computer)	• RJ45
Remote:	Craft Interface (Personal Computer)	• RJ45

Management interface		
Remote:	Transmission Management Network (TMN) interface	TL1 for TDM, SNMP for data
	Information Model	According to ITU-T (G.774) and ETSI specification
Protocol Stack/Information Model messages	According to ITU-T G.774 and ETSI rec. ISO-OSI 7-layers reference model. Data functions are organized according to the TCP/IP reference model. They are managed by means of SNMP protocol tunneling over OSI layers.	
Dual addressing to O.S.	Allows O.S. redundancy	

Operation processes	
SDH configuration and provisioning	Equipment, ports, add-drop, cross-connect, synchronization, protection, Message Communications Function (MCF), Synchronous Equipment Management Function (SEMF), OH connection.
Data configuration and provisioning	Equipment, ports, flow provisioning, SLA provisioning, classification and policing
Software download	Locally as well as remotely on non volatile memories without traffic interruption
SDH performance monitoring	According to ITU-T G.826 (ETSI) and GR-253 and T1.231 requirements.
Data performance monitoring	According to RFC 2863, 2665, 2668, 1471 requirements.
Unit and Equipment acknowledgement	Through Remote Inventory (Company ID, Unit Type, Unit Part Number, Serial Part Number, Software Part Number etc.). For details, refer to the *User Provisioning Guide* .
Security	Password, operator profile, back-up for programs and data
Output housekeeping signals (CPO) and remote alarms	
By electronic relay contact connected to external negative voltage:	
• Max. guaranteed current with closed condition	50 mA

Operation processes	
• Voltage drops vs. ground with closed condition	-2 V [Rarr] 0 V
• Max. allowed voltage with open condition	-72 V
Input housekeeping signals (CPI)	
• Max. guaranteed current with closed condition	3 mA
• Voltage drops vs. ground with closed condition	-2 V [Rarr] 0 V
• Max. allowed voltage with open condition	-72 V
Clock characteristics	
Selectable input clock	• 2048-kHz from 2-Mbit/s port (T2). • 2048-kHz external sync clock (2 input, T3a and T3b) or 2.048-Mbit/s external sync (2 input, T6a and T6b) • STM-N ports (T1)
No. of selected clock (normal mode)	Two max
Synchronization output	• 2048-kHz G.703 (2 output, T4a and T4b) or 2.048-Mbit/s (2 output T5a and T5b) •
Operational modes	• Locked to reference • Free-run mode ±4.6 ppm (PLL without reference) • Holdover mode draft 0.37 ppm max./day (PLL with stored frequency for more than half an hour, with no selected input frequency)
Synchronization selection	Priority and SSM algorithm
Protection against lighting surges	
Not applicable	
Additional features	
• VCi signal label management • Programmable alarms severity • J0 - Section trace management	

Optical safety

Optical safety compliance with American and European norms

The 1646 SM meets the following optical safety standards:

- ETSI standards
  - IEC 60825-1 Edition 1.2 (08-2007)
  - IEC 60825-2 Edition 3.1 (01-2007)

  Note: Due to the inconsistency between the new 60825-1 and the current 60825-2, the previous edition of IEC 60825 Part 1 (IEC 60825-1:1993 and its Amendment 1 (1997) and Amendment 2 (2001) should be used for calculating or measuring hazard levels of optical fibre communication systems using IEC 60825-2:2004 incorporating amendment 1: 2006.

  This instruction will remain valid until a new version of IEC 60825-2 is published.

Hazard level classification

The HAZARD LEVEL classification for the supported optical interfaces is listed in Table 4-2, “Hazard level classification of different optical interfaces” (p. 4-6).

Hazard levels are also assigned in accordance with the following ETSI standards:

- IEC 60825-1 Edition 1.2 (08-2007) and IEC 60825-2 Edition 3.1 (01-2007)

Table 4-2 Hazard level classification of different optical interfaces

Signal/port type	Acronym	Optical Interface	Hazard Level
STM-1 - B&W SFP	SS-11	S-1.1 / IR-1 (intermediate reach)	1
	SL-11	L-1.1 / LR-1 (long reach)	1
	SL-12	L-1.2 / LR-2 (long reach)	1
STM-4 - B&W SFP	SS-41	S-4.1 / IR-1 (intermediate reach)	1
	SL-41	L-4.1 / LR-1 (long reach)	1
	SL-42	L-4.2 / LR-2 (long reach)	1
STM-16 - B&W SFP	SI-161	I-16.1 / SR-1 (short reach)	1
	SS-161	S-16.1 / IR-1 (intermediate reach)	1
	SL-161	L-16.1 / LR-1 (long reach)	1
	SL-162	L-16.2 / LR-2 (long reach)	1
Fast Ethernet Base LX B&W SFP	100B	100Base-LX (long reach)	1

Table 4-2 Hazard level classification of different optical interfaces (continued)

Signal/port type	Acronym	Optical Interface	Hazard Level
1.25 Gigabit Eth-SX - B&W SFP	1000B	1000Base-SX (short reach)	1
1.25 Gigabit Eth-LX - B&W SFP	1000B	1000Base-LX (long reach)	1
1.25 Gigabit Eth-ZX - B&W SFP	1000B	1000Base-ZX (extra long reach)	1

Location type

The 1646 SM equipment must be installed in "restricted locations" (industrial and commercial premises) or "controlled locations" (optical cable ducts and switching centers).

Incorporated laser sources characteristics

Output optical interfaces data: the wavelength and the maximum optical power at the output connector of incorporated laser sources is given in the specific documents (refer to Related information.

Optical safety labelling

The label shown below comes in a plastic bag. The customer is required to use the label corresponding to the highest Hazard level of all the modules equipped on the shelf.

The optical interfaces which have HAZARD LEVEL 1 (see Table 4-2, "Hazard level classification of different optical interfaces" (p. 4-6)) carry the following explanatory label:

Openings and fiber connectors

The locations of openings and fibre connectors can be seen in the figures provided in "Units front view".

Engineering design features

In normal operating conditions, unless intentional manumission, the laser radiation is never accessible.

The laser beam is launched in optical fibre through an appropriate connector that totally shuts up the laser radiation. In case of cable fibre break, to minimize exposure times, Automatic Laser Shutdown (ALS) procedure according to ITU-T G.958 Rec. is implemented on the STM-1, STM-4, or on the STM-16 ports.

ALS meets G.958 requirements.

Optical safety instruction

The safety instructions for proper assembly, maintenance, and safe use including warnings and precautions to avoid possible exposure to hazardous laser radiation are reported in the *Safety Guide*, listed in Related information.

Electrical safety

Electrical safety	
Safety status of the connections with other equipment	• TNV2 (Telecommunication Network Voltage) for Remote Alarms, Housekeeping Alarms (CPO, CPI), Rack Lamp (RM) • SELV (Safety Extra Low Voltage) for all the other

Electrical safety compliance with European norms

The 1646 SM meets the following electrical safety standards:

- IEC 60950-1 ed.2001
- EN 60950-1 ed.2001

Electrical safety labelling

The labels reproduced in “Labels affixed to the equipment” are affixed at the factory.

Electrical safety instructions

The safety instructions for proper assembly, maintenance, and safe use including warnings and precautions to avoid possible exposure to hazardous voltage are reported in “Labels affixed to the equipment”.

Electrical interfaces characteristics

Electrical multirate 100 Mbs Ethernet interface

The system supports the full duplex (i.e., bidirectional) Ethernet interface for:

- Twisted pair cable: Fast Ethernet interfaces featuring 100-Mb/s data rate as specified in IEEE 802.3, clauses 24-25 (100BASE-Tx)
- The maximum link length supported by 100BASE-T interfaces depends on the characteristics of the cable used; minimum target is 100 m.
- RJ-45 connector is supported for RX/TX differential connectivity (MDI connectivity).
- Standard load impedance to be considered for transmitter/receiver characteristics evaluation is 100 ohms.
- When operating as 100BASE-T, an internal 4B/5B block coding is supported in order to convert the 100-Mb/s data rae (at MII) to the 125-Mb/s line rate (at MDI).

Optical units interface characteristics

STM-16 optical interfaces characteristics

Optical Interface Specification	
Type of optical fiber	9/125 µm SMF, according to ITU-T G.652, G.653, G.654, G.655
Connector type	LC (on SFP module)
Optical bit rate	2.488 Gbps (STM-16)
Optical interface type (according to the SFP module plugged on)	*ITU–T* G.957 I–16.1, S-16.1, L–16.1, L–16.2 *ITU-T* G.695 C8L1-1D2, Long haul CWDM w/ APD detector *ITU-T* G.695 C8L1-1D2, Short haul CWDM w/ PIN detector
Wavelength range	2nd window for SR-1/I–16.1, IR-1 S-16.1, LR-1 L-16.1 3rd window for LR-2/L-16.2 and CWDM (PIN/APD)

STM-1/4 optical interfaces characteristics

Optical Interface Specification	
Type of optical fiber	9/125 µm SMF, according to ITU-T G.652, G.653, G.654, G.655
Connector type	LC (on SFP module)
Optical bit rate	155.520 Gbps (STM-1) 622.080 Gbps (STM-4)
Optical interface type (according to the SFP module plugged on)	*ITU–T* G.957 S–1.1, L-1.1, L-1.2, S-4.1, L-4.1, L-4.2
Wavelength range	2nd window for IR-1 S–1.1, LR-1 L-1.1, IR-1 S-4.1, LR-1 L-4.1 3rd window for LR-2 /L-1.2 and LR-2 L-4.2 Refer to “B&W SFPs optical characteristics” (p. 4-11) for SFP details

1 GB optical interface characteristics

Optical Interface Specification		
Type of optical fiber	9/125 µm SMF 50/125 µm MMF 62.5/125 µm MMF	According to ITU-T G.652, G.653, G.654, G.655
Connector type	LC (on SFP module)	
Optical bit rate	1.250 Gbps	Gigabit Ethernet
Number of optical ports	1	
Optical interface type (according to the SFP module plugged on)	*IEEE 802.3* Gigabit Ethernet 1000Base-SX, 1000Base-LX, 1000Base-ZX. The unit also supports 100/1000Base-T electrical interface *Telcordia GR-253-CORE* IR-1 (100 to 2700Mbps) *ITU–T G.957* S-16.1 anyrate (100 to 2700Mbps) *ITU-T G.695* C8L1-1D2, Long haul CWDM w/ APD detector *ITU-T G.695* C8L1-1D2, Short haul CWDM w/ PIN detector	
Wavelength range	1st window for IEEE 1000Base-SX 2nd window for S-16.1/IR-1 anyrate, IEEE 1000Base-LX 3rd window for IEEE 1000Base-ZX and CWDM (PIN/APD)	
Pulse shape	See IEEE 802.3.	

B&W SFPs optical characteristics

Parameter	ETSI Interface	STM-1 S-1.1	STM-1 L-1.1	STM-1 L-1.2	Unit
Addressed wavelength		1261 -> 1360	1270 -> 1360	1480 -> 1580	nm
Min. launched power		-15	-5	-5	dBm
Max. launched power		-8	0	0	dBm
Allowed bit rates		100 -> 155.520	2.048 -> 155.520	155.520	Mbps
Min. extinction ratio		8.2	10	10	dB

Parameter	ETSI Interface	STM-1 S-1.1	STM-1 L-1.1	STM-1 L-1.2	Unit
Spectral width	Max. -20 dB bandwidth	NA	1 *nb1*	1	nm
	Max. RMS width	7.7	3 *nb2*	NA	nm
Minimum SMSR		NA	30 if SLM laser	30	dB
Max. chromatic dispersion		-100 -> +100	-250 -> +250	1900	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-28	-34	-34	dBm
Min. overload		-8	-10	-10	dBm
Max. optical path penalty		1	1	1	dB
Max. receiver reflectance		-14	-14	-25	dB
Optical connector (Tx/Rx) / Fibre type		LC / SMF	LC / SMF	LC / SMF	
Acronym		SS-11	SL-11	SL-12	

Notes:

1. If SLM laser
2. If MLM laser

Parameter	ETSI Interface	STM-4 S-4.1	STM-4 L-4.1	STM-4 L-4.2	Unit
Addressed wavelength		1274 -> 1355	1280 -> 1335	1480 -> 1580	nm
Min. launched power		-15	-3	-3	dBm
Max. launched power		-8	+2	+2	dBm
Allowed bit rates		622.080	622.080	622.080	Mbps
Min. extintion ratio		8.2	10	10	dB
Spectral width	Max. -20dB bandwidth	NA	1	1	nm
	Max. RMS width	2.5	NA	NA	nm
Minimum SMSR		NA	30	30	dB
Max. chromatic dispersion		-100 -> +100	-250 -> +250	1900	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-28	-28	-28	dBm

Parameter	ETSI Interface	STM-4 S-4.1	STM-4 L-4.1	STM-4 L-4.2	Unit
Min. overload		-8	-8	-8	dBm
Max. optical path penalty		1	1	1	dB
Max. receiver reflectance		-14	-14	-27	dB
Optical connector (Tx/Rx)		LC	LC	LC	
Fiber type		SMF	SMF	SMF	
Acronym		SS-41	SL-41	SL-42	

Parameter	ETSI Interface	STM-16 I-16.1	STM-16 S-16.1	Unit
Addressed wavelength		1270 -> 1360	1270 -> 1360	nm
Min. launched power		-10	-5	dBm
Max. launched power		-3	0	dBm
Allowed bit rates		2.48832	2.125; 2.48832	Gbps
Min. extinction ratio		8.2	8.2	dB
Spectral width	Max. -20dB bandwidth	NA	1	nm
	Max. RMS width	4	NA	nm
Minimum SMSR		NA	30	dB
Max. chromatic dispersion		-12 -> +12	-100 -> +100	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-18	-18	dBm
Min. overload		-3	0	dBm
Max. optical path penalty		1	1	dB
Max. receiver reflectance		-27	-27	dB
Optical connector (Tx/Rx)/Fibre type		LC/SMF		
Acronym		SI-161	SS-161	

Parameter	ETSI Interface	S-16.1 Multirate Multiformat	Unit
Addressed wavelength		1290 -> 1330	nm

Parameter	ETSI Interface	S-16.1 Multirate Multiformat	Unit
Min. launched power		-5	dBm
Max. launched power		0	dBm
Allowed bit rates		100 -> 2700	Mbps
Min. extinction ratio		For bit rates > 2.125 Gbps = 8.2 For bit rates < 2.125 Gbps = 9	dB
Spectral width	Max. -20 dB bandwidth (nm)	1	nm
	Max. RMS width (nm)	NA	nm
Minimum SMSR		30	dB
Max. chromatic dispersion		-100 -> +100	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-18	dBm
Min. overload		0	dBm
Max. optical path penalty		1	dB
Max. receiver reflectance		-27	dB
Optical connector (Tx/Rx) / Fibre type		LC / SMF	
Acronym		SS-161AR	

Parameter		1 GE 1000Base-SX	1 GE 1000Base-LX/LH (10)	1 GE 1000Base-ZX	Unit
Addressed wavelength		820 –> 860	1270 -> 1355	1540 –> 1570	nm
Min. launched power		-9.5	-11	0	dBm
Max. launched power		-4	-3	+5	dBm
Allowed bit rates		1.250	1.250	1.250	Gbps
Min. extinction ratio		9.0	9.0	9.0	dB
Spec-tral width	Max. -20 dB bandwidth	NA	NA	1	nm
	Max. RMS width	0.85	4	NA	nm
Minimum SMSR		NA	NA	30	dB
Max. chromatic dispersion		-	-	1200	ps/nm

Parameter	1 GE 1000Base-SX	1 GE 1000Base-LX/LH (10)	1 GE 1000Base-ZX	Unit
Min. sensitivity, @ BER=1E^{-10}	-17	-19	-24	dBm
Min. overload	0	-3	0	dBm
Max. optical path penalty	-	-	2	dB
Max. receiver reflectance	-12	-12	-12	dB
Optical connector (Tx/Rx)	LC	LC	LC	
Fiber type	50/125 µm MMF-550m 62.5/125 µm MMF-275m	10 km 9/125 µm SMF 50/125 µm MMF - 550m 62.5/125 µm MMF-550m	9/125 µm SMF	
Acronym	1000B	1000B	1000B	
Interface type	1000Base-SX	1000Base-LX	1000Base-ZX	

DWDM SFPs

STM-1 electrical SFP	1AB210170001
OPTO TRX SFP DWDM CH620	1AB231410001
OPTO TRX SFP DWDM CH610	1AB231410002
OPTO TRX SFP DWDM CH600	1AB231410003
OPTO TRX SFP DWDM CH590	1AB231410004
OPTO TRX SFP DWDM CH580	1AB231410005
OPTO TRX SFP DWDM CH570	1AB231410006
OPTO TRX SFP DWDM CH560	1AB231410007
OPTO TRX SFP DWDM CH550	1AB231410008
OPTO TRX SFP DWDM CH540	1AB231410009
OPTO TRX SFP DWDM CH530	1AB231410010
OPTO TRX SFP DWDM CH520	1AB231410011
OPTO TRX SFP DWDM CH510	1AB231410012
OPTO TRX SFP DWDM CH500	1AB231410013
OPTO TRX SFP DWDM CH490	1AB231410014

OPTO TRX SFP DWDM CH480	1AB231410015
OPTO TRX SFP DWDM CH470	1AB231410016
OPTO TRX SFP DWDM CH460	1AB231410017
OPTO TRX SFP DWDM CH450	1AB231410018
OPTO TRX SFP DWDM CH440	1AB231410019
OPTO TRX SFP DWDM CH430	1AB231410020
OPTO TRX SFP DWDM CH420	1AB231410021
OPTO TRX SFP DWDM CH410	1AB231410022
OPTO TRX SFP DWDM CH400	1AB231410023
OPTO TRX SFP DWDM CH390	1AB231410024
OPTO TRX SFP DWDM CH380	1AB231410025
OPTO TRX SFP DWDM CH370	1AB231410026
OPTO TRX SFP DWDM CH360	1AB231410027
OPTO TRX SFP DWDM CH350	1AB231410028
OPTO TRX SFP DWDM CH340	1AB231410029
OPTO TRX SFP DWDM CH330	1AB231410030
OPTO TRX SFP DWDM CH320	1AB231410031
OPTO TRX SFP DWDM CH310	1AB231410032
OPTO TRX SFP DWDM CH300	1AB231410033
OPTO TRX SFP DWDM CH290	1AB231410034
OPTO TRX SFP DWDM CH280	1AB231410035
OPTO TRX SFP DWDM CH270	1AB231410036
OPTO TRX SFP DWDM CH260	1AB231410037
OPTO TRX SFP DWDM CH250	1AB231410038
OPTO TRX SFP DWDM CH240	1AB231410039
OPTO TRX SFP DWDM CH230	1AB231410040
OPTO TRX SFP DWDM CH220	1AB231410041
OPTO TRX SFP DWDM CH210	1AB231410042
OPTO TRX SFP DWDM CH200	1AB231410043
OPTO TRX SFP DWDM CH190	1AB231410044
OPTO TRX SFP DWDM CH180	1AB231410045
OPTO TRX SFP DWDM CH170	1AB231410046

Alarm characteristics

Units alarms

Each port card has a bi-color LED (green/red) on the front cover plate.

The LED indicates the following:

- Red: internal failure
- Green: in service unit

Housekeeping alarms/commands:

Two output (CPO) and six input (CPI) contacts for housekeeping alarms or commands are physically available on connectors.

The available housekeeping contacts are as follows:

- HK-OUT 2: Outgoing contacts
- HK-IN 1 to 6: Incoming contacts

Troubleshooting:

The 1646 SM equipment is designed to communicate with a Personal Computer (PC) in order to service, activate, and troubleshoot the equipment.

Troubleshooting procedures for the equipment and details of the alarms for each card and relevant indications are described in the relevant documents.

The unit can also be directly connected to an operation system associated to the Transmission Management Network to execute operations similar to those carried out by the PC.

Characteristics of the reported remote alarms and details of the housekeeping contacts interface (EM type) are provided in "General characteristics" (p. 4-2) in this chapter.

Mechanical characteristics

Description

Table 4-3 Board dimension

Item description	Item code	Width	Depth	Height
RSA-1646 SM (SR2U)	3KC17985AA	482 mm	226mm	88mm
MAINBOARD (MB16P)	3KC17989AA	183.8 mm	197.7mm	22.36mm
2XSTM-1 SFP BOARD (P2S1)	3KC17953AB	183.80mm	197.70mm	19.80mm
2XSTM-4 SFP BOARD (P2S4)	3KC17977AB	183.80mm	197.70mm	19.80mm
42XE1 120OHM BOARD (PE1A)	3KC17957AB	183.8mm	197.7mm	19.8mm
42XE1 75OHM BOARD (PE1B)	3KC17961AB	183.8mm	197.7mm	19.8mm
3XE3/T3 BOARD (P3E3)	3KC17965AB	183.8mm	197.7mm	19.8mm
8X100MB/S SWITCH BOARD (P8FES)	3KC17973AC	183.8mm	197.7mm	19.8mm
1X1000MB/S EOS BOARD (PIGET)	3KC17969AC	183.8mm	197.7mm	19.8mm
PWDC2	3KC17993AA	20mm	197.7mm	41.4mm
P4S1	3KC18142AA	183.8mm	197.7mm	19.8mm
P4FXS	3KC18208AA	183.8mm	197.7mm	19.8mm
HK BOX	3AL97348AA	282.6mm	131mm	44mm
E1A EPS BOX	3KC18178AA	442mm	109mm	21.5mm
E1B EPS BOX	3KC18178AB	442mm	109mm	21.5mm
FAN BOARD	3KC17997AA	26mm	206mm	84mm

Table 4-4 Board power

Item description	Power
MAINBOARD (MB16P)	21W
2XSTM-1 SFP BOARD (P2S1)	4.2W
2XSTM-4 SFP BOARD (P2S4)	4.2W
42XE1 120OHM BOARD (PE1A)	11.2W

Table 4-4 Board power (continued)

Item description	Power
42XE1 75OHM BOARD (PE1B)	11.2W
3XE3/T3 BOARD (P3E3)	4.5W
8X100MB/S SWITCH BOARD (P8FES)	13W
1X1000MB/S EOS BOARD (PIGET)	12.5W
SERVICE	1.3W
FAN	42W
PWDC2	0.8W
P4S1	6.3W
P4FXS	14.4W
HK BOX	4.8W
E1 EPS BOX	0W

Table 4-5 Board weight

Item description	Weight
RSA-1646 SM (SR2U)	2.72kgs
MAINBOARD (MB16P)	0.479kgs
2XSTM-1 SFP BOARD (P2S1)	0.3kgs
2XSTM-4 SFP BOARD (P2S4)	0.3kgs
42XE1 120OHM BOARD (PE1A)	0.85kgs
42XE1 75OHM BOARD (PE1B)	0.85kgs
3XE3/T3 BOARD (P3E3)	0.3kgs
8X100MB/S SWITCH BOARD (P8FES)	0.65kgs
1X1000MB/S EOS BOARD (PIGET)	0.6kgs
PWDC2	0.12kgs
P4S1	0.3kgs
P4FXS	0.54kg

Environmental conditions

Nokia products offer the following environmental benefits:

- Reduced energy consumption during manufacturing and use
- Re-cycle of the products
- Reduced emissions to air, water or soil during the manufacturing and use of the product
- Reduced electromagnetic (EM) emissions
- Value recovery at the product end of life

Electromagnetic compatibility (EMC) norms

The CE markings on the product denote compliance with the following Directives:

- 89/336/EEC of May 3rd, 1989 (EMC Directives), amended:
  - By the 92/31/EEC Directive issued on April 28th, 1992
  - By the 93/68/EEC Directive issued on July 22nd, 1993

A product is compliant with the above directed when the equipment is installed per manufacturer instructions, as stated in their installation guide and according to the following European Norms:

- EN 300 386 (V1.3.1), environment "Telecommunication Center"
- FCC part 15
- Telcordia GR-1089 issue 4

  Note: This is a class A product EN55022. In domestic, residential and light industry environments, this product may cause radio interference, in which case the user may be required to take appropriate measures.

The 1646 SM is compliant with the following norms:

- EN 50121-4 for railway applications
- IEC TS 61000-6-5 for power station and substation environments

EMC condition

Information on the EMC condition are in the *Safety Guide*. *Refer to Related information*.

Waste from Electrical and Electronic Equipment (WEEE)

The marking printed on the subrack indicates compliance with the Directive 2002/96/EC On Waste of Electrical and Electronic Equipment.

This European Union directive outlines the manufacturers' responsibility for the collection and disposal of products at the end of the product life cycle. This directive applies to products put on the market after 13th August 2005.

All Nokia products also fall under in Category 3 of Annex 1A of the WEEE directive (Directive 2002/96/ EC) titled "IT and Telecommunication equipment" under item "other products transmitting sound, images or other information by telecommunications."

Nokia products fall under the WEEE directive in Annex 1B that states: "Other product or equipment of transmitting sound, images or other information by telecommunications".

This mark will not cause any responsibility as all responsibilities will be defined by contract.

Acoustical noise

The acoustical noise level of the product complies with the following standard:

- ETS 300 753 Environmental Class 3.1 for attended telecommunication equipment rooms (maximum sound level 7.2 bels)
- Telcordia GR-63 Issue 3

Climatic for operating conditions

The 1646 SM supports temperature levels specified by the following standard:

- ETS 300 019-1-3 :1992, class 3.2.

  Class 3.2: Partly temperature-controlled locations (see Figure 4-1, “Climatogram for Class 3.2: Partly temperature-controlled locations” (p. 4-23))
- Telcordia GR-63 issue 3

Class 3.2: partly temperature controlled locations

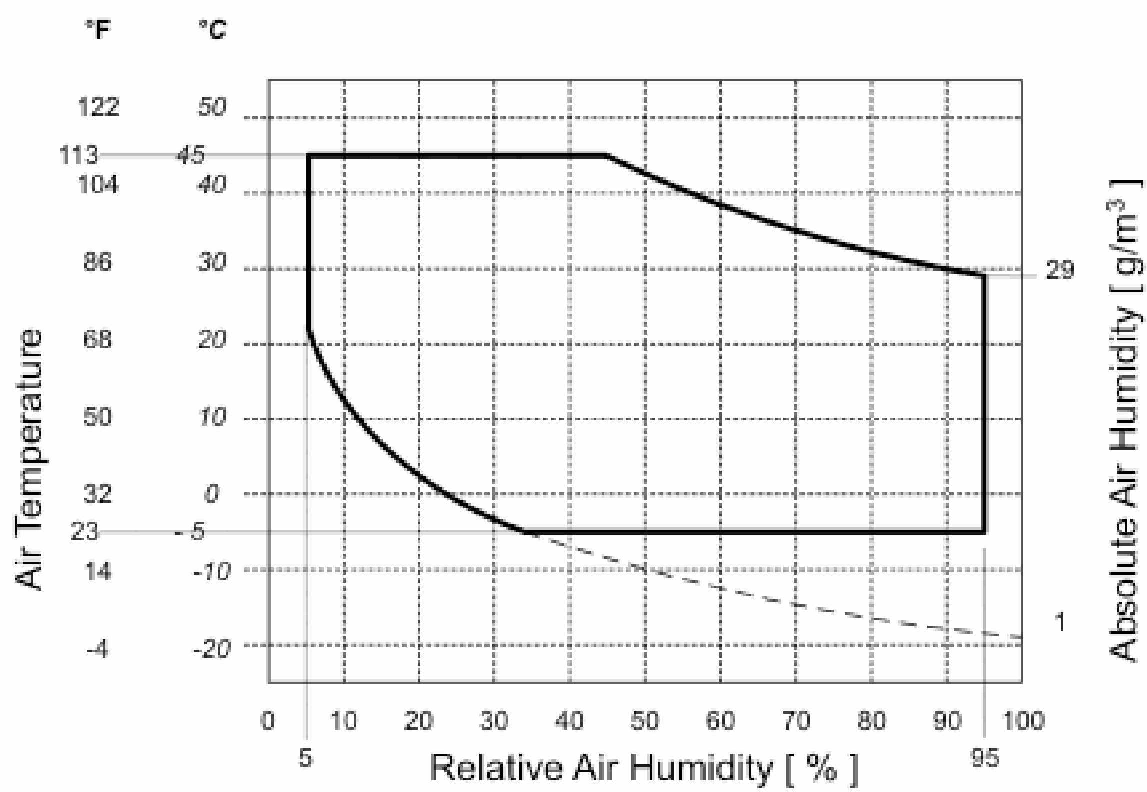
The following are the characteristics of partial temperature controlled locations:

- Where installed equipment is exposed to solar radiation and heat radiation, or to movements of the surrounding air due to draughts in buildings; for example, through open windows. Partial temperature controlled locations also include areas where equipment may be subjected to condensation or to water from sources other than rain and ice
- Where mould growth or attacks by animals, except termites, may occur
- Industrial areas, heavy traffic areas and/or in areas with normal levels of contaminants such as in urban areas
- In close proximity to sources of sand or dust
- With vibration of low significance, e.g. for products fastened to light supporting structures subjected to negligible vibrations.

Class 3.2 conditions may be present in the following locations:

- Entrances and staircases of buildings
- Garages
- Cellars
- Workshops
- Buildings in factories and industrial process plants
- Unattended equipment stations
- Telecommunication buildings
- Storage rooms for frost-resistant products, and farm buildings

Figure 4-1 Climatogram for Class 3.2: Partly temperature-controlled locations



Storage

The 1646 SM equipment meets the following requirements for storage:

- ETS 300 019-1-1: 1992, Class 1.2

  Class 1.2: Weather-protected, not temperature-controlled storage location.

  This class applies to weather-protected storage having neither temperature nor humidity control. The location may have openings directly to the open air; i.e., it may be only partly weatherproofed. The climatogram is shown on Figure 4-2, "Climatogram for Class 1.2: not temperature controlled storage location" (p. 4-24).
- Telcordia GR-63 issue 3

The following are the characteristics of partial storage controlled locations:

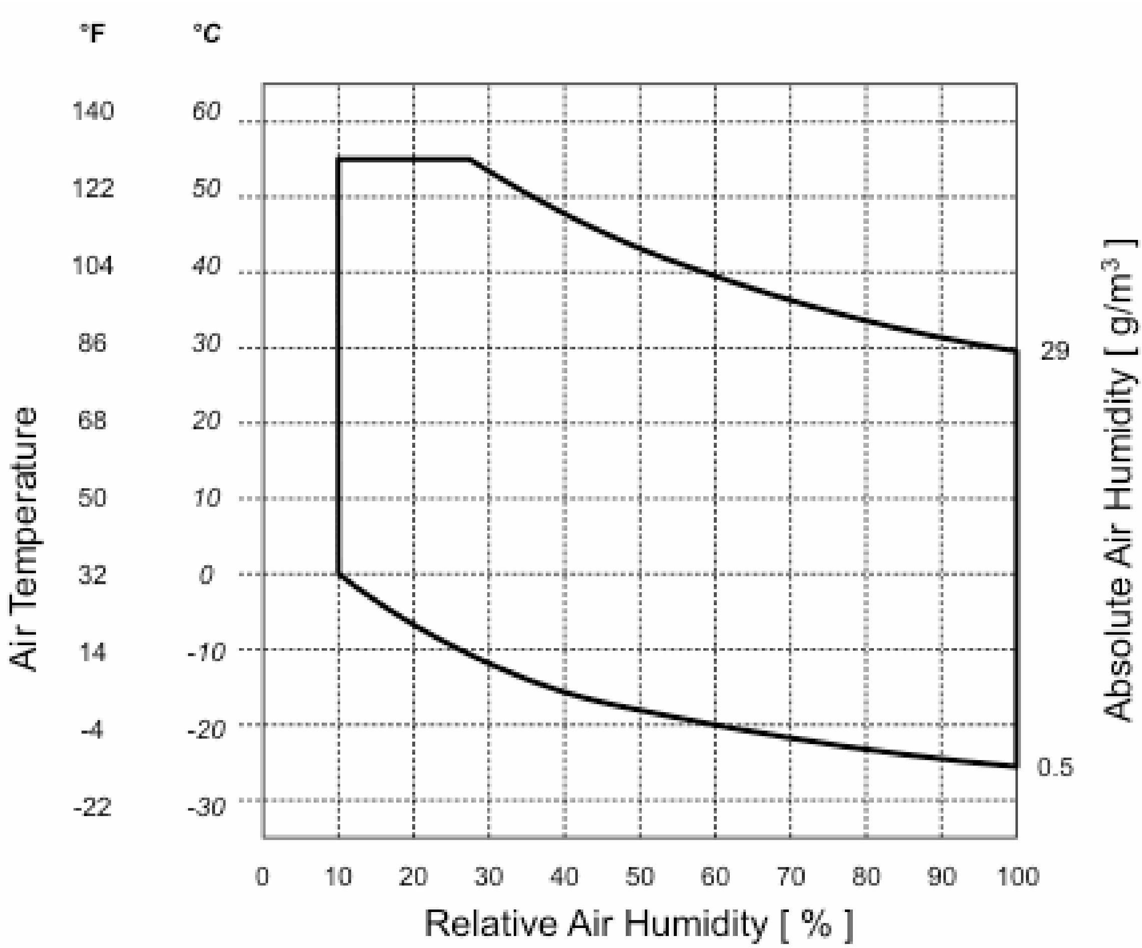
- Where installed equipment is exposed to solar radiation and heat radiation, or to movements of the surrounding air due to draughts in buildings; for example, through open windows. Partial storage controlled locations also include areas where equipment may be subjected to condensation, snow, or water from sources other than rain and ice
- Where mould growth or attacks by animals, except termites, may occur

- Industrial areas, heavy traffic areas and/or in areas with normal levels of contaminants such as in urban areas
- In areas with sources of sand or dust, including urban areas
- with vibration of low significance and insignificant shock

Class 1.2 conditions may be present in the following locations:

- Unattended buildings
- Entrances of buildings
- garages and shacks

Figure 4-2 Climatogram for Class 1.2: not temperature controlled storage location



Transportation

The 1646 SM equipment meets the following requirements for transportation:

- ETS 300 019-1-2 : 1992, class 2.2

  Class 2.2 : Careful transportation (see Table 4-6, “Transportation climatic” (p. 4-25)).

This class applies to transportation where special care has been taken e.g. with respect to low temperature and handling.

Class 2.2 includes all the conditions of Class 2.1. In addition, Class 2.2 includes transportation in all types of lorries and trailers as well as transportation by ship and by train, with a manual loading and unloading limit of 20 kg.

- Telcordia GR-63 Issue 3

In its standard packing, the 1646 SM equipment can be transported under the following conditions without damage to optical interfaces:

AT -40 °C for a maximum of 72 Hours

Table 4-6 Transportation climatic

Environmental parameter		Unit	2.1 and 2.2	2.3
(A)	Low temperature air	°F (°C)	-13 (-25)	-40 (-40)
(B)	High temperature, air in unventilated enclosures (Note 1)	°F (°C)	+158 (+70)	+158 (+70)
(C)	High temperature, air in ventilated enclosures or outdoor air (Note 2)	°F (°C)	+104 (+40)	+104 (+40)
(D)	Change of temperature air/air (Note 3)	°F (°C)	-13/+86 (-25/+30)	-40/+86 (-40/+30)
(E)	Change of temperature air/water (Note 3)	°F (°C)	+104/+41(+40/ +5)	+104/+41(+40/ +5)
(F)	Relative humidity, not combined with rapid temperature changes	% °F (°C)	95 +104 (+40)	95 +45
(G)	Relative humidity, combined with rapid temperature changes air/air, at high relative humidity (Note 3 and Note 6)	% °C	95 -13/+86 (-25/+30)	95 -40/+86 (-40/+30)
(H)	Absolute humidity, combined with rapid temperature changes : air/air at high water content (Note 4)	g/m^3 °C	60 +158/+59(+70/ +15)	60 +158/+59(+70/ +15)
(I)	Low air pressure	kPa	70	70
(J)	Change of air pressure	kPa/min	no	no
(K)	Movement of the surrounding medium, air	m/s	20	20

Table 4-6 Transportation climatic (continued)

Environmental parameter		Unit	2.1 and 2.2	2.3
(L)	Precipitation rain	mm/min	6 (Note 7)	6
(M)	Radiation, solar	W/m^2	1120	1120
(N)	Radiation, heat	W/m^2	600	600
(O)	Water from sources other than rain (Note 5)	m/s	1 (Note 7)	1
(P)	Wetness	none	conditions of wet surfaces	

Note:

1 The high temperature of the surfaces of a product may be influenced by both the surrounding air temperature specified here, and the solar radiation through a window or another opening.

2 The high temperature of the surface of a product is influenced by the surrounding air temperature specified here, and the solar radiation defined below.

3 Direct transfer of the product between the two differing temperatures is presumed.

4 The product is assumed to be subjected to a rapid decrease of temperature only (no rapid increase). The values for water content apply to temperatures down to the dew-point. At lower temperatures, the relative humidity is assumed to be approximately 100 %.

5 This value pertains to the velocity of water, not to the amount of water accumulated.

6 Occurrence of condensation.

7 For short duration only.

5 Functional description

Overview

Purpose

This chapter gives a general description of the main subsystems and the related features.

Contents

SDH transmission architecture

Overview

The overall functional architecture for SDH traffic is depicted in Figure 5-1, "SDH payload functional architecture" (p. 5-2).

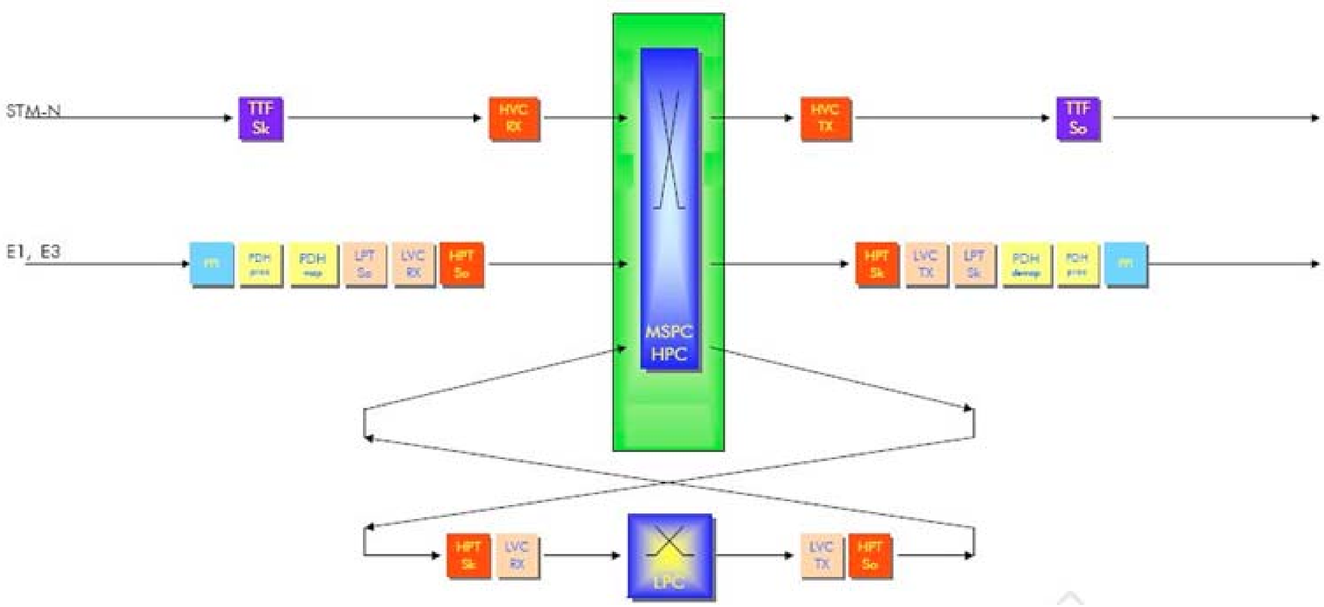
The description of SDH architecture is based on SDH terminologies, taking ITU-T standards (mainly GR-253/G.783) as a reference for the functional model description.

When dealing with SDH traffic, the functions of MSPC and HVC, foreseen by the standard functional model, collapse into one single entity implemented in the central switching element.

SDH functional architecture can be further divided into different subsystems dedicated to the respective management of:

- SDH HO traffic (i.e., VC-4 for SDH) (refer to "SDH higher order part system" (p. 5-3))
- *SDH LO traffic* (i.e., VC-3, VC-12 for SDH) (refer to "SDH lower order part system" (p. 5-3))
- *PDH access and mapping* (refer to "SDH PDH mapping part system" (p. 5-4))

Figure 5-1 SDH payload functional architecture



SDH higher order part system

SDH Higher Order part system performs the processing of the Section and Regenerator and the Multiplex of a SDH signal.

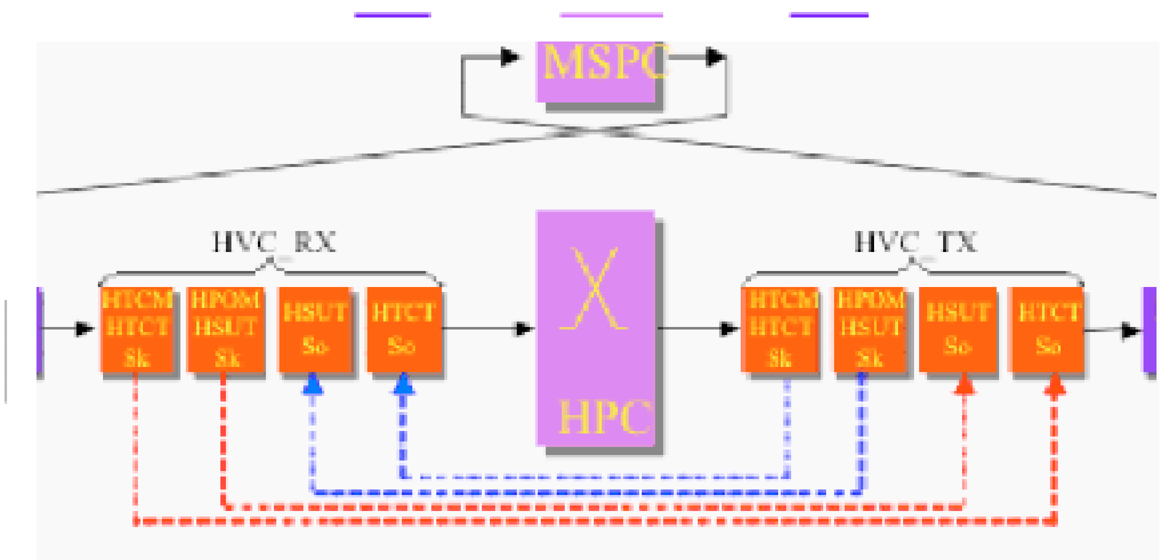
The adaptation to the path layer is also managed, with pointer regeneration, in RX side.

The HO path signals (VC-4 for SDH) are processed.

SDH Payload matrices, foreseen by ANSI and ITU-T standards for the management of Higher Order traffic (i.e., MSP_RX, HPC, MSP_TX matrices, using SDH terminologies) collapse into one single entity performing fully nonblocking AU-4 switch, with respect to any broadcast type.

Full compliancy to ANSI/ITU-T functional model is achieved. The equivalent functional model of the equipment is reported in Figure 5-2, "SDH HO payload subsystem equivalent logical functional model" (p. 5-3)

Figure 5-2 SDH HO payload subsystem equivalent logical functional model



The described functional partitioning for the HO SDH signals introduces some slight difference in the equipment behavior, with respect to the expected one (i.e., described by G.783).

SDH lower order part system

SDH Lower Order part system provides processing capabilities of the LO tributaries part of an HO structured payload. Assembly and disassembly of the HO/LO payload is performed, by means of adaptation of the HO path to the LO path layer. TU pointer processing is also performed. The LO path signals (VC-12 and VC-3 for SDH) are processed.

The implementation of the LO subsystem is fully compliant with the functional model described in the standard (G.783).

SDH Lower Order traffic is cross-connected in a dedicated device, placed in the Matrix board, able to switch VC-11/VC12/VC-3 for SDH tributaries.

SDH PDH mapping part system

This section describes the portion of the system that manages PDH signals mapping into SDH frames. Both PDH into HO SDH and PDH into LO SDH mappings are supported.

PDH over HO SDH tributaries mapping is managed via HOI (Higher Order Interface) cards, which directly interface the Universal Matrix providing the functionalities of the standard Higher Order Path Connection (HPC) connection function.

The mapping of PDH over LO SDH tributaries mapping is managed in LOI (Lower Order Interface) cards, instead. LOI card manage the mapping of the PDH signals into Lower Order tributaries, managing a Virtual container with a meaningless path overhead: LO path termination, therefore, is not managed in LOI cards. The LO VC, carrying PDH clients, are mapped into a structured HO tributary (again, the HO VCs are created wih a meaningless path OH).

Data subsystem architecture

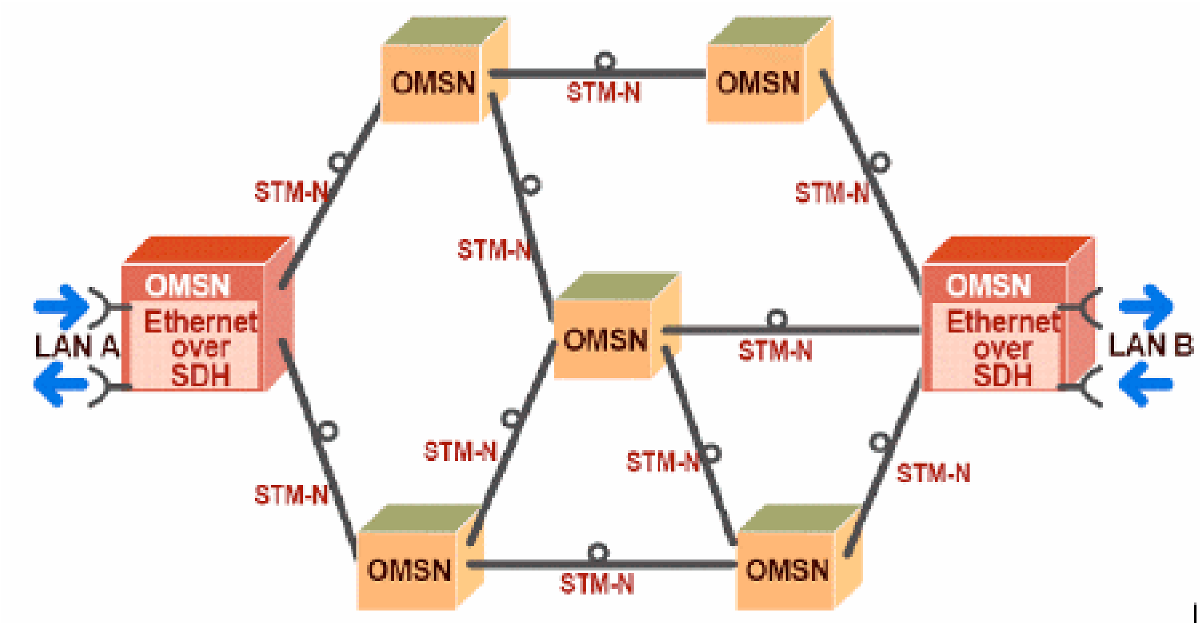
Ethernet transparent transport

LAN to LAN transport service

1646 SM can be equipped with P1GET to allow LAN to LAN service as a point to point connection between two routers or switches through a SDH network. These boards act as a gateway towards the SDH network. In order to guarantee the end to end transparency each Ethernet stream/interface of these boards are mapped in a specific SDH VC (by means of "GFP" encapsulation algorithms, according to ITU-T G.7041 Rec.) performing a one to one Ethernet traffic mapping into the SDH network.

A transport network based on OMSNs equipment provides flexible link service among remote LANs carrying Ethernet traffic as shown in the following Figure 5-3, "Example of an Ethernet stream transport through a SDH network" (p. 5-5).

Figure 5-3 Example of an Ethernet stream transport through a SDH network



- Transparency

  The Ethernet frames are forwarded to the output port with no protocol termination. This cause no impact on service management architecture due to transport network insertion.

- Low latency

  The transport network provides a very low end-to-end delay; the removal of store need in the intermediate nodes using continuous data flow is another consequence of transparency.

- High availability

  The LAN-to-LAN service makes use of the same resources and infrastructures of the other trans¬ported services (ATM, MPLS, PDH and SDH streams...); so availability is very high.
- High quality

  All the features of the transport network, like very low BER, synchronization, alarms management, performance monitoring, protection mechanisms, are used providing so high quality service.

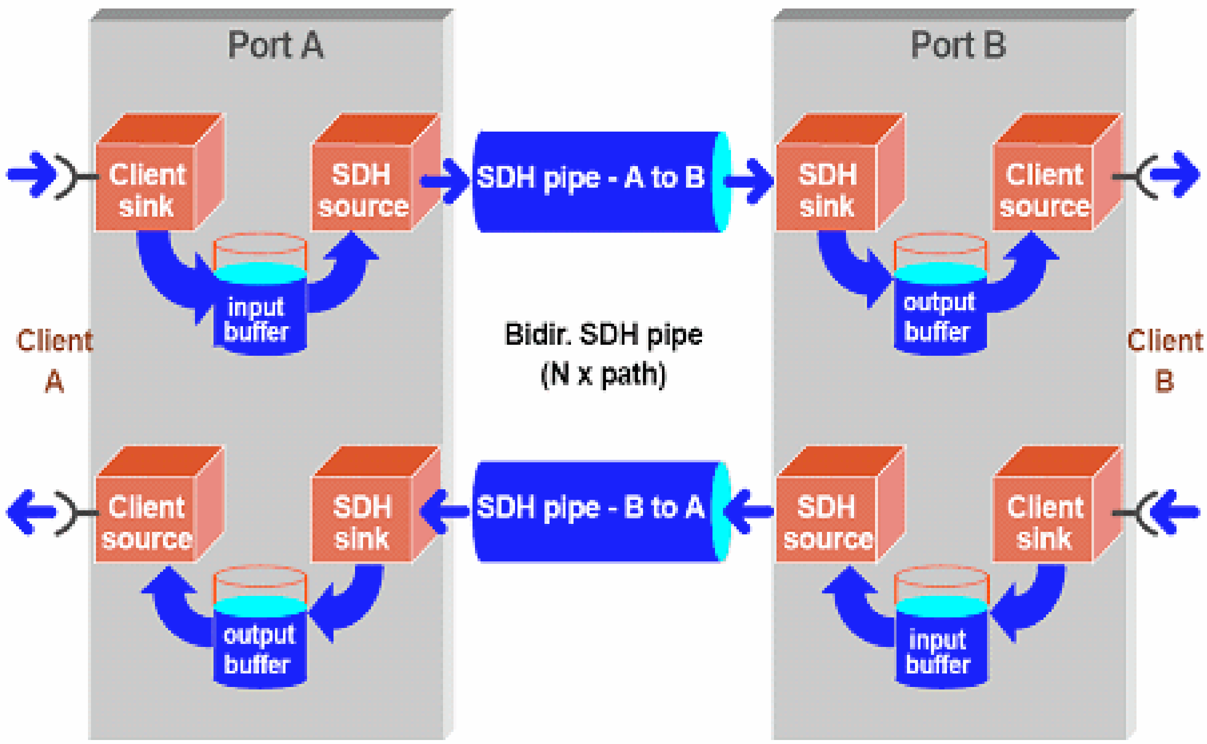
  Note: The minimum bend radius During the cable routing must be more than five times the outer diameter of the cable.

LAN to LAN functional description

The functional block diagram of a LAN to LAN service is shown in Figure 5-4, "LAN to LAN service block diagram" (p. 5-7). The client sink termination function adapts the client interface; all the payload frames received are stored into input buffer queue. The source SDH adaptation function draws the frames from the memory emptying the cluster and making it available again; then maps the frame into SDH Virtual Container applying the GFP encapsulation procedure.

SDH paths are considered as traffic pipes carrying a continuous data flow. At the output port the dual operation is performed: the output buffer queue is written with payload frames received from SDH line and then the client source termination draws from memory and forwards these frames to the client.

Figure 5-4 LAN to LAN service block diagram



Three types of Ethernet interfaces are provided:

- 10 Mbit/s - Ethernet
- 100 Mbit/s - Fast Ethernet
- 1000 Mbit/s - Giga Ethernet

Different Ethernet interfaces types can be used at the termination ends: e.g. an Ethernet client interface in one side and a Fast Ethernet one in the other side.

A SDH pipe can be configured as:

- a single SDH path or
- a virtual concatenation of paths
- 1000 Mbit/s - Giga Ethernet

  N x VC-12

  N x VC-3

  N x VC-4 (for GE interface ONLY)

Depending on client types and SDH pipe, a bandwidth limit can occur. A flow control mechanism is used to adapt the client rate to the transport pipe.

Main features description

Encapsulation

Gigabit Ethernet client is mapped into SDH Virtual Containers using encapsulation algorithms for variable length packets, according to ITU-T G.7041 Recommendation Generic framing procedure (GFP).

GFP has been adopted to solve the incompatibility between the Ethernet traffic, based on discontinuous data, and the SDH traffic needing a continuous data stream. GFP is able to map length-variable data. The Ethernet frames are GFP encapsulated, to be then mapped into SDH Virtual Containers

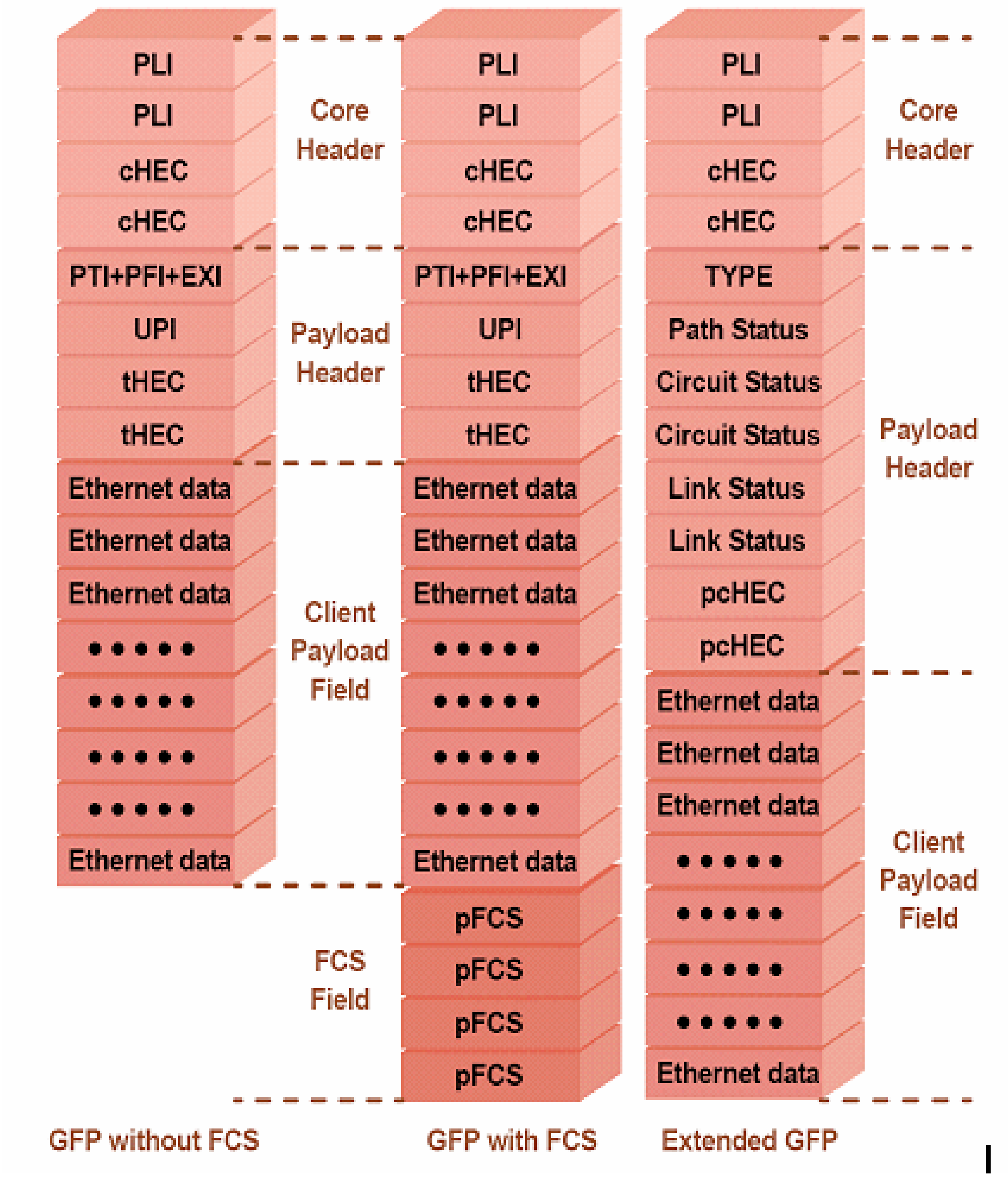
The system supports 'frame mapped' mode, which represents the 'Protocol Data Unit' (PDU) oriented adaptation mode, and it identifies the capability to encapsulate a single client frame into a single GFP frame.

In this application the client signals are Ethernet MAC (PDU oriented) type. The GFP encapsulation is shown on Figure 5-6, “GFP encapsulation of the MAC frames” (p. 5-11).

For each pipe three different GFP frame formats can be configured, as shown on Figure 5-5, “GFP frame format” (p. 5-9):

- GFP without FCS
- GFP with FCS (NOT supported)
- Extended GFP

Figure 5-5 GFP frame format



According to the type, the GFP frame format consists of a Core Header, a Payload Header, a Client Payload field and FCS field.

The *Core Header*, made up of 4 octets, supports frame delineation procedures and essential data link operations functions independent of the higher layer PDUs (Protocol Data Unit).

The GFP Core Header consists of the following fields:

– PLI: it is the PDU Length Indicator field 16 bits length, containing a binary number representing the number of octets in the GFP Payload Area. Zero length means no payload area, i.e. idle frame; this is intended for use as a filler frame for the adaptation process

– cHEC: it is the Core Header Error Control field 16 bits length, containing a CRC-16 generated sequence that protects the integrity of the contents of the Core Header by enabling both single-bit error correction and multi-bit error detection.

The *Payload Header*, is a variable-length area, made up of

– 4 octets in GFP without FCS and GFP with FCS frame format

– 8 octets in Extended GFP frame format, provides payload information like GFP type; when Extended GFP is used this area provides also information used in Packet Concatenation.

According to the frame format, in the following are described the various types of fields

- *GFP without FCS and GFP with FCS frame format*

  the first two octets constitute the GFP type field of the Payload Header, indicating the content and format of the GFP Payload field. The Type field distinguishes between services in a multi-service environment. This field consists of –PTI, Payload Type Identifier, a 3-bit field

  PTI=0 for GFP user frame conveying client data

  PTI=1 for GFP user frame conveying far-end Client Signal Fail indications

  PFI, Payload FCS Indicator, 1-bit field

  PFI=0, Payload FCS is present

  PFI=1, Payload FCS is absent

  EXI, Extension Header Identifier, 4-bit field

  UPI, Used Payload Identifier, 8-bit field

  tHEC: the 3rd and 4th octets constitute the Type Header Error Control field containing a CRC-16 generated sequence that protects the integrity of the contents of the Type Field by bit error detection.

- Extended GFP

  the first octet is made up of the TYPE fields that provides format and frame type

  from 2nd to 6th octet the information about Path Status, Circuit Status and Link Status are given

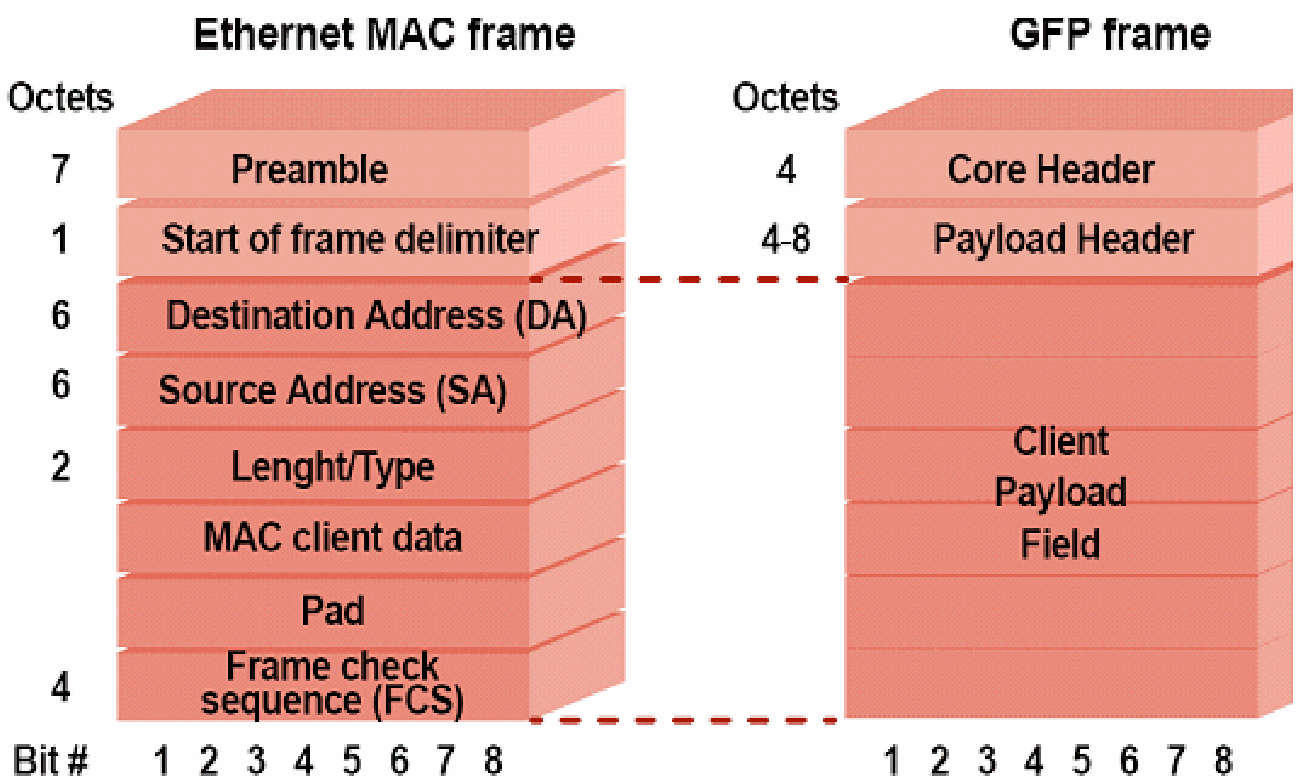
  in the last two octets, the FCS type information are given, in pcFCS fields.

The Payload Field contains the Ethernet frames; this variable-length area may include from 64 to 1574 bytes

The client user/control PDU is always transferred into the GFP Payload field as an octet-aligned packet stream

The payload Frame Check Sequence (pFCS) is an optional field, 4-bytes long. If selected, it's a frame check sequence containing a CRC-32 sequence used to detect any packet corruption inside the transport network.

Figure 5-6 GFP encapsulation of the MAC frames



Ethernet MAC Frame fields:

Preamble the preamble is a 7-octet field that is used to allow the PLS (Physical Signaling) circuitry to reach its state synchronization with the received frame's timing.

Start of Frame Delimiter the SFD field is the sequence 10101011. It immediately follows the preamble pattern and indicates the start of a frame.

Destination Address (DA) the Destination Address field specifies the station(s) for which the frame is intended.

Source Address (SA) the Source Address field specifies the station sending the frame.

Length/Type this two-octet field takes one of two meanings, depending on its numeric value:

–If the value of this field is less than or equal to the value of max Valid Frame, then the LenType field indicates the number of MAC client data octets contained in the subsequent data of the frame (Length interpretation).

–If the value of this field is greater than or equal to 1536 decimal (equal to 0600 hexadecimal), the Length/Type field indicates the nature of the MAC client protocol (Type interpretation). The Length and Type interpretations of this field are mutually exclusive.

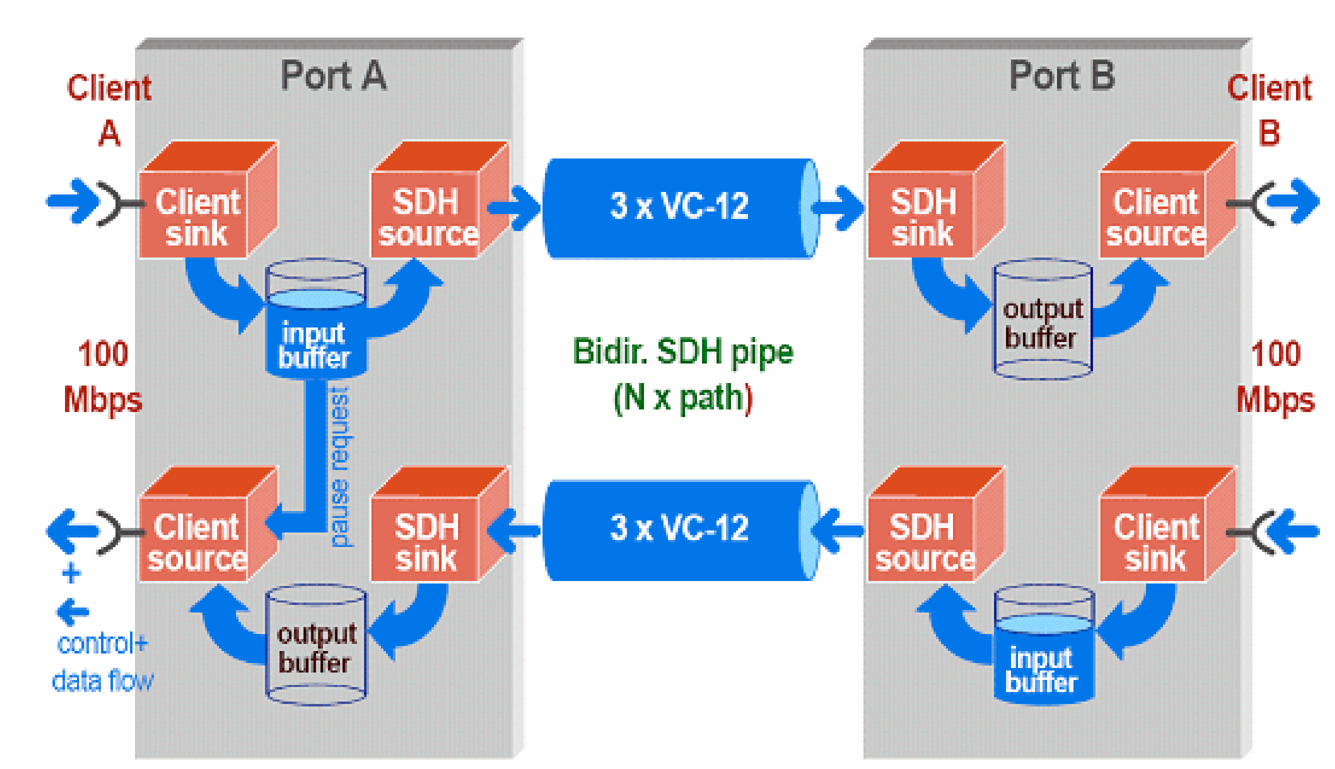
MAC client data and PAD The data field contains a sequence of n octets; full data transparency is provided. If the length of the data field is less than the minimum required for proper operation of the protocol, a PAD field (a sequence of octets will be added at the end of the data field but prior to the FCS field.

Frame check sequence (FCS) a cyclic redundancy check (CRC) is used by the transmit and receive algorithms to generate a CRC value for the FCS field. The frame check sequence (FCS) field contains a 4-octet (32-bit) cyclic redundant check (CRC) value. This value is computed as a function of the contents of the source address, destination address, length/type, LLC data and Pad (that are all the fields except the preamble, SFD, FCS and extension)

Flow control

To avoid buffer saturation problems at the termination end, flow management is very important. When an excessive traffic is received, a control mechanism can be used to slow down the transmitter avoiding a packets loss. In the following the relative actions are described. As you can see from Figure 5-7, "Flow control mechanism" (p. 5-13), the input control is performed at the input port; it is always enabled regardless the GFP type. When the input buffer of Port A crosses a fixed High threshold, a pause request is sent back to the transmitter; The pause request message is defined in IEEE 802.3x; the transmitter is asked to be paused. The transmitter will be re-qualified (pause request stopped) when the input buffer of Port A crosses a fixed Low threshold.

Figure 5-7 Flow control mechanism



LCAS and VCAT

LCAS: This Ethernet feature also implements the Virtual Concatenation and LCAS (Link Capacity Adjustment Scheme) features. LCAS (Link Capacity Adjustment Scheme) permits the operator to "hitless" modify the bandwidth capacity of a virtual concatenated link (VCG), in order to meet the bandwidth needs of the service (by adding or removing virtual containers in all the involved nodes of the network). It can also temporarily remove failed links of the group, in automatic and hitless mode. In case of failure or addition of links, the traffic is automatically redistributed over the working links. Reference: ITU-T G.7042 rec.

VCAT: Virtual Concatenation consists in the fact that frames not fitting into a single SDH-container are transported over more individual containers, indicated with the symbol:

VCn-Xv (e.g., VC12-3v indicates the virtual concatenation of 3 VC12) also called VCG (Virtual Concatenated Group). The original frame is paralleled "Time Slot-by-Time Slot" and loaded over different payloads. The individual containers can follow different paths in the network, with different delays, and they need to be reassembled at the end points, taking into account the different path delays.

This feature is compliant with ITU-T G.707 The NE supports VCAT at the following levels:

ETSI VC-4 (High Order, only GE interface) and VC-3, VC-12 (Low Order)

LPT

Link Pass through (LPT) feature is supported and the purpose of LPT function over a provider network is to propagate link failure as if the customer devices on both end of the service connection are connected via direct Ethernet link. The feature set of link pass through consists of a set of consequent actions between customer interfaces (CIF) and network interface (NIF) relying over Ethernet ports and “Remote” (GFP mapped) Ethernet ports Port-to-Port LPT is supported and following two figures show how LPT works when failures on both CIF and NIF.

Figure 5-8 Failure on CIF interface

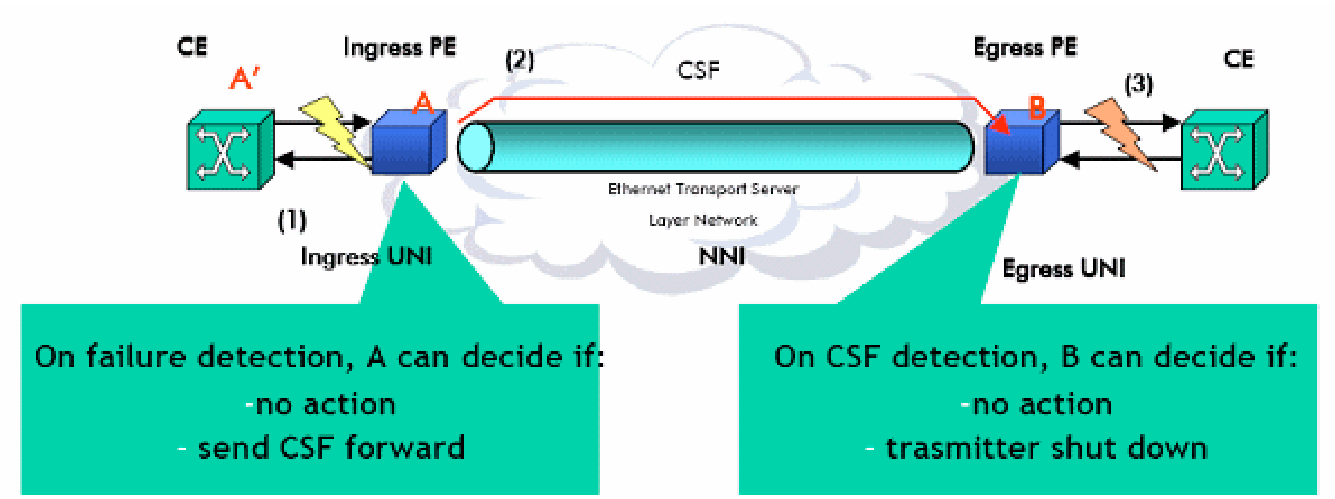
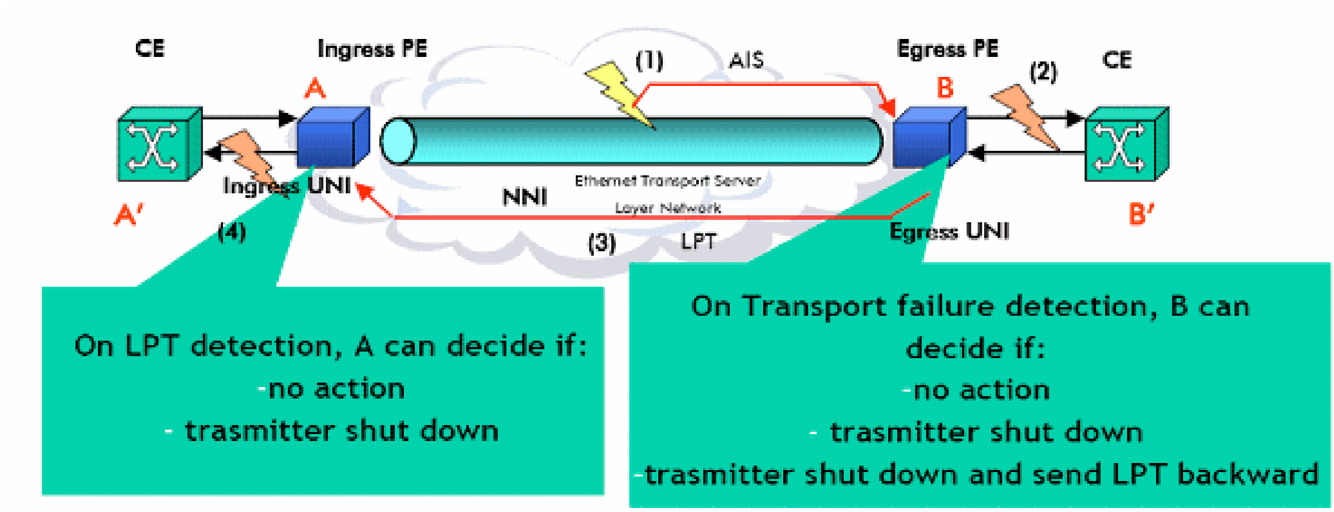


Figure 5-9 Failure on NIF interface



MAC frame processing

It checks that the received/transmitted frames are compliant with the supported technology and checks the FCS value (frame Check Sequence). Furthermore, it removes the "Preamble" and "Start-of- Frame" fields from the Ethernet packet, and inspects the MAC Destination/Source Addresses and the L/T field of the frame. These fields are reinserted in transmit direction. In transmission direction, it recalculates the FCS and inserts it on the outgoing frame.

MAU processing

In compliance with IEEE 802.3, it supports:

- Auto-negotiation to adapt the bit rate of the port to the best rate offered by the far-end connected port
- Flow Control to inform the far-end connected port about the congestion state of the receiver. If the receiver buffer is full, the transmitter sends a "Pause" frame to the far end, in order to stop sending packets
- Full duplex

Ethernet transparent transport boards

Two types of boards are available:

- 1, P1GET: 1x GE interface, refer to P1GET unit description
- 2, MB16A/C: 8x FE interface, refer to MB16 unit description

Ethernet switch

General

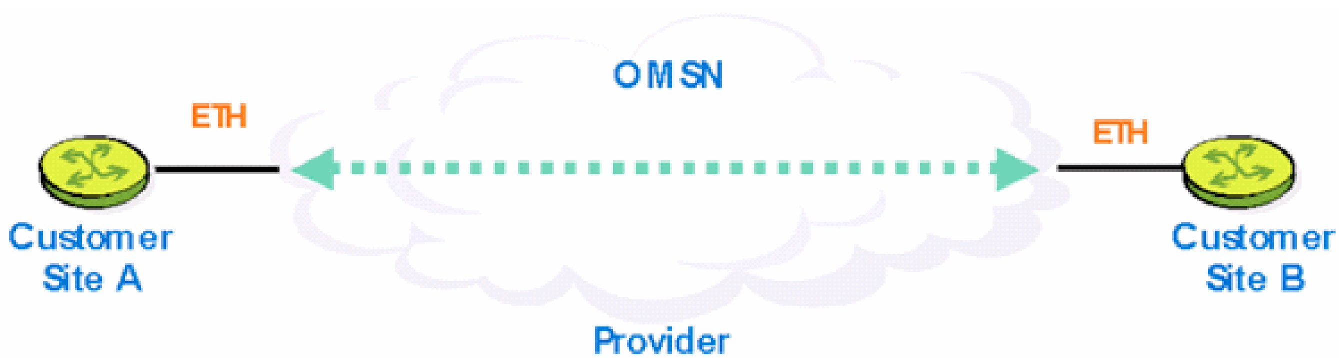
Comparing with Ethernet transparent transport, Ethernet switch provides more plentiful features and services. P8FES and P4FXS Ethernet module in 1646 SM can deliver a full set of Ethernet services that are described in the next points [1] to [4]

[1] Ethernet Private Line

EPLine service connects two ports of a client between each other in a transparent fashion (using transparent mode). Traffic originating from one Customer Port is forwarded to the other one without any filtering and maximum level of security possible (physical segregation through different SDH infrastructure).

The service emulates an Ethernet "wire" which actual bandwidth is determined by the SLA and by network load. EPLine does not require MAC learning or MAC-based forwarding.

Figure 5-10 Ethernet private line service

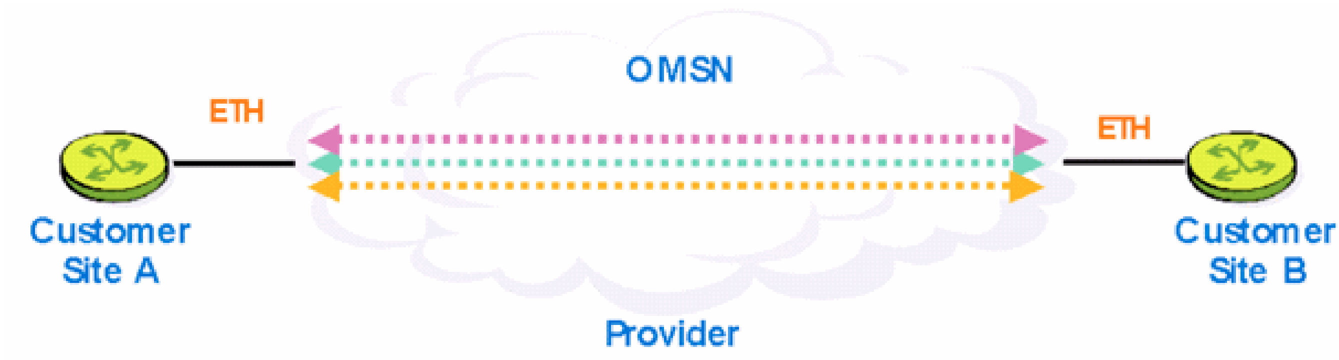


[2] Ethernet Virtual Private Line

EVP-Line service connects two ports of a client between each other (using bridging mode). Traffic originating from one Customer Port is classified and forwarded accordingly to the other end. The service emulates an Ethernet "wire" which actual bandwidth is determined by the SLA and by network load.

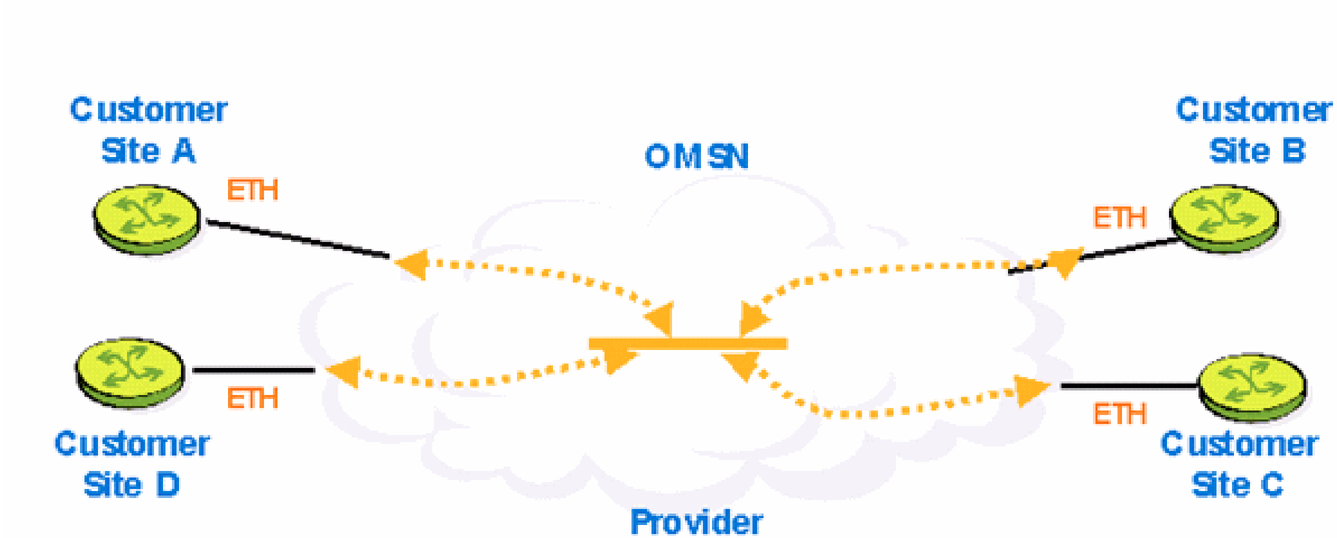
Thanks to the available Eth Multiplexing Function provided by the Ethernet switch module, different Virtual Private Line services can be defined on the same UNI belonging to different applications and with different QoS SLA. EVPLine adopts MAC learning and MAC-based forwarding according to the need.

Figure 5-11 Ethernet virtual private line service



[3] Ethernet Virtual LAN EVP-LAN service connects two or more ports of a client between each other (using bridging mode).

Traffic originating from one Customer Port is classified and forwarded accordingly to the other end. The service emulates an Ethernet LAN which actual bandwidth is determined by the SLA and by network load. EVP-LAN adopts MAC learning and MAC-based forwarding with aging timeout.

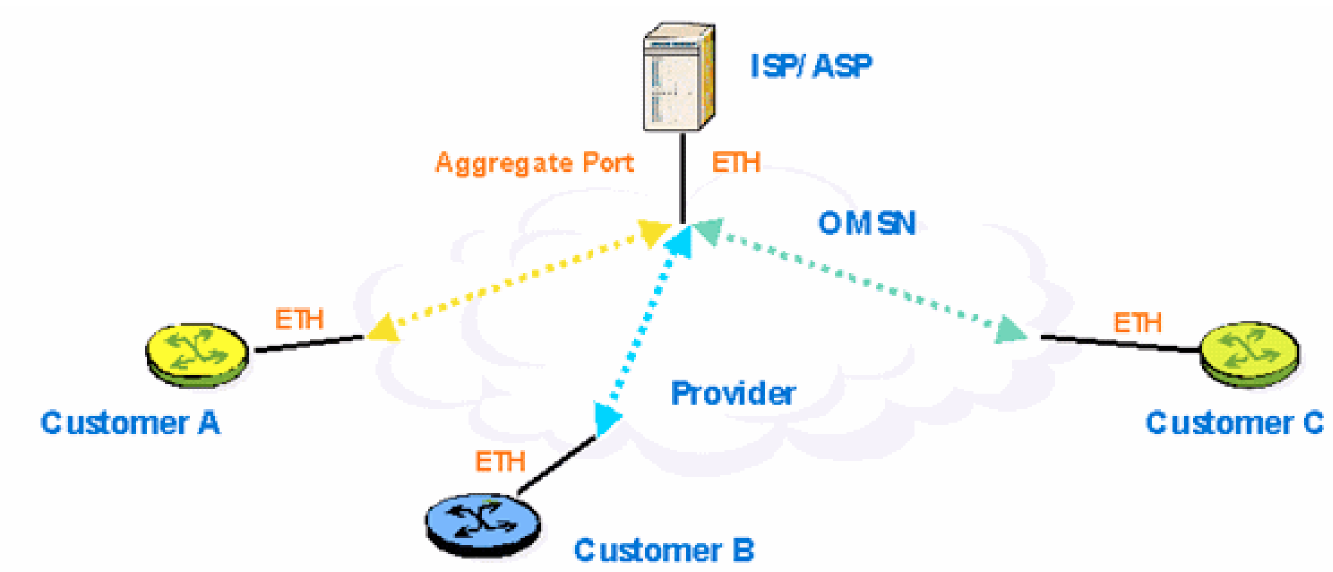


[4] Broadband access

In this service, a number of customers are connected to a common Aggregate Port (e.g. typically connected to an ISP point of presence) Traffic is only delivered from individual Customer Ports to the Aggregate Port.

Broadband Access can distinguish between various customers' traffic at the Aggregate Port using VLAN tags. For each customer that is attached to the BA service it is possible to define a specific QoS SLA.

Figure 5-12 Broadband access service



Ethernet switch module

Ethernet switch module provides ETH 10/100M interfaces connectivity for LAN based clients premises inside the metro area. Beyond mapping ETH flows onto the SDH metro network by means of standard mechanisms (as specified in ITU G.7071, ITU G.7042 and ITU G.707), it also introduces wire speed classifying, policing and scheduling capability empowered by carrier class Ethernet switching engine.

Per customer traffic flow management with low bandwidth granularity, segregation and QoS are just few of the value added arguments that this module offers to the carrier operators at a competitive price.

Ethernet switch is composed by P8FES and P4FXS. P4FXS can support 4×FX ports while P8FES can provide 8×10/100M ports, hereinafter P8FES is taken as an example to present Ethernet switch and protection functions.

Note: GE version is not supported in this release.

Some of the resources available in the SDH infrastructure can be utilized in order to realize a converged multi service network into which different streams (e.g. TDM, ETH, ATM) can travel together in fat big pipes, reducing capital and operational expenses for the operator.

The capacity available from the card to the back panel gives the overall card trunk capacity that is available for traffic to flow from and to the SDH resources (e.g. SDH ports that carry ETH traffic into SDH VC).

Main features of P8FES units

The main characteristics of Ethernet switch, supported in current release:

- Interface: P8FES board supports

  Local Ethernet Interface: 8 x 100BASE-TX interfaces

  SDH-based” interface:

  Up to 8 “SDH-based “ interfaces

  Underlying fully SDH VC rates , encompassing both

  Single lower SDH VCs (VC12, VC3)

  SDH VC-nV [SDH VC12-nV (n=1.. 63), VC3-nV (n=1..12)

  Not support rate limiting per VCG port

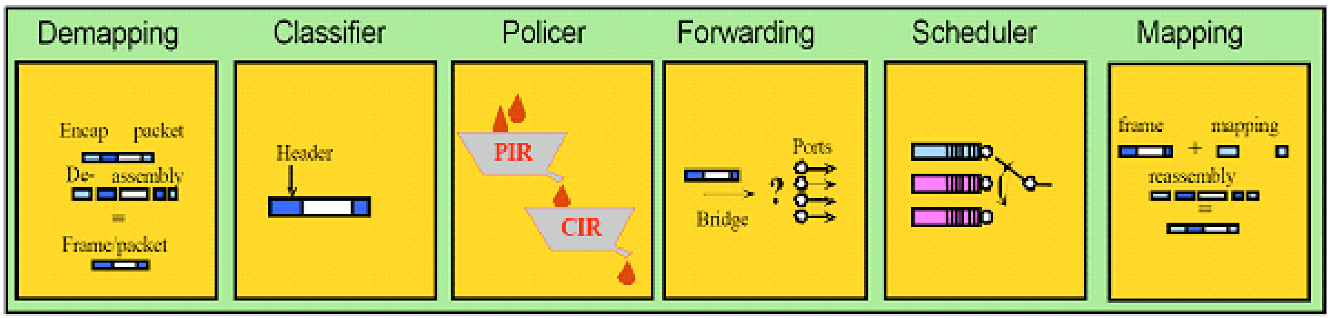
  The throughput on SDH side is 4x VC4
- Auto-negotiation: Configurable
- Flow Control: Configurable
- CSF alarm propagation: Configurable
- Jumbo Frames supporting: Baby JF up to 9000 bytes
- Bridging/Connection: 1, ETH permanent cross-connection 2, MAC Bridge (802.1d) 3,Virtual Bridge (802.1q) 4, Provider Bridge (802.1ad)
- Traffic Classification criteria: 1, Port 2, Port and C-VLAN 3,Port and S-VLAN 4,Port and C-VLAN and S-VLAN 5, Priority
- Forwarding Data Base management: 1, per port 2,MAC Auto-learning and Aging 3, MAC Static configuration
- Look up table size: 1,Number of VLAN-id = 4 K 2,Number of MAC addresses = 16K per card
- Traffic delivery: 1,Unicast 2,Multicast 3,Broadcast
- VLAN capability: 1, C-VLAN PUSH 2,S-VLAN PUSH/POP/SWAP
- COS: Eight class of service, two Guaranteed, four Regulated, one Best effort and one Background
- Policing: 1, Dual rate token-bucket Metering 2, Color Blind policing 3, Marking -> 3 colors 4,Dropping -> out of profile
- Scheduler: SP (Strict priority) and WFQ (Weighted Fair Queue)
- Spanning tree: RSTP, 802.1 w

- Performance Ethernet counters
- Link Aggregation: On Local Ethernet Ports, Max Aggregate-Size = 8 ports

Functional description of the Ethernet main features

An high level overview of the traffic flow and processing in the Ethernet switch modules, shown in Figure 12. The pipeline is composed of five main processing steps that are described in the following paragraphs.

Figure 5-13 Traffic flow and processing in Ethernet switch



Mapping

The following standards apply to ETH physical ports:

- IEEE 802.3 10BASE-T Ethernet (twisted-pair copper)
- IEEE 802.3u 100BASE-TX Fast Ethernet (twisted-pair copper)
- ANSI/IEEE 802.3 Auto-negotiation
- IEEE 802.3x Flow Control
- Data transfer rate from client equipment is limited in accordance with the specified traffic characteristics by the standard IEEE 802.3x flow control mechanism.

Flow control frames are used to prevent congestion of the network that may cause packet discarding at the egress of the network; the flow control mechanism stops the client source until the bandwidth allocated to the service is able to absorb the extra traffic. The result is that no packets are lost even in case of congestion. Flow control can be disabled according to the operator's choice.

The following standards apply to the ETH over SDH ports:

- ITU-T G.7041 GFP (Generic Framing Procedure)
- ITU-T G.7042 LCAS (Link Connection Adjustment Scheme)
- G.707 (SDH VC Virtual Concatenation at Low and High Order VC-12 and VC-3)

The Ethernet mapping scheme on the trunk ports adheres to the Generic Framing Procedure (ITU-T G. 7041).

The Ethernet traffic, opportunely mapped in the SDH transport structures, is then sent by the trunk ports toward the SDH matrix from the back-plane and then to the corresponding SDH port.

A trunk port is realized by a bundle of SDH VCs (VC-12, VC-3) grouped together according to ITU-T G.707 (Virtual Conc) and ITU-T G.7042 (LCAS).

The bandwidth of the trunk port in normal operational mode corresponds to the available bandwidth of the grouped VCs (e.g. 5xVC-12 equals 10 Mbps).

Traffic classification

Ethernet switch module can classify ETH traffic according to a wide set of standard specified criteria in order to provide a feature reach set of capability.

Classification criteria are the following:

- Port (Physical ETH or ETH over SDH)
- Port and C-VLAN
- Port and S-VLAN
- Port and C-VLAN and S-VLAN
- Priority

Policing and metering traffic with QoS

Flow metering measures the traffic rate to determine whether the traffic conforms to the stated contract or exceeds the traffic contract. Metering typically occurs on classified flows, mostly on a per class base.

Policing decides whether each packet conforms, exceeds or violates the configured traffic rate and takes the consequent action. The action taken can include dropping or re-marking the packet.

Marking is the process of inserting information into the frame to allow further elaboration to the packets, e.g. applying "color" to a packet, to differentiate the behavior of the node on different packets of the same flow.

- Conforming traffic ("Green" marked) falls within the configured committed rate (CIR – is the access bit rate contracted with a service provider). It is the first served, according to its traffic profile.
- Exceeding traffic ("Yellow" marked) is above the CIR but still within the configured peak rate (PIR). It is may served just after the "green" packet, according to its traffic profile
- Violating traffic ("Red" marked) is above the PIR. It dropped immediately

This group of features is used not only to drop out-of-profile packets, but also to re-mark them, thus indicating to downstream dropping mechanisms that they should be dropped ahead of the in-profile packets. Ethernet switch modules allow service providers and carrier operators to specify per flow traffic QoS.

ETH flows quality of service is enforced at the ingress of the network and inside the network by traffic conformance check made by the policing function. Policing is performed by means of a token bucket algorithm.

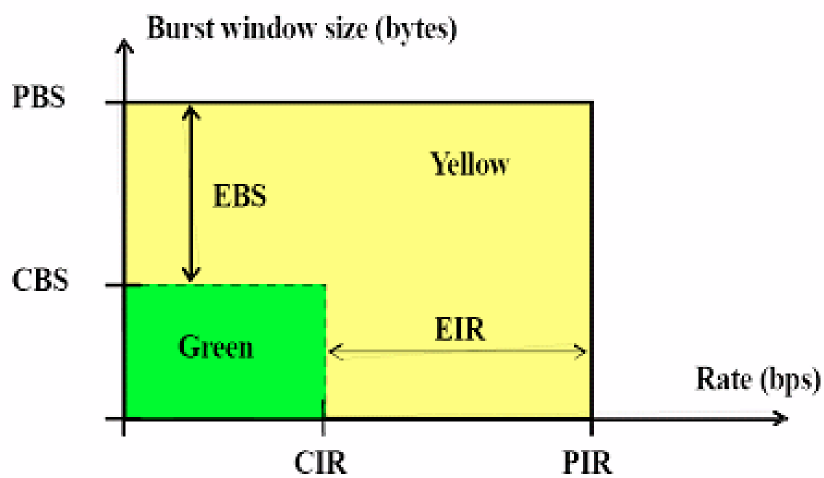
Traffic QoS is specified by a set of parameters that control its max, mean rate and the relative burst window size in bytes.

Policing parameters are specified per classified flow according to:

- CIR = committer information rate
- CBS = burst window size at the CIR
- PIR = excess information rate
- PBS = burst window size at the PIR

Figure 5-14 Traffic parameters

	MIB Granularity	Minimum Value	Default Value	Maximum value
ETS Traffic Descriptor CIR	64Kbps	0	0	Up to PIR
ETS Traffic Descriptor PIR	64Kbps	0	0	2499968kbps
ETS Traffic Descriptor CBS	1 KByte	0	0	34 Kbyte
ETS Traffic Descriptor PBS	1 KByte	0	0	34 Kbyte



Scheduling

Scheduling of packets is performed on eight queues of each egress ports by combining SP (Strict Priority) and WFQ (Weight Fair Queue).

Figure 5-15 Forwarding queue mode

Forwarding	Queue	Default
Q7	Strict	Priority
Q6	Weighted	64
Q5	Weighted	32
Q4	Weighted	16
Q3	Weighted	8
Q2	Weighted	4
Q1	Weighted	2
Q0	Weighted	1

Support of 8 Ethernet Forwarding Classes: Background, Best Effort, Regulated (4), Regulated (3), Regulated, Regulated (1), Guaranteed (2), Guaranteed

Figure 5-16 Default mapping between Traffic Class to Egress Queues

Enhanced Ethernet Forwarding Classes	Forwarding Queue
Guaranteed	Q7
Guaranteed(2)	Q6
Regulated(1)	Q5
Regulated	Q4
Regulated(3)	Q3
Regulated(4)	Q2
Best-Effort	Q1
Background	Q0

Switching and forwarding

Ethernet modules are based onto a carrier class Ethernet switching engine with auto learning bridges according to IEEE 802.1d/802.1q/802.1ad. This engine is either wire speed performing (all the functions are performed in hardware) and highly flexible and configurable.

On a per port basis it can be used in two modes:

Transparent mode: the engine forwards all the traffic incoming from one port to another without inspection at the specified rate.

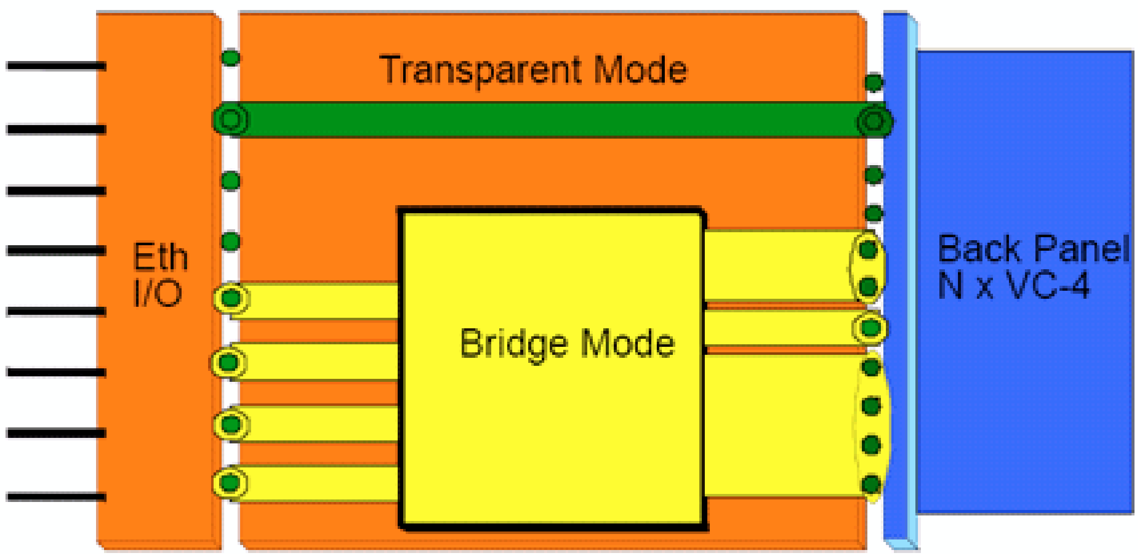
Bridging mode: a group of configured ports (ETH PHY or ETH over SDH) are bridged together with MAC auto learning function according to IEEE 802.1d/802.1q/802.1ad, using the "Auto-Learning" and "Aging" mechanisms.

Auto-Learning mechanism: Unknown incoming frames are flooded on all ports of the bridge, except the port where they arrived. When a far station responds back on a port, the bridge "learns" that frames having this received MAC-Address (and, if existing, the associated VLAN/SVLAN-ID) have to be forwarded to that port. This connection is written on a table (FDB, Forwarding Data Base, reporting the associations between MAC-addresses, ports, and, if used, VLAN/SVLAN Id.), used to forward next incoming frames.

> **Note:** One VLAN/SVLAN identifier will be learned and forwarded on a given port, only if registered on that port, otherwise it will be discarded.

Aging: After a set-able period of time, a record of the FDB table can be deleted.

Figure 5-17 Operational modes



VLAN tag processing

The afferent frames can be optionally VLAN and/or SVLAN tagged (Virtual LAN, Stacked Virtual LAN). It checks the 802.1Q field and the TCI (Tag Control Information) and manages the VLAN (user tag) and S-VLAN (provider tag) fields of the MAC frame (also called "VLAN-tagged MAC frames"). In this way it can further support the SLA (service level agreement) with differentiated CoS (Class of Service). The use of VLAN option permits the aggregation of many users over a single virtual circuit. Furthermore, if they are not physically tied to the same physical segment, they can communicate to each other as if they were on the same LAN. In this way, users may also move from a segment to another without changing their physical address. If requested, it can insert ("Push") or remove ("Pop") the VLAN/SVLAN tags on/from the frames.

Link aggregation

Up to 4 Link Aggregation groups, each group is requested support up to 8 Link Aggregation ports Link Aggregation is supported at the Ethernet side, as specified in IEEE-802.3ad rec.; it is a technique to aggregate many data streams into a single logical link.

The resulting aggregate link will be treated by the system (with regard to instances about STP, IGMP, network protections, etc.), as a single link. It permits to overcome the bandwidth limitation of the single Ethernet interfaces, or to protect the traffic.

Links may be anytime added or removed to/from the bundle. Ports to be aggregated can ONLY be located on the same board. Its management in the network is based upon the communication, between the aggregate partner equipments, of LACP messages (Link Aggregation Control Protocol).

The LACP packets transport information about setup, aggregation capability, links failures, automatic reconfiguration after failure, etc. The packets distribution over the constituting links is based upon classification of

MAC SA / DA (Source Addresses and Destination Addresses) - hashing key for LAG All packets belonging to the same conversation (i.e., same MAC-DA/SA) are transported over the same link. The packets cannot be fragmented, i.e., a packet is transmitted entirely on the same link. More conversations (i.e., different MAC SA/DA) can be transported on the same link.

The benefits of Link Aggregation feature are:

Overcoming Bandwidth limitation

Load balancing (the traffic is distributed over the constituting links); load balancing is based on hashing key made of MAC DA, MAC SA, resulting in a statistical distribution of frames across the links.

Reliability increasing (in case that a link of the aggregate fails, its traffic will be automatically distributed over the other links of the aggregate). 'Link Aggregation' is specified at Ethernet 'Data Link ' layer, just before the 'MAC Client' sub-layer; thus, it is assumed to be supported independently from the type of client carried by the Ethernet frame (e.g., MPLS packet). Only 'Promiscuous mode' is supported - Any client is handled by the port without being terminated (switching only).

The conditions for Link Aggregation option are the followings:

All involved ports must work at the same rate.

All involved ports must have the same configurations, regarding Auto Negotiation and Flow Control

All aggregated links must be point-to-point (Multicast is not allowed).

All involved interfaces must work in full-duplex modality.

All involved ports must be Local (Remote ports are not allowed).

Actor and Partner ports (local and far sides) must be of the same type.

Ethernet LINK OAM

This feature support below Ethernet Link OAM capabilities via “on per port basis” enabling (Default: Disabled) ONLY over local Ethernet interfaces, according to IEEE 802.3ah:

- Link Discovery
- Remote Failure Indication
- Remote Loop-back
- Local loop-back
- A fixed (1 sec) Link OAM PDU Generation Interval
- Link Monitoring

STP: Spanning Tree Protocol management

This function is distributed and performed by local CPU and Ethernet Switch. STP is a link management protocol that provides path redundancy while preventing undesirable loops in the network. In an Ethernet network, only one active path can exist between two stations. STP "breaks" all the loops of the network, permitting only one path from a Bridge to any other Bridge, in order to prevent "infinite loops" (infinite replaying of the frames) due to redundantly connected bridges networks. Moreover, the STP procedure accomplishes the resilience of the network against STP failures, recovering the network connectivity. For instance by electing a new Root-Bridge (that is the root of the tree), if the actual one has failed; or by deactivating a failed link and activating a backup one, if existing

BPDUs (IEEE Std. 802.1w-2001) contain information about the transmitting switch and its ports, including switch and port Media Access Control (MAC) addresses, switch priority, port priority, and port cost. The Spanning-Tree Protocol uses this information to elect the root switch and root port for the switched network, as well as the root port and designated port for each switched segment.

In the current release, the following STP modalities are supported:

1. STP (IEEE802.1D)

2. RSTP (Rapid STP, IEEE802.1W)

RSTP takes advantage of point-to-point wiring and provides rapid convergence (rapid recovery of connectivity following the failure of a switch, a switch port, or a LAN) of the spanning tree, accomplishing reconfiguration of the spanning tree in less than 30 secs. By assigning port roles and by determining the active topology, RSTP builds upon the IEEE 802.1D STP to select the switch with the highest switch priority as the root switch. Then the RSTP assigns one of these port roles to individual ports:

Root port - Provides the best path (lowest cost) when the switch forwards packets to the root switch.

Designated port - It is the port through which the designated switch is attached to the LAN, which incurs the lowest path cost when forwarding packets from that LAN to the root switch

Alternate port - Offers an alternate path to the root switch to that provided by the current root port

Backup port - Acts as a backup for the path provided by a designated port toward the leaves of the spanning tree

Disabled port - Has no role within the operation of the spanning tree.

Root and designated ports are included in the active topology, alternate and backup ports are excluded.

Ethernet OAM

Description of Requirements

The System shall support ONLY Connectivity Fault Management (CFM)tools (i.e. path tracing, connectivity verification, fault detection, isolation, alarm suppression), with the purpose of supporting established operational practice.

The System will not support Performance Monitoring tools, with the purpose of monitoring the Quality of Service for verifying the compliance to 'Service Level Agreement' (SLA).

ETH OAM entities

Within an ETH layer network, below Ethernet OAM (ETH OAM) entities are currently defined by the standard recommendations:

Maintenance Entity (ME) [ITU/IEEE]

ME is, in general, an entity of the Ethernet layer network that requires maintenance; specifically, it represents a point-to-point relationship between two Maintenance End Points (MEPs) at a particular ME Level.

Note - Maintenance Entities can nest but not overlap.

MEG End Point (MEP) [ITU/IEEE]

MEP is an expanded ETH flow point that is capable to initiate and terminate proactive OAM signals.

MEG Intermediate Point (MIP) [ITU/IEEE]

MIP is a expanded ETH flow point that is capable to react to diagnostic OAM signals and do not initiate diagnostic OAM signals.

Maintenance Entity Level [ITU/IEEE]

ME Level represents the information to be used to distinguish between OAM signals belonging to different nested MEs, at any point in a network.

Eight ME Levels are available to accommodate different network deployment scenarios. The eight ME Levels are mutually agreed amongst customer, provider and operator entities involved in ETH connections. Default ME Levels assignment amongst customer, provider, and operator entities are defined in the following manner:

Customers are assigned 3 ME Levels: 0, 1, and 2

Providers are assigned 2 ME Levels: 3 and 4

Operators are assigned 3 ME Levels: 5, 6, and 7

The MEPs associated with an administrative domain operate at the assigned ME Level. Inter-domain MEPs, associated with MEs between two administrative domains, can operate at a ME Level agreeable between the two administrative domains, such that associated inter-domain OAM flows are prevented from leaking into either administrative domain. The default ME Level for inter-domain OAM flows is one just below the ME Level at which the administrative domain is providing transparency.

The following table highlights ME Level assignments for MEs within the context of Customer, Provider and Operator administrative domains, as mapped to Y.1730 and G.8010.

Figure 5-18 ME level assignments

Y.1730 ME	G.8010 ME	ME Level
UNI-UNI (Customer)	UNI_C to UNI-C ME	0,1, or 2
UNI-UNI (provider)	UNI_N to UNI_N ME	3, or 4
Segment (PE-PE) intra-provider	Intra Domain ME	3, or 4
Segment (PE-PE) inter-provider (provider – provider)	Inter Domain ME	7 (default)
ETY Link OAM – UNI (customer – provider)	Access Link ME	7 (default)
ETY Link OAM – NNI (operator – operator)	Inter Domain ME	7 (default)

Maintenance Entity Group (MEG) [ITU/IEEE]

ME Group (MEG) includes different MEs (Maintenance Entities) that satisfy the following conditions:

MEs in a MEG exist in the same administrative boundary; AND

-MEs in a MEG have the same ME Level; AND

-MEs in a MEG belong to the same point-to-point ETH connection or multipoint ETH connection.

Note - For a point-to-point ETH connection, a MEG contains a single ME. For a multipoint ETH connection containing n end-points, a MEG contains n(n-1)/2 MEs

Maintenance Domain [IEEE]

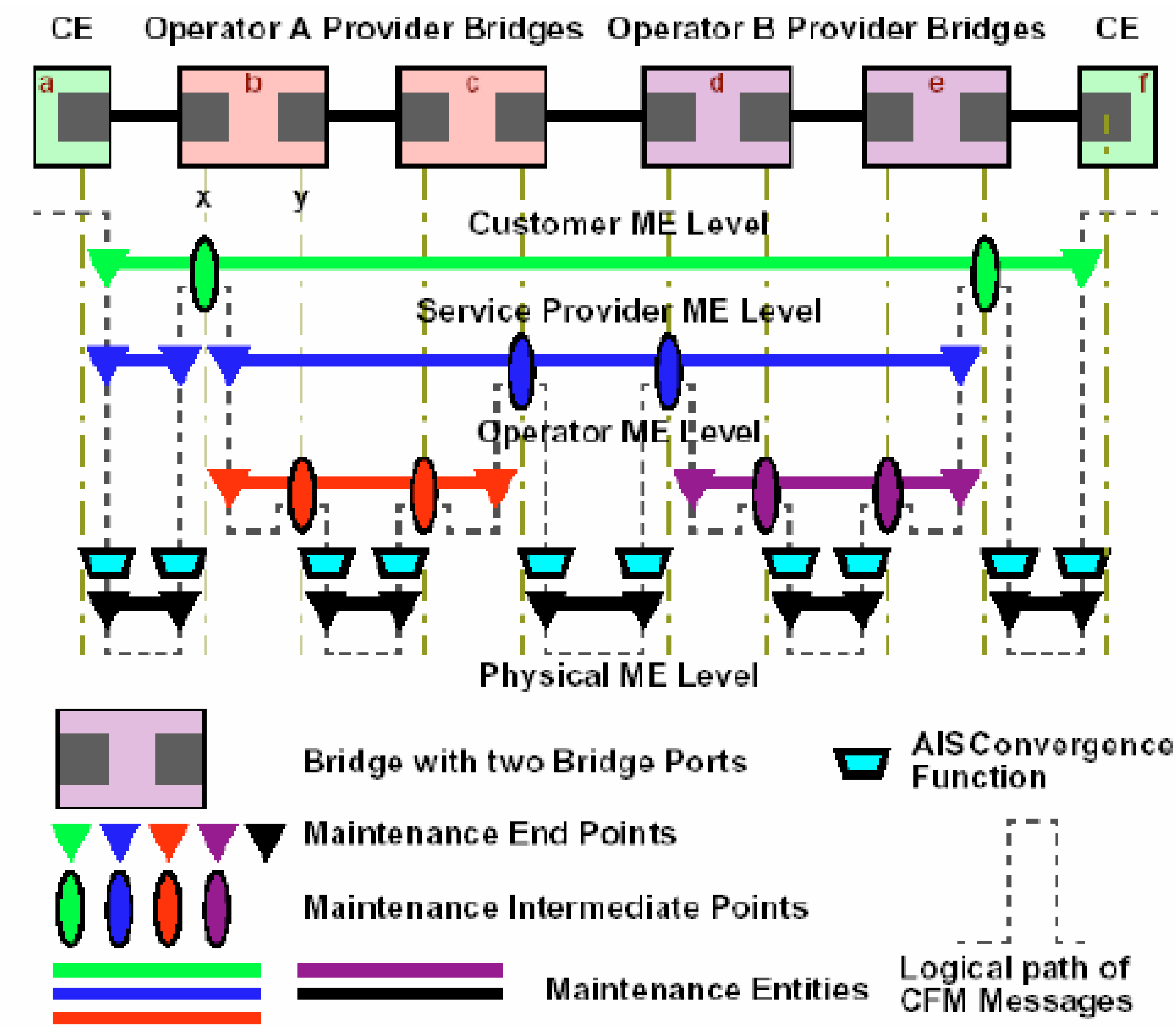
One or more ME Groups, all at the same ME Level, may be grouped into a “Maintenance Domain”. One advantage of this grouping is that it makes it easier to structure access controls to the management variables and command structures (e.g. SNMP MIBs).

For another, a Maintenance Domain is an excellent tool for synchronizing the scopes of CFM Messages and the protocols, such as the Spanning Tree Protocols and GVRP, that control the flow of all data frames, including CFM Messages.

In any given Provider Bridge, the Maintenance Domain is the starting point for managing Connectivity Fault Management.

A MIB exists in each Provider Bridge for each Maintenance Domain which has a ME Group whose messages are likely to pass through that Provider Bridge.

Figure 5-19 MEPs, MIBs and ME



ETH OAM frames

The System shall support ONLY Loopback, Linktrace and Continuity Check messages.

ETH-LB(Loopback) Request/Reply [ITU] / Loopback Message/Reply [IEEE] generated by a MEP to verify connectivity failure to a remote flow point, either MEP or MIP; this loopback mode is non-intrusive, since it affects only ETH-LB frames. It can be performed both in ‘slow’ mode and ‘fast’ mode, depending on the ETH-LB frame rate generation

ETH-LT Request / Reply [ITU] / Linktrace Message/Reply [IEEE] generated by a MEP either for route discovery or for fault isolation. The 'request' signal is sent to a target MEP with the target MEP identified in Target Address TLV; the 'reply' signal is sent back to the orginating MEP, both by the 'destination' MEP and by the MIPs encountered along the route (these last MEs have, specifically to sent the 'reply' and relay ahead the 'request')

“on per MEP basis” Continuity Check protocol, according to below Continuity Check transmission interval: 3.3ms,1 sec (Default), 10 sec, 1min, 10min

Table 5-1 Summary of P8FES ETH OAM functionality

	Down MEP on UNI	UP MEP on UNI	DOWN MEP on NNI (for inter-domain MD level and for protection purpose)
MEL	0-7	0-7	0-7
MA VLAN	untagged	Untagged (for port-to-port service) or tagged	Untagged or tagged
CCM	Support CCM rate 3.3ms, 10ms, 100ms, 1s (default), 10sec, 1min, 10min	Support CCM rate 3.3ms, 10ms, 100ms, 1s (default), 10sec, 1min, 10min	Support CCM rate 3.3ms, 10ms, 100ms, 1s (default), 10sec, 1min, 10min
LB	Support Unicast: LB initiator and LB responder	Support Unicast: LB initiator and LB responder	Support Unicast: LB initiator and LB responder
LT	Support	Support	Support

Note: P8FES do not support UP MEP on UNI port in PB mode.

EFM

EFM is a OAM standard for Ethernet for monitoring Link operation, such as remote failure indications and remote loop-back control. EFM is intended for point-to-point Ethernet links and conveys OAM information in OAMPDU frames containing control and status information used to monitor, test and troubleshoot OAM enabled links: OAMPDU frames cannot propagate beyond a single hop within a Ethernet network.

The System in Active Mode configuration (Active mode DTEs initiate OAM communications and can issue queries and commands to a remote device) is requested to support below EFM functions:

- **Discovery**: a means for detecting the presence of an OAM sub-layer at the remote peer and establishing OAM;
- **Link Monitoring**: for detecting link faults; and
- **Remote Failure indications**: a mechanism for an OAM entity to convey failure conditions to its peer via specific flags in the OAMPDU. Failure conditions include: Link fault- loss of signal detected by the receiver; Dying Gasp – an unrecoverable, vendor-specific condition (e.g. power failure); Critical Event;
- **Remote Loopback**

  An OAM entity can put its remote entity into loopback mode using a loopback control OAMPDU. This helps you ensure the quality of links during installation or when troubleshooting. In loopback mode, every frame received is transmitted back on that same port except for OAMPDUs and pause frames. The periodic exchange of OAMPDUs must continue during loopback state to maintain the OAM session.

1646 SM support Ethernet OAM architecture for monitoring of a given Ethernet service, as per ITU-T Y.1731. This architecture is based on a reference network model in which a customer subscribes a service offered by a service provider which in turn uses the network infrastructure of one or more operators.

The network model consists of:

Different administrative domains (a.k.a. OAM levels). Each administrative domain can be independently monitored by its own Ethernet Connectivity Fault Management (CFM) frames. The scope of OAM frames is limited to the domain in which the carried information is significant

Two planes: a “vertical plane” (red arrow) that represents the OAM entities across different administrative domains, and an “horizontal plane” (blue arrow) that represents the OAM entities within a single administrative domain.

Figure 5-20 OAM network model

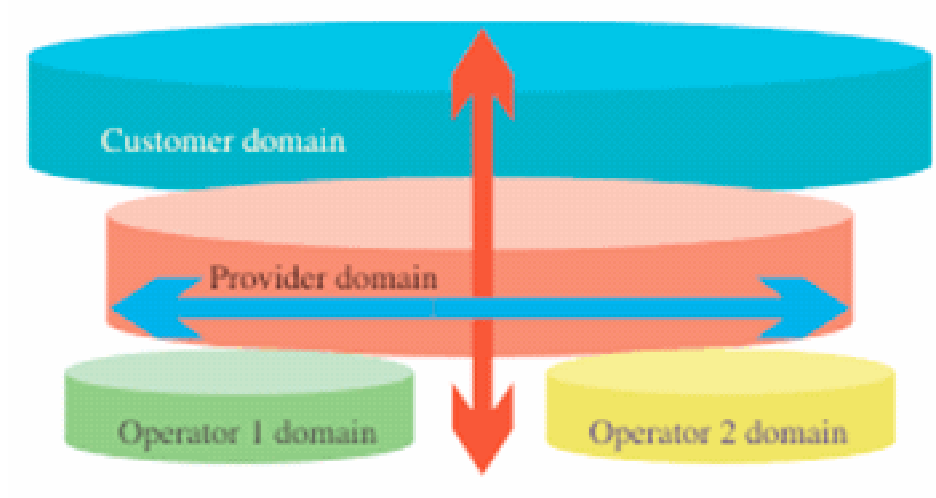


Figure 5-21 Ethernet OAM entities: vertical plane

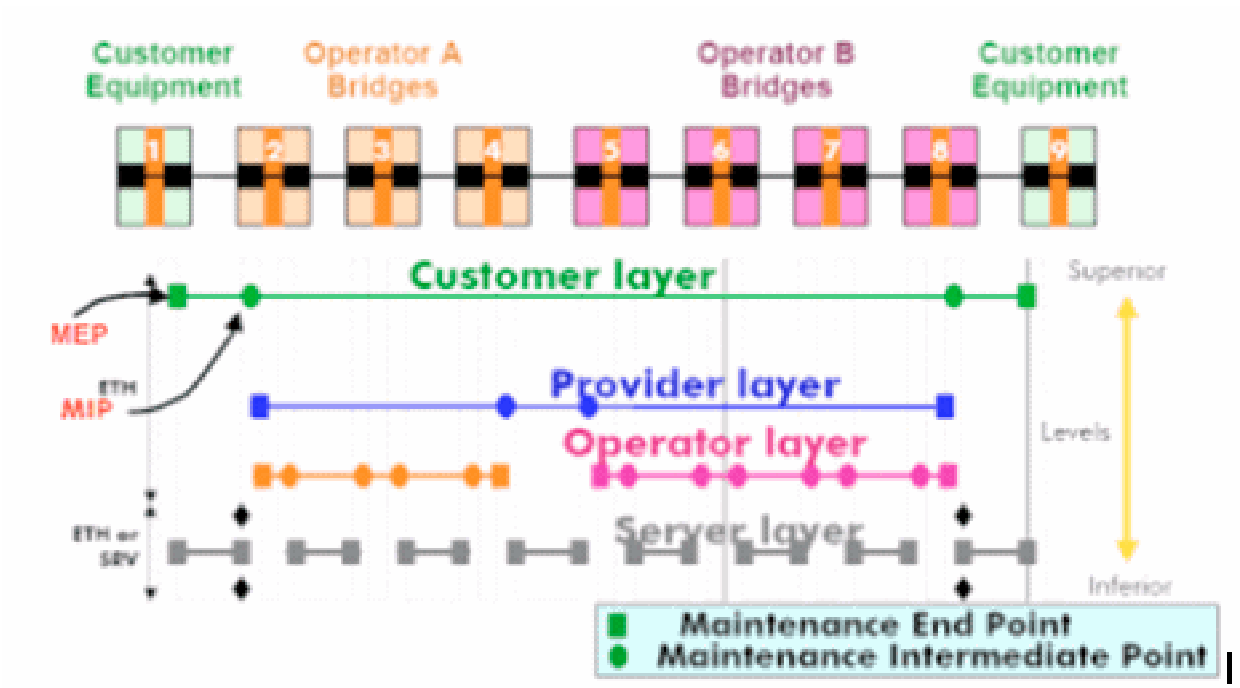
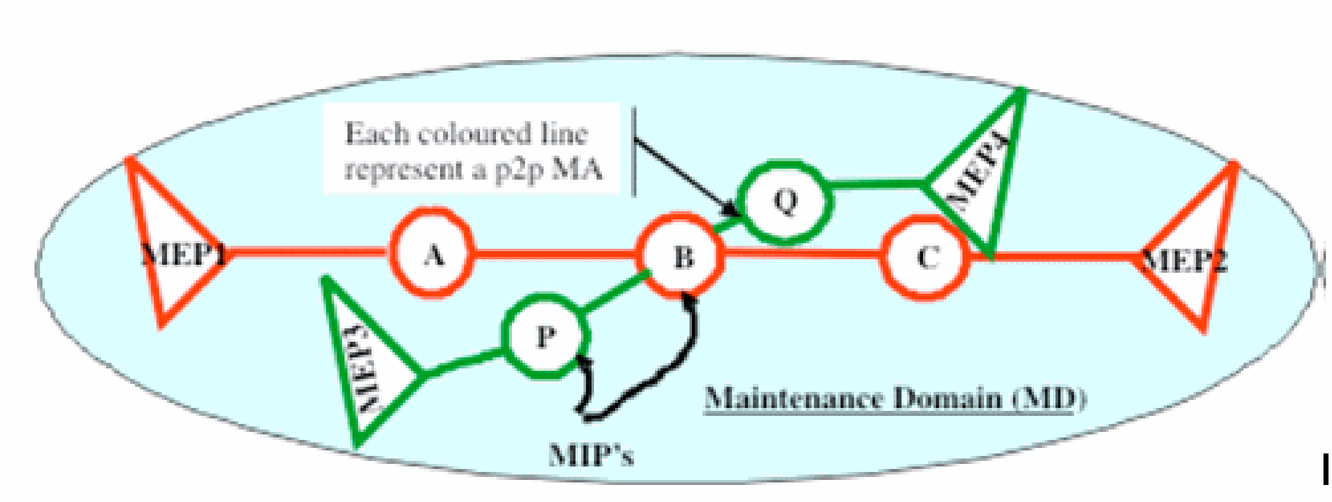


Figure 5-22 Ethernet OAM entities: horizontal plane



ETH OAM provides OAM frames to support CFM tools for connectivity and diagnostic purposes. The following CFM tools are provided:

- Ethernet Connectivity Check (ETH-CC)
- Ethernet Loop-back (ETH-LB)
- Ethernet Link Trace (ETH-LT)

Depending on notification type of monitoring action (autonomous or after request), CFM tools provide:

- “Proactive” monitoring (autonomous notification) for Connectivity Check tool
- “On demand” monitoring (notification after user request) for LB and LT tools

Ethernet OAM entities

The following ETH OAM entities can be provisioned:

- Maintenance Domain (MD): it defines the part of the network that provides Ethernet connectivity services to be monitored by ETH OAM tool. AMD can be either:

  A MST Region, identified by its MST Configuration Name

  A number of such MST regions, interconnected via CIST

  An entire Virtual Bridged LAN network

Each MD has a level (ME level: from 0 to 7) to accommodate different deployment scenarios, as per IEEE 802.1ag

- Maintenance Association (MA): it allows monitoring of a service instance, within a MD. Each MA inside the MD inherits its ME level. A Maintenance Association can encompass a set of MEPs to provide transmission, termination, processing of the ETH OAM frames. A point–to-point relationship between two MEPs is defined a Maintenance Entity (ME). A MA can monitor either a point-to-point or multipoint ETH connection.

  Note: In the ITU-T notation, MA is known as MEG (Maintenance Entity Group).
- Maintenance End Point (MEP): it is the object that performs the ETH OAM function, transmitting, receiving and processing the ETH OAM PDUs.

  MEP is an endpoint (e.g. sink/source) of a single MA corresponding to a certain service instance. It filters (discards) all frames with level lower than its own and ignore all frames with level high.

  MEP inside the MA has an unique ID (called MEPID). All the MEPs within an MA are configured with the same MAID and MD level. The system supports ETH OAM MEP at Service (Provider) and Operator maintenance level.
- Maintenance Intermediate End Point (MIP): it is an OAM intermediate entity which reacts and responds to OAM frames coming from MEPs, without generating them. MIP checks only the MD level and is automatically created above MEPs.

  Note: in Provider Bridge configuration, MIP can be created ONLY on bridge network ports; MIPs at UNI are not supported.

Ethernet Continuity Check messages (ETH-CC)

The system supports “proactive” ETH-CC: OAM monitoring of Ethernet service connectivity, providing configuration and activation of ETH OAM Continuity Check messages according to below Continuity Check transmission interval: 3.3ms, 10ms, 100ms, 1 sec(Default), 10 sec, 1 min, 10 min

Continuity Check protocol is used for fault detection purposes and to monitor the connectivity of a MA exchanging periodical CC messages (CCM). CCM are multicast periodically by every MEP inside a MD. CCM may operate on any service instance (either VLAN tagged or untagged frame).

The following list of detected defects and alarm causes are retrieved with CC notification:

- Loss of Continuity: DLOC (defect) -> cLOC alarm
- Mis-Merge Condition: dMMG (defect) -> cMMG alarm
- Unexpected MEG (MA) level: dUNL (defect) -> cUNL alarm
- Unexpected MEP id: dUNM (defect) -> cUNM alarm
- Unexpected Period: dUNP (defect) -> cUNP alarm
- Remote Defect Indication: dRDI (defect) -> cRDI alarm

Note: the above defects are filtered (discarded) in case of the following defect conditions: Ethernet Physical Interface defect; Underlying Resource Unavailable defect (URU); Traffic Disable defect

ETH Loop-back messages (ETH-LB)

The system supports “on demand” unicast ETH-LB function for OAM monitoring, so providing configuration and activation of ETH OAM Loop-back messages. This is a diagnostic tool, used for fault verification (e.g. a MEP fails to receive Cocoons) so allowing to verify the connectivity between MEPs and towards MIPs.

A Loop-back Message (LBM, a.k.a. ping) is a single unicast frame sent by a MEP to a specific MEP or MIP within the same MA. Loop-back frames operate on any service instance (either VLAN tagged or untagged frame).

ETH Link Trace messages (ETH-LT)

The system supports “on demand” ETH-LT for OAM monitoring, so providing configuration and activation of ETH OAM Link Trace messages. This is a diagnostic tool, used to keep path trace for a target MAC DA (like IP trace route). Its purposes are:

- fault isolation, e.g. to isolate a fault along the service path
- fault detection, e.g. to detect a connectivity failure
- trace routing, e.g. to discover the route of the service along the network

It traces a target MAC address, like an IP trace route. Link Trace Message (LTM) is a frame sent from a MEP to another MEP or MIP in the same Maintenance Domain (MD) using a set of reserved multicast MAC address.

IGMP

The IP packets can be transmitted in unicast (one sender to one receiver), broadcast (one sender to all receivers) or multicast (one sender to a group of receivers) inside a network.

Multicast transmission requires to provide traffic only to receivers which are interested in it. IGMP (Internet Group Multicast Protocol) is a L3 protocol defined by IETF for associating groups of IP multicast transmitters and receivers. It allows network devices to automatically handle IP multicast groups membership

Overtime the IETF has defined three versions of IGMP:

- IGMPv1 ([1]) is the original version of IGMP. It defines the join message that hosts use to join an IP multicast group, but it does not define a method for hosts to leave a multicast group. With IGMPv1, multicast routers must use a timeout mechanism to determine which hosts are still members of a group
- IGMPv2 ([2]) defines the leave message that hosts use to leave an IP multicast group. It reduces the time needed for multicast routers to learn that there are no more hosts of a particular group on an attached network
- IGMPv3 ([3]) adds support of "source filtering", that is the ability for a host to report interest in receiving packets 'only' from specific source addresses or 'all but' specific source addresses, which are sent to a particular multicast address.

As L3 protocol, IGMP applies to L3 IP networks allowing to efficiently deploying the IP Multicast traffic. It does not apply to L2 Ethernet switched networks. By default, an Ethernet switch treats the IP Multicast traffic in the same manner as broadcast traffic, i.e. by forwarding traffic received on one port to all other ports. This may create excessive traffic in the network and degrade the performance of hosts attached to the switches.

This problem is addressed by IGMP snooping functionality. It is a method by which an Ethernet switch can "listen in" IGMP conversation between routers and hosts.

When a switch hears a group join message from a host, it notes which port has heard the message and adds the group being queried to the group membership list of that port. Similarly, when a switch hears a group leave message from a host or a response timer expires, the switch will remove that group from the list.

As a result, IGMP Snooping requires that the Ethernet switch checks IGMP packets passing through it, picks out the group registration information and configures the multicasting accordingly. This allows the multicast traffic of a group to be forwarded only to ports that have behind members of that group, so efficiently using network bandwidth.

Only when provisioned as "VLAN-aware" Bridge (either Virtual or Provider bridge), is requested to support IGMP Snooping, recognizing below IGMP Messages addressed to IP multicast Group Destination Addresses:

- IGMP Membership Query [with default value=IGMP v2]
- IGMPv1 Membership Report
- IGMPv2 Membership Report

LPT

Refer to "LPT" (p. 5-14), same specification with Ethernet transparent transport.

ERP (Ethernet Ring Protection)

General requirements

P8FES (from Rel.2.2 onward and ONLY configured as Provider Bridge), is required to support Ethernet Ring Protection (ERP) mechanism as ETH Layer Protection Protocol, based on ITU-T G.8032.

ERP protocol, configured “on per ERP instance basis”, will be based on the following assignments:

- Either Per Port (backward compatible with ERP v.1)
- Or Per VLAN (Group) , i.e. on per VLAN basis

P8FES is requested to support multiple physical rings topology. P8FES is NOT requested to support sub-ring physical rings topology, and provisioning of Interconnection Node. P8FES shall accept physical port (ETH PHY), and VC Trunk port to be assigned as Ring Ports to a ERP Topology instance. P8FES don’t support LAG port as Ring Port. ONLY Provider Bridge NNI ports (Provider Bridge network side) are supported as Ring Ports..

ERP Ring ports have to be excluded from flat (per-port) RSTP/MSTP bridging protocols according to below behavior:

- per-port bridging protocols are allowed ONLY over those ports outside ERP Topology

As 1646 SM only supports per-port xSTP, it does not support per-vlan xSTP. If the customer migrate from xSTP to per-vlan ERP directly, those VLANs which not included in the protected VLAN list of pervlan ERP may be in danger of ‘loop’. In this case, the customer is responsible to prevent loop for the VLANS that are not protected by ERP.

ERP terms definition

The following ERP entities are defined for ERP processing:

- **Ethernet Ring**: A collection of nodes (Ethernet Ring Nodes) forming a closed loop whereby each node is connected (via 2 independent links) to two adjacent nodes participating in the same ring in a duplex mode. In multi-ring topology Ethernet Ring is known as Major-Ring.
- Ethernet Ring Link is bounded by two adjacent nodes and a port for a ring link is called a ring port.
- **Ethernet Ring Node**: A NE with 2 ring ports, implementing the following basic functions: o Forwarding of R-APS control traffic at the Ring Maintenance Entity group Level (MEL); o blocking and unblocking of traffic over the ring ports.
- **Ring Protection Link (RPL)**: It is the ring link which under normal conditions, that is, without any failure or request, is blocked (at one end or both ends) for traffic channel, to prevent the formation of loops.
- **RPL Owner Node**: It is an Ethernet Ring Node adjacent to the RPL that is responsible for blocking its end of the RPL under normal conditions.
- **RPL Node**: It is an Ethernet Ring Node with the same behavior of the previous one, except that it is not responsible for the reverting activation

Ring MEL: It is the Maintenance Entity Group (MEG) level providing a communication channel for ring automatic protection switching (R-APS) information.

Theory of operation

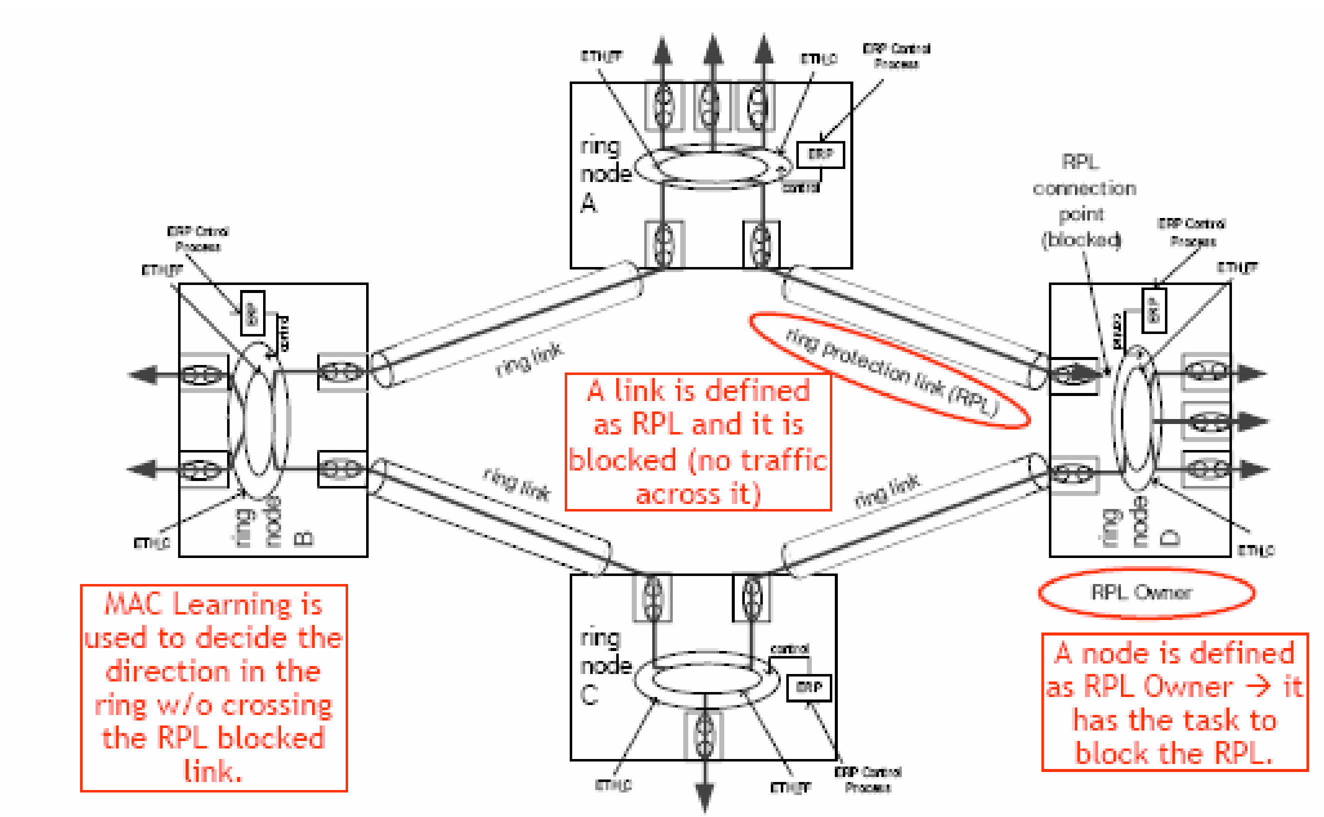
The fundamentals of this ring protection switching architecture are both the principle of loop avoidance and the utilization of learning, forwarding, and MAC address table flushing mechanisms.

Loop avoidance in the ring is achieved by guaranteeing that, at any time, traffic may flow on all but one of the ring links. This particular link is called the Ring Protection Link (RPL), and under normal conditions this link is blocked, i.e., not used for traffic.

One designated node, the RPL Owner, is responsible to block traffic over the RPL. Under a ring failure condition, the RPL Owner is responsible to unblock the RPL, allowing the RPL to be used for traffic. The other node adjacent to the RPL may also participate in blocking or unblocking its end of the RPL.

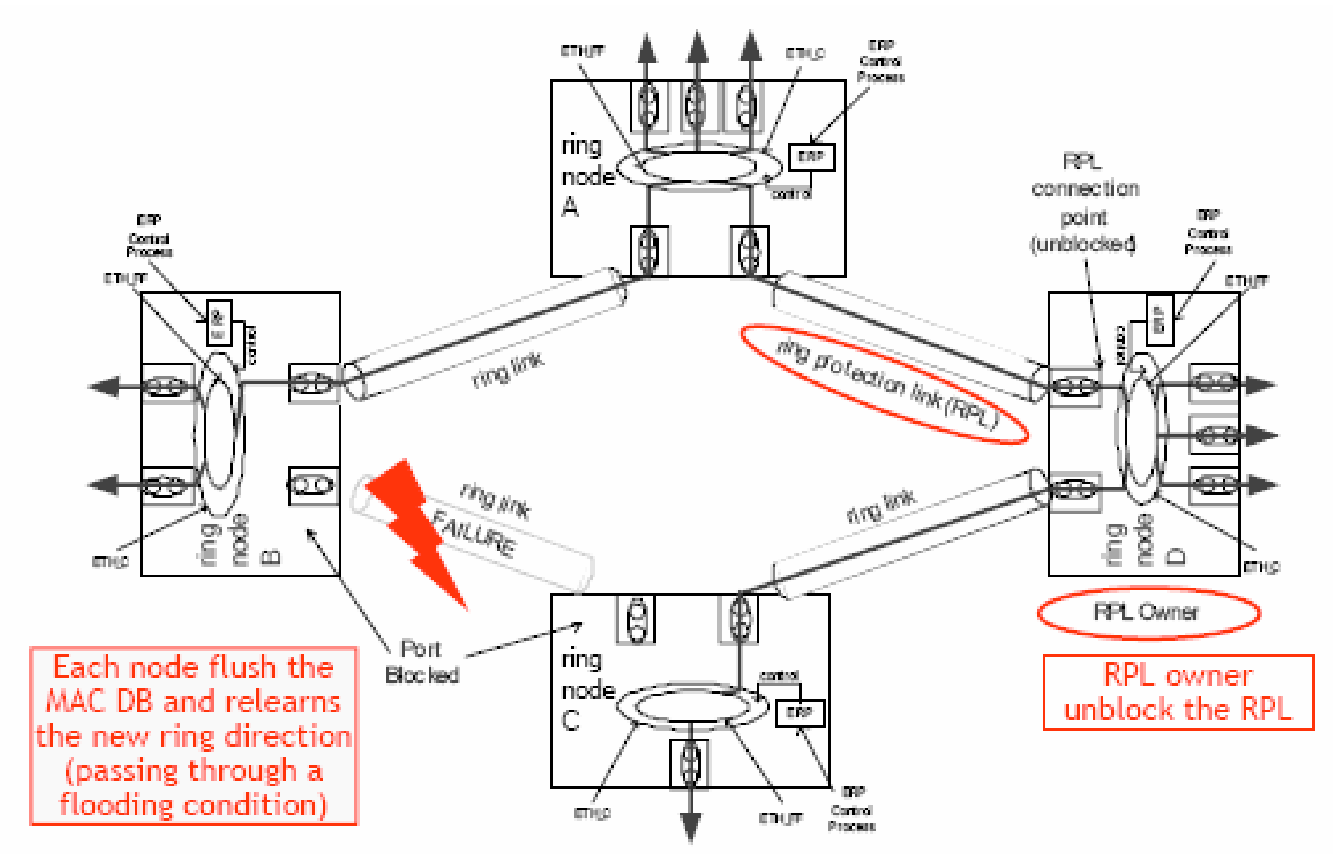
The event of a ring failure results in protection switching of the traffic on all ring nodes. An R-APS protocol is used to coordinate the protection actions over the ring, triggering a flush action on MAC learnt addresses. The R-APS protocol uses specific R-APS channel to carry ETH OAM R-APS PDU packets, with a dedicated VLAN ID in ETH OAM frame. The R-APS channel is blocked for those ports also in blocked state for data traffic.

Figure 5-23 ERP reference model (idle state)



The following figure shows the reference model for ERP ring when a failure condition is managed:

Figure 5-24 ERP reference model (failure state)



ERP configuration

P8FES is requested to configure ERP protocol (according to ITU-T G.8032 v. 2) on ERP instance basis over a physical ring topology, where ERP instance inherits the Ring Port(s) from the "ERP Topology" with which it is associated.

The user shall have the option to bind an Ethernet OAM Down MEP to a Ring Port, ONLY down MEP with 3.3ms inverval can be associated to ERP instance Ring Port, so supporting both:

- ERP Ring port Link monitoring

  Continuity Check packets are requested to be terminated on each Ring Port, supporting the reporting of Ethernet OAM CCM defects

- ERP switch trigger

The ERP protection mechanism can be triggered to switch on defects that are detected by a MEP that is assigned to a Ring Port. In this case the defects detected by the MEP processes are “added” to the defects that are directly detected on the physical port level. To enable this additional monitoring, one MEP can be selected on each Ring Port to supply the additional defects.

The VLAN ID of this down MEP should be the same VLAN ID that carries the R-APS PDUs. Note that in this case the MEL (Ethernet OAM Maintenance Level) to be assigned to the MEP needs to be lower than the MEL assigned to the ERP instance, otherwise the R-APS messages (which are a special kind of CFM PDUs) will be blocked by the MEP.

Protocol behavior control

The user shall have the option to read or provision:

- Wait-to-Restore Time (WTR) of an ERP instance. This parameter must be in the set { 0, 1, 2, .., 12 minutes}, with default value at 5 minutes. A value “infinite” (corresponding to “non revertive “switching behavior) is not requested to be supported
- Guard Timer of an ERP instance. This parameter must be in the range [10 - 2000 msec] with 10 msec steps. Default value is 500 msec
- Hold-off Timer of an ERP instance. This parameter must be in the range [0 - 10 sec], with 0.1 sec. steps.Default value is 0 sec
- This parameter [in the set { IncludeSD, ExcludeSD } - default is ExcludeSD] covers BOTH “GFP-based” dTSD (defect Trail Signal Degrade) and defect LAG Degrade

  P8FES do not support SD as trigger.
- Contribution of Ethernet OAM CCM defects to the switching criteria of an ERP instance. CCM defects are all either enabled or disabled. This parameter must be in the set {IncludeCCM, ExcludeCCM }, default is ExcludeCCM. In case of set IncludeCCM, also dUNP (Unexpected Period) is automatically included as additional switching criteria of an ERP instance.
- Forced Switch Administrative command, forcing a certain ERP port to be blocked, irrespective of the failed state of that port. Multiple simultaneous forced switches are allowed, allowing Forced Switch commands to be active on both ERP Ring Ports simultaneously.

The user will be denied to provision the following:

- The switching behavior of an ERP instance. Fixed value is “Revertive”.

  P8FES only supports “Revertive” mode; “Non-Revertive” mode is for future release.
- Protection administrative commands: P8FES only support clear, FS-w, FS-e. Manual switch is for future release.

ERP basic instance configuration

To avoid messages to "spill-over" from one ERP instance to another, each ERP instance that is active in a P8FES is requested to use a different Ring APS VID, provided this VID is not otherwise used, including any VID that is designated to carry management information.

P8FES shall automatically add the Ring Ports that are assigned to the ERP instance in the "port member set" of the provisioned Ring. uses the VLAN filtering mechanism to control the blocking / unblocking of Ring Ports.

An ERP instance can operate in two different ERP scope:

- "Per Port": the ERP instance will block all untagged traffic intending to ingress or egress a blocked port, when the attached link is selected by the protocol to be blocked. All VLANs that have registered on this port are (temporarily) removed from their "Active Port Member Set" until the port is unblocked again. Note that this does not prevent the local node to receive or transmit R-APS PDUs over a blocked port.
- "Per VLAN (group)": the ERP instance will only block the traffic of the VLANs in the group, including the Ring APS VID, by temporarily removing this port from their "Active Port Member Set" (untagged traffic shall not be affected by an ERP block) . Note that this does not prevent the local node to receive or transmit R-APS PDUs over a blocked port

In case simultaneously an ERP per Port and one or more ERP per VLAN instances are configured on a certain Ring, the ERP per Port instance protects only those VLANs that are not protected by any of the ERP per VLAN instances.

The assignment of a VLAN to an active ERP instance when operating in "Per VLAN" mode, shall always be accepted, on condition that the VLAN is not already assigned to another "Per VLAN" instance. It shall be allowed to assign a VLAN to a "Per VLAN" instance if it was up to that moment protected by a "Per Port" instance.

The removal of a VLAN from an ERP instance when operating in "Per VLAN" mode is always accepted. P8FES shall unblock any Ring Ports, which may have been blocked by the ERP instance that protected the VLAN at the moment of the removal. In case a "Per Port" instance is active on the same Ring Port, the traffic that belongs to the removed VLAN shall be protected by this ERP instance after removal from the "Per VLAN" instance. The provisioned port member set of the VLAN is not changed during this operation.

Performance objectives

P8FES shall support up to 8 ERP Topology (up to 8 rings per P8FES board) and up to 16 (TBD) ERP instances per board, up to 8 (TBD) ERP instances per topology.

P8FES shall be able to support up to 15 nodes per ring with 50 ms. of timing switchover for an ERP protection instance. This period includes FDB Flush time and shall be applicable for any single Signal Fail event. [However in this case the time to detect the failure and the Hold-Off Time is not included in the switch completion time.]

Ethernet 1:1 linear EVC protection (ELP)

General requirements

P8FES (from Rel.2.2 onward and ONLY configured as Provider Bridge), is required to support Ethernet Linear Protection (ELP) functions as per compliant to ITU-T G.8031.

The system is required to support the bidirectional 1:1 linear architecture only. The system shall only support revertive mode.

The system is NOT required to support Exercise request. The system is required to supports only SF as auto switching trigger, but SD is NOT supported in this release.

The system supports 1:1 Ethernet Linear Protection only on NIF Ethernet interfaces. The system shall support Ethernet bidirectional 1:1 linear protection in IVL learning mode.

The system shall support the 1-phase APS protocol with acknowledge.

The system supports 1:1 Ethernet Linear Protection only on default NIF interfaces, but NOT on LAG NIF ports.

ELP definition

1:1 architecture: normal traffic is transported either on the working transport entity or on the protection transport entity using a selector bridge at the source of the protected domain. At the sink of the protected domain the entity that carries the normal traffic is selected. Since source and sink bridge need to be coordinated, an APS protocol is necessary.If ETH-CC OAM packets are used to detect defects of the working and protection connection, they are inserted at both working and protection side. It should be noted that they should be sent regardless of whether the connection is selected by the selector or not.

End-to-end Switch time: 50 ms as a target time; It is Transfer Time (Tt) defined in ITU-T G.808.1. It excludes the detection time necessary to initiate the protection switch and the hold-off time.

Hold-off time: starts when a defect condition is declared and runs for a non-resettable period which is provisionable from 0 to 10 s in steps of 100 ms. When the timer expires, protection switching is initiated if a defect condition is still present at this point (defect not necessary present for the entire duration of the hold-off period, not necessary the same defect for all hold-off period).

APS (Automatic Protection Switching): protocol used to align both ends of the protected domain; it is required for bi-directional switching only.

1-phase APS protocol: when the communication between the two ends of the protected domain A and Z is only in one phase, from Z to A or A to Z.

Bi-directional switching type: both directions of the connection are switched to protection. APS protocol is required to coordinate the two endpoints.

Non-revertive: service will not be switched back to the working connection when the switch requests are terminated.

Revertive: service will always return to (or remain on) the working connection when the switch requests are terminated.

Clear: This command clears all the externally initiated switch commands.

Lockout of Protection (LO): This command fixes the selector position to the working connection. Prevents the selector from switching to the protection connection when it is selecting the working connection. Switches the selector from the protection to the working connection when it is selecting the protection connection.

Forced Switch (FS) normal traffic signal-to-protection: This command switches the selector from the working connection to the protection connection, unless a higher priority switch request (i.e., LO) is in effect.

Manual Switch (MS) normal traffic signal-to-protection: This command switches the selector from the working connection to the protection connection, unless an equal or higher priority switch request (i.e., LO, FS, SF or MS) is in effect.

Manual switch (MS-W) normal traffic signal to working:In the absence of a failure of a working or protection transport entity in non-revertive operation, forces normal traffic signal to be selected from the working transport entity.

Exercise signal: Exercise of the APS protocol. The signal is chosen so as not to modify the selector.

Exercise signal: normal traffic signal: this state is only applicable for the revertive mode and applies to a working connection. This state is entered by the local protection switching function when working traffic is being received via the protection connection and the working connection is restored. This is the case in which a local protection switching requests have been previously active and now become inactive; it maintains normal traffic signal selection from the protection transport entity until a Wait-to-Restore timer expires, preventing the reversion. This is used to prevent frequent operations in the case of intermittent failures.

No Request (NR): this state is entered by the local protection switching function under all conditions where no local protection switching requests (including Wait to Restore) are active.

Freeze: This is a local command, i.e. even when an APS protocol is supported, it is not signalled to the far end. This command freezes the state of the protection group. Condition changes and received APS information are ignored, unless the Freeze command is cleared.

Clear Freeze: This is a local command, i.e. even when an APS protocol is supported, it is not signalled to the far end. This command clears the local Freeze Command.

Lockout normal traffic signal from protection: This is a local command, i.e. even when an APS protocol is supported, it is not signalled to the far end. When this command is executed, any command for normal traffic signal will be rejected and any indication of SF (or SD if applicable) will be ignored unless the Lockout normal traffic signal from protection command is cleared.

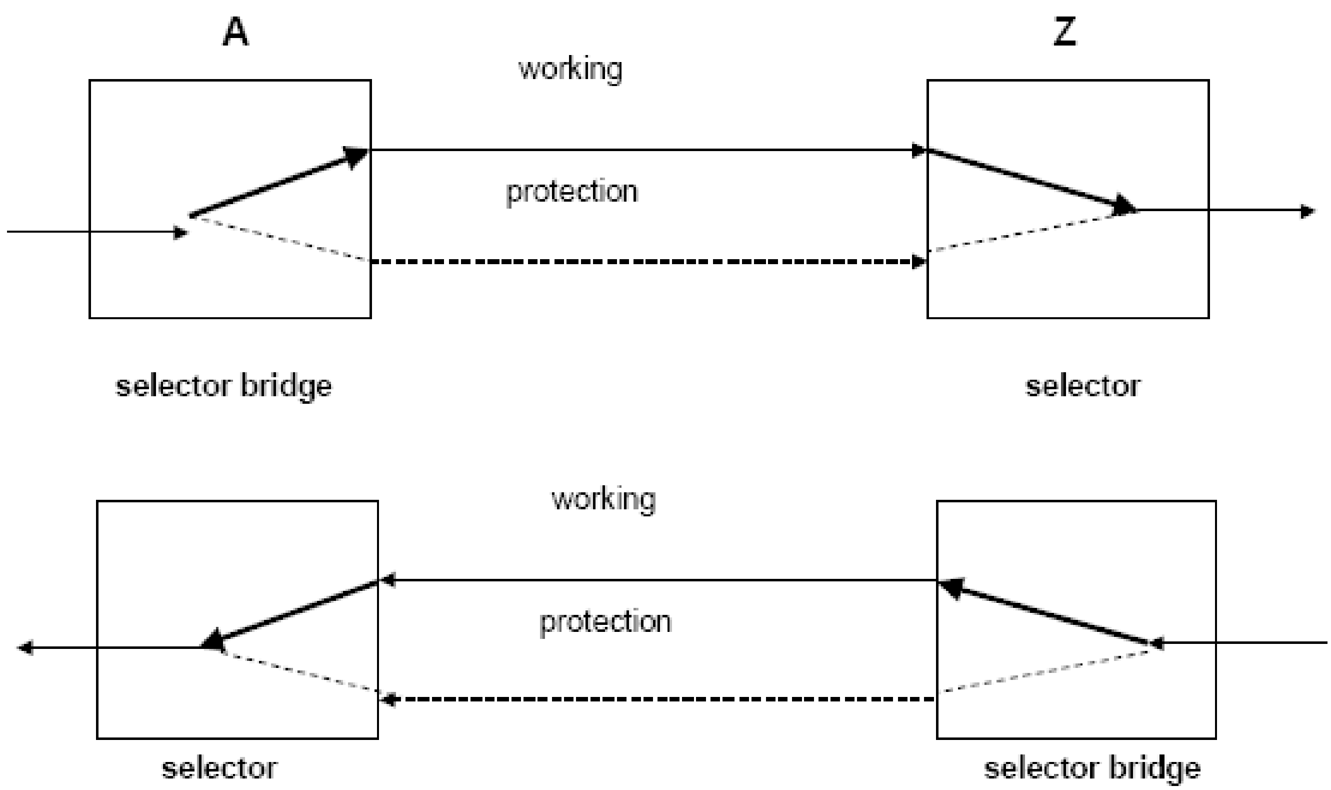
Clear Lockout normal traffic signal from protection: This is a local command, i.e. even when an APS protocol is supported, they are not signalled to the far end. This command clears the Lockout normal traffic signal from protection command.

Theory of operation

In the following the bidirectional 1:1 linear protection switching, using a 1-Phase APS protocol, is described.

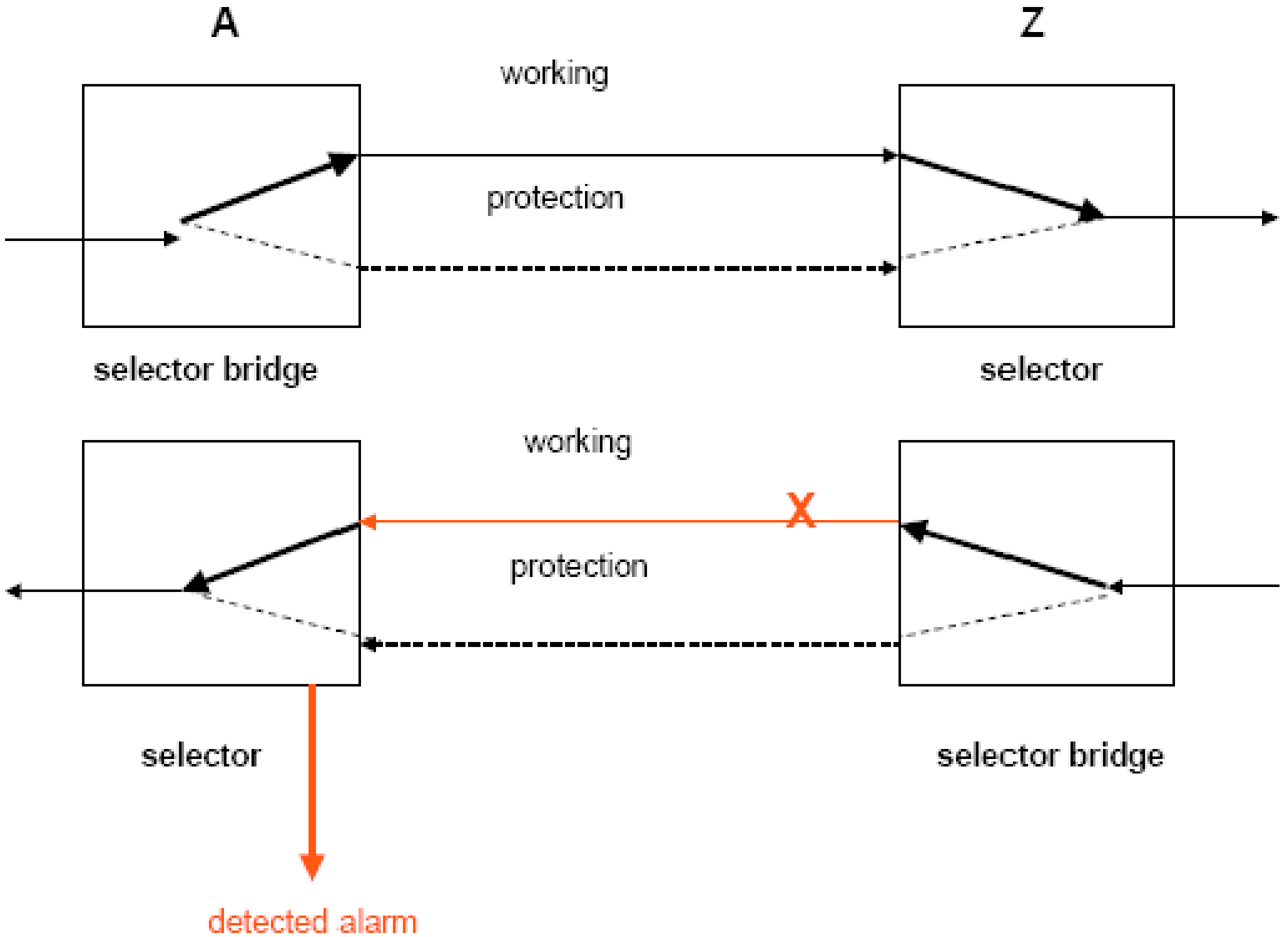
In normal condition, packets are sent on the working path on both directions, from A to Z and Z to A

Figure 5-25 Normal condition



A defect in the direction of transmission from node Z to node A occurs for the working connection Z-to-A, a defect is detected at the node A

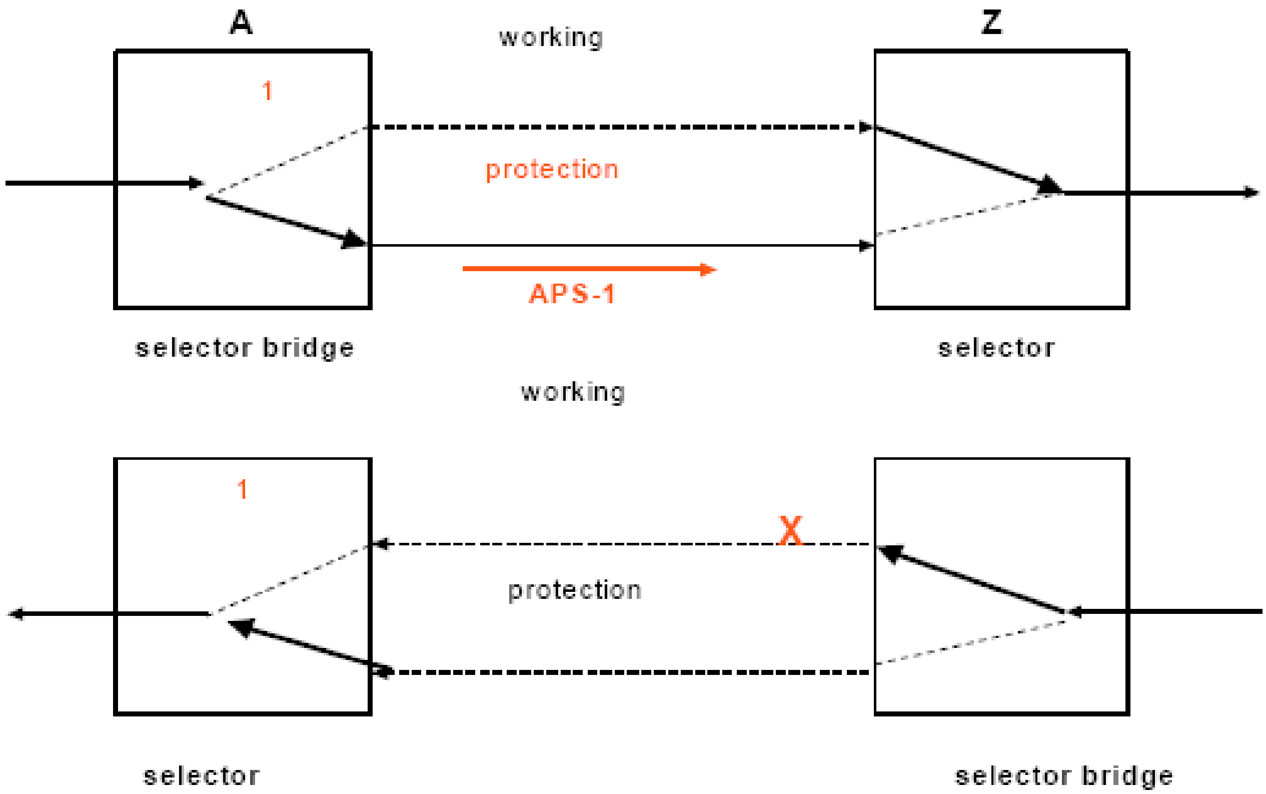
Figure 5-26 Defect detected on working connection Z-to-A



A 1-phase APS protocol initiates the protection switching: the selector bridge at node A is switched to protection connection A-to-Z and the selector at node A switches to protection connection Z to A.

The APS packet, sent from node A to node Z, requests a protection switch to node Z.

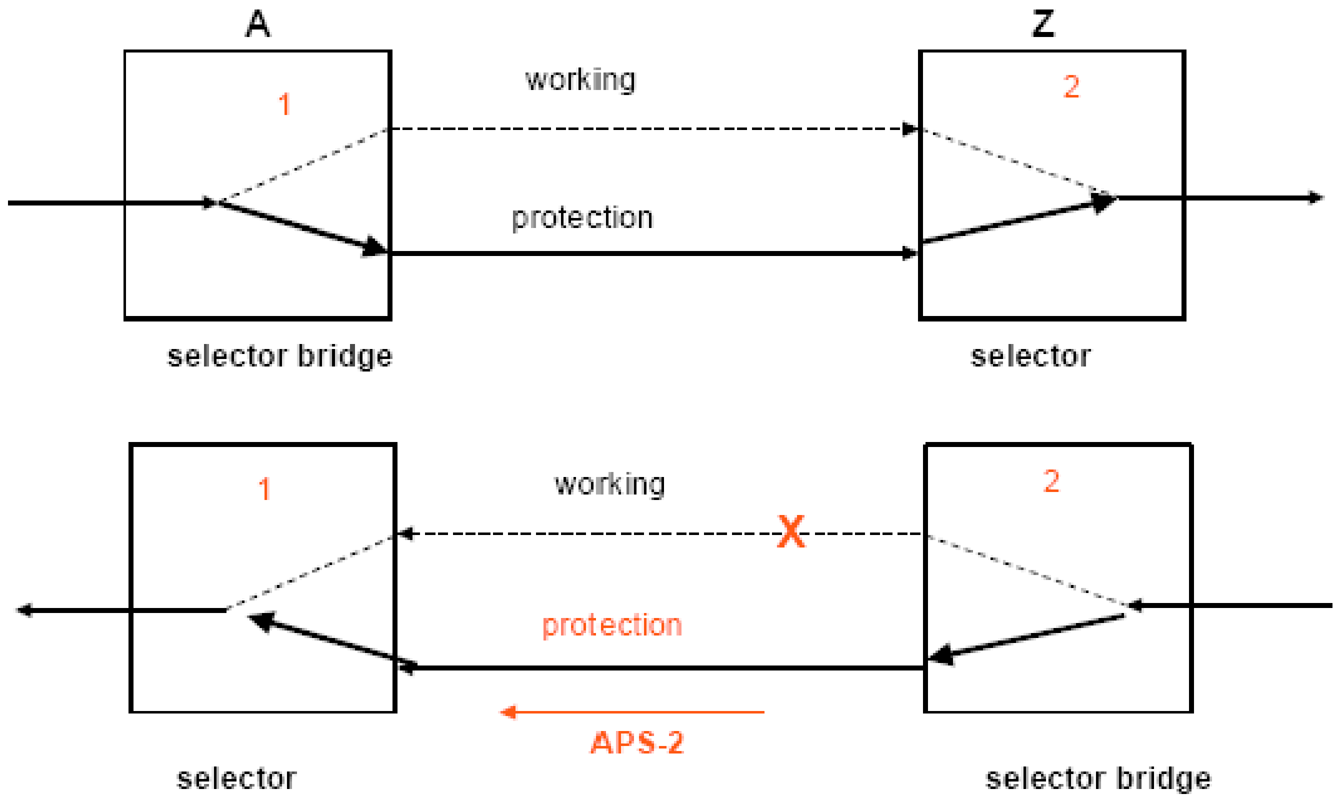
Figure 5-27 Switch at node A



After node Z validates the priority of the protection switch request, the selector at node Z is switched to protection connection A-to-Z and the selector bridge at the node Z is switched to protection connection Z to A.

The APS packet, sent from node Z to node A, is used as acknowledge, informing node A about the switching.

Figure 5-28 Switch at node Z



Performance objectives

The system shall support up to 40 ELP groups.

The system supports 50 ms as target value for the switching time. It is Transfer Time (Tt) defined in ITUT G.808.1. It excludes the detection time necessary to initiate the protection switch and the hold-off time.

Equipment and network protections

Overview

The following protection types are supported

- Equipment protection.
- Network protections:
  SDH protections:
  - 1+1 Linear APS (MSP, Multiplex Section Protection), single/dual ended (STM1/4/16)
  - SNCP/I, SNCP/N (Subnetwork Connection Protection), (VC12/VC3/VC4)
  - 2F MS-SPRING (2 Fibers Multiple Section Shared Protection), (STM16)
- DATA protections:
  - Rapid Spanning Tree Protocol (RSTP) (802.1D)
  - STP has the ability to prevent network loops within a bridged network
  - Link Aggregation Group (LAG) on UNIs, is able to group a set of Ethernet interfaces into one logical interface with greater capacity and reliability, providing link protection
  - Ethernet Linear and Ring Protection

Equipment protection

E1 EPS 1+1

1+1 equipment protection switching for the following E1 cards:

- PE1A
- PE1B

The following types of operator switching commands are supported:

- Lockout of Working/Protection, clear lockout of Working/Protection
- Forced switch to Working, Forced switch to Protection
- Manual switch to Working, Manual switch to Protection

The following operation types are supported:

- Revertive
- Non-Revertive

E1 EPS functionality is implemented by two kinds of E1 EPS box, E1A EPS (120 Ohm) and E1B EPS (75 Ohm).

For detailed information on E1 EPS BOX, refer to “E1 EPS BOX” (p. 6-39).

Network protections

SDH protections

- *Multiple Section linear trail Protection (MSP)*

  The characteristics parameters for MSP are listed in the following table:

Architecture type	1 + 1 MSP
Switching type	UNIDIR / BIDIR
Operation type	Non Revertive
WTR time	NA
HO time	Selectable
Switching time	< 50 ms
Signal switching criteria	SF, SD
External commands	all the operator commands as per G.841
Supported interfaces	STM-1 / STM-4 / STM-16

- *Subnetwork Protections (SNCP)*

  It is used on ring, linear and mesh network topology. Switching occurs on the path, selecting (Rx side) the signal transmitted to both Tx A and Tx B (A and B are two different directions) sides (see also “SNCP (SDH) protections” (p. 5-52)). The characteristic parameters are listed in the following table:

Architecture type	SNCP/I	SNCP/N
Switching type	UNIDIR, single ended	
Operation type	Revertive / Non Revertive	
WTR time	5 min fixed	
HO time	Selectable	
Switching time	< 50 ms	
Signal switching criteria	AU-AIS, AU-LOP	SSF, ExBER, TIM, UNEQ, SD
External commands	all the operator commands as per G.841	
Applied to	AU4/TU3/TU12	

- *Drop and Continue*

  It is an architecture to connect sub-networks, in order to improve traffic availability (see “MS SPRING Drop and Continue” (p. 5-55))

The standard Linear 1+1 MSP with K1-K2 protocol is compliant with ITU-T G.841.

Figure 5-29 Linear 1+1 single ended protection

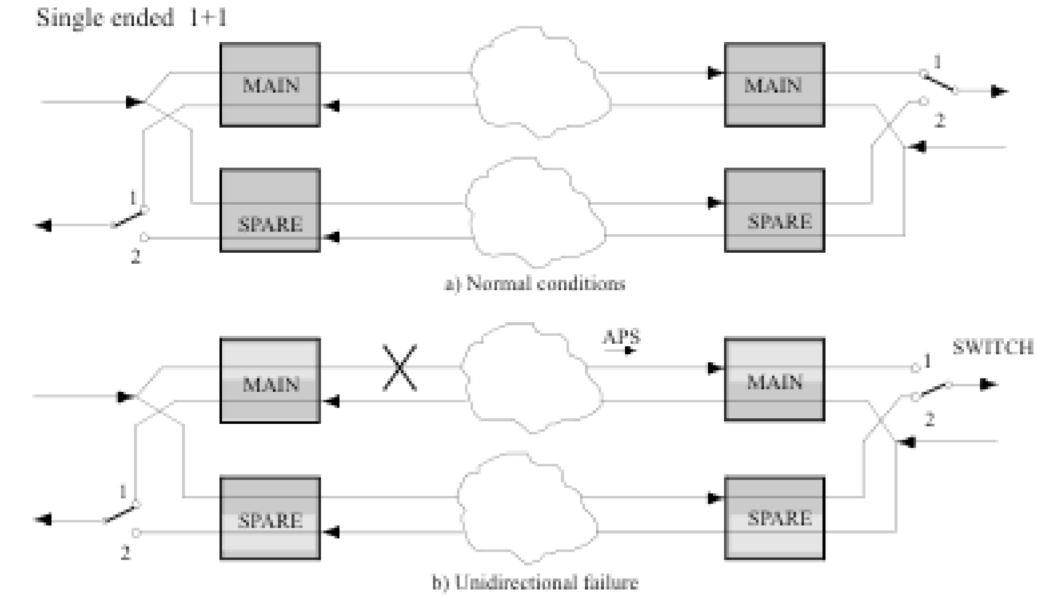
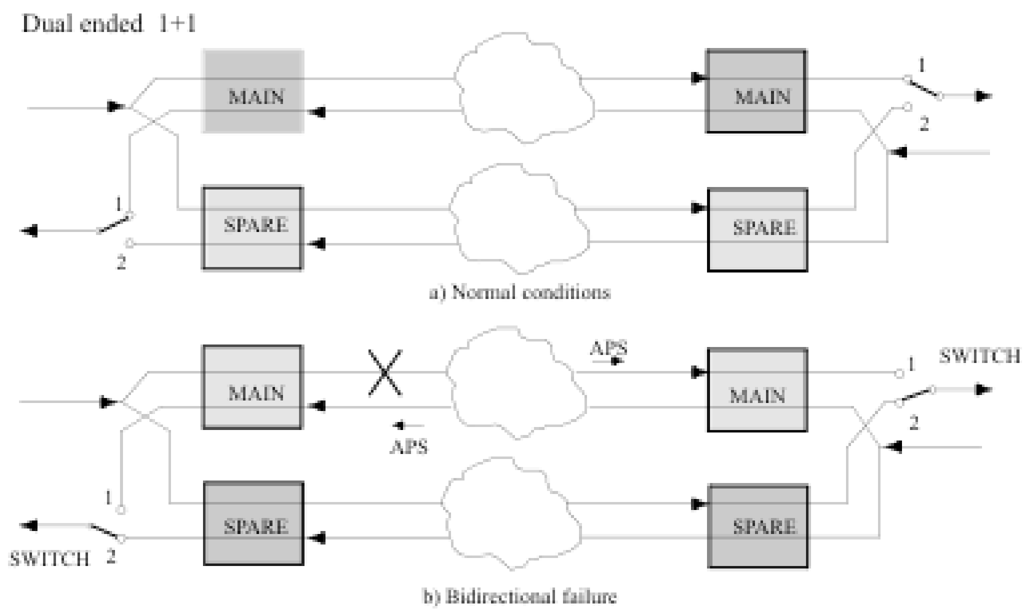


Figure 5-30 Linear 1+1 dual ended protection



Operator command are according to G.841 for SDH are supported:

- *Manual to protection*: to switch from protected (main resource) to protecting unit (Spare resource). This command is Y if no failure is present on protecting unit;
- *Force to protection*: to switch from protected (main resource) to protecting unit (Spare resource). This command is Y if no failure is present on protecting unit;
- *Lockout*: the protection is locked, the traffic is managed by protected unit independently of its status, in failure or not in failure;
- *Clear*: release command which is active;
- *Clear WTR*: supported;
- *Exercise*: not supported.

SNCP (SDH) protections

See Figure 5-31, “Typical ring network with SNCP” (p. 5-54) and Figure 5-32, “Failure examples in SNCP ring” (p. 5-55).

Sub-network Connection Protection (SNCP) in SDH networks are used to protect a path (Example: The portion where two separate path segments are available) or the full end-to-end path, that is HO/LO Path layer for SDH.

In both cases, the traffic is recovered through a 'dedicated' mechanism, where one 'protection' resource is used for protecting one 'working' resource (that is 1+1). As a consequence the traffic is bridged to both resources.

These protection types may be applied at any path layer in a layered network.

The protection switching occurs in 'unidirectional' (or 'single-ended') mode only, in this case only the 'Near End' defects/commands are taken into account for starting the protection activity independently at the two ends of the scheme. No APS protocol is needed.

In SDH technology, two possible types of SNCP are considered:

- SNCP/I (Inherent monitoring) protecting the traffic against failures that affects the 'server' layer; it switches on SSF criteria (AU-AIS and AU-LOP).
- SNCP/N (Non-intrusive monitoring) protecting traffic against failures that affects the 'server' layer and failures affecting the 'client' layer; POH is monitored by the POM enable before the matrix. The switches criteria are SSF and one or more of ExBER, TIM, UNEQ, SD; in this case the same selection must be made on each N.E. of the ring *(not operative in current release)*

In SDH the applicability of this method is, generically, addressed to 'Sub Network Connection' (SNC) and, then, the network topology may be ring, linear or meshed. In both technologies this path protection method is also used for protecting traffic to be connected across two rings (that is ring interworking).

As illustrated in the example shown in next Figure 5-31, "Typical ring network with SNCP" (p. 5-54) several equipment (numbered 1 to 5) are ring-connected on a looped path.

Each of the equipment on the node is bidirectionally connected (Side A and Side B). One of the two directions represents the main path (clockwise). The opposite direction will utilize a second fiber line for the spare traffic (counter clockwise).

The SNCP automatic protection intervenes upon detecting path failure (SSF).

Each transmitting signal node is permanently connected (bridge) in the main traffic direction (clockwise) and in the protected traffic direction (counter clockwise).

The Tx signal reaches destination through two different paths thus enabling the node receiving it to select the best one (switch).

The switching decision can be taken at the NE level (automatic switch) or at the OS level (management switch).

The example of Figure 5-31, "Typical ring network with SNCP" (p. 5-54) illustrates the connection between two signals (T1, between nodes 2 and 5 and T2 between nodes 1 and 4) and relevant input/output nodes with associated pass-through.

Figure 5-32, "Failure examples in SNCP ring" (p. 5-55) illustrates two examples of failures and subsequent SNCP switching mechanism.

A failure or degrade on the main path causes to switch over to the spare one.

When the receiving end switches no information is sent to the corresponding Tx side to activate the switching operation at the remote end ("Single ended" switching operation).

To manage switching the SNCP architecture utilizes the data inherent to the Path and not to the Line. Switching is in fact activated by defective operations occurring at the VCn levels (AU-AIS).

When the path is no longer available, an AIS signal is transmitted on the same path to activate protection.

In this manner SNCP/UPSR can protect the paths following cable break-down or failures along the fiber and nodes.

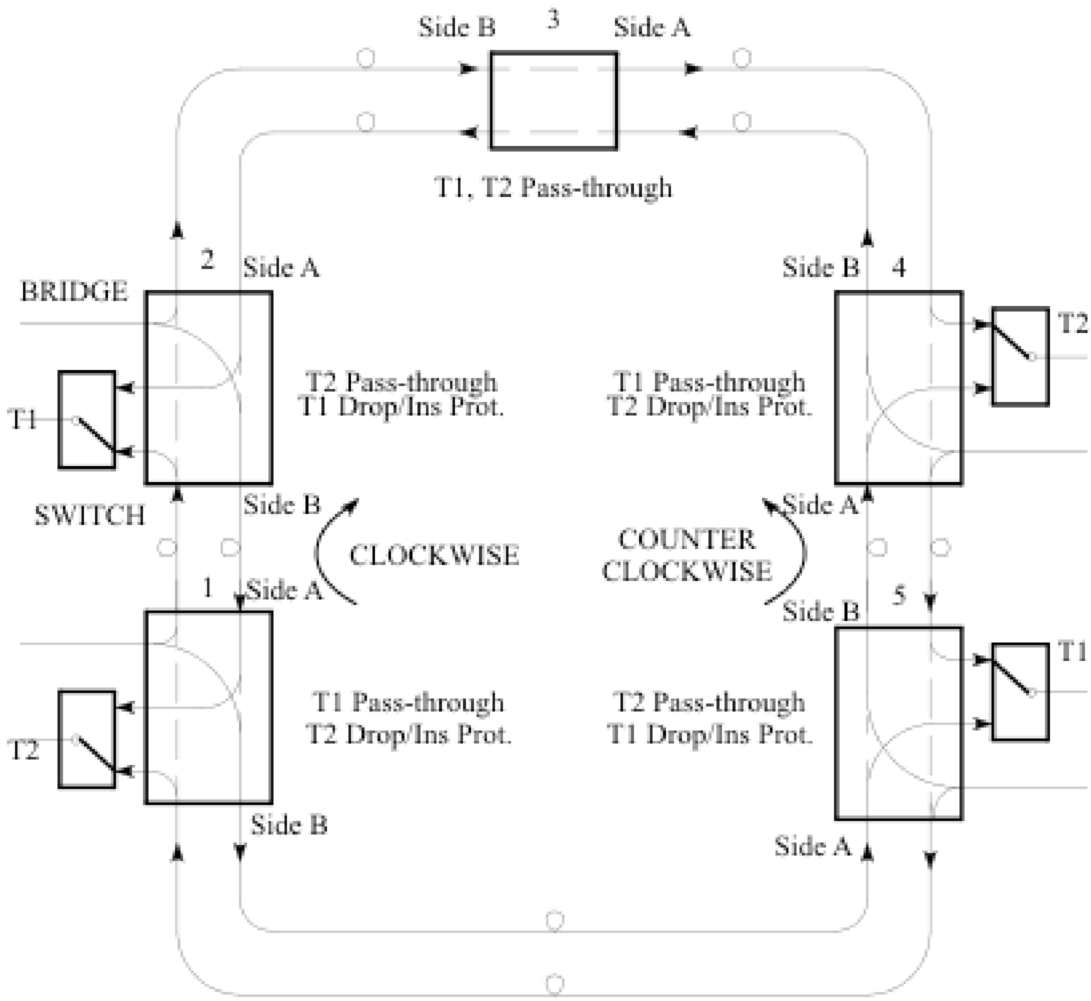
Cable break-down concerns all the fibers it contains hence it places traffic in both directions out-of-service, while a failure concerns only one fiber.

The units are provided with a path switching circuit (bridge + switch).

It is enabling depends on the equipment configuration.

With SNCP each working path has a dedicated protection path.

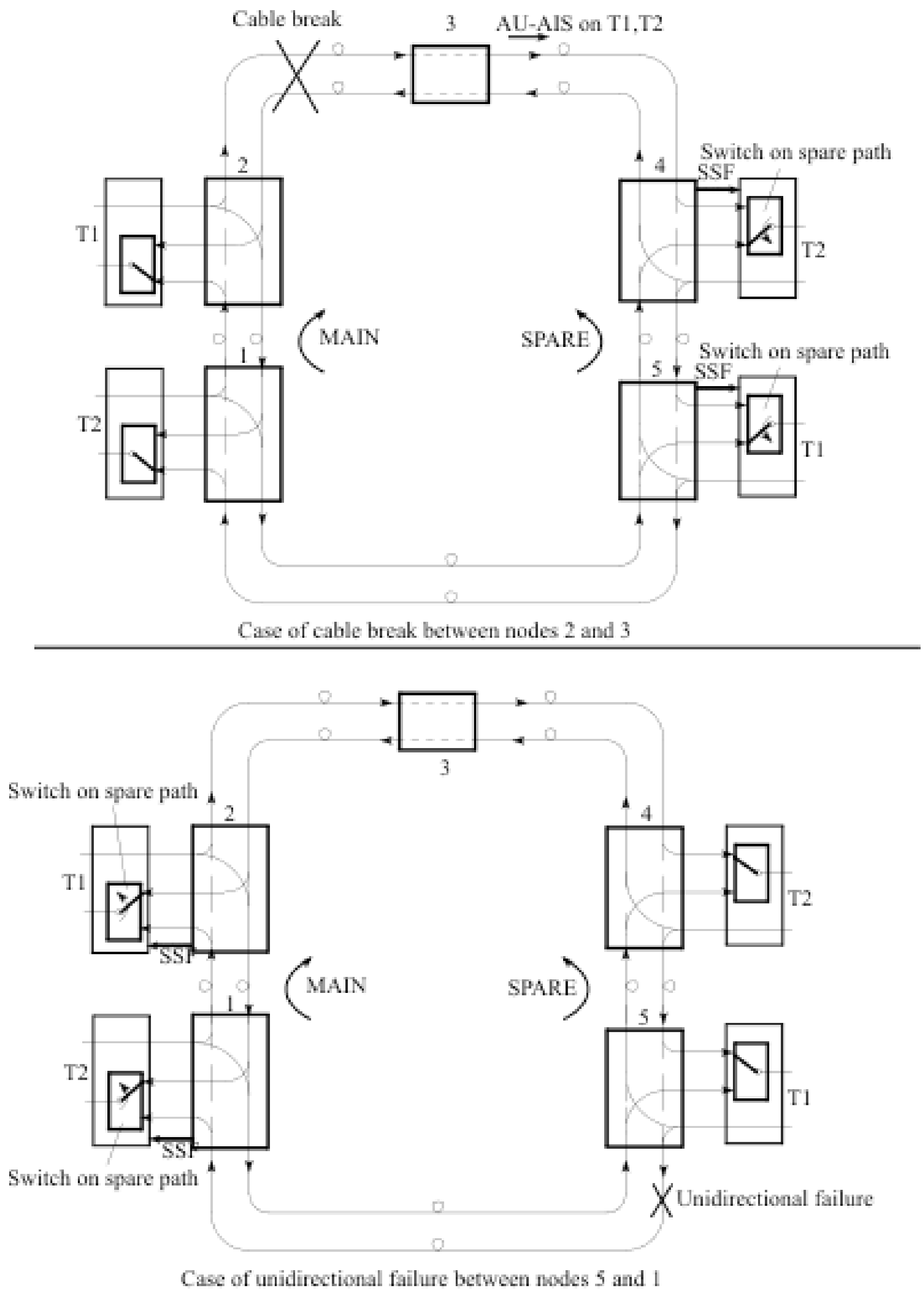
Figure 5-31 Typical ring network with SNCP



NOTES:
On Craft Terminal, the following terminology is used:

Pass-Through= Bidirectional Connection
Drop/Ins Prot.= Bidirectonal Protected Connection

Figure 5-32 Failure examples in SNCP ring



MS SPRING Drop and Continue

See Figure 5-37, "Drop and Continue - Node failure" (p. 5-60).

The Drop and Continue architecture has been implemented in the network to improve traffic availability.

Drop and Continue is a way of protecting a path crossing a number of sub-networks, for example rings.

The sub-networks should be connected through at least two nodes (so realizing two independent connections).

The equipment is configured as "DROP and CONTINUE" on each interconnection node.

The subnetworks equipment implement the connection between two SNCP / UPSR rings.

The resulting architecture affords protection against multiple failures (evenly distributed one per subnetwork) tolerated without traffic loss (node failure or single cable cut).

The Drop and Continue feature improves traffic availability as compared with the simple "end-to-end SNCP / UPSR". More subnetworks are connected the further is availability increased.

The Drop and Continue features simultaneously realizes the following on one node:

- unidirectional pass-through
- protected drop
- insertion in one direction

The achievable configurations are:

- D/C-A INS-A
- D/C-A INS-B

D/C stands for "Drop and Continue", the letter after it (A = line side" A") indicates the "drop" side (Example: "A" means "A main side", and consequently the spare side is the "B" one).

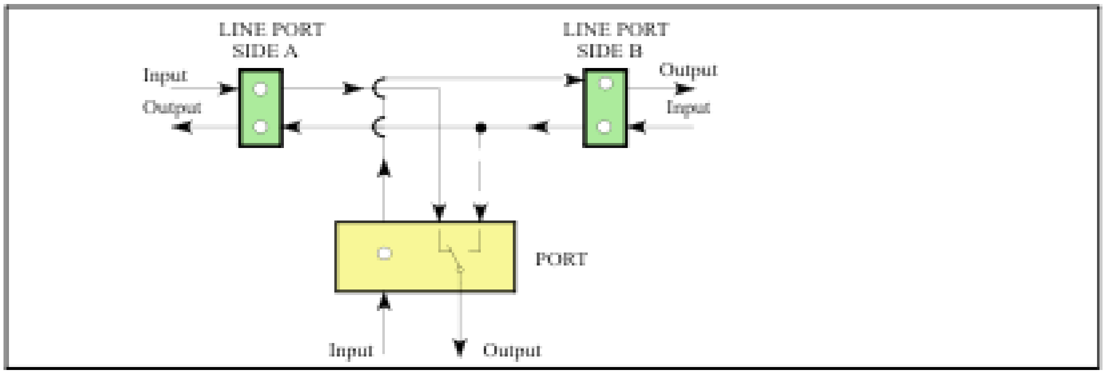
The end letter (INS-B or INS-A) indicates the insert side.

> **Note:** The letters A and B are not referred to a specific board or ports in a physical slot of the subrack; "A" and "B" are used in the figures of this paragraph to identify a Line direction.

The *Unidirectional pass-through* is always in the direction opposite to that of the *insert* side (Example: When *INS B* the pass-through is from B side to A side).

For further information refer to Figure 5-33, “Drop and Continue D/C A INS B” (p. 5-57) which shows the D/C-A INS-B configuration.

Figure 5-33 Drop and Continue D/C A INS B



The *Drop and Continue* featuring two connected SNCP rings (with dual node connection) is indicated in Figure 5-34, "Drop and Continue" (p. 5-58). It shows the connection of a path signal between the two nodes 1 and 8.

The relevant path signal is:

- connected in Drop and Continue (D/C A - INS A) in nodes 3, 4, 6 and 10.
- connected in pass-through in nodes 2, 5, 7, 9.
- connected in drop/ins protection in nodes 1, 8.

When in normal condition, the unidirectional way of traffic from 1 to 8 is supposed to be 1 ! 2 ! 3 ! 6 ! 7 ! 8.

After a failure on the 1st ring between nodes 2 and 3 (see Figure 5-35, "Drop and Continue - 1st failure" (p. 5-59)), the link direction is: 1 ! 5 ! 4 ! 3 ! 6 ! 7 ! 8, with a switch on node 3.

After a second failure on the 2nd ring between nodes 6 and 7 (see Figure 5-36, "Drop and Continue - 2nd failure" (p. 5-59)) the selected direction on the link is: 1 ! 5 ! 4 ! 10 ! 9 ! 8. The operative switch is on node 8 and the previous pass-through between nodes 4 and 3 is no more used.

Figure 5-34 Drop and Continue

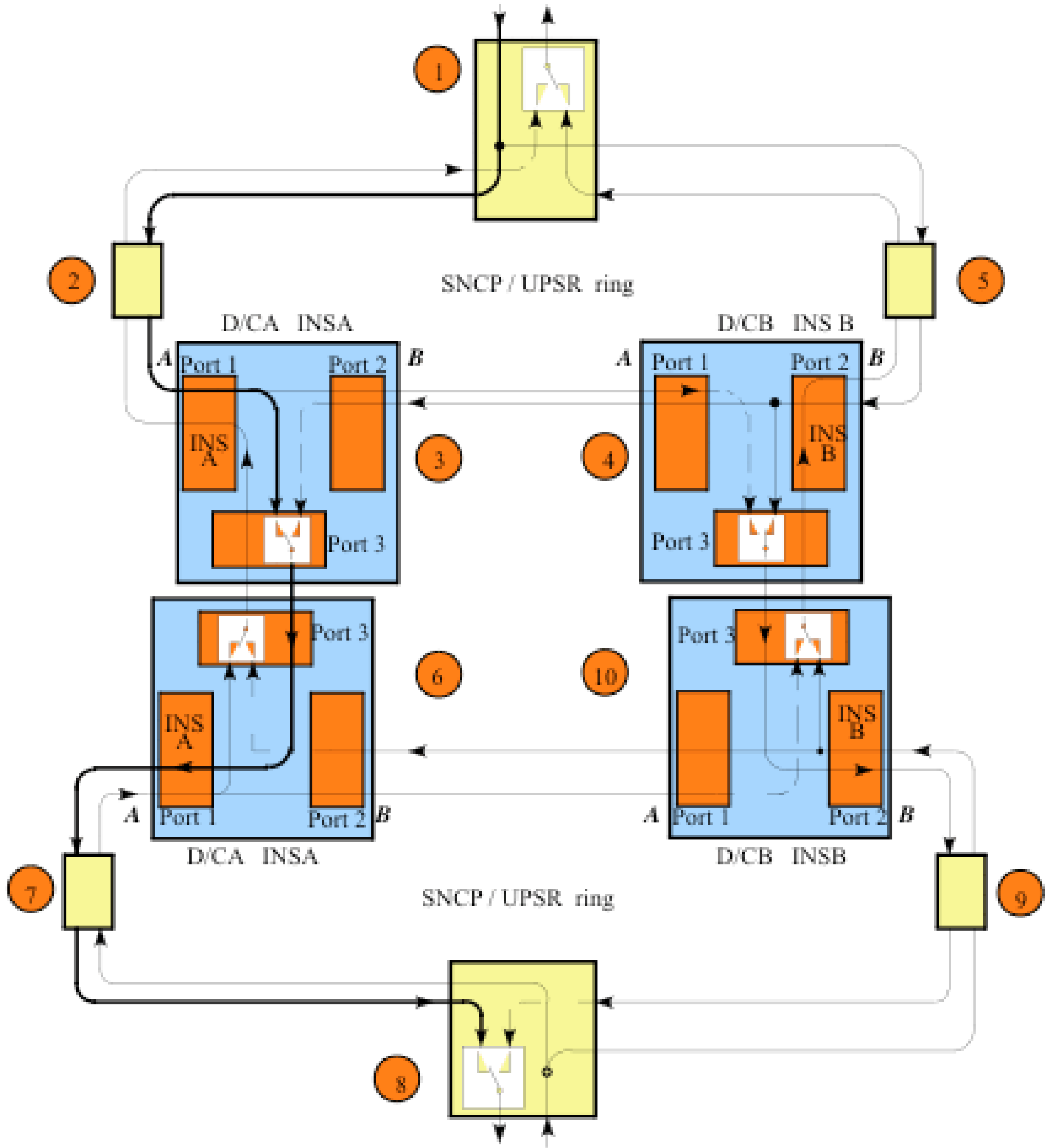


Figure 5-35 Drop and Continue - 1st failure

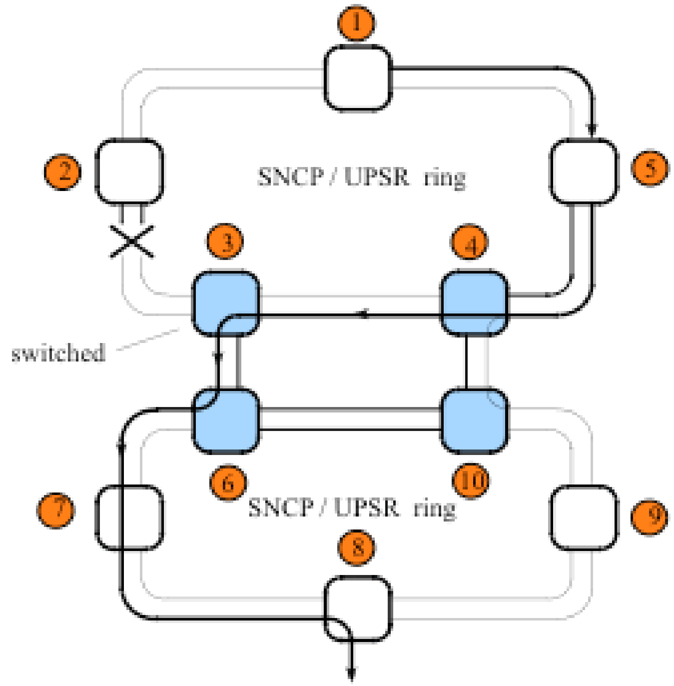


Figure 5-36 Drop and Continue - 2nd failure

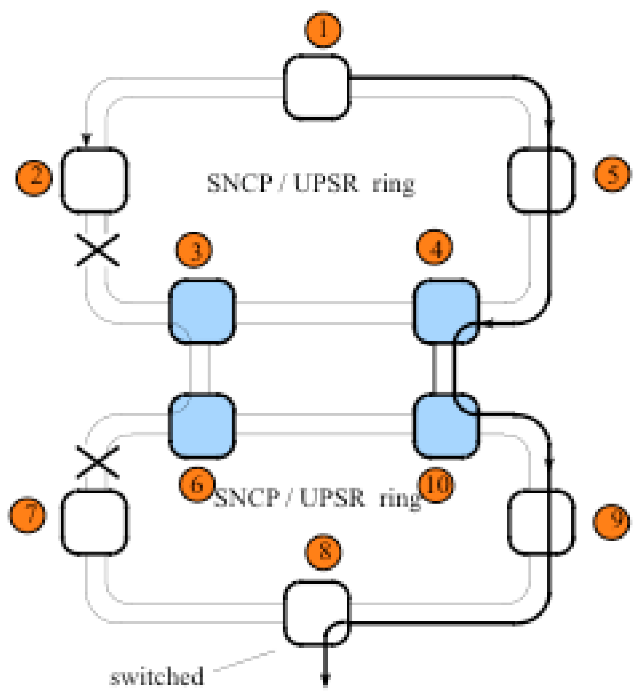
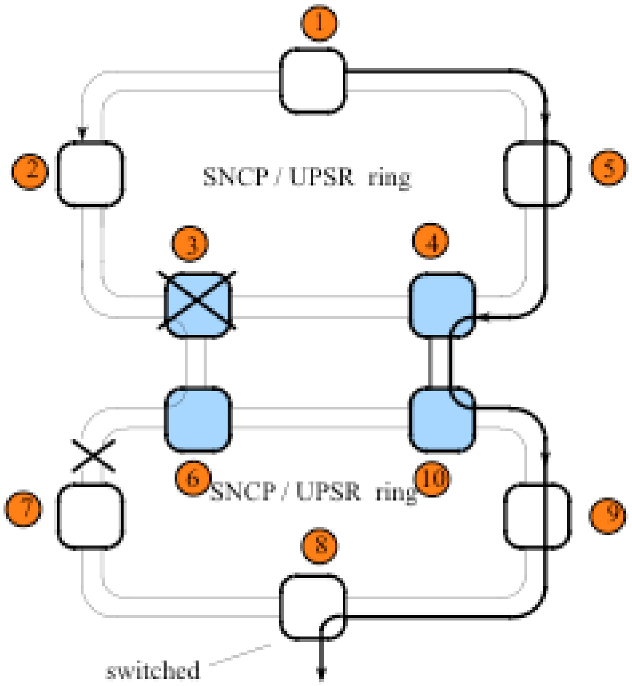


Figure 5-37 Drop and Continue - Node failure



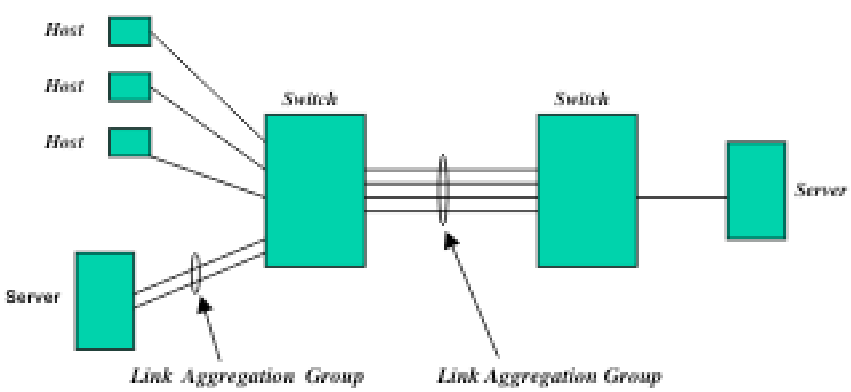
DATA protections

Link aggregation

The Link Aggregation function is an extension of the MAC layer in order to group a set of physical or logical Ethernet interfaces into one logical interface with greater capacity and reliability. The group (Link Aggregation Group or LAG) is valid only as a link between two systems (called the Partners). Grouping of more interfaces linking one system with two or more Partners is not allowed.

The following picture describes a typical network configuration for link aggregation:

Figure 5-38 Link Aggregation typical architecture



All kind of Ethernet interfaces can be aggregated, with the following constraint: all the interfaces belonging to the same LAG must be of the same data rate, according to IEEE802.3ad Rec.

It is possible to aggregate also logical Ethernet interfaces coming from VCG in SDH payload.

The Packet processor board must be configured as a bridge. A Port-to-Port configured board cannot support Link Aggregation.

In the Link Aggregation the concept of conversation is used, that is a flow of Ethernet frames which must maintain in receipt the same ordering they have on transmission. This constraint is achievable with a strict mapping between conversations and physical ports: each conversation has to be forwarded to a single physical port.

Each single physical port can be assigned to only one LAG, that is there could not be an overlapping between LAG's and each LAG's a unique MAC address is assigned. To assign the MAC to a LAG the common pool of 128 MAC of the T-BUS is used. Every single port belonging to a LAG maintains their MAC address

To avoid possible issues, the transmission of packets received by a port in a LAG towards other ports of the same LAG must be prohibited; in this case the packet must be discarded. It also applies in case of multicast/broadcast packets or when packets are flooded.

Spanning tree protocol

Refer to Figure 5-39, “Example of Spanning Tree Protocol function (STP)” (p. 5-64).

The *Spanning Tree Protocol (STP)* is a link management protocol that provides path redundancy while preventing undesirable loops in the network. For an Ethernet network to function properly, only one active path can exist between two stations.

Multiple active paths between stations cause loops in the network. If a loop exists in the network topology, the potential exists for duplication of messages. When loops occur, some switches see stations appear on both sides of the switch. This condition confuses the forwarding algorithm and allows duplicate frames to be forwarded.

To provide path redundancy, Spanning-Tree Protocol defines a tree that spans all switches in an extended network. Spanning-Tree Protocol forces certain redundant data paths into a standby (blocked) state. If one network segment in the Spanning-Tree Protocol becomes unreachable, or if Spanning-Tree Protocol costs change, the spanning-tree algorithm reconfigures the spanning-tree topology and reestablishes the link by activating the standby path.

Spanning-Tree Protocol operation is transparent to end stations, which are unaware whether they are connected to a single LAN segment or a switched LAN of multiple segments.

All switches in an extended LAN participating in Spanning Tree Protocol gather information on other switches in the network through an exchange of data messages. These messages are Bridge protocol data units (BPDUs).

The Spanning Tree Protocol root switch is the logical center of the spanning-tree topology in a switched network. All paths that are not needed to reach the root switch from anywhere in the switched network are placed in Spanning Tree Protocol backup mode.

BPDUs contain information about the transmitting switch and its ports, including switch and port Media Access Control (MAC) addresses, switch priority, port priority, and port cost. The Spanning-Tree Protocol uses this information to elect the root switch and root port for the switched network, as well as the root port and designated port for each switched segment.

The stable active topology of a switched network is determined by:

- the unique switch identifier (MAC address) associated with each switch
- the path cost to the root associated with each switch port
- the port identifier (MAC address) associated with each switch port.

Each configuration BPDU contains the following minimal information:

- the unique identifier of the switch that the transmitting switch believes to be the root switch
- the cost of the path to the root from the transmitting port
- the identifier of the transmitting port.

The switch sends configuration BPDUs to communicate and compute the spanning-tree topology. A MAC frame conveying a BPDU sends the switch group address to the destination address field. All switches connected to the LAN on which the frame is transmitted receive the BPDU. BPDUs are not directly forwarded by the switch, but the information contained in the frame can be used to calculate a BPDU by the receiving switch, and, if the topology changes, instigate a BPDU transmission.

A BPDU exchange results in the following:

- one switch is elected as the root switch
- the shortest distance to the root switch is calculated for each switch
- a designated switch is selected. This is the switch closest to the root switch through which frames will be forwarded to the root
- a port for each switch is selected: it provides the best path from the switch to the root switch
- ports included in the Spanning-Tree Protocol are selected.

Summarizing, STP accomplishes network resilience against STP failures recovering network connectivity in case of link failures, if the bridged network is redundantly protected (that is by electing a new Root Bridge, if the actual one is failed or by deactivating a failed link and activating a backup one, if existing) and "breaks" all the loops of the network, allowing only one path from a Bridge to any other Bridge, in order to prevent "infinite loops" (infinite replying of the frames) due to redundantly connected bridges network.

STP is compliant with 802.1d, 802.1q, 802.1ad.

The *RSTP* (Rapid STP) takes advantage of point-to-point wiring and provides rapid convergence (rapid recovery of connectivity following the failure of a switch, a switch port, or a LAN) of the spanning tree, accomplishing reconfiguration of the spanning tree in less than 1 second.

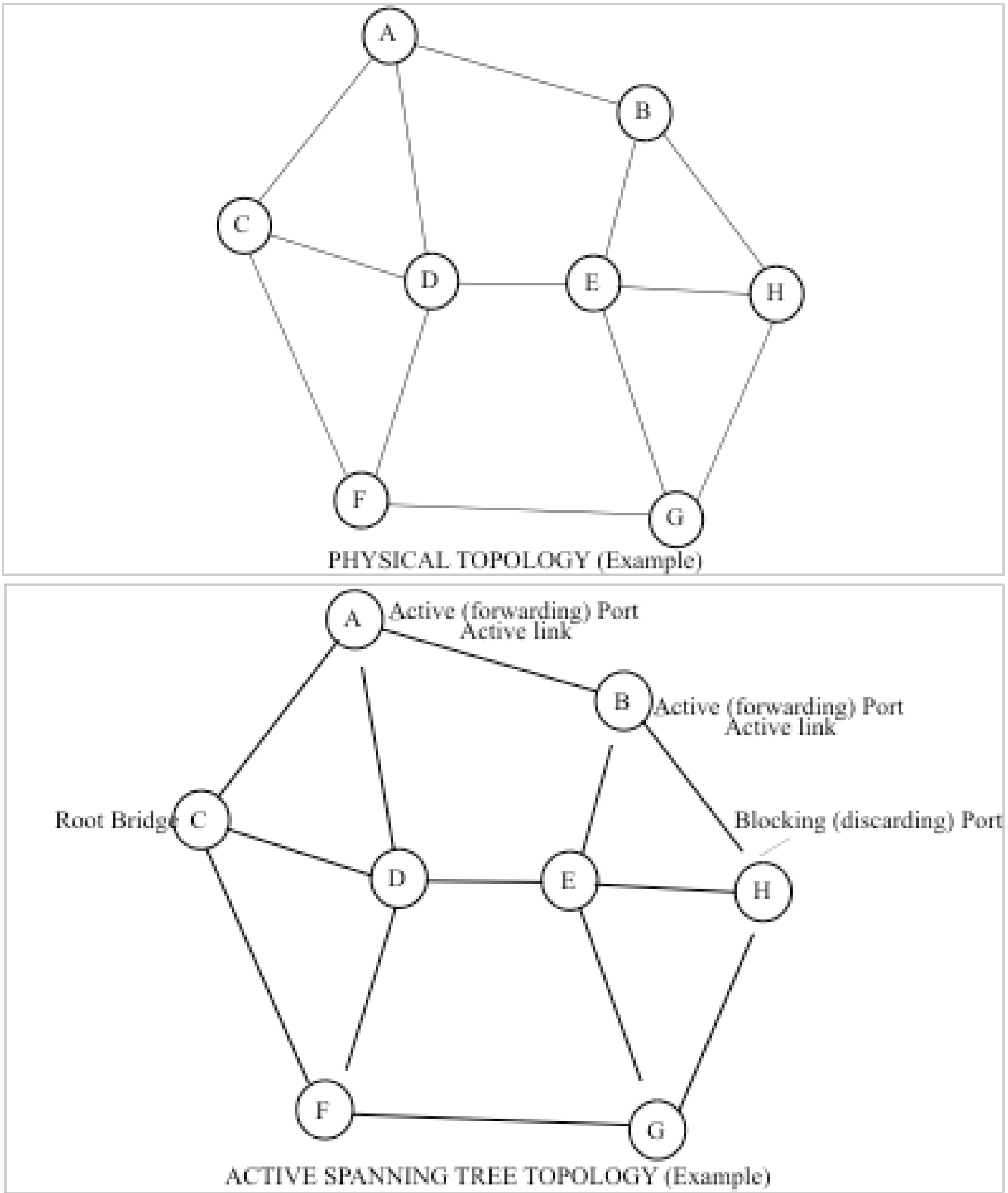
The RSTP provides rapid convergence of the spanning tree by assigning port roles and by determining the active topology. The RSTP builds upon the IEEE 802.1D STP to select the switch with the highest switch priority as the root switch. Then the RSTP assigns one of these port roles to individual ports:

- Root port - provides the best path (lowest cost) when the switch forwards packets to the root switch.
- Designated port - connects to the designated switch, which incurs the lowest path cost when forwarding packets from that LAN to the root switch. The port through which the designated switch is attached to the LAN is called the designated port.
- Alternate port - offers an alternate path toward the root switch to that provided by the current root port
- Backup port - acts as a backup for the path provided by a designated port toward the leaves of the spanning tree. A backup port can exist only when two ports are connected together in a loopback by a point-to-point link or when a switch has two or more connections to a shared LAN segment.
- Disabled port - has no role within the operation of the spanning tree.

A port with the root or a designated port role is included in the active topology. A port with the alternate or backup port role is excluded from the active topology.

In a stable topology with consistent port roles throughout the network, the RSTP ensures that every root port and designated port immediately transition to the forwarding state while all alternate and backup ports are always in the discarding state (equivalent to blocking in 802.1D).

Figure 5-39 Example of Spanning Tree Protocol function (STP)



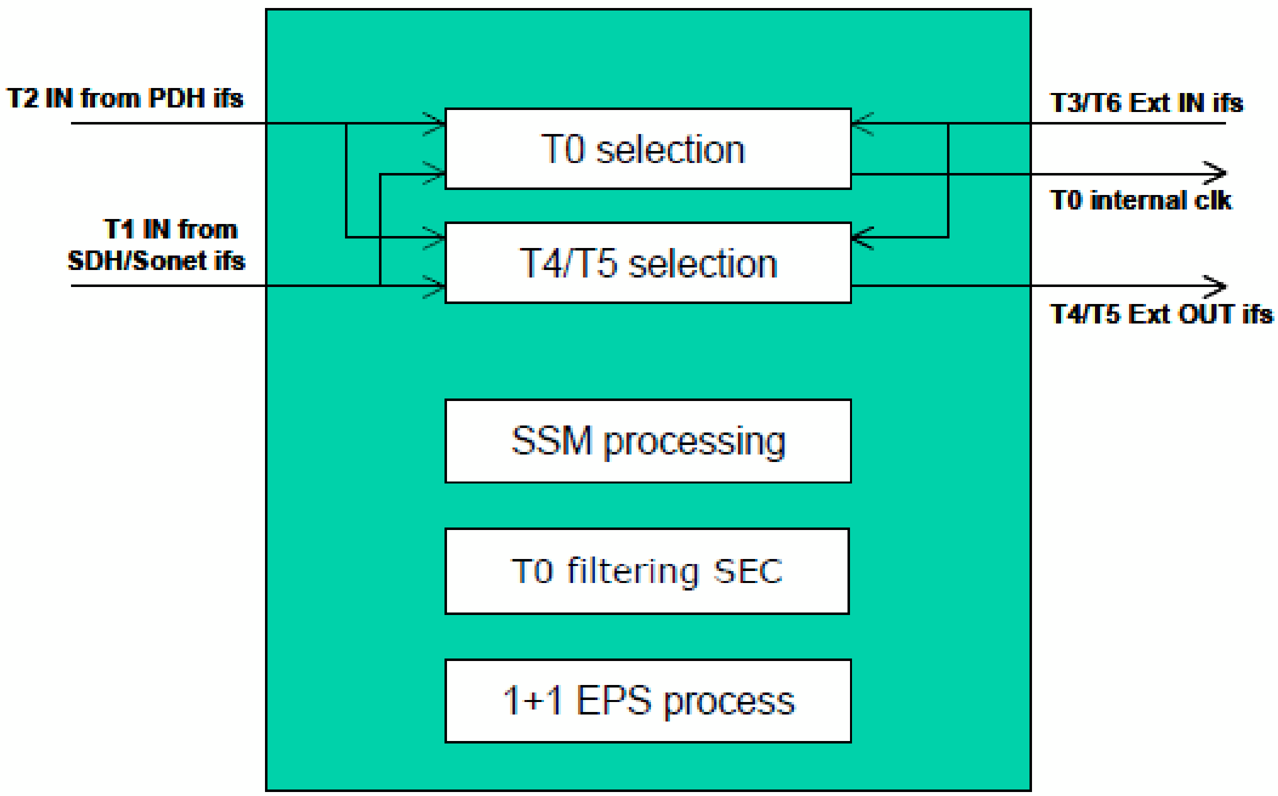
Synchronization

Synchronization architecture

The equipment Clock Reference Generator (CRG) function is located on MB16 or MB16 A/B, supported internal Oscillator G.813 Opt 1 (SEC quality).

The main processes by which the clock reference function is made up, are summarized as follows:

Figure 5-40 Synchronization main processes

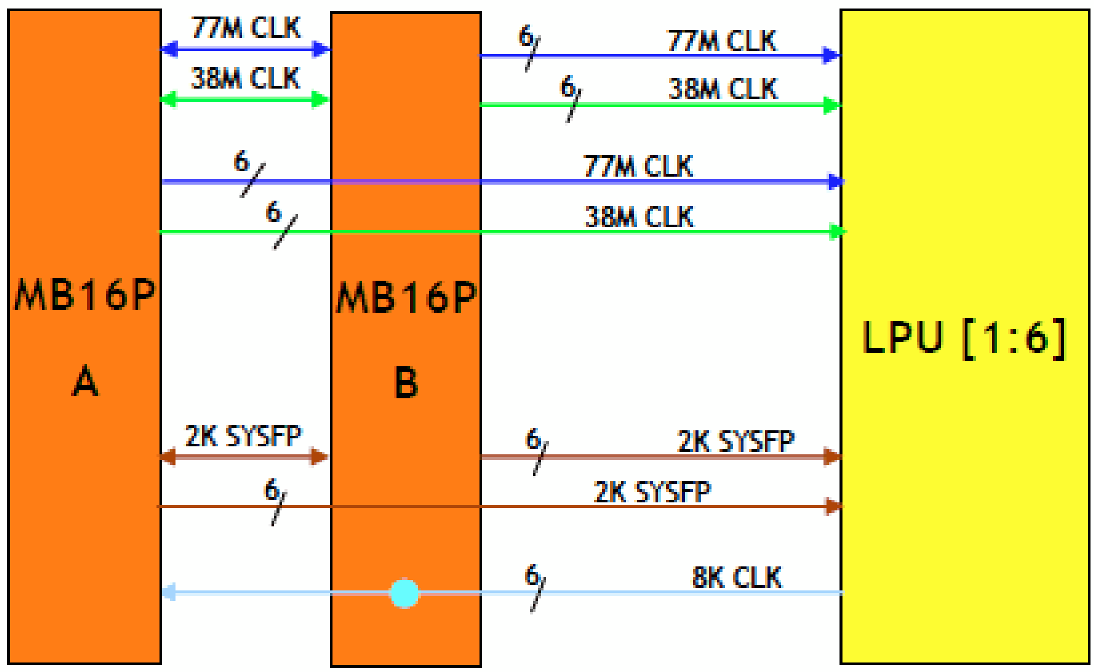


Synchronization link on BP

Among two MB16 (A/B) and six LPU on 1646SM, synchronization links includes:

- System clock includes two types: 38.88MHz and 77.76MHz, point-to-point structure
- System Frame Pulse: 2K SYSFP, point-to-point structure
- System clock source: 8K CLK, line clock reference for system clock. At the same time, this signal is also LPU online signal, so this clock has to be always available, even if line clock loss.

Figure 5-41 Synchronization Link on 1646SM



CRG function

System clock and frame pulse are provided by CRG block of MB16P. CRG selects clock reference from SDH line interfaces(T1), PDH interfaces(T2) and 2M external timing interfaces(T3/T6), then generates synchronization system clock(T0) and 2M external timing output(T4/T5).

For 1646SM, there are two MB16P, which Fabric are working in 1+1 hot backup mode. So normally, Active and Standby CRG will lock to the same clock reference to guarantee that both CRG output same frequency system clock. And also phase alignment for both CRG are required.

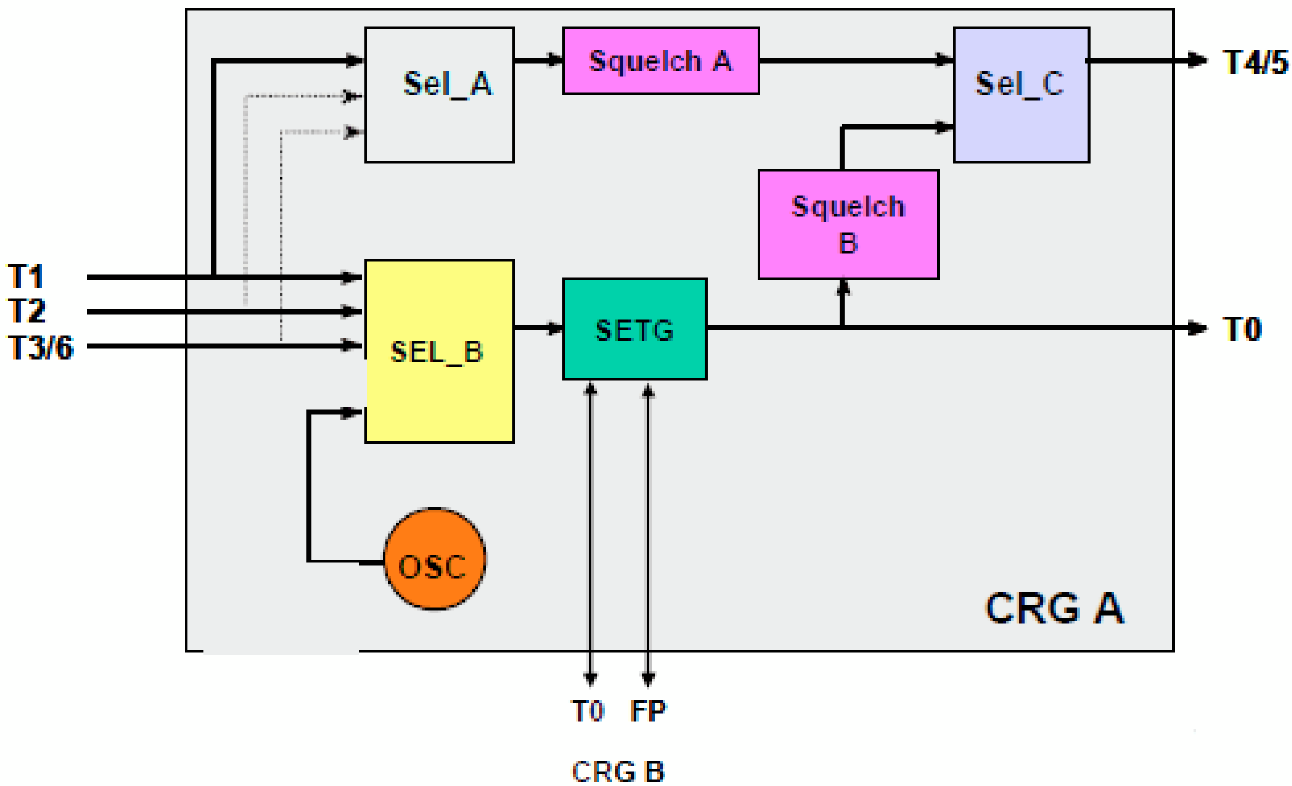
The equipment Clock Reference Generator (CRG) function includes an internal oscillator and two synchronous timing generators one for the internal clock (T0) and another one for the station output clock (T4/T6).

The active CRG, for instance CRG A , provides the internal equipment master clock (T0) to every card in the system which can be phase locked to different synchronization sources as determined by T0 selection process; when no valid synch inputs are available the CRG will run in free-running or holdover mode. Furthermore the CRG can provide a redundant output reference clock to an external timing generator as determined by T4/T5 selection process.

The selectors SEL_A and SEL_B controlling the synchronization sources for the equipment internal clock (T0) and for the generated output reference clock (T4/T5) are controlled by processes fully independent.

In any operation mode (i.e. locked, holdover and free-running) the stand-by CRG, for instance CRG B, is phase locked to same synchronization source selected by the active one (CRG A in the example); both CRG receive the same reference sources. To guarantee the hitless switching between the two CRG on manual command1, not only the clock but also the sync pulse generator of the slave copy (CRG B in the example) is kept aligned with sync pulse generator of CRG copy A acting as master.

Figure 5-42 CRG function view



Synchronization sources

The T0 clock selector SEL_B selects one reference synchronization source from a number of signals derived from SDH/PDH signals and/or from external reference (station) synchronization signals:

1. T3/T6 clock:

For 1646SM, two external 2Mhz (T3) or 2Mbit/s (T6) input clocks from SERVICE card are supported and there is a option to choose only one to CRG. SERVICE can be inserted into any LPU slot.

2. Up to 8 recovered clock from traffic interfaces (T1 and/or T2) for 1646SM. Each LPU slot has one 8K clock wire to main-board, which comes from optical or electrical interface of any SDH and PDH port card.

   T1 : STM-N transport signals carry (in addition to the payload) reference timing information and the indication of the quality level of the source generating this timing information, via S1 byte as defined in Rec ITU-T G.707

   T2: 2Mbit/s or 1.5Mbit/s transport signal may carry (in addition to the payload) reference timing information and the indication of the quality level of the source generating this timing information through San bits as defined in Rec ITU-T G.704.

   Note: Only port 1 and 17 can be assigned to the timing reference, if port type is PDH port.

3. Local and remote oscillators (OSC) clocks.

   The local oscillator clock is connected to the local SETG.

Output clock generation T4/T5

T4/T5 can be 2Mhz without SSM information (T4) or 2Mbit/s with SSM information (T5) output references. The T4/T5 clock selector (SEL_A) will receive the same references defined for T0 generation with the exception of the remote T0 clock; this distribution is in line with ITU-T G.781 (in old ITU-T G.783 versions just T1 was required as synch source for SEL_A).

Note: ITU-T G.781 allows the use of the station clock input as a source for the station clock output, either directly or via SETG block according to SEL_A and SEL_C configuration. This functionality is intended just for timing quality monitoring purposes and not as normal operation mode.

Output clock squelching

Purpose of the *squelch* function after SEL_A is the qualification process for the timing output; the output is silenced (fix output level for T4 or AIS activation for T5) to prevent transmission of a timing signal failed or having a quality (SSM) worse than a provisioned threshold. This is useful for instance in ADM with SSU configuration.

Operating mode

Three modes of operation of SETG function are provided:

- Free running mode : it is a temporary operating mode entered when the clock has never acquired the lock to an external timing reference (e.g. at system startup), or has not access to the stored data acquired during previous lock state. The SETG output timing is totally internally controlled and determined by the internal oscillator quality having a frequency accuracy of better than ±4.6ppm as required by G.813 Opt 1

When Active SETG is in free running mode, Standby SETG switches to lock Active SETG T0 clock, instead of others reference clock, so that to make sure T0 frequency alignment. Phase alignment module still works.

- Locked mode (steady state) : the SETG generated clock signal is controlled by the selected external timing reference determined by the T0 selection process; the output clock is traceable to the selected input frequency over long term and the phase difference between the input and output is bounded. The “holdover memory” is acquired and periodically updated (acquiring holdover memory is a temporary mode entered when coming from free run state), short term stability as required by G.813 Opt 1

  Both SETG lock to same reference clock to make sure same frequency on Active/Standby T0. At same time standby SETG do phase detection on both T0 and sends result to control module to eliminate phase difference.

- Holdover mode (steady state) : SETG has lost its controlling external timing reference, and is using stored data, acquired whilst in locked mode, to control its output; the stored "holdover value" is an average figure obtained over a certain period of time in order to reduce the effects of any short-term variations that might occur in the locked reference frequency during normal operations. The internal oscillator signal is then phase corrected according to the stored data, and used as timing reference by SETG in holdover mode. The holdover mode will guarantee an accuracy as required by G.813 Opt 1.

  When Active SETG is in holdover mode, Standby SETG switches to lock Active SETG T0 clock, instead of others reference clock, so that to make sure T0 frequency alignment. Phase alignment module still works.

  Note: In all three above modes, Standby SETG always locks Active SETG T0 clock and Phase alignment always works.

SSM handling and timing selection processes

STM-N and PDH references (T1 and T2 signals) can provide (Rx direction) not only the frequency information of the corresponding timing source but also the quality of that source by way of SSM message extracted from the line signal: SSM information when available is typically accessed by the port framer and collected through the SMB bus.

> **Note:** If an alarm is detected on any sync source, the corresponding clock signal is turned off, insuring that the CRG will detect a bad reference. If the source is the currently selected (the active one) a switch to another reference or to holdover will occur; vice versa if the source is not the currently selected it will be marked as unavailable for the selection process until the alarm disappears.

In Tx direction the SSM message is set again via SMB bus on any outgoing STM-N or PDH interface.

SSM information in station input/output references carrying the SSM information (T5 and T6) are accessed via SMB bus.

The source selection can work in two distinct modes: QL-disabled (selection based on SF, Priority and Ext Commands) and QL-enabled (selection based on Quality, SF, Priority and Ext Commands).

T0 and T4/5 selection process are independent although the implemented algorithm is the same; in a protected configuration happens that

- There is always one T0 selection process controlling and keeping aligned SEL_B on CRG copy A and B; the selection of the internal clock from the active copy is done at port level.
- There is one T4/T5 selection process controlling and keeping aligned SEL_A on CRG copy A and B (protected mode); the selection of the output clock is done by SERVICE card(1646SM).

The quality information can be also allocated (if the source signal does not support SSM) or overruled by provisioning.

All the output signals generated with the internal clock are marked with same SSM value with the following two exceptions:

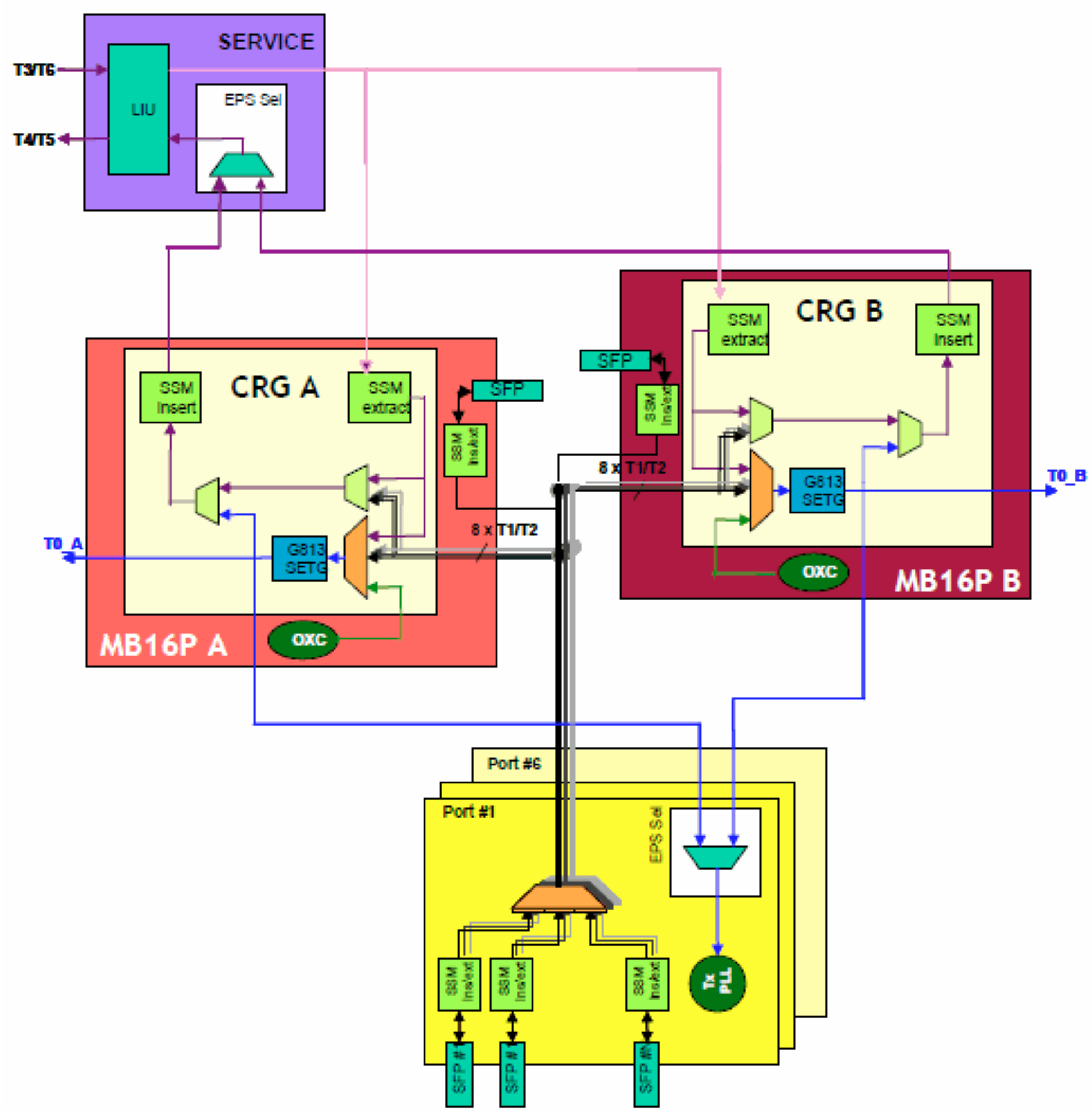
- The source being selected as the timing source for internal synchronization sends the SSM “do not use” for preventing potential creation of a timing loop in the network.
- A forced transmit SSM = “do not use” is configured for that port

In accordance to ETSI prETS 300 417-6 standard if the received SSM changes without triggering the selection process (because it is still the best quality available in QL-enabled mode) this change is forwarded to the transmit SSM in less than 200 ms; if the received SSM changes and this triggers the selection process the new selection and the new SSM is performed within 500 ms; if the holdover mode is entered the requirement is 2000 ms.

Clock architecture overview

The following is the clock architecture overview of the 1646 SM:

Figure 5-43 Clock architecture overview for 1646SM



T0 signal distribution

The T0 system (payload) clock distribution is based on 38.88Mhz signal (LVTTL signal type) from each CRG (copy A and copy B) with an accompanying sync signal FP (500ms period - LVTTL signal type). Each LPU card in the system is in charge of extracting from it the needed sync pulses, for instance

- 1sec sync pulse synchronizing Performance Monitoring counters.
- 2KHz signal aligning LO multi-frames (TU or VT LO frames)

The T0 system (payload) clock and the related sync information are also used to synchronize DCC and AUX back-panel frames.

A PLL on each I/O port card is required to generate the Tx line clock; the analog Tx PLL is VCXO based with a bandwidth large enough in order not to influence SETG jitter transfer characteristic but narrow enough to provide good backpanel jitter filtering capability (jitter generated mainly determined by VCXO).

T1/T2, T3/T6 and T4/T5 reference clock distribution

Each LPU port that can be source of synchronization, i.e. SDH ports for T1 and PDH ports for T2 references, each will send a 8KHz clock reference to main-board, point-to-point structure.

Either 2Mhz (T3) or 2Mbit/s(T6) for SDH synchronization (Frame termination and SSM extraction are done on SERVICE) will use the 8KHz wire to CRG block, but only one of two T3/T6 will be sent. Selection is done by SERVICE.

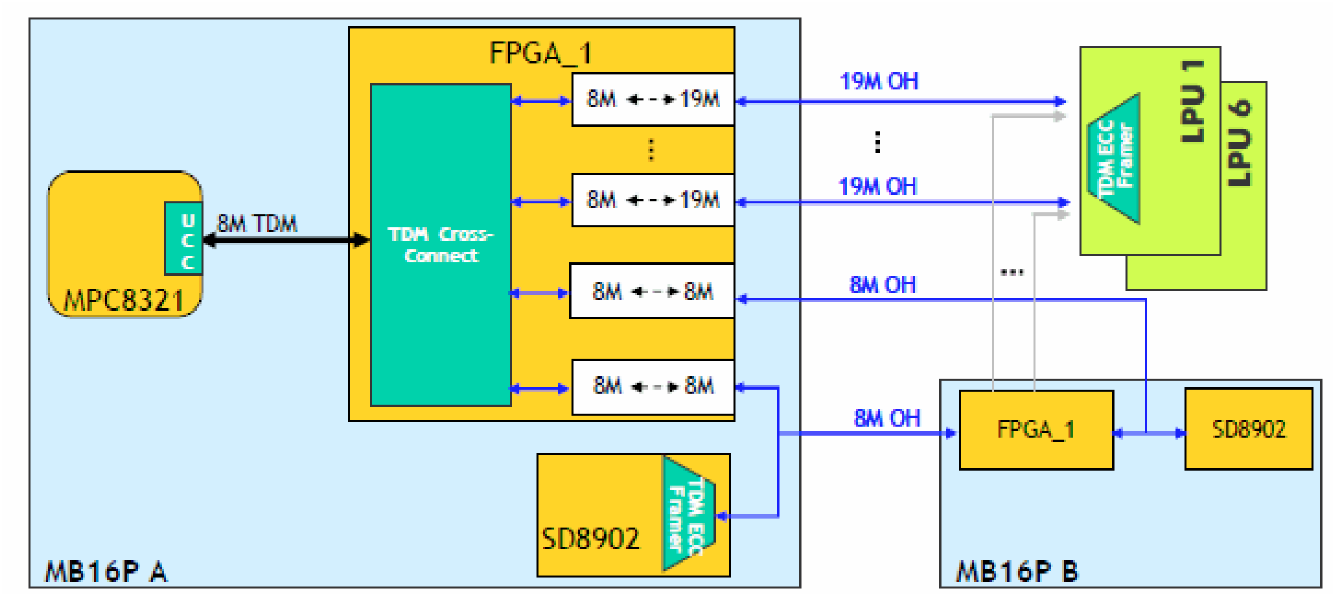
Either 2MHz(T4) or 2Mbit/s(T5) output for external timing reference (Frame termination and SSM insertion are done on SERVICE) will use one reserved wire from MB16 to SERVICE on LPU slot.

ECC and OH architecture

Overview

For each MB16P, there are six 19M OH bus to six LPU slot, one for each. And there are also two 8M OH bus to another MB16P, because each MB16P has one STM-1/4/16 line interface.

Figure 5-44 OH architecture on 1646SM



19Mbps OH bus includes 16Mbps OH data payload and 3Mbps reserved bandwidth. It can also be upgrade to 38Mbps, which reserved 22Mbps for others protocol packet transmission. 16Mbps OH data payload is interleaved by eight 2Mbps, each 2Mbps contains some overhead bytes of one STM-1. Till now, maximum optical line interfaces is two, so only 4Mbps meaningful payload. 8M OH bus is interleaved by four 2Mbps, one for each optical line interface.

Eight channels overhead bus are processed: six from LPU slot, one from local SD8902 and one from remote SD8902. 19Mbps OH bus from LPU will converted to 8Mbps, part of unused payload is discarded. Then all OH bus will enter a 64K TDM cross-connect process block, DCC bytes are aggregated into 8M TDM bus and is sent to CPU UCC resource, after processed by CPU UCC resource, DCC bytes are sent back. Bus conversion is done in FPGA. Others AUX and EOW bytes, such as F2/E1/E2 and so on, can also be cross-connected.

If SERVICE card is inserted into LPU slot, only E1/F2 and embedded DCC information in external 2Mbit/s are processed in overhead bus.

Each 2Mbps includes 32 time slot, the frame is shown as in

Table 5-2 2Mbps time slot

Time SLOT	Byte Name	Time SLOT	Byte Name
00:[A:D]	E1	16:[A:D]	D10
01:[A:D]	F1	17:[A:D]	D11
02:[A:D]	D1	18:[A:D]	D12
03:[A:D]	D2	19:[A:D]	Serial3
04:[A:D]	D3	20:[A:D]	E2
05:[A:D]	Serial1	21:[A:D]	Configurable0
06:[A:D]	Serial2	22:[A:D]	Configurable1
07:[A:D]	K1	23:[A:D]	Configurable2
08:[A:D]	K2	24:[A:D]	Configurable3
09:[A:D]	D4	25:[A:D]	Configurable4
10:[A:D]	Serial4	26:[A:D]	Configurable5
11:[A:D]	D5	27:[A:D]	Configurable6
12:[A:D]	D6	28:[A:D]	Configurable7
13:[A:D]	D7	29:[A:D]	Configurable8
14:[A:D]	D8	30:[A:D]	Configurable9
15:[A:D]	D9	31:[A:D]	ID

Notes:

1. Byte name is same with SOH byte, extraction and insertion are from same position.
2. Configurable bytes means they can be any SOH and POH byte
3. Serial1~Serial4 are located the first STM-1.

Overhead bytes position in one STM-1 frame is shown in the following table.

Figure 5-45 STM-1 Overhead

A1 00	A1 01	A1 02	A2 03	A2 04	A2 05	J0 06	07	08	J1 51
B1 09	0A	0B	E1 0C	0D	0E	F1 0F	10	11	B3 52
D1 12	13	14	D2 15	16	17	D3 18	Serial1 19	Serial2 1A	C2 53
AU-PTR									G1 54
B2 24	B2 25	B2 26	K1 27	28	29	K2 2A	KC 2B	KM 2C	F2 55
D4 2D	Serial4 2E	2F	D5 30	31	32	D6 33	34	35	H4 56
D7 36	37	38	D8 39	3A	3B	D9 3C	3D	3E	F3 57
D10 3F	40	41	D11 42	43	44	D12 45	46	Serial3 47	K3 58
S1 48	49	4A	4B	4C	M1 4D	E2 4E	4F	50	N1 59

Power management

1646 SM power distribution architecture

1646SM support only DC power supply.

When two PWDC2 are used, two -48V DC input can support 1+1 protection.

Three types of power are available on BP:

- -48V A/B

  -48V A/B are main power supply, which are distributed to all LPU slot and MB16P slot. Two - 48V are introduced by two PWDC2 boards, then after protection process, they are sent to MB16P and LPU slot.

  3.3VS is also a service power, which is used by LPU/FAN/PWDC/PWAC, to supply I2C management chip, such as EEPROM, PCA9555 and ADS7828; Then MB16P can still get some information from these boards, such as RI and voltage monitoring, even if their main power fail.

- 12V A/B

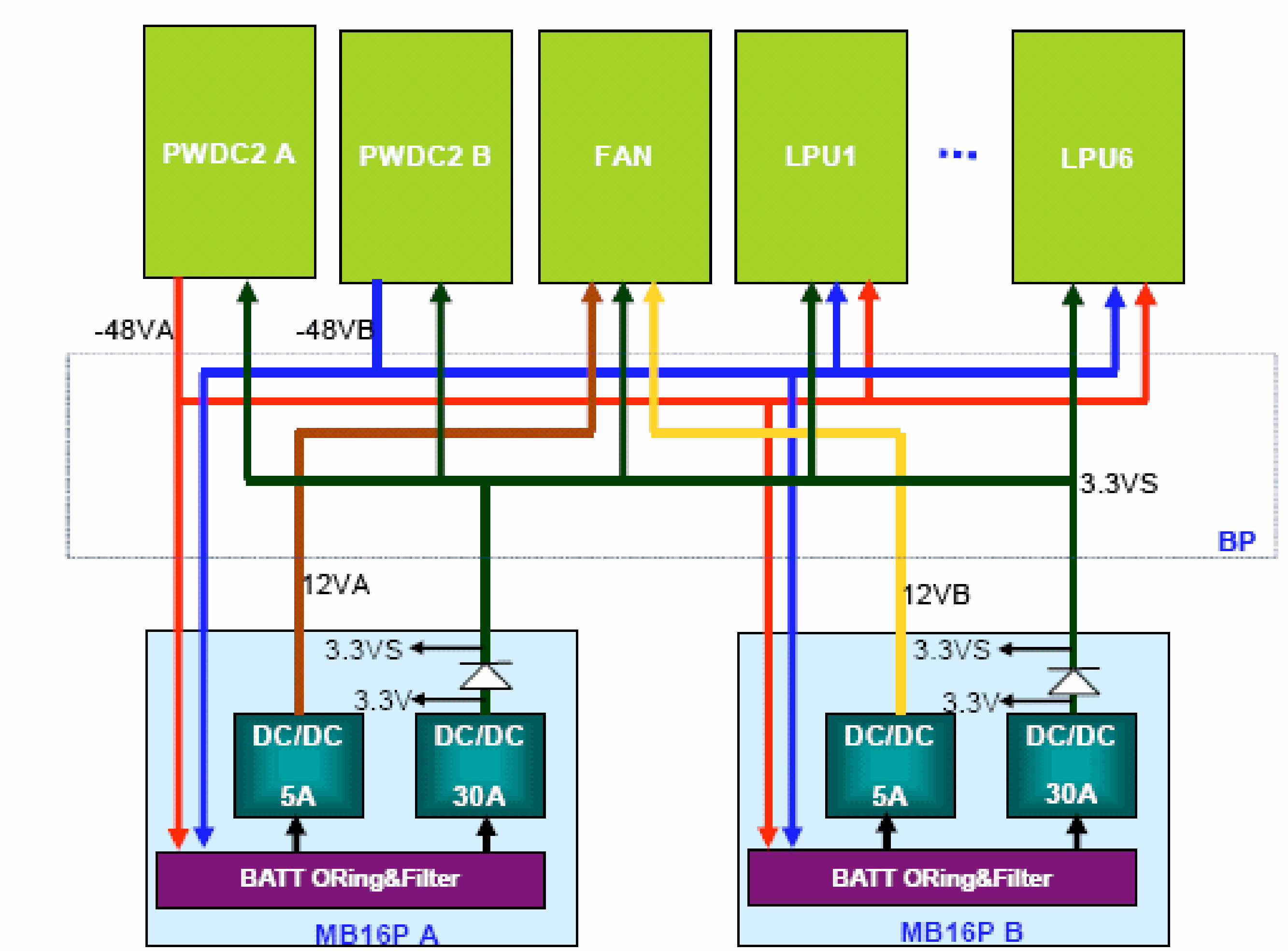
  12V A/B are supplied by two MB16P to FAN board and they are ORed on FAN.

- 3.3VS

  3.3VS is backup power supply, which can also be main power for LPU slot when LPU board power consumption lower than 10W, instead of -48V A/B. There is only one 3.3VS, which is ORed together by two MB16P board.

  3.3VS is also a service power, which is used by LPU/FAN/PWDC/PWAC, to supply I2C management chip, such as EEPROM, PCA9555 and ADS7828; Then MB16P can still get some information from these boards, such as RI and voltage monitoring, even if their main power fail.

Figure 5-46 Power architecture on 1646 SM



Power consumption

The 1646 SM is designed for low power consumption. Developing new components with very high integration density and low voltage supply leads to a significant reduction in power consumption.

Performance Monitoring

General

The system provides the following storage registers for each PM parameter monitored, as per ITU-T G.783 (ETSI):

- One (1) Current 15-Minute register
- One (1) Current Day Register
- One (1) Previous 15-Minute register
- One (1) Previous Day register
- Sixteen (16) Recent 15-Minute registers
- Six (6) Recent Day registers.

The Current 15-minute (1-Day) register accumulates the current 15-minute (1-Day) PM data. At the end of each 15-minute (1-Day) boundary, the contents of the Current 15-minute (1-Day) register is transferred to the Previous 15-minute (1-Day) register. The current 15-minute (1-Day) registers is then automatically initialized to zero.

The 31 (6) Recent 15-minute (1-Day) registers are arranged as a Push-down stack. At the end of each 15-minute (1-Day) boundary, the content of the Previous 15-minute (1-Day) register are transferred at the top of the stack. The data at the bottom of the stack is pushed off and lost. The Recent 15-minute (1-Day) registers stack thus contains the 31 most recent 15-minute PM data.

The system is able to reset the current registers and to enable/disable PM collection, by operator commands. Performance data are reported to the OS interface, via operator request.

Both Near-End and Far-End PM counters are provided for STM-N and embedded VC-4, VC-3, VC-12. PM collection is compliant with ITU-T G.783.

The NE supports threshold crossing registers and TCA for the 15 minutes and 1 day registers.

PM registers can be enabled, created or deleted:

- For 15 minutes and 1 day time periods independently
- For section, line and path independently

Current registers can be initialized automatically (on 15-minute and 1-day time boundaries) or manually (via command, at any time).

Threshold Crossing Alerts (TCAs) - ETSI

TCAs are reported as standing conditins and managed via Alarm Severity Profiles, like each other alarm.

TCA raise and clear events are reported via spontaneous messages. TCA messages identifies the monitored facility, monitored parameter register, current threshold value, current register value, time and date of the occurrence. Active TCAs are retrievable.

Each 15-min PM register which supports TCA, has a raise threshold value (TR) and independent threshold values.

Each 15-min PM register which supports TCA, has a clear threshold value (TR) and independent threshold values. Itr is possible to provision the threshold value for the raise and clear thresholds independently.

Each 24-h PM register which supports TCA, has a raise threshold value (TR) and independent threshold values.

Threshold Alert Raise and Clear. There are two types of thresholds:

- counter-threshold, associated with digital parameters

Unlike the value of a 'counter' parameter can only increase in value unless its value is reset, the value for a 'gauge' parameter can increase or decrease continuously over time.

Counter threshold values are considered as crossed when the value in the Current Register is equal to or exceeds the value in the corresponding raise threshold value.

ETSI PM Parameters

SDH Regenerator Section (Section) layer

The Near End Regenerator Section parameters listed in next table are monitored.

Table 5-3 SDH Regenerator Section (Section) layer PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition
Out of Frame Seconds	OFS-RS	NEND	Count of seconds there at least one OOF event occurs
Background Block Errors	BBE-RS	NEND	The count of Near-End Errored Block is increased if the received BIP does not match with the BIP calculated from the previous block (Byte-B1). One Block is defined as one frame
Errored Seconds	ES-RS	NEND	Count of seconds with Background Block (B1) errors ≥1 or LOS, or LOF or AIS or equipment defects are active
Severely Errored Seconds	SES-RS	NEND	Count of seconds with (B1) errors ≥2400 (30%) or LOS, or LOF or TIM or AIS or equipment defects are active
Unavailable Seconds	UAS-RS	NEND	A second of Unavailability which begins at the on-set of 10 contiguous SES-RSs and ends at the on-set of 10 contiguous seconds with no SES-RSs

Performance Monitoring for Regenerator Section are supported in receive direction.

Table 5-4 STM-1 / STM-4 / STM-16 RS SECTION NEAR END PM parameters

MONTYPE parameter		THRESHOLD LEVEL			
		15-MIN. Register		1-DAY Register	
	Definition	Maximum	Factory Default	Maximum	Factory Default
BBE-RS	[ETSI] Background Block Errors - Near End Regenerator Section	7199100	24000-200	691113600	36000
ES-RS	[ETSI] Error Second - Near End Regenerator Section	900	50-5	86400	150
OFS-RS	[ETSI] Out of Frame Seconds - Near End Regenerator Section	900	900-0	86400	86400
SES-RS	[ETSI] Severely Error Second - Near End Regenerator Section	810	10-0	77760	15
UAS-RS	[ETSI] Unavailable Seconds - Near End Regenerator Section	no TCA	no TCA	no TCA	no TCA

SDH Multiplex Section (Line) layer

The **Near End Multiplex Section parameters** listed in next table are monitored.

Table 5-5 SDH Multiplex Section (Line) layer Near End PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition
Background Block Errors	BBE-MS	NEND	The count of Near-End Errored Block is increased if the received BIP does not match with the BIP calculated from the previous block (Byte-B2). One Block is defined as one BIP-N position
Errored Seconds	ES-MS	NEND	Count of seconds with Background Block (B2) errors ≥1 or AIS. The counter counts not when equipment defects are active
Severely Errored Seconds	SES-MS	NEND	Count of seconds with Background Block (B2) errors ≥1 (see Table 5-7, “Number of BBEs per SES-MS” (p. 5-81)) or AIS. The counter counts not when equipment defects are active
Unavailable Seconds	UAS-MS	NEND	A second of Unavailability which begins at the on-set of 10 contiguous SES-RSs and ends at the on-set of 10 contiguous seconds with no SES-MSs

The **Far End Multiplex Section parameters** listed in next table are monitored.

Table 5-6 SDH Multiplex Section (Line) layer Far End PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition
Background Block Errors	BBE-MS	FEND	Count of REI-L (M1) ≥1. If Near End Defect Seconds are declared (AIS), the counter doesn't count
Errored Seconds	ES-MS	FEND	Count of seconds with Background Block (REI-L) errors ≥1 or RDI-L. If Near End Defect Seconds are declared (AIS), the counter doesn't count
Severely Errored Seconds	SES-MS	FEND	Count of seconds with Background Block (REI-L) errors ≥x (see Table 5-7, "Number of BBEs per SES-MS" (p. 5-81)) or RDI-L. If Near End Defect Seconds are declared (AIS), the counter doesn't count
Unavailable Seconds	UAS-MS	FEND	A second of Unavailability which begins at the on-set of 10 contiguous SES-RSs and ends at the on-set of 10 contiguous seconds with no SES-MSs

Table 5-7 Number of BBEs per SES-MS

VALUES of x	Entity
≥ 3668400 (30%) Background Block Errors (Byte-B2)	STM-64
≥ 921600 (30%) Background Block Errors (Byte-B2)	STM-16
≥ 192000 (25%) Background Block Errors (Byte-B2)	STM-4
≥ 28800 (15%) Background Block Errors (Byte-B2)	STM-1

In next table the same values apply to both near end and far end parameters

Table 5-8 STM-1 MS (Line) Near End and Far End PM parameters

MONTYPE parameter		THRESHOLD LEVEL			
		15-MIN. Register		1-DAY Register	
	Definition	Maxi-mum	Factory Default	Maxi-mum	Factory Default
BBE-MS (FEND & NEND)	[ETSI] Background Block Errors - Far End Multiplex Section	172799100	24000-200	4294967295	36000

Table 5-8 STM-1 MS (Line) Near End and Far End PM parameters (continued)

MONTYPE parameter	Definition	THRESHOLD LEVEL 15-MIN. Register Maximum	THRESHOLD LEVEL 15-MIN. Register Factory Default	THRESHOLD LEVEL 1-DAY Register Maximum	THRESHOLD LEVEL 1-DAY Register Factory Default
ES-MS (FEND & NEND)	[ETSI] Error Second - Far End Multiplex Section	900	50 - 5	86400	150
SES-MS (FEND & NEND)	[ETSI] Severely Error Second - Far End Multiplex Section	810	10-0	77760	15
UAS-MS (FEND & NEND)	[ETSI] Unavailable Seconds - Far End Multiplex Section	no TCA	no TCA	no TCA	no TCA

In next table the same values apply to both near end and far end parameters

Table 5-9 STM-4 MS (Line) Near End and Far End PM parameters

MONTYPE parameter	Definition	THRESHOLD LEVEL 15-MIN. Register Maximum	THRESHOLD LEVEL 15-MIN. Register Factory Default	THRESHOLD LEVEL 1-DAY Register Maximum	THRESHOLD LEVEL 1-DAY Register Factory Default
BBE-MS (FEND & NEND)	[ETSI] Background Block Errors - Near End Multiplex Section	691199100	96000-800	4294967295	144000
ES-MS (FEND & NEND)	[ETSI] Error Second - Near End Multiplex Section	900	50 - 5	86400	150
SES-MS (FEND & NEND)	[ETSI] Severely Error Second - Near End Multiplex Section	810	10 - 0	77760	15
UAS-MS (FEND & NEND)	[ETSI] Unavailable Seconds - Near End Multiplex Section	no TCA	no TCA	no TCA	no TCA

In next table the same values apply to both near end and far end parameters

Table 5-10 STM-16 MS (Line) Near End and Far End PM parameters

MONTYPE parameter		THRESHOLD LEVEL			
		15-MIN. Register		1-DAY Register	
	Definition	Maxi-mum	Factory Default	Maxi-mum	Factory Default
BBE-MS (FEND & NEND)	[ETSI] Background Block Errors - Near End Multiplex Section	2764799	184000-3200	4294967295	576000
ES-MS (FEND & NEND)	[ETSI] Error Second - Near End Multiplex Section	900	50 - 5	86400	150
SES-MS (FEND & NEND)	[ETSI] Severely Error Second - Near End Multiplex Section	810	10 - 0	77760	15
UAS-MS (FEND & NEND)	[ETSI] Unavailable Seconds - Near End Multiplex Section	no TCA	no TCA	no TCA	no TCA

SDH (Higher Order) Path layer

SDH Near End Higher Order Path (VC4 path) Monitoring.

The **Near End Higher Order Path (VC4) parameters** listed in next table are monitored.

Table 5-11 SDH Near End Higher Order Path (VC4 path) PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition - terminated (VC4)
Background Block Errors	BBE-HOVC	NEND	
Errored Seconds	ES-HOVC	NEND	Count of seconds with Background Block (B3) errors ≥1 or SSF-P or VC-AIS or TIM-P and AIS insertion on TIM enabled or LOP-P or UNEQ-P. The counter counts not when equipment defects are active

Table 5-11 SDH Near End Higher Order Path (VC4 path) PM Parameters definitions (continued)

Parameter	Mnemonic	LOCN	Definition - terminated (VC4)
Severely Errored Seconds	SES-HOVC	NEND	Count of seconds with Background Block (B3) errors ≥ 2400 (30%) or SSF-P or VC-AIS or TIM-P and AIS insertion on TIM enabled or LOP-P or UNEQ-P. The counter counts not when equipment defects are active
Unavailable Seconds	UAS-HOVC	NEND	
Positive Pointer Justification Events	PJEP-HOVC	NEND	not applicable
Negative Pointer Justification Events	PJEN-HOVC	NEND	not applicable

Table 5-12 VC4 path Near End PM parameters

MONTYPE parameter		THRESHOLD LEVEL			
		15-MIN. Register		1-DAY Register	
	Definition	Maximum	Factory Default	Maximum	Factory Default
BBE-HOVC	[ETSI] Background Block Errors - Near End Higher Order VC Path	7199100	36000-200	691113600	48000
ES-HOVC	[ETSI] Error Second - Near End Higher Order VC Path	900	180-20	86400	1500
PJEN-HOVC	[ETSI] Negative Pointer Justification Events - Near End Higher Order VC Path	NA	no TCA	NA	no TCA
PJEP-HOVC	[ETSI] Positive Pointer Justification Events - Near End Higher Order VC Path	NA	no TCA	NA	no TCA
SES-HOVC	[ETSI] Severely Error Second - Near End Higher Order VC Path	810	15-0	77760	20
UAS-HOVC	[ETSI] Unavailable Seconds - Near End Higher Order VC Path	no TCA	no TCA	no TCA	no TCA

SDH Far End Higher Order Path (VCn/AUn path) Monitoring.

The **Far End Higher Order Path (VCn/AUn) parameters** listed in next table are monitored.

Table 5-13 SDH Far End Higher Order Path (VC4 path) PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition - unterminated (AUn, AU4nC)	Definition - terminated (VC4)
Background Block Errors	BBE-HOVC	FEND	Count of REI-P (bits 1-4 of Byte-G1) ≥1. If Near End Defect Seconds are declared (AIS-P or LOP-P or VC-AIS or UNEQ-P or TIM-P), the second doesn't count	Count of REI-P (bits 1-4 of Byte-G1) ≥1. If Near End Defect Seconds are declared (SSF-P or VC-AIS or TIM-P and AIS insertion on TIM enabled or LOPP or UNEQ-P), the second doesn't count
Errored Seconds	ES-HOVC	FEND	Count of seconds with Background Block (REI-P) errors ≥1 or RDI-P. If Near End Defect Seconds are declared (AIS-P or LOP-P or VC-AIS or UNEQ-P or TIM-P), the second doesn't count	Count of seconds with Background Block (REI-P) errors ≥1 or RDI-P. If Near End Defect Seconds are declared (SSF-P or VC-AIS or TIM-P and AIS insertion on TIM enabled or LOPP or UNEQ-P), the second doesn't count
Severely Errored Seconds	SES-HOVC	FEND	Count of seconds with Background Block (REI-P) errors ≥2400 (30%) or RDI-P. If Near End Defect Seconds are declared (AIS-P or LOP-P or VCAIS or UNEQ-P or TIM-P), the second doesn't count	Count of seconds with Background Block (REI-P) errorss ≥2400 (30%) or RDI-P. If Near End Defect Seconds are declared (SSF-P or VC-AIS or TIM-P and AIS insertion on TIM enabled or LOP-P or UNEQ-P), the second doesn't count
Unavailable Seconds	UAS-HOVC	FEND	A second of Unavailability which begins at the on-set of 10 contiguous SES-HOVCs and ends at the on-set of 10 contiguous seconds with no SES-HOVCs	

PM for Far End HO Path are supported for terminated paths (VCn) in receive direction.

PM for Far End HO Path are supported for unterminated paths (AUn) in receive and transmit direction.

For the **VC4 path Far End PM parameters** threshold level, refer to Table 5-12, “VC4 path Near End PM parameters” (p. 5-84). (a part “Positive and Negative Pointer Justification Events”, they're not Far End HO path parameters).

PM for Bidirectional terminated HO Path (VC4/VC4nC path) are enabled/reported in receive direction.

SDH Bidirectional unterminated Higher Order Path (AUn path) Monitoring

PM for Bidirectional un-terminated HO Path (AUn path) are enabled/reported in receive direction.

Table 5-14 VC4-/VC4-4C path bi-directional PM parameters

MONTYPE parameter	THRESHOLD LEVEL			
	15-MIN. Register		1-DAY Register	
	Maximum	Factory Default	Maximum	Factory Default
BBE-HOVC-EG	no TCA	no TCA	no TCA	no TCA
BBE-HOVC-FE	no TCA	no TCA	no TCA	no TCA
BBE-HOVC-IN	no TCA	no TCA	no TCA	no TCA
BBE-HOVC-NE	no TCA	no TCA	no TCA	no TCA
ES-HOVC-EG	no TCA	no TCA	no TCA	no TCA
ES-HOVC-FE	no TCA	no TCA	no TCA	no TCA
ES-HOVC-IN	no TCA	no TCA	no TCA	no TCA
ES-HOVC-NE	no TCA	no TCA	no TCA	no TCA
SES-HOVC-EG	no TCA	no TCA	no TCA	no TCA
SES-HOVC-FE	no TCA	no TCA	no TCA	no TCA
SES-HOVC-IN	no TCA	no TCA	no TCA	no TCA
SES-HOVC-NE	no TCA	no TCA	no TCA	no TCA
UAS-HOVC-BI	no TCA	no TCA	no TCA	no TCA

SDH Lower Order Path layer

SDH Near End Lower Order Path (VC3/VC12 path) Monitoring

The **Near End Lower Order Path (VC3/VC12 path) parameters** listed in next table are monitored.

Table 5-15 SDH Near End Lower Order Path (VC3/VC12 path) PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition - terminated (VCn)
Background Block Errors	BBE-LOVC	NEND	
Errored Seconds	ES-LOVC	NEND	Count of seconds with Background Block (B3/V5 BIP-2) errors ≥1 or SSF-V or TIM-V and AIS insertion on TIM enabled or VC-AIS or UNEQ-V. The counter doesn't count when equipment defects are active
Severely Errored Seconds	SES-LOVC	NEND	Count of seconds with Background Block (B3/V5 BIP-2) errors ≥x (see Table 5-19, “Number of BBEs per SES-LO” (p. 5-90)) or SSF-V or TIMV and AIS insertion on TIM enabled or VC-AIS or UNEQ-V. The counter doesn't count when equipment defects are active
Unavailable Seconds	UAS-LOVC	NEND	

PM for Near End LO Path are supported for terminated paths (VCn) in receive direction.

In next table the same values apply to both near end and far end parameters

Table 5-16 LOVC3 path Near End and Far End PM parameters

LOVC parameter		THRESHOLD LEVEL			
		15-MIN. Register		1-DAY Register	
	Definition	Maxi-mum	Factory Default	Maxi-mum	Factory Default
BBE-LOVC	[ETSI] Background Block Errors - Near End Lower Order VC Path	7199100	36000-200	691113600	48000
ES-LOVC	[ETSI] Error Second - Near End Lower Order VC Path	900	150-10	86400	600

Table 5-16 LOVC3 path Near End and Far End PM parameters (continued)

LOVC parameter	Definition	THRESHOLD LEVEL 15-MIN. Register Maximum	THRESHOLD LEVEL 15-MIN. Register Factory Default	THRESHOLD LEVEL 1-DAY Register Maximum	THRESHOLD LEVEL 1-DAY Register Factory Default
SES-LOVC	[ETSI] Severely Error Second - Near End Lower Order VC Path	810	15-0	77760	20
UAS-LOVC	[ETSI] Unavailable Seconds - Near End Lower Order VC Path	no TCA	no TCA	no TCA	no TCA
PJEN-LOVC	[ETSI] Negative Pointer Justification Events - Near End Lower Order VC Path	NA	no TCA	NA	no TCA
PJEP-LOVC	[ETSI] Positive Pointer Justification Events - Near End Lower Order VC Path	NA	no TCA	NA	no TCA

In next table the same values apply to both near end and far end parameters

Table 5-17 LOVC12 path Near End and Far End PM parameters

LOVC parameter	Definition	THRESHOLD LEVEL 15-MIN. Register Maximum	THRESHOLD LEVEL 15-MIN. Register Factory Default	THRESHOLD LEVEL 1-DAY Register Maximum	THRESHOLD LEVEL 1-DAY Register Factory Default
BBE-HOVC	[ETSI] Background Block Errors - Near End Lower Order VC Path	65535	1500 - 300	65535	15000
ES-HOVC	[ETSI] Error Second - Near End Lower Order VC Path	900	50 - 20	65535	100
SES-HOVC	[ETSI] Severely Error Second - Near End Lower Order VC Path	900	20 - 0	65535	50
UAS-HOVC	[ETSI] Unavailable Seconds - Near End Lower Order VC Path	900	20–0	65535	50
PJEN-LOVC	[ETSI] Negative Pointer Justification Events - Near End Lower Order VC Path	NA	no TCA	NA	no TCA
PJEP-LOVC	[ETSI] Positive Pointer Justification Events - Near End Lower Order VC Path	NA	no TCA	NA	no TCA

SDH Far End Lower Order Path (VC3/VC12 path) Monitoring

The **Far End Lower Order Path (VC3/VC12 path) parameters** listed in next table are monitored.

Table 5-18 SDH Far End Lower Order Path (VC3/VC12 path) PM Parameters definitions

Parameter	Mnemonic	LOCN	Definition - terminated (VC3/VC12)
Background Block Errors	BBE-LOVC	FEND	Count of REI-V (VC3: bits 1-4 of Byte-G1 / VC12: bit 3 of V5 byte) ≥1. If Near End Defect Seconds are declared (SSF-V or TIM-V and AIS insertion on TIM enabled or VCAIS or UNEQ-V), the second doesn't count
Errored Seconds	ES-LOVC	FEND	Count of seconds with Background Block (REI-V) errors ≥1 or RDI-V. If Near End Defect Seconds are declared (SSF-V or TIM-V and AIS insertion on TIM enabled or VCAIS or UNEQ-V), the second doesn't count
Severely Errored Seconds	SES-LOVC	FEND	Count of seconds with Background Block (REI-P) errors ≥x (see Table 5-19, “Number of BBEs per SES-LO” (p. 5-90)) or RDI-V. If Near End Defect Seconds are declared (SSF-V or TIM-V and AIS insertion on TIM enabled or VC-AIS or UNEQ-V), the second doesn't count.
Unavailable Seconds	UAS-LOVC	FEND	

PM for Near End LO Path are supported for terminated paths (VCn) in receive direction.

PM for Near End LO Path are supported for unterminated paths (TUn) in receive and transmit direction.

For the **LOVC3 path Far End PM parameters**, refer to Table 5-16, “LOVC3 path Near End and Far End PM parameters” (p. 5-87).

For the **LOVC12 path Far End PM parameters**, refer to Table 5-17, “LOVC12 path Near End and Far End PM parameters” (p. 5-88).

PM for Bidirectional terminated LO Path (VC3/VC12 path) are enabled/reported in receive direction.

PM for Bidirectional unterminated HO Path (TUn path) are enabled/reported in receive direction.

SES estimator for Lower Order Path

The number of Background Block Errors, x, within a second that constitute a Severely Errored Second - Lower Order Path (SES-LOVC) is defined in next table.

Table 5-19 Number of BBEs per SES-LO

VALUES of x	Entity
≥ 2400 (30%) Background Block Errors (Byte-B3)	VC3, TU3
≥ 600 (30%) Background Block Errors (Byte-B3)	VC12, TU12

Bidirectional Lower Order Path (VC3/VC12 path) PM parameters

Table 5-20 VC3 / VC12 (LO) path Bidirectional PM parameters

MONTYPE parameter	THRESHOLD LEVEL			
	15-MIN. Register		1-DAY Register	
	Maximum	Factory Default	Maximum	Factory Default
BBE-LOVC-EG	no TCA	no TCA	no TCA	no TCA
BBE-LOVC-FE	no TCA	no TCA	no TCA	no TCA
BBE-LOVC-IN	no TCA	no TCA	no TCA	no TCA
BBE-LOVC-NE	no TCA	no TCA	no TCA	no TCA
ES-LOVC-EG	no TCA	no TCA	no TCA	no TCA
ES-LOVC-FE	no TCA	no TCA	no TCA	no TCA
ES-LOVC-IN	no TCA	no TCA	no TCA	no TCA
ES-LOVC-NE	no TCA	no TCA	no TCA	no TCA
SES-LOVC-EG	no TCA	no TCA	no TCA	no TCA
SES-LOVC-FE	no TCA	no TCA	no TCA	no TCA
SES-LOVC-IN	no TCA	no TCA	no TCA	no TCA
SES-LOVC-NE	no TCA	no TCA	no TCA	no TCA
UAS-LOVC-BI	no TCA	no TCA	no TCA	no TCA

Ethernet Performance Monitoring

P8FES and P4FXS: YES

P8FES and P4FXS is requested to support:

- Ethernet PM QoS Counters over Aggregate ports for:

  Local Ethernet interface

  (Since Rel.2.1) Remote Ethernet Interface

P8FES and P4FXS is not requested to support:

- Ethernet PM maintenance Counters over physical interfaces
- Ethernet PM Counters over flow
- TCA (Threshold Cross Alarm) management on aggregate port

P8FES and P4FXS support two kinds of granularity period , 24h and 15min.

Ethernet PM counters

P8FES and P4FXS: YES

1646SM/C shall support the following Ethernet PM counters:

Ethernet PM Counters	Description	1646SM
RxEINF	The number of Ethernet frames received correctly	Rel.1.0
RxEINB	The number of octets of Ethernet frames received correctly	Rel.1.0
RxEINFUnicast	The collected number of Ethernet Unicast frames received correctly	N
RxEINFMulticast	The collected number of Ethernet Multicast frames received correctly	Rel.1.0
RxEINFBroadcast	The collected number of Ethernet Broadcast frames received correctly	Rel.1.0
RxEIFE	the collection of the sum of three contributions: dot3StatsAlignmentErrors, dot3StatsFCSErrors and dot3StatsFrameTooLongs	N
RxTUF	the collection of the total un-recoginized frames	N
RxTDF	the number of received Ethernet frames which where choosen to be discarded due to buffer congestion	N
TxEONF	The number of Ethernet frames transmitted out	Rel.1.0
TxEONB	The number of octets of Ethernet frames transmitted out	Rel.1.0

Ethernet PM Counters	Description	1646SM
TxEONFUnicast	The collected number of Ethernet Unicast frames transmitted out	N
TxEONFMulticast	The collected number of Ethernet Multicast frames transmitted out	Rel.1.0
TxEONFBroadcast	The collected number of Ethernet Broadcast frames transmitted out	Rel.1.0
TxTDF	the number of Ethernet frames which where chosen to be discarded due to buffer congestion on transmission	N

PM counter start/stop

P8FES and P4FXS: YES

The System shall allow an operator to start/stop counting of ALL counters of ONE PORT configured through SNMP application.

PM counter clear

P8FES and P4FXS: YES

The System shall support the capability to clear current data of ALL counters of ONE PORT.

Management

Overview

The administration main features of the 1646 SM system is described in this section.

The following parts are included in this paragraph:

Network management

The NE is provided with the following user service interfaces for connection from external management systems:

MB16P front panel:

- One *M2*(ref. 11) general purpose switched LAN ports (10/100BaseTX), for connection to EMS and craft terminal
- *DBG* (ref. 4) a Debug port that can be used for a craft terminal interface

Separate debug LAN ports are available on each module that hosts a general processor. These LAN ports are connected directly to the processor LAN port and not switched

These interfaces provide an easy-to-use interface and security features to prevent unauthorized access. They support the following:

- Local access control based on login and password
- User provisioning of cross-connections, equipment, Ethernet services, software management, protection provisioning, and fault management
- Reports on NE equipage, cross-connections, alarms, and states

The interfaces can use:

- Zero-Installation Craft (ZIC) terminal
- TL1 and SNMP command

The NE's MAC address is installed/assigned at the factory and is not lost due to any single hardware failure or replacement of any normally field-replaceable module.

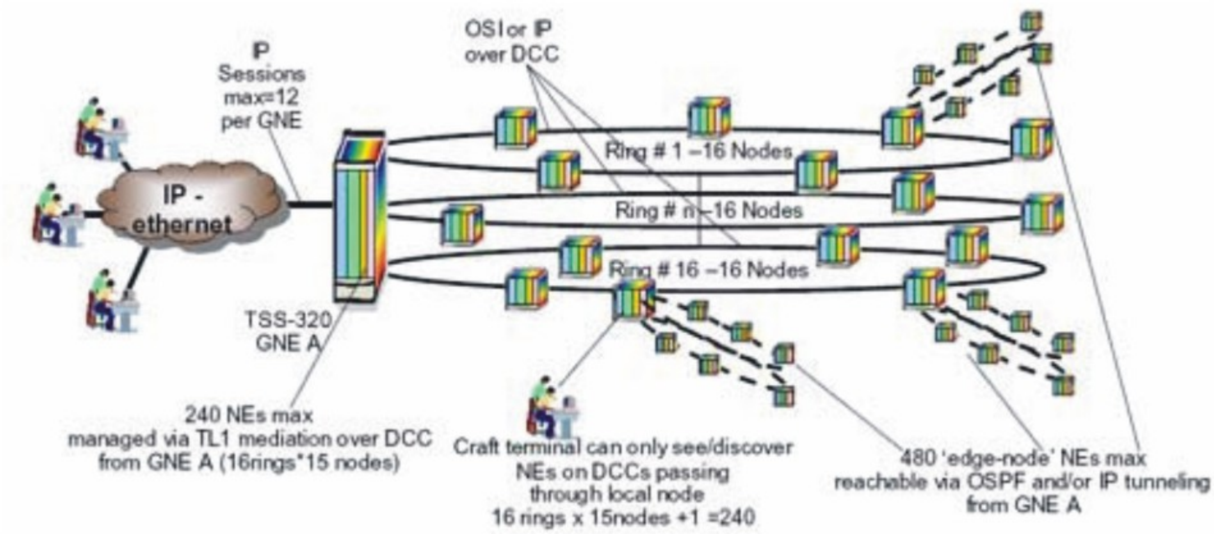
External IP address and MAC address remains fixed and follow the active LAN ports

A local craft terminal connected either through a serial or a LAN interface is able to establish TL1 connections to any NE reachable through DCC from the local NE.

Communications Network Sizing

The basic communications network architecture for TL1 management is described in the following Figure 5-47, "Communications network architecture example" (p. 5-94).

Figure 5-47 Communications network architecture example



The NE supports:

- Up to 6 simultaneous TCP connections to either of the L1 ports 3082 and 3083.
- Up to 12 section DCC and up to 6 line DCC channels in 1646SM, and only on DCC channel can be created on one STM-n port.
- Up to 128 as max number of IP tunnels.

The 7 layers of the OSI protocol stack as defined in Telcordia GR-253 are supported allowing interoperation with NEs supporting TCP/IP over DCC. The OSI protocol stack supported is shown in Table 5-21, "OSI over DCC protocol stack" (p. 5-94).

Table 5-21 OSI over DCC protocol stack

Layer	Name	Service/Protocol
7	Application	TL1, ACSE
6	Presentation	The presentation layer will support the TL1 abstract syntax and TL1 transfer syntax as specified in GR-253 Section 8.3.6, and GR-253 Appendix D.

Table 5-21 OSI over DCC protocol stack (continued)

Layer	Name	Service/Protocol
5	Session	The session layer will support X.215 and X.225 as specified in GR-828, ANSI T1.208 and GR-253 Appendix D.
4	Transport	The transport layer will support the mandatory features for Transport Class 4 over CLNS as defined in ISO 8073, ISO 8073 Addendum 2 (TP4/CLNS), and GR-253 Appendix C.
3	Network	The OSI Network Layer will be supported as specified in ISO/IEC 8473 (CLNS), ISO 8473/AD 3 SNDCF, ISO/IEC 9542 (ES-IS routing), ISO/IEC 10589 (IS-IS routing) and Appendix C of GR-253-CORE, Issue 3
2	Data Link	The Data Link Layer protocol for the SONET Section and Line DCC channel will be based on Link Access Protocol on the D-channel (LAPD) as specified in ITU-T Recommendation Q.921 *ISDN user-network interface - Data link layer specification* and as described in Appendix C of the GR-253-CORE.
1	Physical	OSI over DCC support will be provided. OSI over Customer LAN not supported.

The OSI protocol stack is enabled on a specified DCC channel.

TCP/IP protocol stack

The TCP/IP protocol stack supported for an IP-based DCN will be as shown in next Table 5-22, “TCP/IP over DCC protocol stack” (p. 5-95).

Table 5-22 TCP/IP over DCC protocol stack

Layer	Name	Service / Protocol
7	Application	TCP/IP support is required over Customer LAN interface. TCP/IP routing support is required over the Customer LAN interfaces. (Not required for debug)
6	Presentation	
5	Session	For TL1 over TCP/IP, the following encoding methods are supported: Raw terminal encoding and Telnet encoding
4	Transport	TCP
3	Network	IPv4, ICMP, Integrated IS-IS (RFC1377), ARP
2	Data Link	The Data Link Layer protocol used for the TCP/IP over DCC will be TCP/IP over LAPD.
1	Physical	TCP/IP support is required over Customer LAN interface.

The TCP/IP protocol stack can be enabled or disabled on a specified DCC channel, or the Customer LAN.

TL1 messages over the TCP/IP stack

TL1 message formats comply with the GR-831-CORE, so supporting:

- The raw encoding of TL1 over TCP.

  Raw terminal encoding provides to keep-alive probes. The character sequence used in keep alive probes consists of the character ASCII 255 immediately followed by the character ASCII 241.

  Both of these characters are outside of the TL1 character set. This character pair was chosen because in the Telnet protocol the command IAC NOP is encoded as ASCII 255 241, and it is desirable that the same keep-alive probe encoding is used for the raw encoding and the Telnet encoding.

  TL1 responders uses the port number 3082 to listen for incoming TL1 connections using the raw terminal encoding.

- The Telnet encoding of TL1 over TCP.

  The Telnet encoding is provided for human-machine interactions.

  The TL1 responders use port number 3083 to listen for incoming TL1 connections using the telnet encoding.

  Only the support for the ECHO and the SUPPRESS-GO-AHEAD Telnet options is required.

  These options are supplied by Telnet commands. A Telnet command consists of an escape byte - the Interpreter As Command escaping character (IAC) - followed by a command code of at least one byte.

  When a TCP connection is in urgent mode (signaling the presence of urgent data on the TCP connection) incoming data are processed in the same way as when the TCP connection is in normal mode (that is not in urgent mode). Specifically, when the TCP connection is in urgent mode, incoming user data (that is TL1 messages carried over normal mode) must not be discarded.

  TL1 Responder function supports prompts on a Telnet encoded connection, in order to make more user-friendly the interface between network elements and users.

  Whenever the TL1 responder is ready to begin reading the next TL1 command it should send a prompt string.

SNMP messages over the IP stack

SNMP message format complies with the RFC3417.

The SNMP messages are carried by DCN over UDP/IP stack.

Table 5-23 UDP/IP over DCC protocol stack

Layer	Name	Service / Protocol
5	Application	SNMP
4	Transport	UDP
3	Network	IPv4, ICMP, Integrated IS-IS
2	Data Link	PPP over HDLC (RFC 1662) or SNDCF (ISO 8473) over LAPD (ITU Q.921), IPCP (RFC 1332), LCP (RFC 1661)
1	Physical	DCC

The SNMP messages can be also carried by IP over OSI tunnels (see "IP tunneling" (p. 5-97)).

IP routing

Integrated IS-IS is not supported in 1646SM.

The OSPF protocol is supported, and can be enabled or disable on customer LAN.

IP-MAC resolution

To allow correct IP routing over an Ethernet interface, the ARP (Address Resolution Protocol) is used to map IP addresses with the corresponding MAC (Medium Access Control) addresses.

The IP-MAC associations established by ARP software are collected in the ARP Cache.

The ARP Cache entries are filled automatically by ARP protocol's software.

IP tunneling

> **Note:** The IP tunnels are basically uni-directional and they have to be created from each side to get a bidirectional tunnel.

The NE shall provide the capability to establish IP Tunnels (IPT) between NEs on the same DCC subnetwork. This function allows NEs with existing OSI connectivity to be able to establish an IP tunnel over CLNP.

The NE shall support direct IP in CLNP encapsulation according to the Nokia proprietary method used by OMSN systems.

The loop-back IP address that represents the local IP address for all the tunnels is configured first, before any tunnel is configured.

Ping

Remote ping operations is performed in compliance with RFC 2925. Ping capability is provided by means of ICMP (Internet Control Message Protocol) ECHO facility.

The NE is able to answer to remote ping tests which have been started by a Network Manager through a Ping Request. In particular, this Ping Request shall be an ICMP Echo Message, as described in RFC 792.

The NE answers to a ping request sending its own IP address in a Ping Response. In particular, this Ping Response is an ICMP Echo Reply Message.

Network Management for Data/Ethernet system

Mixed Ethernet and SDH Network

The management of SDH/WDM equipment is organized as required by the 7-layers ISO/OSI protocol stack, while the Ethernet system is managed by means of SNMP (Simple Network Management Protocol), that is an application of the 5-layers TCP/IP reference model.

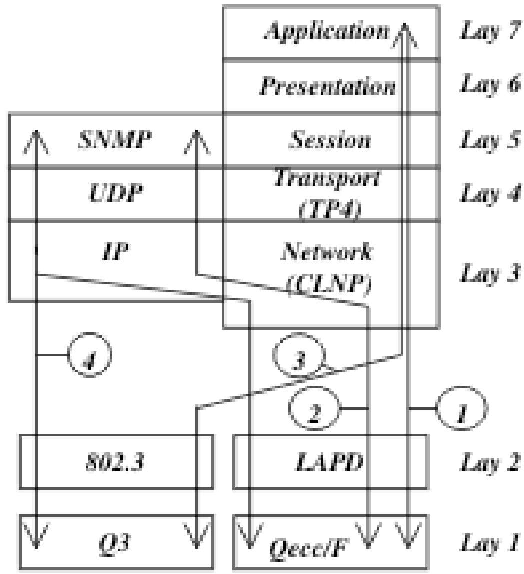
In networks with Ethernet over SDH there is the need to manage together and contemporarily SDH and Ethernet systems; this task is accomplished by means of the encapsulation of SNMP messages inside the OSI layers (IP over OSI tunneling). In this way the Ethernet management information is transported together with the SDH control messages.

For Ethernet and SDH networks, the protocols relationships are illustrated in Figure 5-48, “Protocol stack for Ethernet and SDH management” (p. 5-99).

An example of Ethernet and SDH network management is shown in Figure 5-49, “Example of management of SDH network with Ethernet traffic” (p. 5-100). In this example, the OS enters the network management messaging over an Ethernet link (IEEE-802.3 protocol) of a Gateway NE (GNE); here the messages are transported over the optical Qecc links by means of the LAPD protocol; at the remote managed nodes, the messages are acknowledged as belonging to:

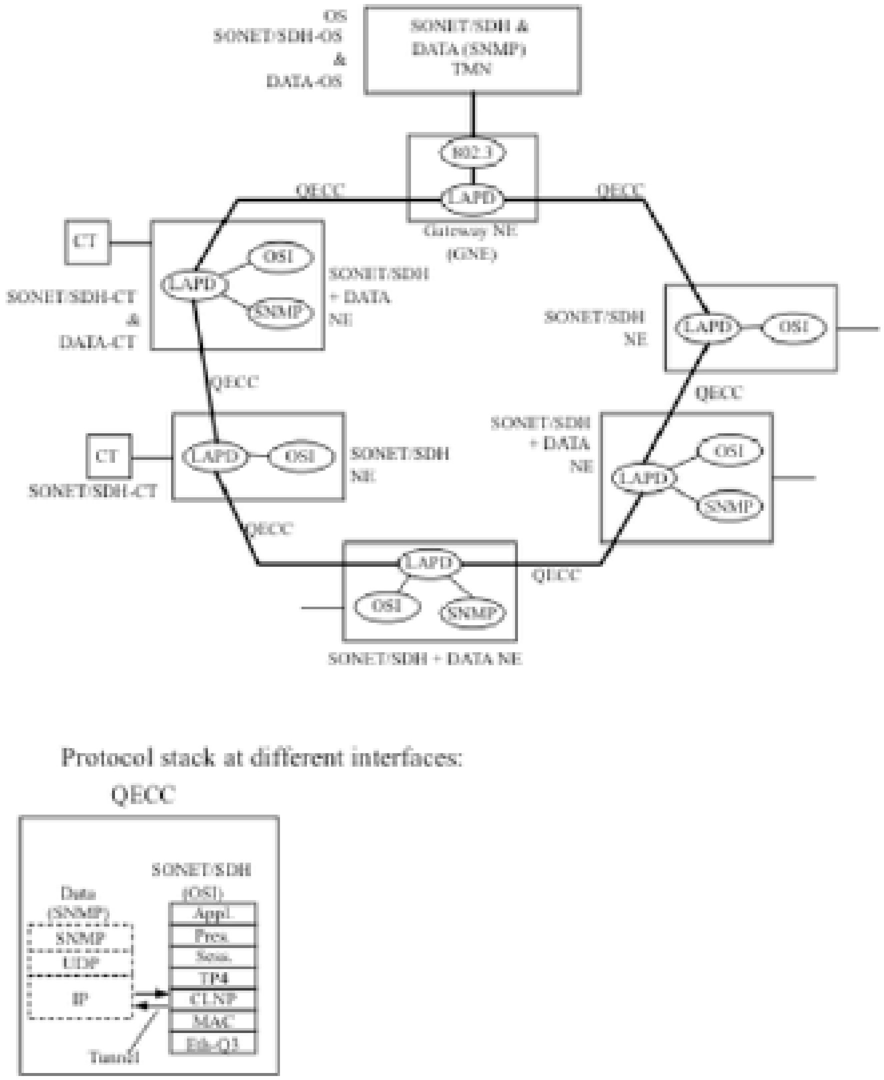
- OSI reference model, for SDH management
- TCP/IP (SNMP) reference model, for Ethernet, or MPLS management.

Figure 5-48 Protocol stack for Ethernet and SDH management



- OSI stack for SDH management (Qecc Interface)
- IP over CLNP tunneling for DATA Management (/Qecc Interface)
- OSI stack for SDH management (Qecc Interface)
- IP over CLNP tunneling for DATA management (GNE entry from OS, IEEE-802.3)

Figure 5-49 Example of management of SDH network with Ethernet traffic



Note:

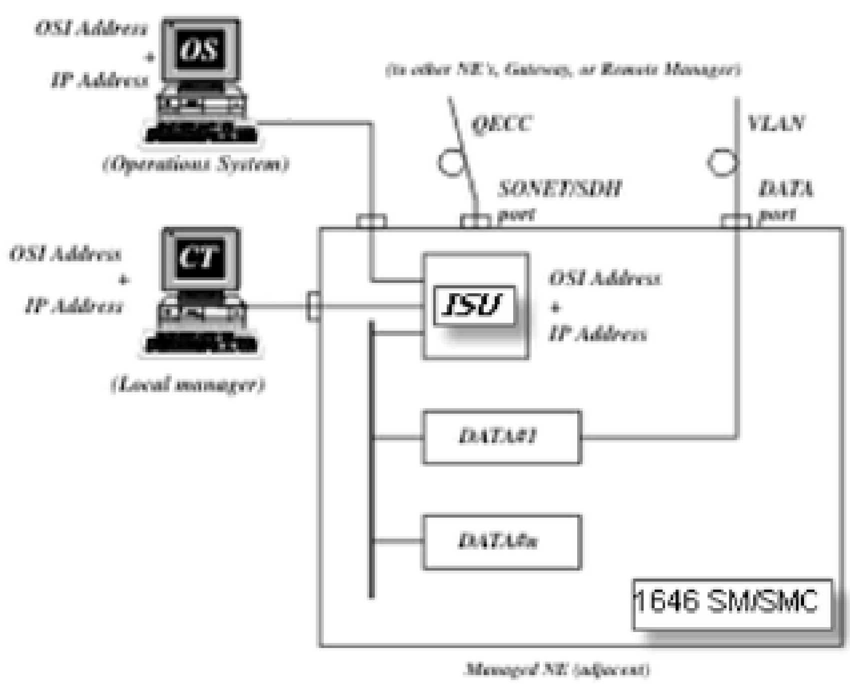
- The tunnel IP over CLNP is initiated inside the Manager (CT or OS) and terminated at the destination NE, in order to carry SNMP management messages into the SDH network
- The SNMP messages are tunneled in the NE's where the message is not to be opened

Note: In order to transfer the management information, the involved entities need an OSI address (for the ISO/OSI information messages) and an IP address (for the SNMP information messages). In case of *full-data* network, the only IP addressing is sufficient. In case of *pure-TDM* (SDH) network, the OSI addressing is sufficient.

1. *CT* (personal computer, local manager or craft terminal) addressing. The OSI address is assigned by means of the Nokia Lower Layers Manager (ALL) application; the IP address assignment is done in the WINDOWS environment by means of the *Network* application of the *ControlPanel*. Refer to 1646 SM User provisioning Guide, 1646 SM TL1 Commands guide, 1646 SM TL1 UPG listed in *Related information* for these operations.
2. The OSI address and IP address are assigned by means of the SDH-CT application (Configuration: Comm/Routing:... options). Refer to the 1646 SM User provisioning Guide, 1646 SM TL1 Commands guide, 1646 SM TL1 UPG *Related information* for these operations.

An illustrative example is reported in next Figure 5-50, "OSI and IP addressing example" (p. 5-101).

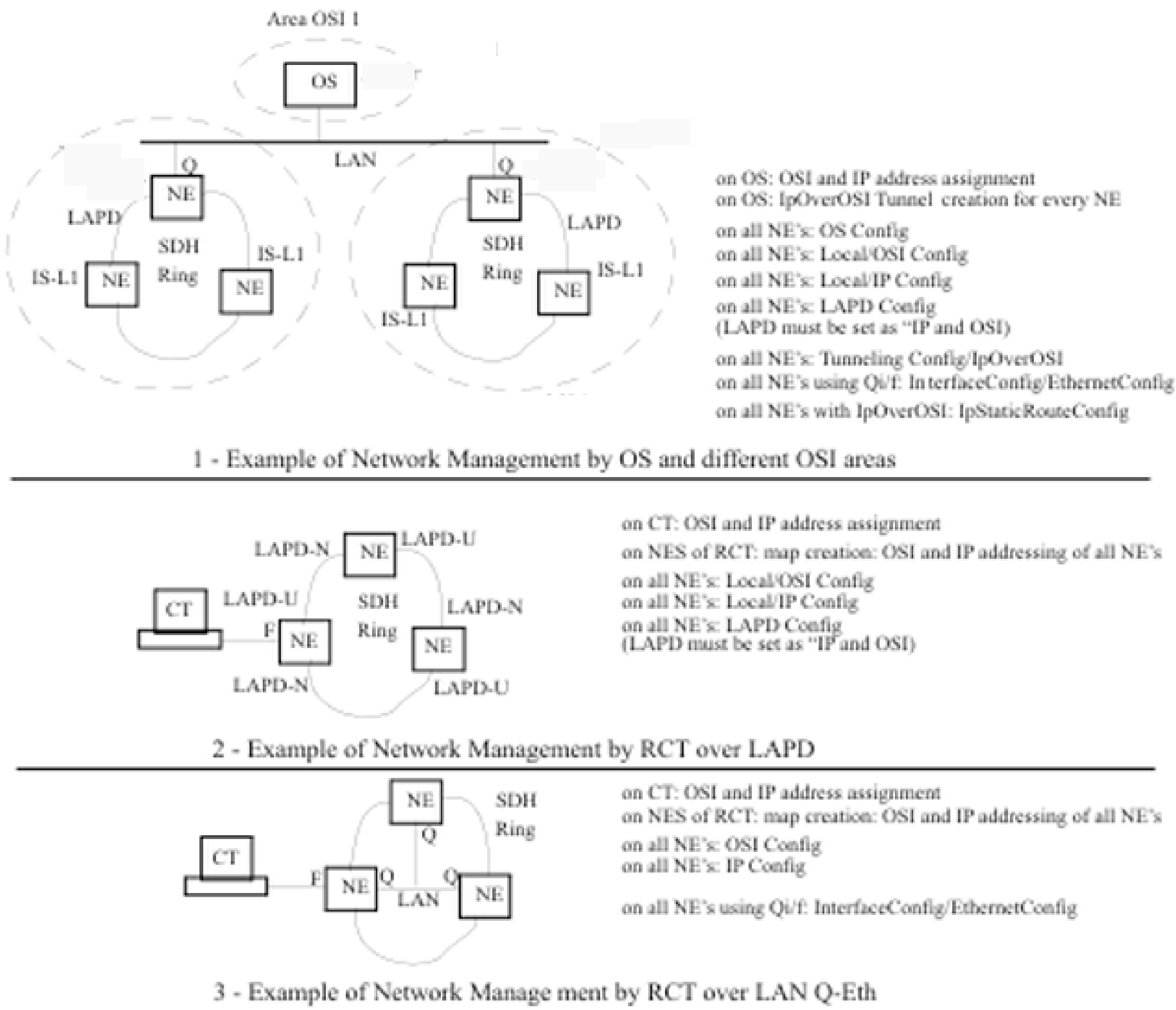
Figure 5-50 OSI and IP addressing example



Examples of Management Networks

The following figure illustrates some examples of network management. Each NE is supposed to be equipped with Data boards.

Figure 5-51 Examples of Network Management



Note:

1. *IS*: Intermediate System. IS-L1 is a Level1 (Intra-Area) system; IS-L2 is a Level2 (Inter-Area) system. The IS function performs the routing of control messages inside the OSI network.
2. 1646 can support up to 100 NEs in one IS-L1 area if DCN traffic and NE CPU is in low load.
3. *LAPD*: (also called Q-ECC), protocol for transporting network control messages over DCC bytes of the SDH frame. LAPD-N (Network role) is used when source convention is used at the interface; LAPD-U (User role) is used when sink convention is used at the interface; the two conventions must be alternated.

Refer to 1646 SM User Provisioning Guide, listed in *Related information* for details about these operations.

Equipment Management

This section contains the details for Equipment Management feature for the 1646 SM node.

The NE provides the initialization, pre-provisioning, auto-provisioning, post-provisioning, and de-provisioning functionality of all the modules.

Post provisioning is the capacity to explicitly provision by management, an IO card which cannot be automatically configured through plug and play. These types of IO cards are not automatically entered and provisioned when plugged in an unassigned slot until explicitly provisioned by the management system.

The NE is based on one shelf version: 1646 SM. It supports only single shelf configurations.

1646 SM: SSC, XC, STG units are automatically pre-provisioned on each provisioned Main Shelf and cannot be deleted.

Provisioning/de-provisioning procedures on an entity does not cause errors on other entities.

The NE detects insertion and extraction of all modules in the system.

Slot Assignment

The shelf layout describes which boards can go into which slots in the shelf.

Physical removal of a module raises an Alarm Condition.

Equipment discovery

Card detection is supported for the following equipment entities.

- SCC
- XC

- STG
- EOW

The SFP modules are detected by SC polling of their relative IO boards. For SFP, the active SC retrieves the remote inventory data from the card that hosts the module. For these modules, the system performs the following minimum set of operations after SFP insertion.

- SC is not able to collect its RI data directly through SPI bus. It is retrieved by the card which hosts the module
- SC makes a periodic check of hardware setting, at the first check performed after inserting SFP, SC collects its RI data from the main card which retrieves and send it to SC.

Physical removal of a module raises an alarm condition.

Insertion or extraction of a module does not cause errors to occur on other entities.

Manual Restart

It is possible to reset a specified equipment entity or the entire NE through TL1 command (INIT-SYS). Different possible level of restart are defined:

- *COLD*: Reload of dynamic and static data (SW and DB if present). Processor is restarted
- *POWER-ON*: Full restart (as if unplugged and plugged), including processor restart and reloading of sw and db.

Provisioning

Mandatory equipment are automatically provisioned whether present or not.

For non-mandatory equipment (including SFP modules), the following modes are defined for provisioning:

- Pre-provisioning, where the slot is provisioned in advance of a card being inserted

If a plug and play module is inserted in a slot which cannot be provisioned with that entity, the provisioning attempt fails, a PRCDERR condition is raised on the generic module AID (MDL). No data is provisioned for the inserted module.

Factory default values for equipment provisioning parameters referred in *TL1 User Provisioning Guide*. Factory default values cannot be changed through TL1.

Provisioning procedures on an entity does not cause errors on other entities.

De-provisioning

A Delete Equipment command is supported to delete a provisioned equipment.

The Delete Equipment command allows the following equipment entities to be deleted:

- SCC
- IOC
- SFP

De-provisioning procedures on an entity does not cause errors on other entities.

Specific equipment provisioning/de-provisioning characteristics

In this paragraph, we provide additional information pertaining to provisioning/de-provisioning and to logical removal/restoration, specific for any equipment entities.

SCC

Main features:

- Mandatory modules (slot 2)
- Mandatory Module automatically pre-provisioned whether present or not
- Modify equipment expected is not allowed
- No possibility to plug in a wrong module
- No equipment protection is available for SCC
- Power-on diagnostics
- Software download support required
- Fault detection

The SCC board provides a flash disk for non-volatile program and data storage.

- SCC disk is not managed as a separate entity, it is simply considered a part of SCC. A disk failure implies an SCC failure (HWFAIL condition).
- SCC disks cannot run out of space, disk space is controlled and managed with opportune mechanism to avoid this situation. No *disk full* event is generated by disk or managed by SCC, there is no condition related to this case.

XC

Main features:

- Mandatory modules (slot 2 and 1)
- Both Modules Automatically pre-provisioned whether present or not
- **`ENT-EQPT`** command is not allowed
- **`DLT-EQPT`** command is not allowed
- Modify equipment expected is not allowed
- No Possibility to plug in a *wrong* module
- No software download required
- Fault detection

The XC board provides cross-connection management function.

STG

Main features:

- Mandatory modules (slot 2, sub-slot 2)
- Automatically pre-provisioned
- Modify equipment expected is not allowed
- No Possibility to plug in a *wrong* module
- No software download required
- Fault detection

IOC

Main features:

- Pre-provisioning allowed
- When an IOC is created, also every SFP inside is created together with it. AINSMODE parameter is not supported in this release
- When an IOC is deleted, also every SFP inside is deleted together with it
- Possibility to plug in a *wrong* module (mismatch of equipment) and to manage this situation
- Power-on diagnostics
- Software download is required for P8FES and P4FXS module
- Fault detection

IO modules are SDH cards.

SFP

Main features:

- SFP is automatically created if the related IOC module is created
- SFP is automatically deleted if the related IOC module is deleted
- No power-on diagnostics
- Fault detection (SFP may fail separate than their relative IOC)
- Non MSA SFP generate a card missing alarm

Alarm management

The operation and maintenance of the NE is accomplished through the built-in monitoring features and the interpretation of this information to operational support system interfaces.

Equipment and incoming signal failures are autonomously detected by the NE.

The system supports the following condition severities (notification codes) which are reported to Maintenance and Operations personnel responsible for the equipment:

- Critical (CR)
- Major (MJ)
- Minor (MN)
- Non-Alarmed (NA).

The NE supports a Not-Reported (NR) notification code for conditions that are declared but not autonomously reported.

The system supports autonomous reporting and logging of alarms and conditions for equipment and facilities management.

All currently existing alarmed, not alarmed, and not reported events are retrievable.

When an entity is deleted, all of its associated alarms and conditions are cleared.

When an entity is not provisioned no alarms or conditions are set against that entity. For further details, please refer to the *1646 Synchronous Multiplexer (SM) Release 2.3 User Provisioning Guide* (see *Related information*).

Alarm hierarchy

The alarm hierarchy affects the issuance of alarm reports and alarm clear reports in the following manner:

- When a condition is raised that is higher than any existing condition, an alarm report is issued for the new condition and alarm clear reports for any previously reported lower level alarms.
- While the higher level alarm condition is present, lower level alarm reports are suppressed. When the highest level condition is cleared, an alarm report is issued for the next highest level condition, if any.

The alarm hierarchy is reevaluated whenever one of the following events occur:

- A standing condition is declared
- A standing condition is cleared

To prevent false alarm transitions due to transients, the integration period of the new alarm condition is performed as specified in “Alarm management” (p. 5-106) before clearing any existing alarm and activating the new alarm condition when transitions from a lower-level alarm to a higher level occur. Transitions to lower-level alarms requires the high-level alarm integration time to expire before it is cleared and any low-level alarm is activated. The alarm delays are always measured from the entering and exiting of their related failure states.

The near-end and far-end alarms are independent of each other in the sense that both near-end and far-end alarms on a line port could exist at the same time with both near-end and far-end alarm being reported.

Supervision

The elementary building blocks of any telecommunication network are the Network Elements (NEs).

Operating with the Craft Terminal the NE can present different management states according to the condition of the connection (supervision, local access, connection state, etc). Also, general Alarm status is presented.

Management states are present at *Network Element Synthesis* view level and at *USM-EML* view level.

All the information referred to the management states are inserted in the Operator's document Common.

Any disruption in the communication link between the CT and the NE results in an update of the management states when the CT has detected the communication failure.

Housekeeping

The NE is able to receive and process six (6) separate customer-defined inputs for fault conditions arising externally to the NE. The fault conditions are processed and reported as for internally detected fault conditions. It is possible to disable the reporting from any input if not used.

The controls is present in Housekeeping functionality is provided by the main board. Customer access to the HKP connections is through RJ45 connector on the Main board.

The inputs are capable of interfacing to a dry relay contact, that is an input comprises two-wire interface capable of detecting an open or closed circuit condition between the two connections. Each user alarm input is separately configurable to accept either a closed circuit or open circuit state as the active alarm condition. The inputs from the dry contacts are normally used for site *specific* alarms such as open door, high temperature, high water level, etc. The polarity of an external input control determines the relationship between the declaration of an environmental condition and the physical signal.

The NE drives two (2) separate output station controls for customer defined site specific facilities external to the NE, such as air conditioning, generators, etc. Operating an external control means that a relay is activated to control some external device. Releasing an external control means deactivating the relay. The polarity of an external output control determines the relationship between the control state (CONTSTATE) value and the physical signal.

Installation and Upgrade (IAU)

The Installation and Upgrade feature consists of these areas:

- Initial Software Installation

For initial download of system software to the NE, a network boot approach is used. The process used to perform an initial software installation and turn-up on the NE system is documented for customers and customer service personnel. The basic mechanisms for initial software installation are described in the *1646 Synchronous Multiplexer (SM) Release 2.3 User Provisioning Guide* (refer to *Related information*.

- Software download

  The Software download feature provides a mechanism to load a software from a remote file server onto a NE system.

  The software to be downloaded is identified by a build identifier.

Commands are provided to retrieve the firmware version and software version (release ID) of the software being run on the NE.

The download completion time is a maximum of 15 minutes for download through an Ethernet LAN connection (10 Mb/s).

The download completion time is a maximum of 4 hours for download through an DCC connection (576 kbs).

System performance is not adversely affected by the download process.

- MB16P

  The In-Service Upgrade process converts the existing system database to the new release database and upgrades the existing release software to a new release software while in service, without impact to existing traffic.

  The new SW packages are installed by the appropriate TL1 command directly on the active MB16P. The standby MB16P is updated automatically, by means of an internal mechanism.

  The whole content of the database, including all provisioning, but excluding historical performance monitoring data, alarm data and the event log, are preserved during an In-Service Upgrade.

  The NE supports to fall back to the previously active release after a successfully performed MB16P to a new release, until the new release is explicitly committed by the operator

  The 1646SM can fall back to the previously active release if performed MB16P for a new release fail. But if MB16P performed to a new release successfully, then there can be no fall back to the previous release.

Database management

A NE maintains all its configuration in a volatile memory database. Non-volatile disk backup databases are maintained implicitly by the NE, and explicitly by operator commands. The NE is able to restore its memory database from the contents of a disk backup database at restart time.

The NE provides mechanisms to transfer a locally stored disk database backup to an RFS (Remote File Server) and vice versa.

Database overview

The volatile memory database (ACTV CPU DB) is maintained by the NE and reflects the NE configuration, its alarm states and conditions.

Two non-volatile disk database types exists for the NE:

- the primary backup database (ACTV DSK DB)
- the secondary backup data base (STBY DB)

The primary backup database and secondary backup database are maintained implicitly by the NE during its normal operation. Every 30 minutes, the primary backup database and secondary backup database is updated at the same time automatically. Updating the primary backup database occurs online without interrupting the NE's normal service operation. The primary backup database can be copied to/from a remote file server (RFS) by operator commands (remote backup and remote restore). The NE shall meet the DB requirements from GR-472-CORE and other applicable standards.

The NE meets the DB requirements from GR-472-CORE and other applicable standards.

Disk redundancy

The NE disk is considered to be part of the main board. In case of a redundant NE configuration, the system shall assure consistency of disk contents between active and standby main board. It is therefore assumed that all locally stored backup databases are consistent between the redundant main board of the NE without need for specific operator action. All database operations described, refer to the disk on the active main board unless explicitly mentioned otherwise. The system is responsible to replicate any change to disk databases on the active main board to the corresponding disk database on standby main board (if available). In particular, the implementation of the operations for creation of a database backup and download of a database backup to the disk on the active main board is expected to have the corresponding effects on the disk of the standby main board.

Local database operations

Any failures in updating the database is reported by the NE.

The system is capable of being automatically restored after a power failure or severe faults from the primary backup database to the latest stable and consistent configuration before the failure occurred.

The system restores the memory database from the primary backup database when initializing the NE.

Restoration of the memory database from the primary backup database, once initiated, is completed within the time the system is required to achieve full operational control, under normal operating conditions.

A method of verifying the valid state of locally stored disk databases is provided.

The NE prevents inadvertent restoration of an obsolete, corrupt or empty database or database from another system. The system incorporates timestamp checks, system ID comparisons, and so on.

Backup is done automatically by NE.

Remote database operations

The 1646SM transfer the primary backup database to and from a Remote File Server (upload and download).

The completion of the file transfer is reported through an autonomous message.

Information includes the SID, NE type, and release of the NE on which the backup took place, and the date and time at which the backup occurred.

The correct file size of a remotely stored disk databases is verified before downloading the database to the NE.

The file transfer functionality works with any RFS supporting an IP connection, a standard ftp file server.

The system is not required to resume automatically a previously started remote file transfer operation (either direction) that was interrupted by an NE restart or MB16P protection switch.

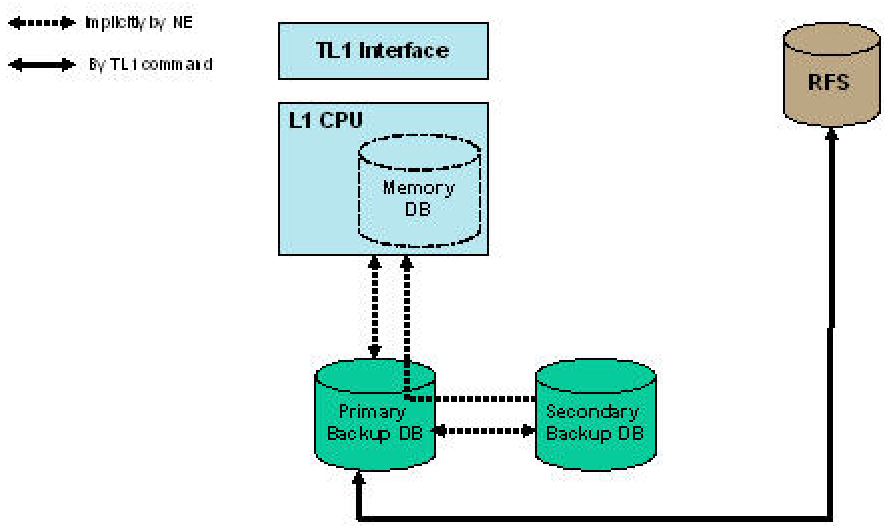
Database types

The following database types are provided for the NE:

- ACTV CPU DB — Database in volatile memory (e.g. RAM on the L1 controller). At FLC (re-)start time the contents of the ACTV DSK DB is copied into the ACTV CPU DB
- ACTV DSK DB — Primary backup database on the NE's disk. This database is also used to automatically restore the ACTV CPU DB on system initialization
- RFS DB — Remote File Server Database. This database can be copied to the DB during a successful file transfer operation
- STBY DB — Stand By Database is on the NE's disk.

Figure 5-52, “Database types and transitions” (p. 5-112) depicts the memory database (ACTV CPU DB), the factory default database, and the remote file server (RFS).

Figure 5-52 Database types and transitions



Setting site identifier

A command allows to provision the NE Site Identifier (SID).

The factory default SID is the following: On initial turn-up, the NE automatically generates an unique SID, using the last 5 hexadecimal characters of the NE's MAC address and appending them to the PLEASESET-SID name. This SID will be updated (by reading the MAC address from the appropriate NE hardware module) and stored in the NE's database during any cold restart of the NE, as long as the SID is already set to PLEASE-SET-SID- xxxxx, or a default database is created.

Facility management

Default signals

After a power-on condition and before provisioning of its database is complete, the lasers on optical IO modules remains off.

After a power-on condition and software downloading of the provisioning database, if the STM-n/OC-n facility is provisioned but the embedded facilities are not provisioned, a default SDH signal is transmitted with valid Framing in the A1 and A2 bytes, valid B1 and B2 values and 'n' valid pointer values in the H1, H2 and H3 bytes. All other bytes in the TOH is set to Hex 00.

Factory defaults

Factory defaults for provisionable parameters, shipped with the software load, is specified in *TL1 Commands Guide*, refer to *Related information*, where are also described the command defaults.

Facility provisioning

When a hardware port can support SFP modules at different signal rates without generating a hardware mismatch condition, the system verifies that an OCn to be entered is compatible with the SFP signal rate of the provisioned hardware. In the case of incompatibility, the command is denied.

Automatic laser shutdown and restart

The NE optical TDM IO Modules supports transmitter automatic laser shutdown (ALS) in the event of LOS on the corresponding receive signal.

It is possible:

- To enable or disable this feature on a per port basis. The default is disabled.
- To retrieve the current state of ALS provisioning on a per-port basis.

When ALS is enabled, following a laser shutdown, the IOC emits periodic laser pulses to attempt to restart the circuit.

The duration and interval of the restart pulses is specified in the hardware design.

The maximum duty cycle of the restart pulses is 15%.

Manual restart capability is accomplished by disabling ALS. Whenever ALS is disabled, laser power is always transmitted.

Failure detection and alarm generation

Once a Facility entity is provisioned, the entity can be monitored for near-end and far-end failure conditions for STM-n, VCn, facilities

When a line or path facility enters a failure condition, AIS is generated and transmitted on all supported facilities that are cross connected

STM-n failures

To be added.

VC-n Failures

To be added

Maintenance

Overview

Maintenance consists of a set of operations which maintain or bring back the assembly to optimum operating conditions in a very short time, with the aim of obtaining maximum operational availability.

The maintenance activities have been subdivided in the following topics:

- *Routine maintenance*
- *Corrective maintenance (troubleshooting)*.

Routine maintenance

Routine maintenance is a periodic set of measurements and checks.

This maintenance discovers those devices whose function has deteriorated with time and therefore need adjustment or replacement.

Usually, digital equipment requires no routine maintenance.

The equipment allows to assess the quality of the connection links for SECTION and PATH o counting the errored events and obtaining performance data.

Corrective maintenance (troubleshooting)

Corrective Maintenance (or *Troubleshooting*) involves the detection, location and correction of failures in the equipment and the replacement of the defective parts.

The troubleshooting procedure is carried out with the help of some flow-charts and tables, reported hereinafter. Anyway this method does not deal with the following aspects (which are to be deduced in other ways):

- faulty electronic alarm indication, processing and detection circuits
- faulty wiring (back-panel, connectors, etc.)

For details about Maintenance, refer to *Maintenance and Trouble-Clearing Guide*, listed in *Related information*.

6 Units description

Overview

Purpose

This chapter provides a detailed description of all the units in 1646 Synchronous Multiplexer (SM).

Contents

SFP optical modules

SFP optical modules overview

The SFP modules provide the optical physical access necessary to operate the SDH units, DATA units.

SFPs are optical transceivers enabling the building of a unit with a client-oriented optical interface. The following types of B and W SFP optical modules are provided:

- IEEE 802.3 1000Base-S: 1.25 Gbps, 550m (50/125 µm) or 275m (62.5/125 µm) reach, short haul, 850 nm
- IEEE 802.3 1000Base-L: 1.25 Gbps, 10-Km reach (SMF), long haul, 1310 nm
- IEEE 802.3 1000Base-Z: 1.25 Gbps, 80-Km reach, long haul, 1550 nm
- S-1.1 / IR-1 OC3; STM–1/OC-3 at 155 Mbps, 15-Km reach, short haul, operating at 1310 nm
- L-1.1 / LR-1 OC3; STM–1/OC-3 at 155 Mbps, 40-Km reach, long haul, operating at 1310 nm
- L-1.2 / LR-2 OC3; STM–1/OC-3 at 155 Mbps, 80-Km reach, long haul, operating at 1550 nm
- S-4.1 / IR-1 OC12; STM-4/OC-12 at 622 Mbps, 15-Km reach, short haul, at 1310 nm
- L-4.1 / LR-1 OC12; STM-4/OC-12 at 622 Mbps, 40-Km reach, long haul, operating at 1310 nm
- L-4.2 / LR-2 O-12; STM-4/OC-12 at 622 Mbps, 80-Km reach, long haul, operating at 1550 nm
- I-16.1 / SR-1 OC48; STM-16/OC-48 at 2.488 Gbps, 2-Km reach, Intraoffice, operating at 1310 nm
- S-16.1 / IR-1 OC48; STM-16/OC-48 at 2.488 Gbps, 15-Km reach, short haul, operating at 1310 nm
- L-16.1 / LR-1 OC48; STM-16/OC-48 at 2.488 Gbps, 40-Km reach, long haul, operating at 1310 nm
- L-16.2 / LR-2 OC-4 ; STM-16/OC-48 at 2.488 Gbps, 80-Km reach, long haul, operating at 1550 nm

As regard the Ethernet modules, they implement the PMD (Physical Medium Dependent) and the PMA (Physical Media Attachment Sublayer) functions according to IEE 802.3.

Each module contains on transmitter side an automatic optical output power control circuit, a laser driver and a laser diode module on the transmission side.

The *transmitter* is based on an uncooled DFB laser.

The laser safety class for the complete integrated module is CLASS 1 according to IEC 60825-1: Ed.1.2 (08-2007) and IEC 60825-2: Ed.3.1 (01-2007).

It can manage command for TX disable and provides TX Fault alarm.

Depending on the SFP type, the optical access is compatible with

- A single mode fiber (9/125 µm) or
- Multi-mode fiber (50/125 µm or 62,5/125 µm)

with standard LC optical connector.

TX Fault indicates a laser fault of some kind. The Transmitter is not disabled when TX Fault signal is active.

Tx Disable is an input that is used to shut down the transmitter optical output.

On *receiver* side each module contains a PIN or APD photodetector (according to the module type) for light to electrical current conversion and a limiting amplifier. The photo detected current is amplified by a an electrical circuit which delivers two complementary data signals.

The module provides LOS alarm (Loss of input Power Signal alarm). This output signal indicates the received optical power is below the worst-case receiver sensitivity (as defined by the standard in use).

Depending on the SFP type, the optical access is compatible with

- A single µfiber (9/125 µm) or
- Multi-mode fiber (50/125 µm or 62,5/125 µm)

with standard LC optical connector.

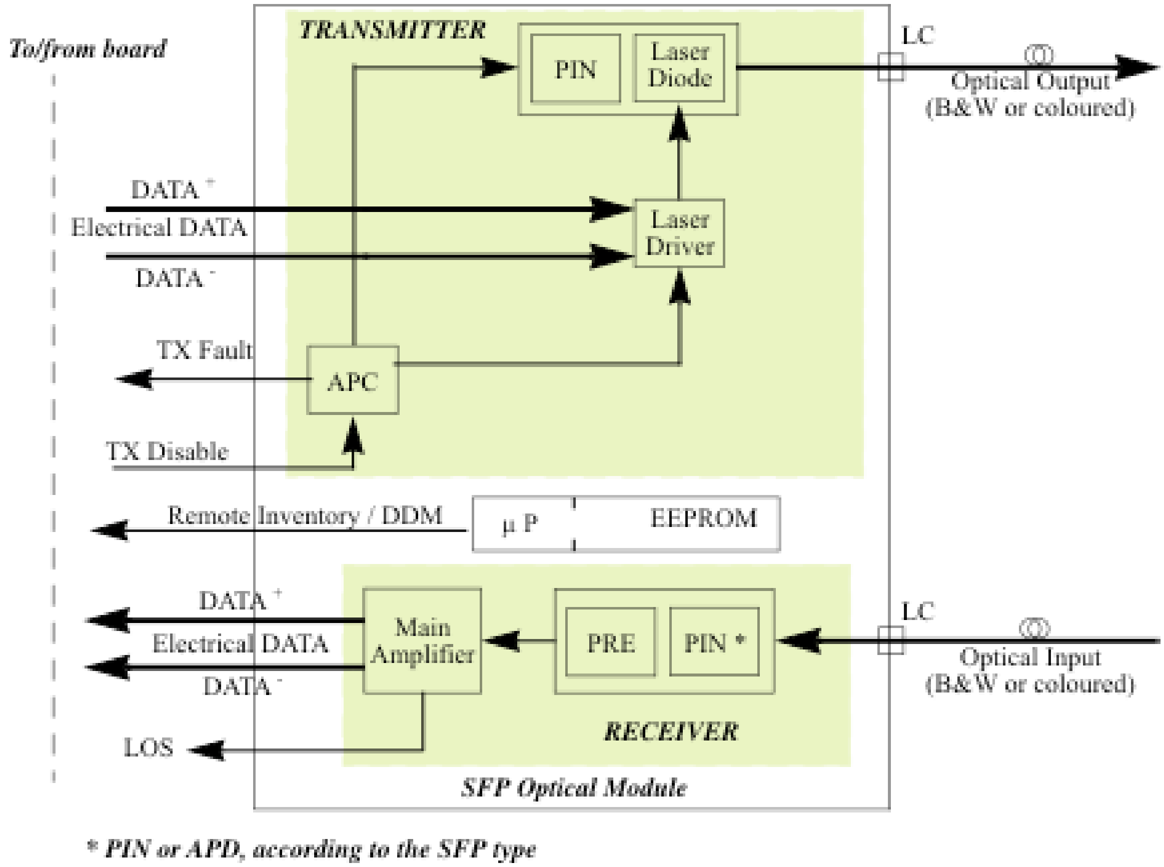
The Transceiver has an EEPROM inside to provide *Remote Inventory*, containing information about transceiver's capabilities, standard interfaces, manufacturer, code, series number, construction date etc. These information are read by the "Alarms and Remote Inventory Management" block of the board in which the module is inserted.

The new SFP families provide a set of information called *Digital Diagnostic Monitoring (DDM)*. Such information reports the characteristic parameters of the interface; they are not static but dynamically updated and directly pursued by the hardware component itself. They are useful for indicating the performance of the optical interface and for monitoring a possible degrade of the component. The reported parameters are:

- Temperature, with 1/256 Celsius degrees as unit measure with range (-128, 128);
- Power supply voltage, with 100 microVolt as unit measure with range (0, 6.5V);
- Transmitter laser bias current, with microAmpere as unit measure;
- Transmitter output power, with milliWatt as unit measure;
- Receiver input power, with milliWatt as unit measure

Power Supply. The Electrical module receives the +3.3 Vdc from the relevant board in which is inserted.

Figure 6-1 Optical SFP modules general block diagram

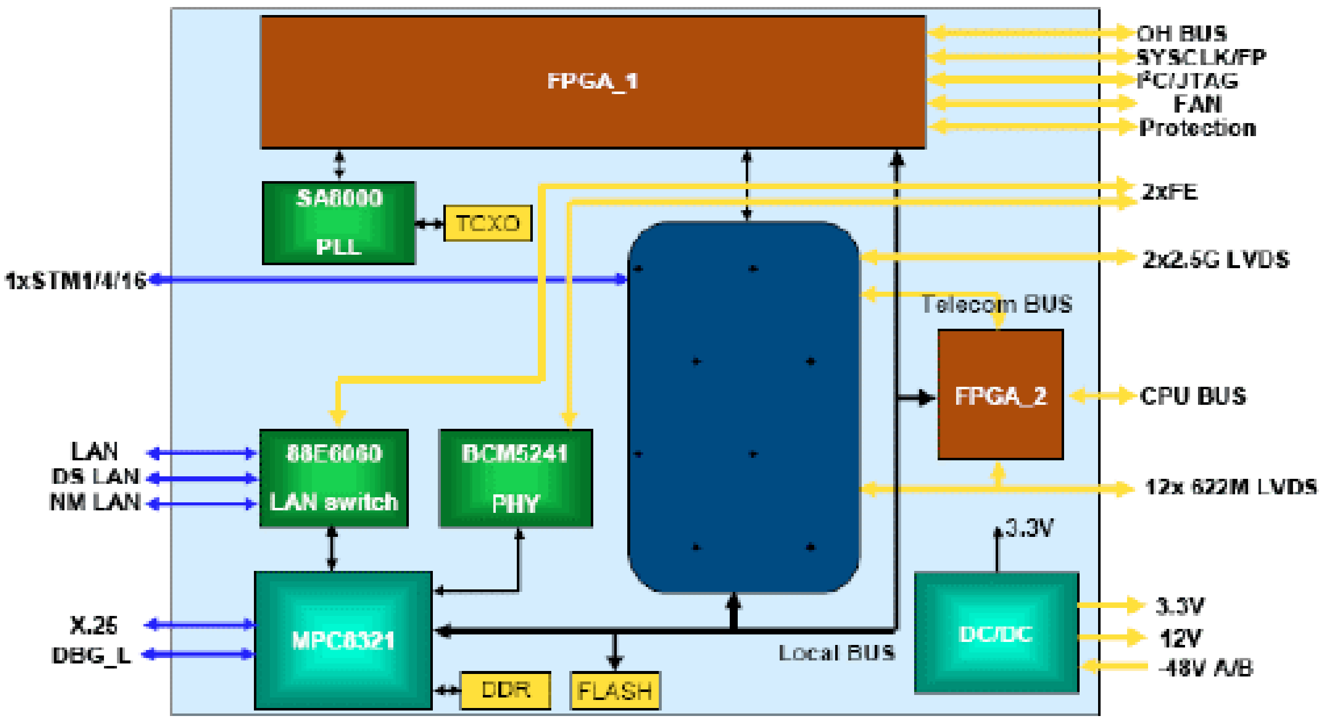


MB16P

MB16P function block

MB16P is an integration board for 1646SM, which includes controller, fabric, timing and SDH line. No PDH and ETH interface, but EPS protection is supported.

Figure 6-2 MB16P function block



General function description

MB16P integrates many function blocks, including:

- Fabric
  - 21.25G High Order and 5G Low Order full cross-connect
  - Support VC-4/VC-3/VC-12 cross-connect
  - Traffic scheduler on all interfaces (STM-N,PDH and ETH)
  - Providing 12x622M LVDS to six LPU slot, two for each
  - Providing 2x2.5G LVDS to another MB16P slot for STM-1/4/16 line interface protection
- STM-1/4/16 interface
  - Providing one STM-1/4/16 optical interfaces
  - Providing one line timing source for CRG block

- SOH/POH and AU pointer process
- K byte reporting, transmitting and pass-through
- Transparent DCC
- Supporting J0/J1/C2 byte setting and query
- Maintenance functions: VC-4 loop-back, transmit/receive OH byte setting and so on

- Synchronization
  - Providing system clock and frame pulse
  - SSM process, timing source priority and switch
  - Lock, holdover and free-running mode
  - One external timing source: 2MHz or 2Mbit/s, 120Ohm interface
- Controller, including SEMF and MCF
  - Providing NM/DS LAN and debug interfaces
  - Providing NE management bus and taking in charge of configuration and collection of alarm and performance.
- EPS protection support
- FAN management

  Supporting six FAN units monitoring and controlling

Front Panel

Refer to Figure 3-4, "MB16P front panel" (p. 3-7)

- Six led (STAT, PROG, SYNC, SRV, ACT, LOS) and one RST button
- One STM1/4/16 line interface
- Four RJ-45 management interfaces
  - LAN1/COM: NMS interface
  - DS/DBG: drop shelf LAN and DBG_L
  - CTL: reserved

– LAN2: spare LAN
– PIN assignment of Front Panel connectors

Front Panel Interface	PIN	Description
LAN1/COM	1	Transmit signal (+)
	2	Transmit signal (-)
	3	Receive signal (+)
	4	GND
	5	X.25 receive signal(not used)
	6	Receive signal (-)
	7	Not used
	8	X.25 transmit signal (not used)
DS/DBG	1	Transmit signal (+)
	2	Transmit signal (-)
	3	Receive signal (+)
	4	GND
	5	DBG_L receive signal
	6	Receive signal (-)
	7	Not used
	8	DBG_L transmit signal
CTL	1	Reserved
	2	
	3	
	4	
	5	
	6	
	7	
	8	

Front Panel Interface	PIN	Description
LAN2	1	Transmit signal (+)
	2	Transmit signal (-)
	3	Receive signal (+)
	4	GND
	5	Serial receive (not used)
	6	Receive signal (-)
	7	Not used
	8	Serial transmit (not used)

Mechanical

- Dimension: 183.8mm (W)×197.7mm (L)×19.8mm (H)
- Weight: 0.479kg

Power consumption

In normal condition (25ºC), maximum power consumption is 21W.

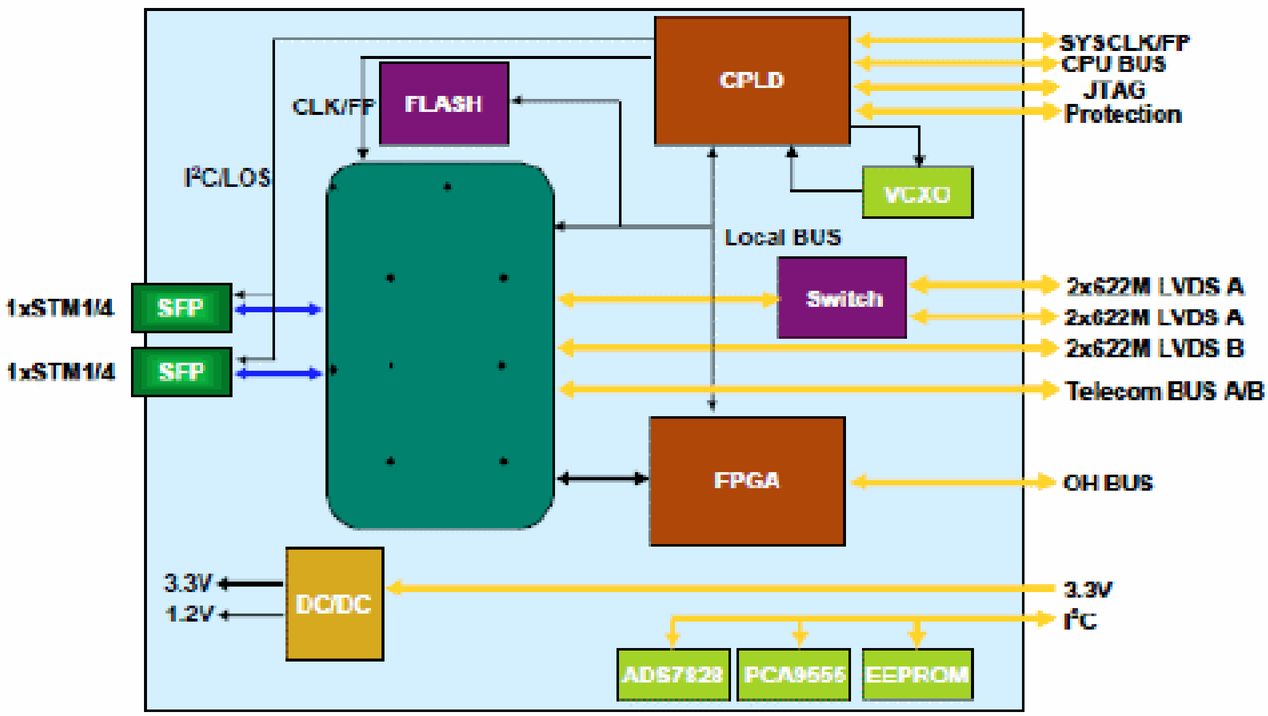
P2S1 and P2S4

P2S1 and P2S4 function block

P2S1 is 2x STM-1 line card and P2S4 is 2x STM-4 line card. Both can be inserted into LPU slot.

P2S1 and P2S4 have similar hardware structure with very few differences, such as board type and so on.

Figure 6-3 P2S1 and P2S4 function block



General function description

- Framer

  It is a STM-1/4 framer, which also integrated CDR/CMU function for line interface. It also includes scramble/de-scramble, multiplexer/de-multiplexer, OH extraction/insertion, AU pointer process and so on.

- I2C BUS

  It is used to read RI, board type and voltage monitoring

- FPGA and CPLD

  Traffic related functions are allocated into CPLD, so that to avoid traffic effect when FPGA upgrade. OH bus process function is in FPGA. FPGA can be download by FLASH.

- LVDS and Telecom BUS

  622M LVDS are used as traffic bus between P2S1/P2S4 and Matrix. For 1646 SM different LVDS bus A are used, so a bus switch is used.
- EPS protection.
- Power

  Only 3.3V from BP is used and power consumption is 4.2W in normal condition (25ºC)

Front panel

Refer to Figure 3-5, “P2S1/P2S4 front panel” (p. 3-7) and

- Four indication LED: STAT, SRV, LOS1, LOS2
- Two STM-1/4 interfaces

Mechanical

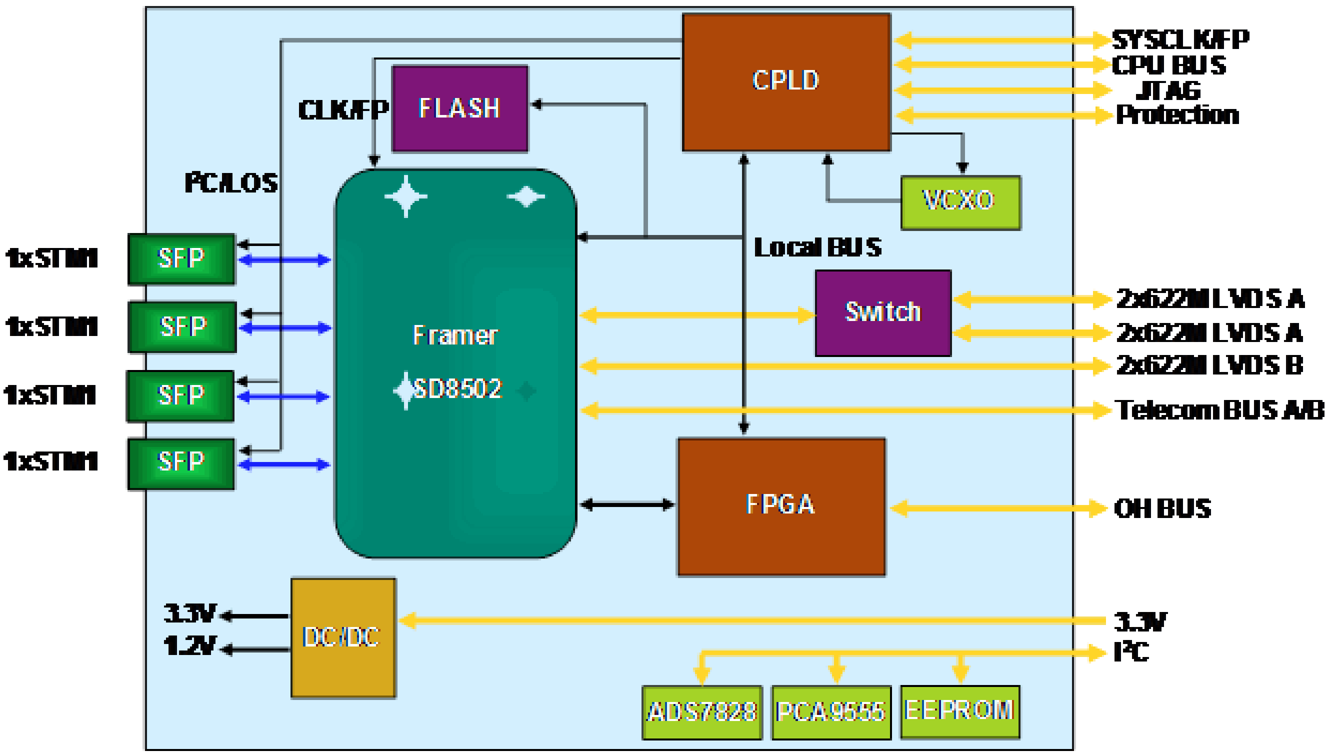
- Dimension: 183.8mm (W) x197.7mm (L) x19.8mm (H)
- Weight: 0.3kg

P4S1

P4S1 function block

P4S1 is a 4x STM-1 line card, which can be inserted into LPU slot.

Figure 6-4 P4S1 function block



General function description

It also supports ETH GFP encapsulation/ de-encapsulation, VCG based on VC-3/12, SDH mapping/de-mapping with back-panel bandwidth 622Mbps.

- **Framer**

  It is an STM-1/4 framer, which also integrates CDR/CMU function for line interface. It also includes processes like scramble/de-scramble, multiplexer/de-multiplexer, OH extraction/insertion, AU pointer, and so on.

- **I2C BUS**

  It is used to read RI, board type and voltage monitoring.

- **FPGA and CPLD**

  Traffic related functions are allocated into CPLD, to avoid traffic effect during FPGA upgrade. OH bus process function is in FPGA. FPGA can be download by FLASH.

- **LVDS and Telecom BUS**

622M LVDS are used as traffic bus between P4S1 and Matrix. For 1646SM uses a different LVDS bus A, so that a bus switch is used.

- **EPS protection**

  EPS protection signals from both MB16P are introduced into CPLD, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP, OH bus, CPU bus and so on.

Front panel

Refer to Figure 3-6, “P4S1 front panel” (p. 3-7)

- Six indication led: STAT, SRV, LOS1, LOS2, LOS3, and LOS4
- Four STM-1 interfaces

Mechanical

- Dimension: 183.8mm (W) × 197.7mm (L) × 19.8mm (H)
- Weight: 0.3kg

Power consumption

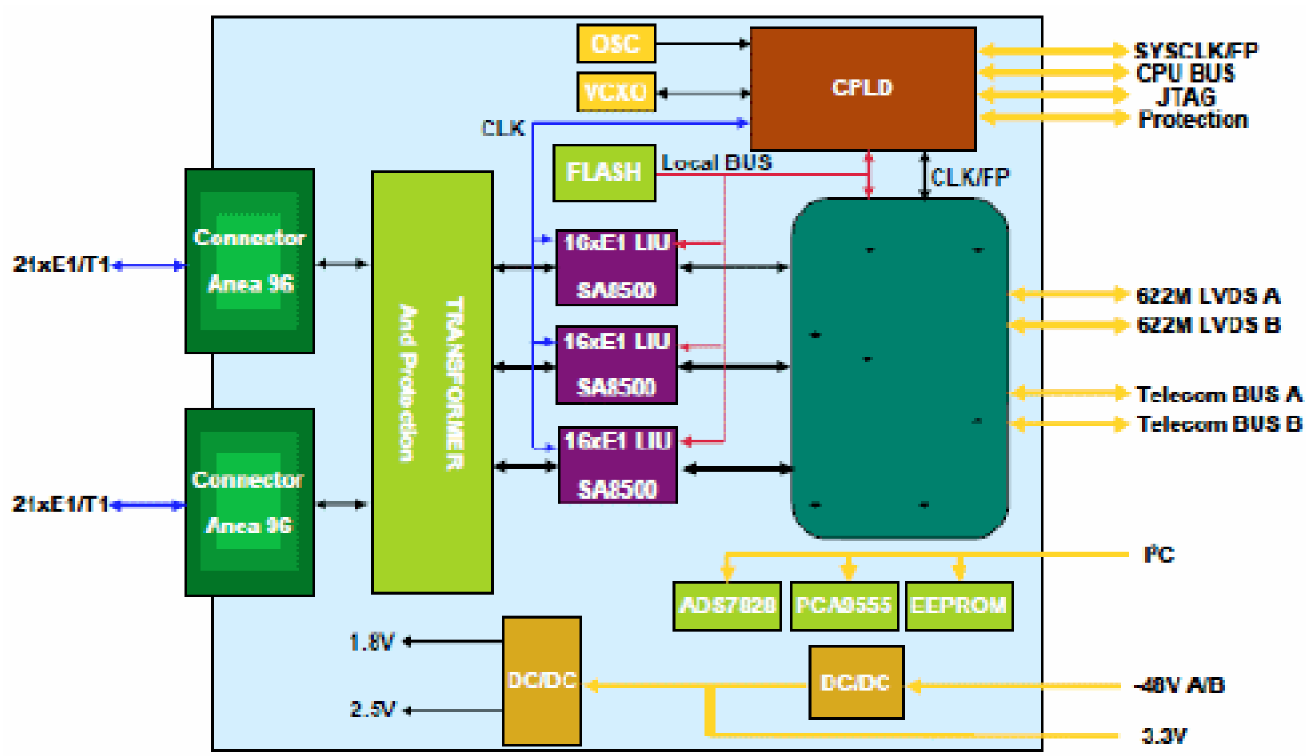
Only 3.3V from BP is used and power consumption is 6.3W in normal condition (25ºC).

PE1A and PE1B

PE1A and PE1B function block

PE1A and PE1B are both 42x E1 PDH access card, which can be inserted into LPU slot. PE1A is 42x E1(120Ohm) and PE1B is 42x E1 (75Ohm).

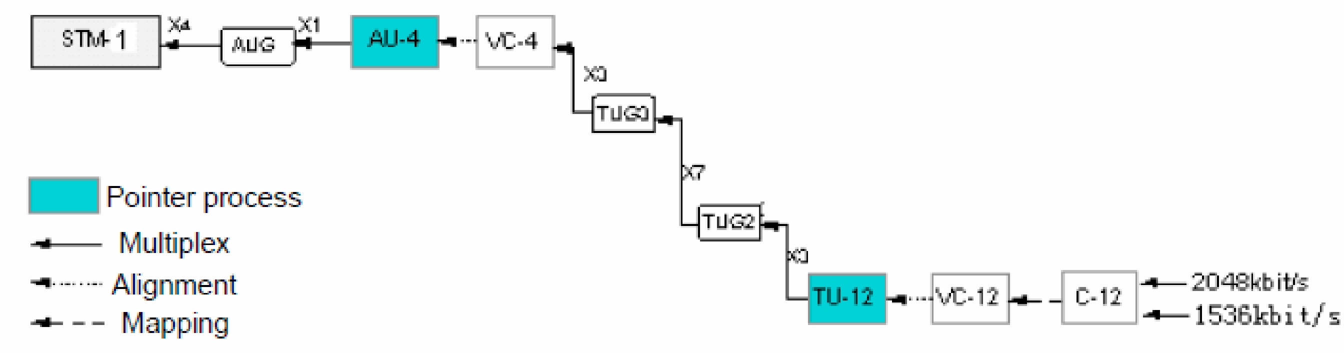
Figure 6-5 PE1A and PE1B function block



General function description

PE1A is 42x E1(120Ohm) and PE1B is 42x E1 (75Ohm).

- E1 mapping path



- Mapper and E1 LIU

  PDH mapper supports 63x E1 and 16x E1 LIU can also extract timing source from PDH interface for system clock.
- I2C BUS

  It is used to read RI, board type and voltage monitoring.
- CPLD

  SMB BUS to Local BUS conversion, timing source selection, system clock/frame pulse and so on
- LVDS and Telecom BUS

  Both LVDS and Telecom BUS are supported by PDH mapper. On 1646SM, only 622M LVDS is used.
- EPS protection

  EPS protection signals from both MB16P are introduced into CPLD, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP, CPU bus and so on.

Front Panel

Refer to Figure 3-7, “PE1A/PE1B front panel” (p. 3-8)

- Two indication led: STAT and SRV
- Two 21x E1 interfaces (Anea96 connector): 1~21 and 22~42 E1 transmit/receive.

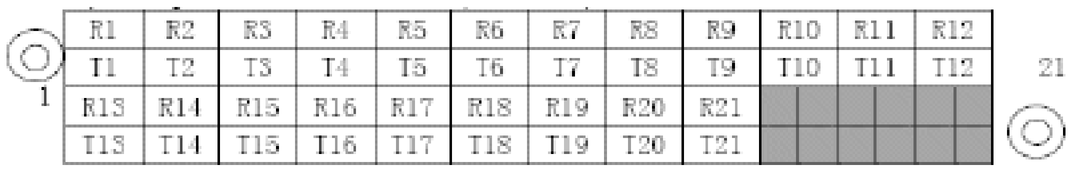
Mechanical

- Dimension: 183.8mm (W) ×197.7mm (L) ×19.8mm (H)
- Weight: 0.85kg

Power consumption

48V to 3.3V DC/DC is used to provide 3.3V power supply and the 3.3V from BP is backup solution. Power consumption is 11.2W in normal condition (25ºC).

Figure 6-6 Connector pin assignment

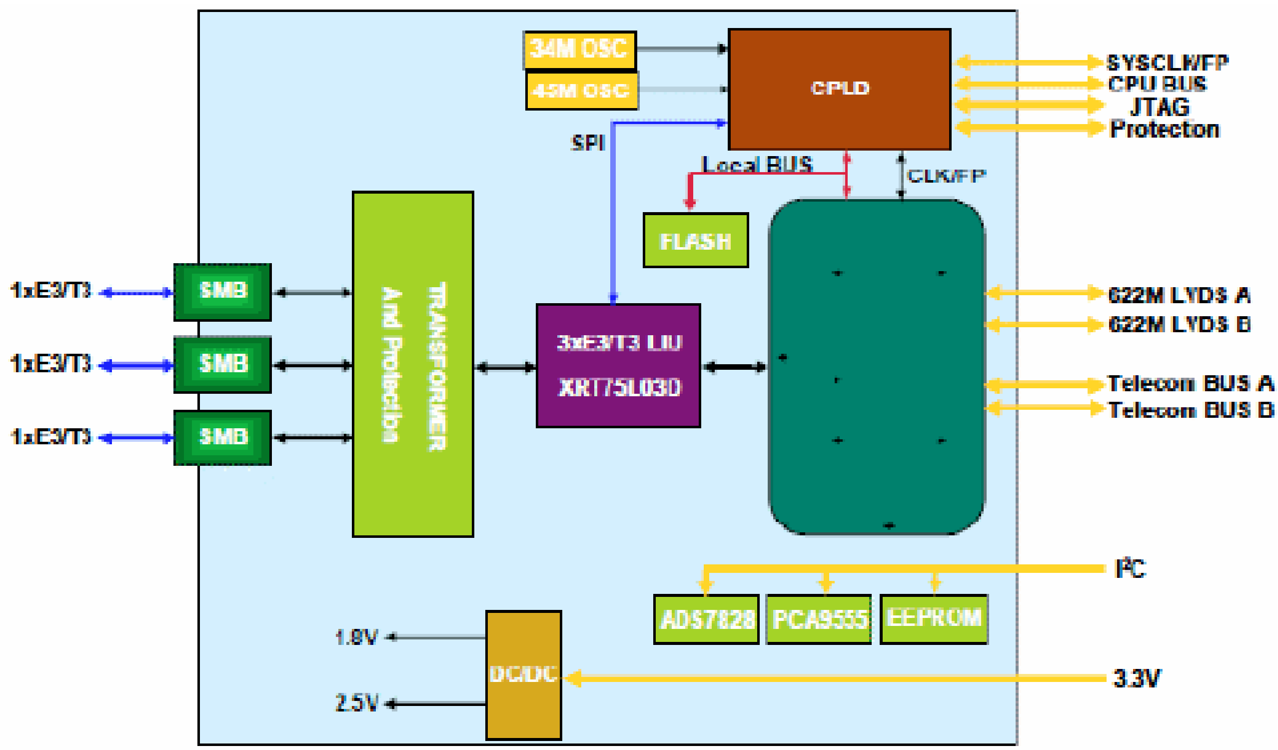


P3E3

P3E3 function block

P3E3 is three channels E3/T3 access card, which can be inserted into LPU slot.

Figure 6-7 P3E3 function block



General function description

- Mapper and E3 LIU

  PDH mapper can support 12x E3/T3 and 3x E3/T3 LIU can also reduce jitter from mapper.

- I2C BUS

  It is used to read RI, board type and voltage monitoring

- CPLD

  SMB BUS to Local BUS and SPI BUS conversion, system clock/frame pulse and so on.

- LVDS and Telecom BUS

  Both LVDS and Telecom BUS are supported by PDH mapper. On 1646SM, only 622M LVDS is used.

- EPS protection

EPS protection signals from both MB16P are introduced into CPLD, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP, CPU bus and so on.

Front Panel

Refer to Figure 3-8, “P3E3 front panel” (p. 3-8)

- Two indication led: STAT and SRV
- 3x E3/T3 interfaces

Mechanical

- Dimension: 183.8mm(W) ×197.7mm (L)×19.8mm (H)
- Weight: 0.3kg

Power consumption

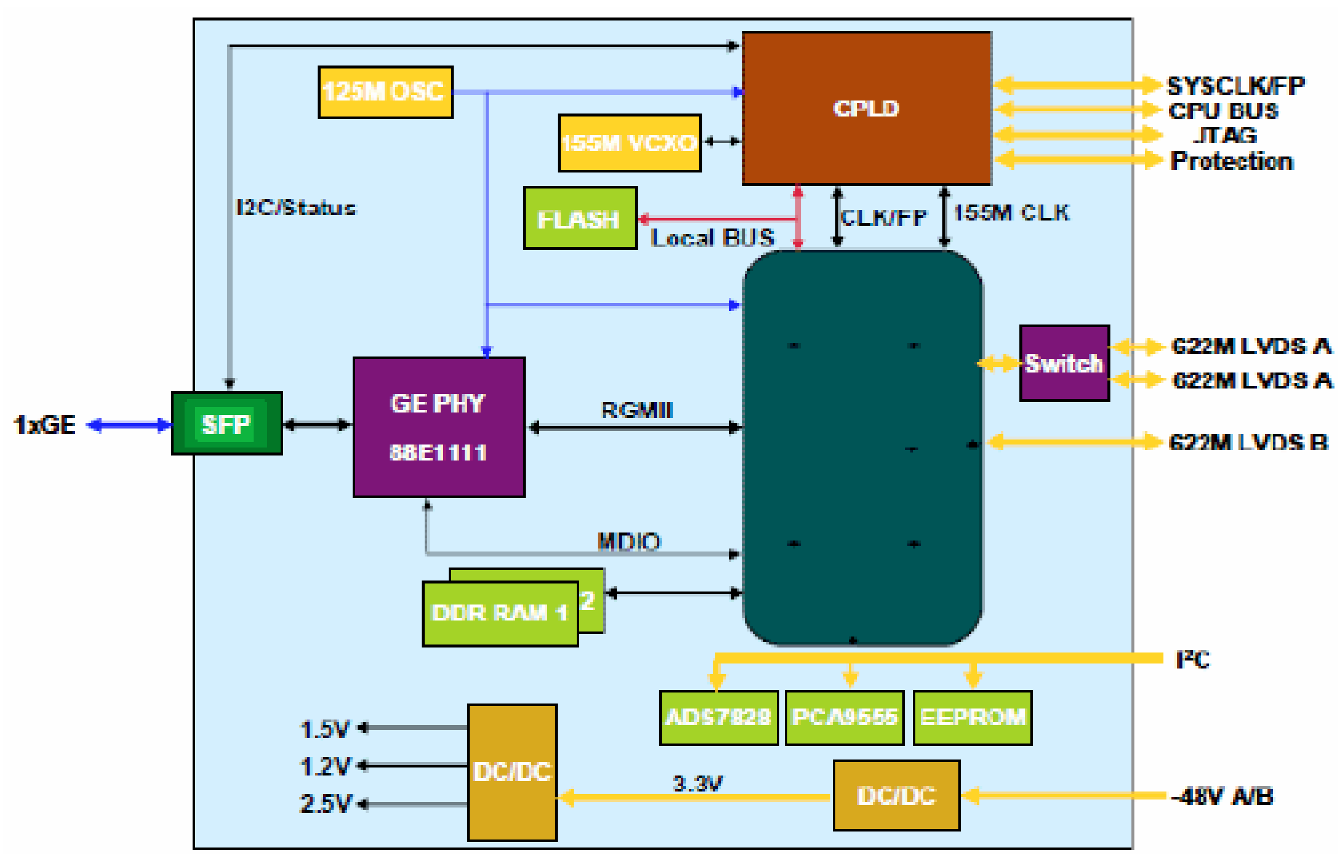
Only 3.3V from BP is used and power consumption is 4.5W in normal condition (25ºC)

P1GET

P1GET function block

P1GET supports 1x GE Ethernet traffic transparent transmission over GFP over SDH network, which can be inserted into LPU slot.

Figure 6-8 P1GET function block



General function description

- General
  - Interface type: 1000BASE-SX/LX
  - Back-panel bandwidth: 622M
  - Encapsulation: GFP-F
  - LCAS: ITU-T G.7042
  - VCG: one VC-trunk
  - VCG type: VC-4-nV VC-3-nV VC12-nV
  - Traffic type: Ethernet II, Ethernet 802.3, Ethernet 802.1 q/p
  - Packet size: 64Byte to 9600Byte

  - VLAN: transparent transmission
  - LPT: P2P LPT (Link State Pass Through)
  - RMON
  - Does not support MPLS and CAR
- EOS mapper and GE PHY

  EOS mapper supports 2x GE MAC or SPI-3 interfaces and up to 2.5G back-panel bandwidth. GE PHY is a single channel GE PHY.
- I2C BUS

  It is used to read RI, board type and voltage monitoring.
- CPLD

  SMB BUS to Local BUS and SPI BUS conversion, system clock/frame pulse, 155M PLL and so on.
- LVDS BUS

  Different 622M LVDS A bus is used on 1646 SM, so a switch is used for compatible design.
- EPS protection

  EPS protection signals from both MB16P are introduced into CPLD, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP, CPU bus and so on.

Front Panel

Refer to Figure 3-9, “P1GET front panel” (p. 3-8)

- Five indication led: STAT, SRV, LINK, ACT and OPM
- 1x GE SFP interfaces

Mechanical

- Dimension: 183.8mm (W)×197.7mm (L)×19.8mm (H)
- Weight: 0.6kg

Power consumption

-48V A/B from BP are used to convert 3.3V and power consumption is 12.5W in normal condition (25ºC).

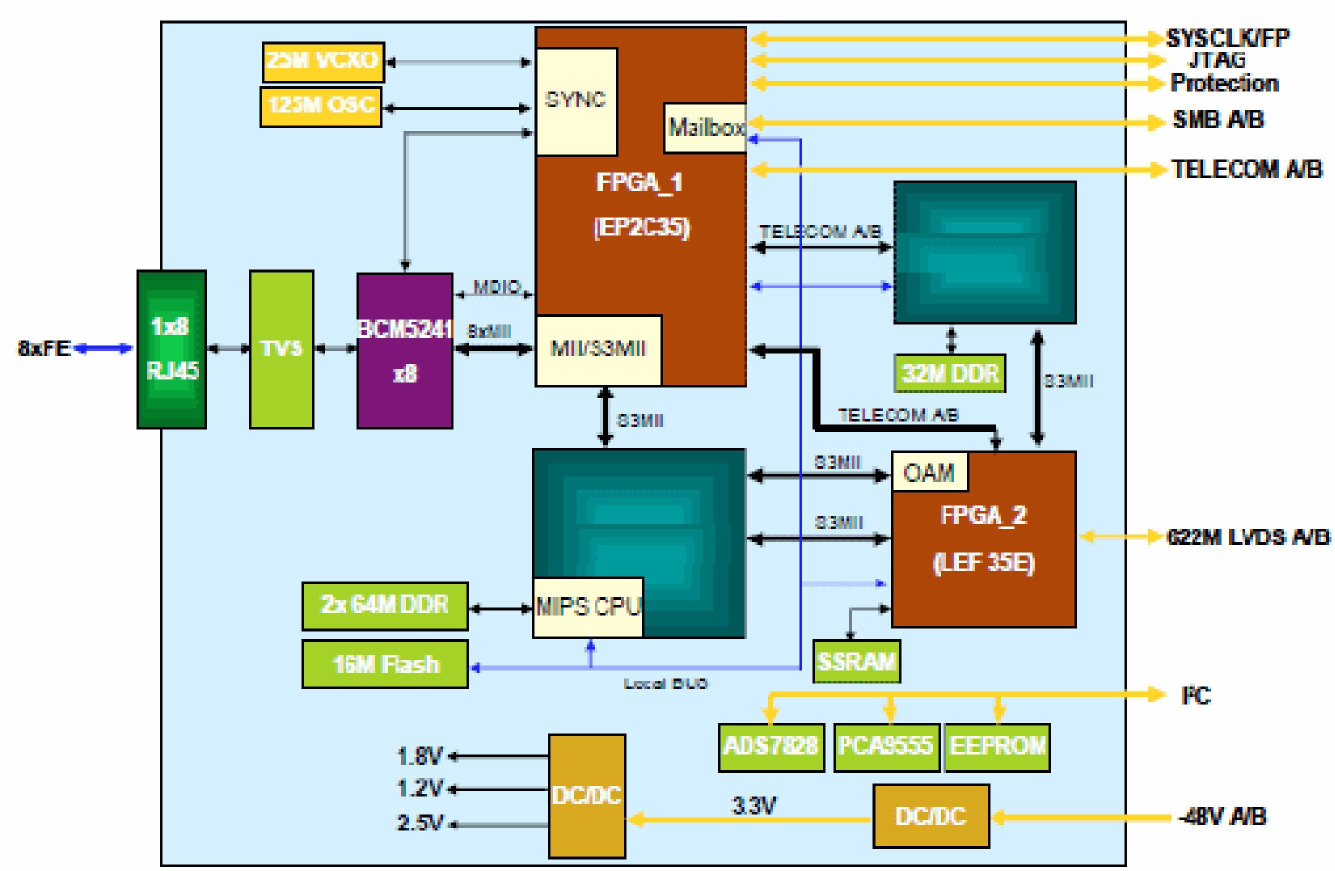
P8FES

P8FES function block

P8FES is a 8 channels 10M/100M Ethernet L2 switch board, which can be inserted into LPU slot.

It supports 8x FE electrical traffic interfaces, FE to FE P2P transparent transmission, FE to FE aggregation, packet L2 switch, port isolation, flow classification, flow control, VLAN management, priority configuration.

Figure 6-9 P8FES function block



General function description

It also supports ETH GFP encapsulation/ de-encapsulation, VCG based on VC-3/12, SDH mapping/de-mapping with back-panel bandwidth 622Mbps.

-
  - Interface type: 100BASE-TX, IEEE802.3u
  - Back-panel bandwidth: 622M

- Encapsulation: GFP-F
- LCAS: ITU-T G.7042
- VCG: 8 VC-trunk
- VCG type: VC-3-nV, VC12- Nv
- Service type: EPL, EVPL, EPLAN, EVPLAN
- Traffic type: Ethernet II, Ethernet 802.3, Ethernet 802.1 q/p
- Packet size: 64Byte to 9600Byte
- ETH OAM: CC(Continuity check), LB (Loop-back), LT (Link trace), LD (Loop detection) and so on
- VLAN: transparent transmission
- LPT: P2P and P2MP LPT (Link State Pass Through)
- QoS
- Flow control: IEEE 802.3x
- RMON
- Port mirror
- LAG
- STP/RSTP
- Does not support MPLS
- ERP (G.8032) and ELP (G.8031)

- FE PHY, L2 switch and EOS mapper

  BCM5241 is a single channel 10M/100M PHY, it supports SYNC-E function. BCM56024 is a L2 switch ASIC, which also integrates MIPS CPU. SD8821 is a EOS ASIC with Telecom BUS interface on BP side.

- I2C BUS

  It is used to read RI, board type and voltage monitoring.

- FPGA

  Two FPGA are used:

  FPGA_1 is for SMB BUS to Local BUS conversion, system clock/frame pulse, SYNC, Mailbox, MII/S3MII conversion and so on.

  FPGA_2 is for LVDS/ Telecom BUS conversion and ETH OAM.

- LVDS and Telecom BUS

  622M LVDS BUS is used on 1646SM system.

- EPS protection

EPS protection signals from both MB16P are introduced into CPLD, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP, CPU bus and so on.

Front panel

Refer to Figure 3-10, “P8FES front panel” (p. 3-8)

- Three indication led: STAT, SRV and PROG
- 8x FE RJ-45 interfaces

Mechanical

- Dimension: 183.8mm (W)c×197.7mm (L)×19.8mm (H)
- Weight: 0.65kg

Power consumption

-48V A/B from BP are used to convert 3.3V and power consumption is 13W in normal condition (25ºC)

Table 6-1 PIN assignment of front panel connector

Front Panel Interface	PIN	Description
FE Interface (1~4, 5~8)	1	Transmit signal (+)
	2	Transmit signal (-)
	3	Receive signal (+)
	4	Not used
	5	Not used
	6	Receive signal (-)
	7	Not used
	8	Not used

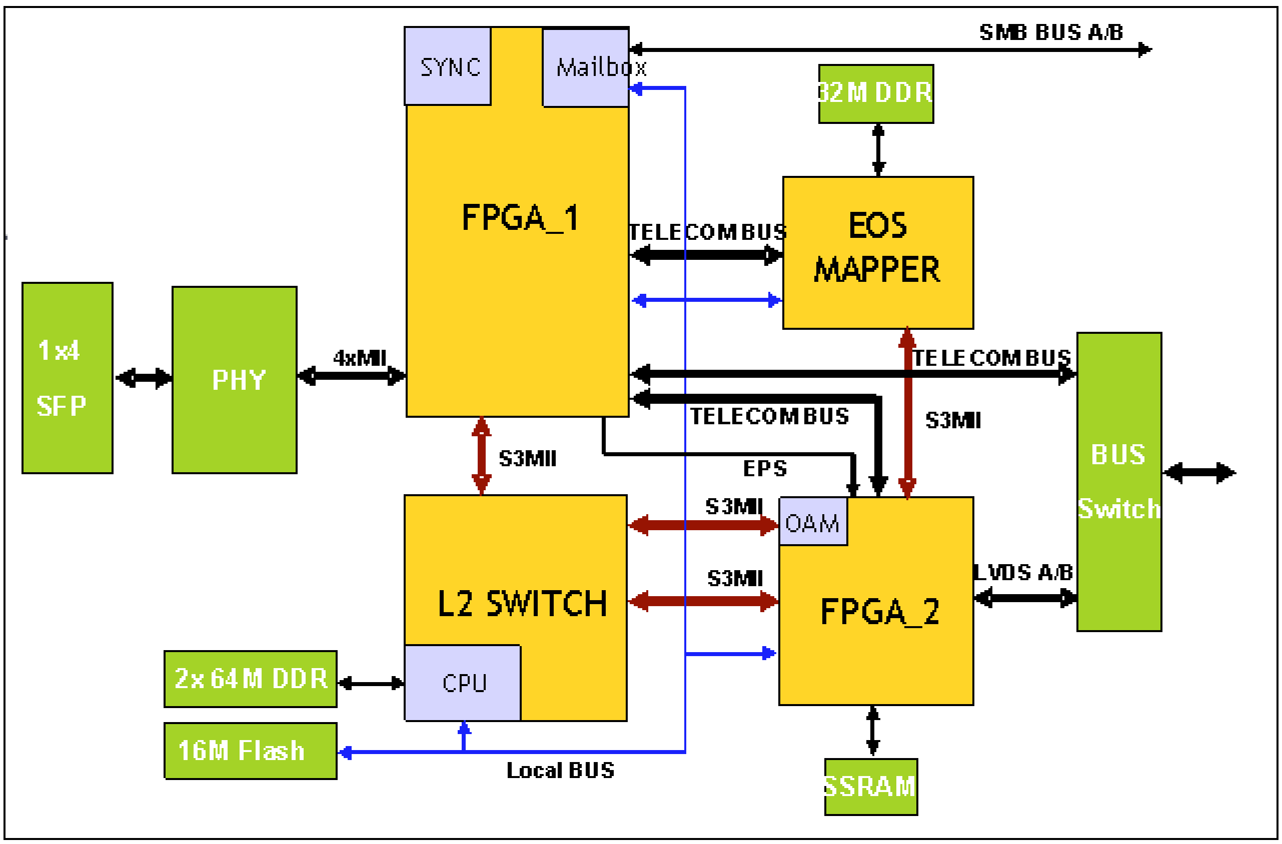
P4FXS

P4FXS function block

P4FXS is a 4 channels 100M Ethernet L2 switch board with SFP interfaces, which can be inserted into LPU slot of the 1646SM.

It supports 4xFX optical traffic interfaces, FX to FX P2P transparent transmission, FX to FX aggregation, packet L2 switch, port isolation, flow classification, flow control, VLAN management, and priority configuration.

Figure 6-10 P4FXS function block



General function description

It also supports ETH GFP encapsulation/ de-encapsulation, VCG based on VC-3/12, SDH mapping/de-mapping with back-panel bandwidth 622Mbps

-
  - Interface type: 100Base-FX
  - Back-panel bandwidth: 622M
  - Encapsulation: GFP-F

- LCAS: ITU-T G.7042
- VCG: 4 VC-trunk
- VCG type: VC-3-nV, VC12- Nv
- Service type: EPL, EVPL, EPLAN, EVPLAN
- Traffic type: Ethernet II, Ethernet 802.3, Ethernet 802.1 q/p
- Packet size: 64Byte to 9600Byte
- ETH OAM: CC(Continuity check), LB (Loop-back), LT (Link trace), LD (Loop detection) and so on
- VLAN: transparent transmission
- LPT: P2P and P2MP LPT (Link State Pass Through)
- QoS
- Flow control: IEEE 802.3x
- RMON
- Port mirror
- LAG
- STP/RSTP
- ERP (G.8032) and ELP (G.8031)
- Does not support MPLS

- FE PHY, L2 switch and EOS mapper

  FE PHY is a single channel 10M/100M PHY, it supports also SYNC-E function. L2 switch ASIC also integrates MIPS CPU. EOS mapper supports only Telecom BUS interface on BP side.

- I2C BUS

  It is used to read RI, board type and voltage monitoring.

- FPGA
  Two FPGA are used:
  - FPGA_1 is for SMB BUS to Local BUS conversion, system clock/frame pulse, SYNC, Mailbox, MII/S3MII conversion and so on.
  - FPGA_2 is for LVDS/ Telecom BUS conversion and ETH OAM.

- LVDS and Telecom BUS

  622M LVDS BUS is used on 1646 SM system.

- EPS protection

  EPS protection signals from both MB16P are introduced into CPLD, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP,CPU bus and so on.

Front panel

Refer to Figure 3-11, “P4FXS front panel” (p. 3-9).

- Three indication led: STAT, SRV and PROG. Four indication LEDs for four interfaces.
- 4x FX SFP interfaces.

Mechanical

- Dimension: 183.8mm (W)c×197.7mm (L)×19.8mm (H)
- Weight: 0.54kg

Power consumption

-48V A/B from BP are used to convert 3.3V and power consumption is 14.4W in normal condition (25°C)

SERVICE

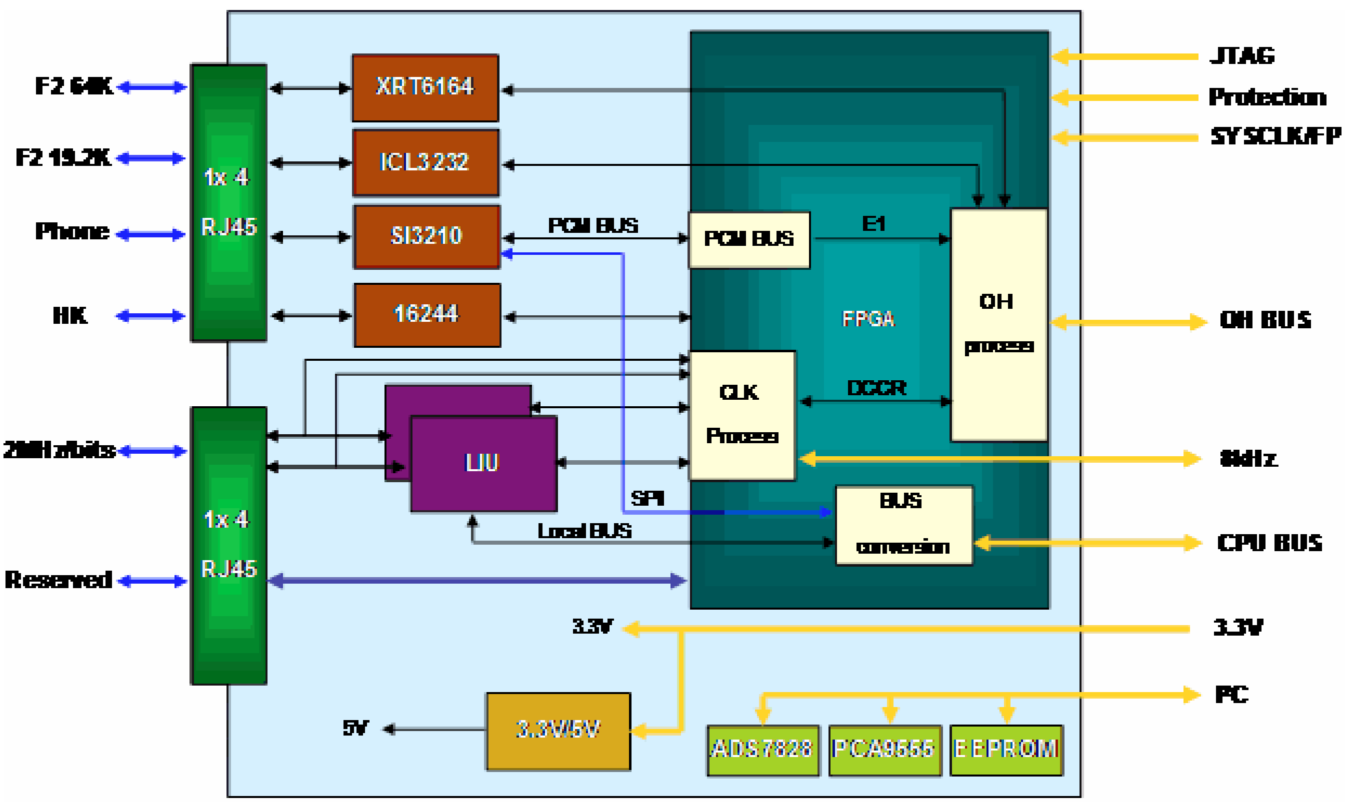
Overview

SERVICE can only be used in 1646SM and should be inserted into anyone of the LPU slot.

It supports the following features.

- EOW UNIT: A phone interface is provided instead of the EOW box. (not used)
- Transparent F2: 64K sync and 19.2K async
- House Keeping: six input and two output
- External Timing: Two external clock sources 2MHz or 2Mbit/s. 2Mbit/s can also be embedded with DCC information, which also needs to be processed
- 1PPS and TOD interfaces (not used)
- All above interfaces are provided with RJ-45 connectors

Figure 6-11 EOW BOX function block



General function description

- I2C BUS

It is used to read RI, board type and voltage monitoring.

- FPGA

  FPGA completes several function blocks: OH process, CLK process, BUS conversion, PCM bus and so on.
- EPS protection

  EPS protection signals from both MB16P are introduced into FPGA, then according to a switch table, MB16P A or B is selected, including SYSCLK/FP,CPU bus and so on.
- Power

  3.3V from BP are used and power consumption is 5W in normal condition (25ºC)
- Front panel

  Two indication led: STAT and SRV

  8 x RJ-45 interfaces

  a) F2: 19.2K asynchronous and 64K synchronous serial interface

  b) EOW: phone (not used)

  c) HK1: two housekeeping output

  d) HK2: four housekeeping input

  e) HK3/EXT: two housekeeping input and one extension interface for external equipment management

  f) SYNC: two external clock sourcing

  g) TOD1 and TOD2: 1PPS and TODS interfaces (not used)
- Mechanical

  Dimension: 183.8mm (W) × 197.7mm (L) × 19.8mm (H)

  Weight: 0.3Kg

Front panel

Refer to Figure 3-12, “SERVICE front panel” (p. 3-9)

- PIN assignment of eight RJ-45 interfaces

Table 6-2 PIN assignment of eight RJ-45 interfaces

Front Panel Interface	PIN	Description
F2	1	RS232 transmit
	2	GND
	3	RS232 receive
	4	F2 transmit (+)
	5	F2 transmit (-)
	6	GND
	7	F2 receive (+)
	8	F2 receive (-)
EOW	1	Not used
	2	Not used
	3	Not used
	4	EOW RING
	5	EOW TIP
	6	Not used
	7	Not used
	8	Not used
HK1	1	HK output0 A
	2	HK output0 B
	3	HK output1 B
	4	HK output0 B
	5	HK output0 A
	6	HK output1 A
	7	HK output1 B
	8	HK output1 A

Table 6-2 PIN assignment of eight RJ-45 interfaces (continued)

Front Panel Interface	PIN	Description
HK2	1	HK in1
	2	GND
	3	HK in2
	4	HK in3
	5	GND
	6	GND
	7	HK in4
	8	GND
HK3/EXT	1	HK in5
	2	GND
	3	EXT receive (-), not used
	4	HK in6
	5	GND
	6	EXT receive (+), not used
	7	EXT transmit (-), not used
	8	EXT transmit (+), not used
SYNC	1	External CLK0 receive (-)
	2	External CLK0 receive (+)
	3	External CLK1 receive (+)
	4	External CLK0 transmit (-)
	5	External CLK0 transmit (+)
	6	External CLK1 receive (-)
	7	External CLK1 transmit (+)
	8	External CLK1 transmit (-)

Table 6-2 PIN assignment of eight RJ-45 interfaces (continued)

Front Panel Interface	PIN	Description
TOD1	1	Not used
	2	Not used
	3	1PPS0 (-)
	4	GND
	5	GND
	6	1PPS0 (+)
	7	TOD0(-)
	8	TOD0(+)
TOD2	1	Not used
	2	Not used
	3	1PPS1 (-)
	4	GND
	5	GND
	6	1PPS1 (+)
	7	TOD1(-)
	8	TOD1(+)

PWDC2

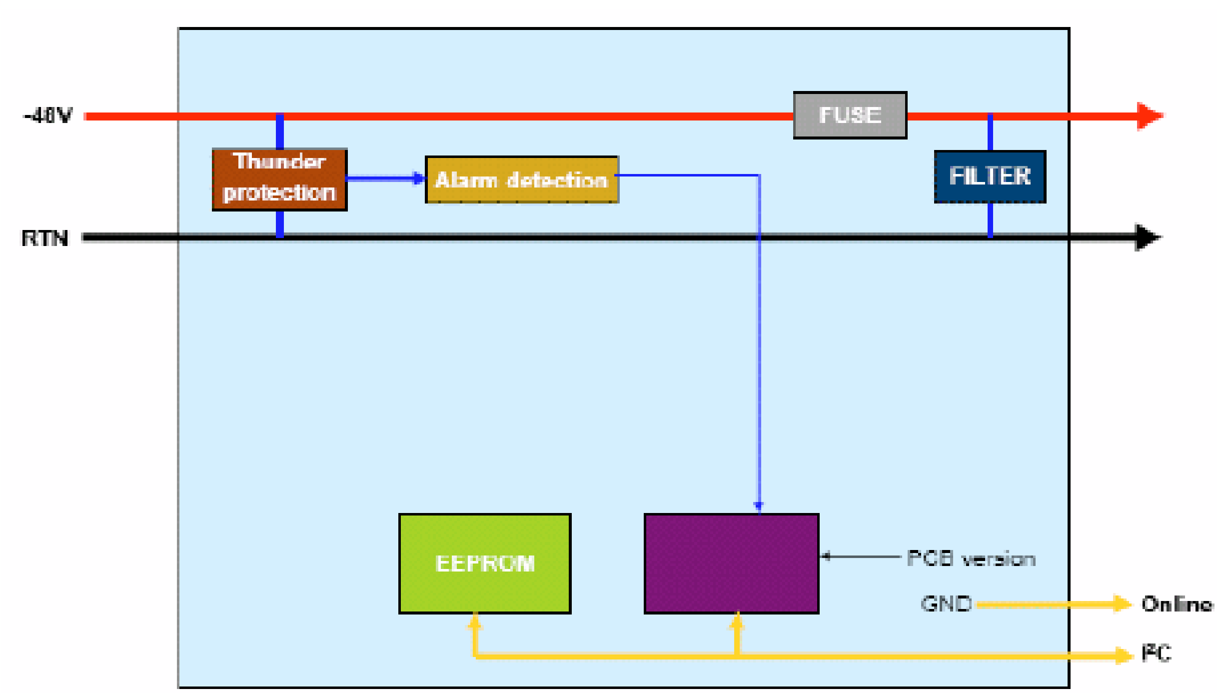
PWDC2 function block

Two PWDC2 boards are supported in 1646SM, These boards are located on the left side of the shelf and provide one power supply interface on each board. PWDC2 provides one -48V power input interface and two PWDC2 boards can work as 1+1 protection.

PWDC2 can be plugged in or out.

It supports power input, thunder protection and protection failure alarm detection and filter, then two -48V are sent to BP. -48V ORed circuit is realized on others boards. Because of layout space limitation, power filter has to be done on others boards, which use this power.

Figure 6-12 PWDC2 function block



General function description

PWDC2 supports following functions:

- One maximum 550W/DC48 power input, range -38.4VDC-72VD and maximum current 15A.
- Input power protection and filter, so that to meet related protection and EMC standard
- Over-current protection
- Power thunder protection, class 1KV/2KV and also provides protection failure detection

- Provide RI, ONLINE and PCB version
- Power indication led

Front Panel

Refer to Figure 3-13, “PWDC2 front panel” (p. 3-9)

- One indication led
- Two -48V interfaces

Power consumption

3.3V from BP is used by I^2C components.

Maximum power consumption of PWDC is 2W.

Two PWDC2 supports 1+1 protection. When only one PWDC2 is inserted and the input voltage is lowest, high power is passed though PWDC2 leading high power consumption. Maximum power consumption of PWDC is 2W.

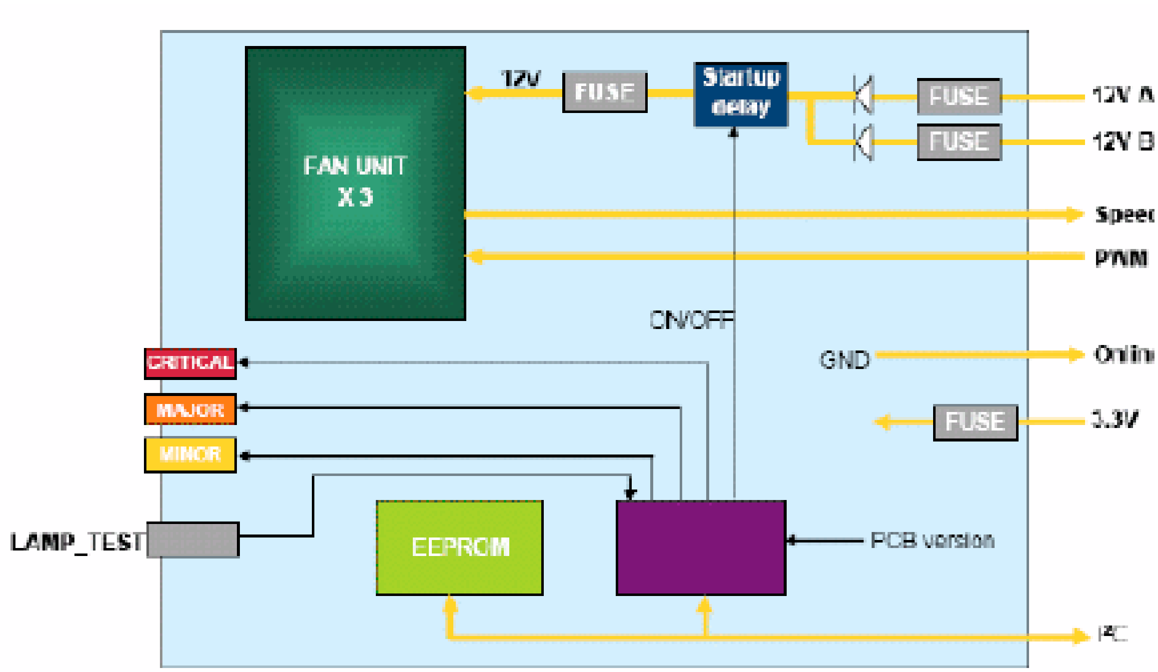
FAN

Overview

One FAN can be used in 1646SM. This block supports FAN speed monitoring and adjustment according to the shelf temperature.

Following is the functional block of the FAN:

Figure 6-13 FAN function block



FAN provides following functions:

- Two 12V power input and can drive maximum 6*6W FAN UNIT, range 10.8Vdc to 13.2Vdc. There is one FAN board containing six FAN units.
- FAN power startup delay and filter
- FAN speed monitoring and PWM adjustment signals
- RI, online and PCB version
- Receive alarm signals from BP, then drive system and FAN indication led
- FAN over-current protection
- FAN power shut down
- LAMP_TEST function
- Temperature monitoring
- System indication led

Three system alarm indication LED are supported:

CRITICAL: red

MAJOR: orange

MINOR: yellow

- LAMP_TEST

  A LAMP_TEST button is available on FAN front panel, which is used to test all led in system. When the LAMP_TEST button is pressed, all LEDs should glow.

- PWM adjustment

  FAN UNIT speed can be adjusted by PWM signals, which comes from MB16P. PWM signals are 1KHz and different duty-cycle can control FAN UNIT speed.

- Power

  3.3V from BP is used by I2C components.

  Total FAN power consumption is around 42W.

- Front panel

  Four indication led: FAN, CRITICAL, MAJOR and MINOR

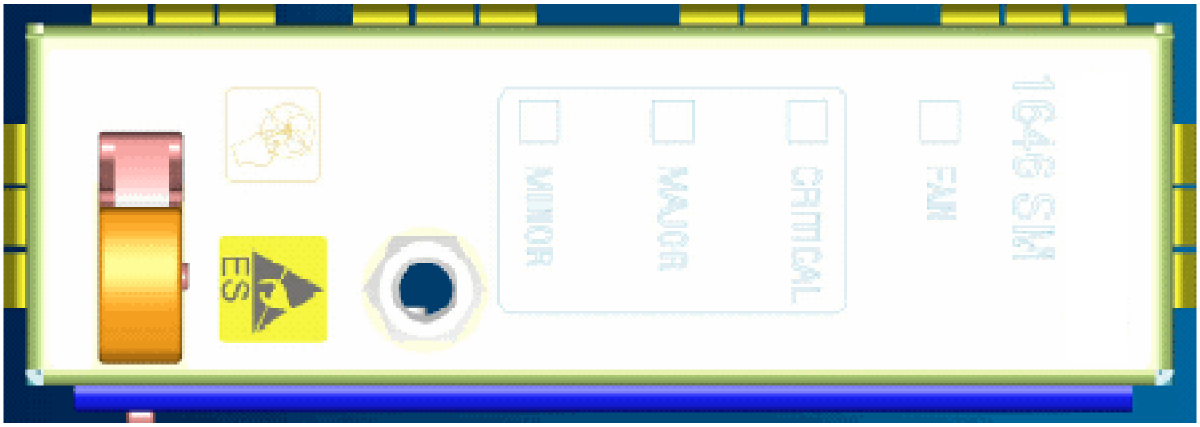
  LAMP_TEST button

Table 6-3 PWM and FAN speed

PWM duty-cycle	FAN speed
100%	16000±10%
80%	12800±10%
70%	11200±10%
60%	9600±10%
50%	8000±10%
40%	6400±10%
30%	4800±10%
0	0

Note: Currently supports only three levels of speed control that includes low, middle, and high.

Figure 6-14 FAN front panel



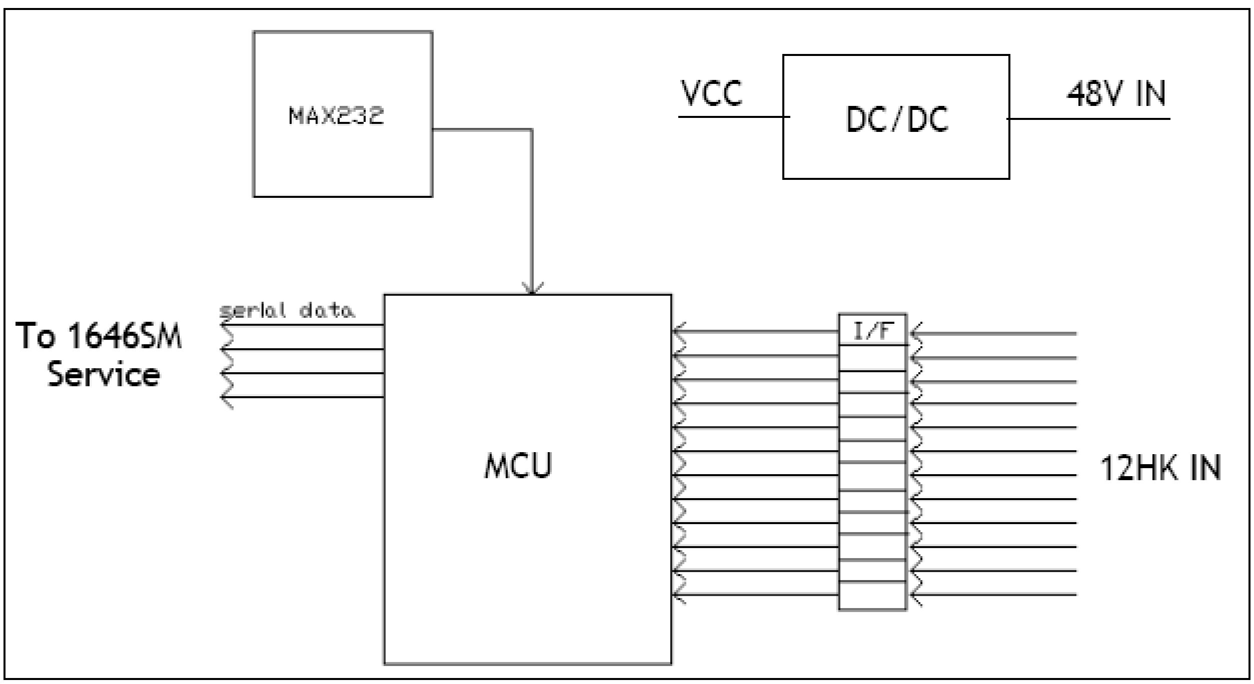
HK BOX

HK BOX function block

Functional description of HK box is as follows:

- Used to extend housekeeping input capacity.
- An external box that can be attached to the 1646 SM.
- Provides 12 housekeeping inputs.
- Has dedicated interface to connect with four housekeeping input I/F on 1646 SM SERVICE card.
- 12 housekeeping input is converted into four serial data and then connected with SERVICE card.
- 1646 SM HK input capacity is increased from 6 to 12.

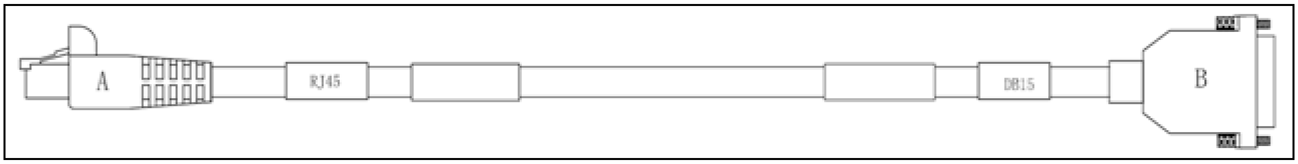
Figure 6-15 HK BOX function block



Housekeeping connections between HK BOX and 1646 SM

Special cable with D_SUB 15 P male connector and RJ45 connector:

Figure 6-16 Housekeeping cable for 1646 SM



- At HK BOX side, plug in the B side D_SUB 15P male connector on the middle of HK BOX.
- At 1646 side, plug in the A side RJ45 jacket on the 1646 SM SERV HK2 port.

Figure 6-17 Housekeeping Cable Pin Sequence

CONNECTOR A (RJ45)		CONNECTOR B (DB15)	
PINS	NAME OF SIGNAL	PINS	NAME OF SIGNAL
1	PIN1	5	PIN5(1646OUT0)
3	PIN3	6	PIN6(1646OUT1)
4	PIN4	7	PIN7(1646OUT2)
7	PIN7	8	PIN8(1646OUT3)
2	PIN2	12	PIN12(1646GND)
5	PIN5	13	PIN13(1646GND)
6	PIN6	14	PIN14(1646GND)
8	PIN8	15	PIN15(1646GND)
		1	Blank
		2	Blank
		3	Blank
		4	Blank
		9	Blank
		10	Blank
		11	Blank

Housekeeping Pin Sequence on 1646 SM SERV HK2 Port.

Figure 6-18 Housekeeping input in SERV(HK2)

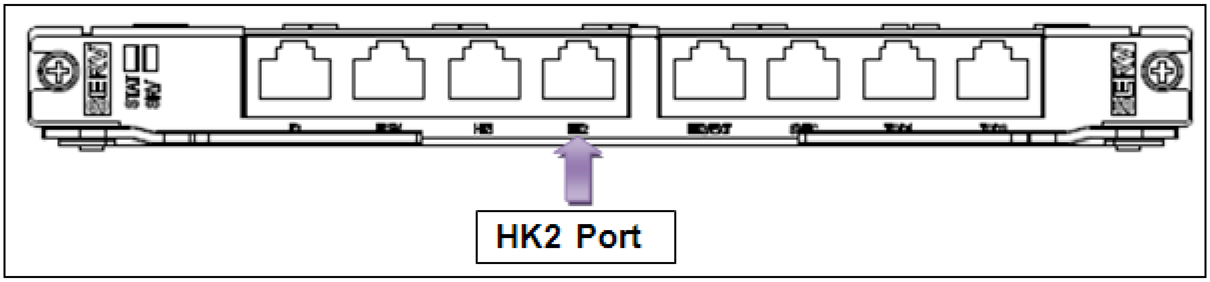


Figure 6-19 Housekeeping Pin Sequence on HK2 Port

	RJ45 ON SERV	
	PINS	FUNCTION
HK2	1	HK INPUT 1
	3	GND
	4	HK INPUT 2
	7	HK INPUT 3
	2	GND
	5	GND
	6	HK INPUT
	8	GND

Mechanical

- Dimension: TBA
- Weight: TBA

Power consumption

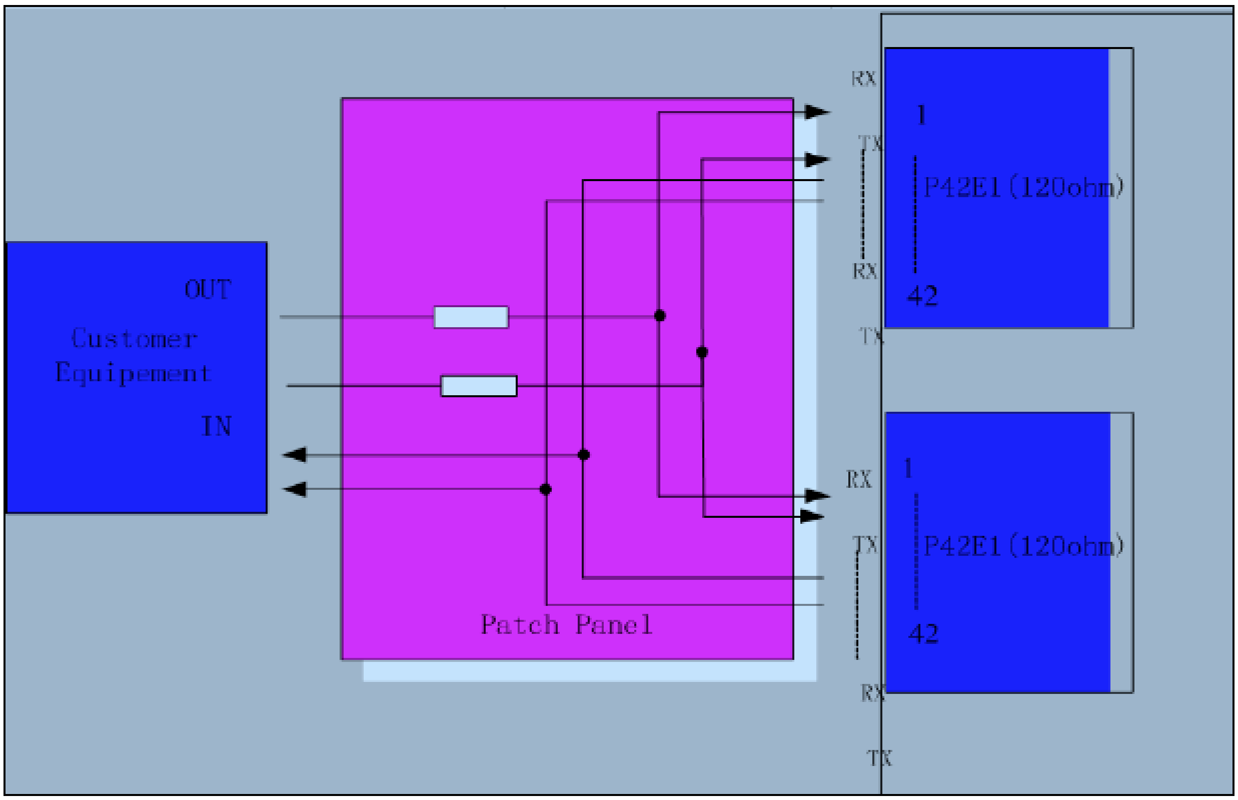
TBA

E1 EPS BOX

E1 EPS BOX function block

Two external EPS box, E1A EPS (120 Ohm) and E1B EPS (75 Ohm), are designed to support 1+1 E1 EPS in 1646SM shelf.

Figure 6-20 E1 EPS BOX function block



Unit description of E1 EPS BOX is as follows:

- The E1 EPS boxes are passive and hence do not consume power.
- Supports 75 Ohm and 120 Ohm.
- Each external box can support one 1+1 EPS protection group for PE1A/B.
- Each external box can support 42×E1. It complies with ITUT G.703 standards.
- Up to three groups of 1+1 EPS protection are supported in 1646SM, that are listed as follows.
  - Maximum protected E1: 3x42 =126.
  - Three external EPS protection boxes must be equipped in this case.
  - Three EPS slot groups for 1646SM: Slot 1 and 2, Slot 3 and 4, Slot 5 and 6 as shown in the following figure:

<table>
<tr><td rowspan="2">PowerA</td><td rowspan="4">F
A
N</td><td>Slot7(mainboardA)</td><td>Slot8(mainboardB)</td></tr>
<tr><td>Slot5</td><td>Slot6</td></tr>
<tr><td rowspan="2">PowerB</td><td>Slot3</td><td>Slot4</td></tr>
<tr><td>Slot1</td><td>Slot2</td></tr>
</table>

- EPS configuration menu on USM: Configuration and status of EPS group.
- Auto switch in Equipment failure condition: *Card fail, Card mismatch*, and *Card out*.
- Switch commands are supported: Manual and Force release.
- EPS time target is 50ms for *Manual switch* and *Card out*.
- EPS box can be installed in Rack 19 which is a 21 inch slot.

Front panel

Refer to Figure 3-14, “E1 EPS BOX front panel” (p. 3-9).

Mechanical

Dimension: 442mm(W)x 109mm(L)x21.5mm(H)

Power consumption

The E1 EPS Box is passive and does not consume power.

7 Maintenance

Overview

Purpose

This chapter informs the user on the maintenance aspects for the 1646 Synchronous Multiplexer Compact.

> **Important!** While performing the maintenance tasks, observe the safety norms stated in Safety topic.

Contents

General safety rules

DANGER

Danger Possibility of personal injury:

Carefully observe the front-panel warning labels prior to working on optical connections while the equipment is in-service.

Should it be necessary to cut off power during the maintenance phase, proceed to switch off the power supply units as well as cut off power station upstream (rack or station distribution frame)

DANGER

Danger Possibility of personal injury:

A TNV-2 (battery) voltage could be present on "R/M interface connector" (cable side); do not touch the pins when unplugged.

Possibility of personal injury. Short circuiting, low–voltage, low–impedance, DC circuits can cause severe arcing that can result in burns and/or eye damage. Remove rings, watches, and other metal jewelry before working with primary circuits. Exercise caution to avoid shorting power input terminals.

DANGER

Danger Possibility of personal injury:

Possibility of eyes damage: read carefully and strictly observe the rules pointed out in para.Harmful Optical Signals.

General rules

Types

a. Check that the equipment is operating with all the shields properly positioned (dummy covers, ESD connector protections, etc)

b. In order to reduce the risk of damage the electrostatic sensitive devices, is mandatory to use the elasticized band (around the wrist) and the coiled cord joined connect with the ground rack during the touching of the equipment

Maintenance aspects

Overview

Maintenance consists of a set of operations which maintain or bring back the assembly to optimum operating conditions in a very short time, with the aim of obtaining maximum operational availability.

Maintenance is classified as:

- Routine
- Corrective

Instruments and accessories

There is a local terminal (PC) which permits to display all the alarms and manages the Equipment. The relative processing is described in the operator's handbook.

Where TMN is implemented, an Operation System displays alarms and manages all the connected Equipments of the network. Refer to the relevant handbooks.

The need of special tools and accessories to perform possible routine and corrective maintenance procedures is described inside the procedures themselves.

Routine maintenance

Routine maintenance of dust filter

Routine maintenance is a periodic set of measurements and checks. This maintenance discovers those devices whose function has deteriorated with time and therefore need adjustment or replacement.

Typically, digital equipment requires no routine maintenance.

The equipment allows to assess the quality of the connection links for SECTION and PATH for counting the error events and obtaining performance data.

Metallic filter cleaning

WARNING

Safety rules:

(Caution to avoid equipment damage)

Before installing or removing the metallic filter, check that the protective adhesive film has been removed.

Replace the “Metallic filter” from the FANS Shelf as follows:

- Unscrew the screws that ensure the Metallic filter to the fans shelf
- Extract the Metallic filter
- Clean the metallic filter removing the dust using a brush. It's not recommend to use water (to avoid rust the metal parts).
- Insert and ensure the “Metallic filter” to the “FAN shelf” using the relevant screw.

Danger

DANGER

Possibility of personal injury:

Possibility of personal injury. Personal injury can be caused by rotating fans.

Note: It is required to clean the filter every 3 months; this period can be shorter depending on the location environmental conditions.

Dust Filter cleaning

WARNING

Safety rules:

(Caution to avoid equipment damage)

Before installing or removing the metallic filter, check that the protective adhesive film has been removed.

Danger

DANGER

Danger Possibility of personal injury:

Possibility of personal injury. Personal injury can be caused by rotating fans.

Short circuit, low voltage, low-impedance, DC circuits can cause severe arcing that can result in burns and/or eye damage. Remove rings, watches, and other metal jewelry before working with primary circuits. Exercise caution to avoid shorting power input terminals

Replace the "Metallic filter" from the FANS Shelf as follows:

- *Unscrew the screws that ensure the Metallic filter to the fans shelf*
- *Extract the Metallic filter*
- *Clean the metallic filter removing the dust using a brush. It's not recommend to use water (to avoid rust the metal parts).*
- *Insert and ensure the "Metallic filter" to the "FAN shelf" using the relevant screw.*

  Note: It is required to clean the filter every 1 month; this period can be shorter depending on the location environmental conditions. Furthermore, it is required to replace this type of filter every 6 months.

Dust filter for fan shelf substitution

WARNING

Safety rules:

(Caution to avoid equipment damage)

BEFORE INSTALLING OR REMOVING THE METALLIC FILTER, CHECK THAT THE PROTECTIVE ADHESIVE FILM HAS BEEN REMOVED.

Danger

DANGER

Possibility of personal injury:

Possibility of personal injury. Personal injury can be caused by rotating fans.

Replace the “Dust filter” from the FANS Shelf as follows:

- Unscrew the screws that ensure the dust filter to the fans shelf
- Extract the Dust filter
- Insert the new Dust filter
- Ensure the “Dust filter” to the “FAN shelf“ using the relevant screw

  Note: It is required to replace the filter every 6 months; this period can be shorter depending on the environmental conditions.

Routine maintenance every year

It is suggested to carry out the following operations yearly:

- power cables check

DANGER

Possibility of personal injury:

Possibility of personal injury. Personal injury can be caused by -48 V DC Possibility of personal injury.

Short circuting, low–voltage, low–impedance, DC circuits can cause severe arcing that can result in burns and/or eye damage. Remove rings, watches, and other metal jewelry before working with primary circuits. Exercise caution to avoid shorting power input terminals.

Make these operations:

- Check that the power cable is perfectly safety grounded.
- Make sure that the subrack has been tightly fastened to the rack with screws, to guarantee grounding (the rack is connected to the station ground).

Routine maintenance every five year

It is suggested the replacement of each FANS UNIT equipped in the Fans Subrack after **five** years of working.

Corrective maintenance (Troubleshooting)

Fixing the units (and modules) into the subrack

CAUTION

Caution to avoid equipment damage:

The screw tightening torque for fixing the units (and modules, if any and if fixed by screws) into the subrack must be:2.8 kg x cm (0.28 Newton x m) ±10 %

Exceeding this value may result in screw breaking.

Since the Troubleshooting procedure is carried out with the use of the Craft Terminal, please refer, for details, to the Maintenance Section of the Operator's Handbook.

Spare parts management

Suggested spare parts

The overall number of spares depends on customer requirements, and should be based on the average amount of transmission circuits available to be accounted for not only during MTBF but also during MTTR.

Note: The MTTR depends on the amount of spare parts available.

The set of spare parts is inclusive of a minimum number of spares for each type of replaceable plug-in unit (see unit list in Chapter 2).

The spare part numbers are recommended (see Chapter 9).

General rules on spare parts management

Before storing the spare units make sure that they are working by inserting them in operating equipment.

It is suggested to periodically check those spare units have not been utilized for over a year.

If the spare parts and the equipment are stored in the same environment, make sure that the spare parts are placed in cabinets to safeguard them from dust and damp.

Moreover, they should also be well grounded to avoid electrostatic discharges.

If the spare parts are stored in another room, or have to be moved from another place, building or site, make sure that the following is observed:

- The spare parts must be wrapped in anti-static and padded envelopes
- The spare parts must not touch wet surfaces or chemical agents that might damage them (e.g., gas);
- If during transport the temperature is lower than that of the room where they had been kept, make sure that before using them they pass a certain period in a climatic chamber to prevent thermal shocks and/or the possibility of steaming up.

  Note: When replacing a unit/sub-unit, make sure that the spare unit/sub-unit is set exactly as the replaced one. For the presetting procedures, see section HARDWARE SETTING DOCUMENTATION.

Particular rules on spare parts management

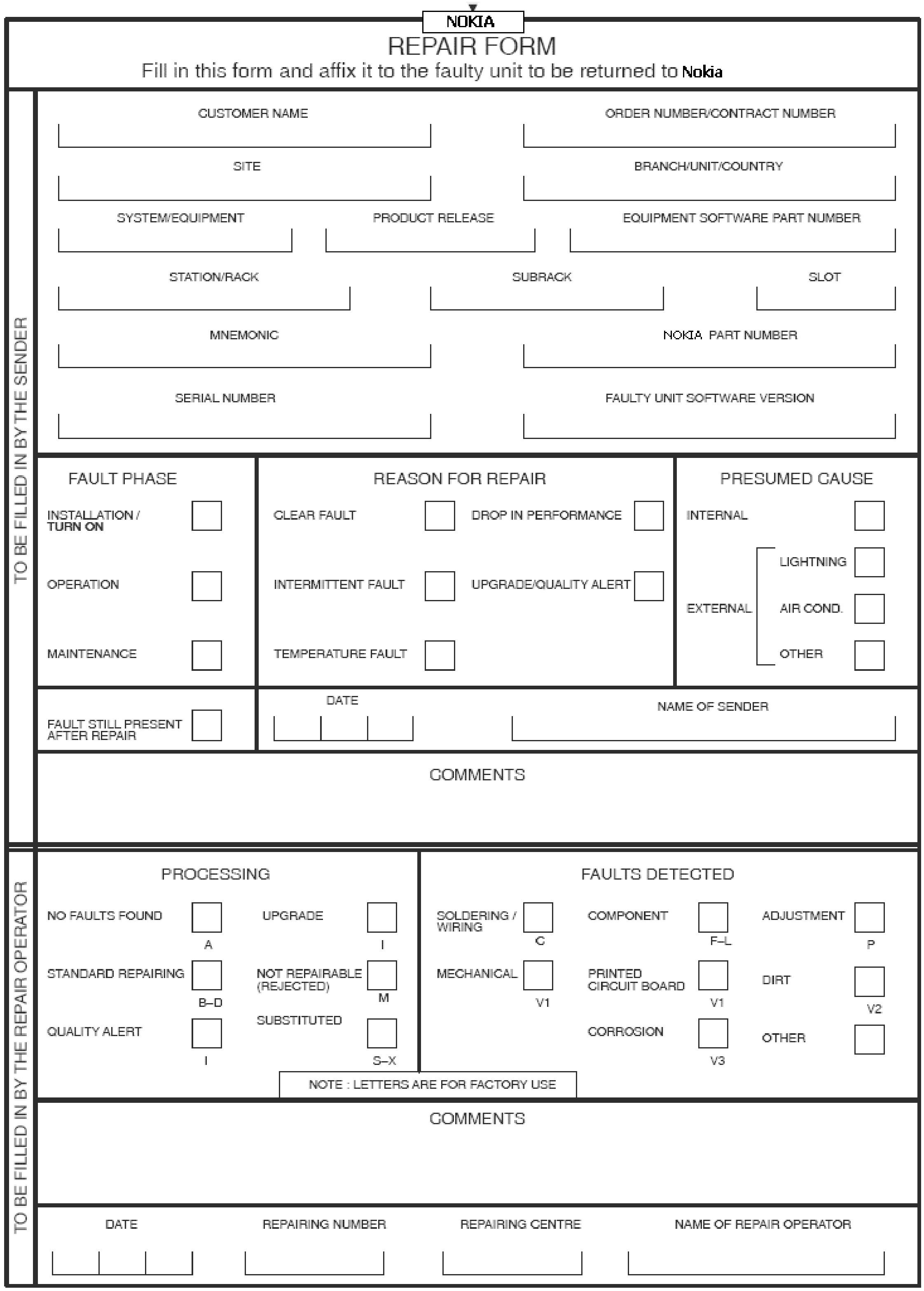
Whenever some units with flash–memories are common to different kinds of equipment or to different versions of the same type of equipment, it is possible to maintain one spare part only: this allows spare part stock saving, even though software downloading will be necessary when the software loaded into the unit (program part or data part) is different from that necessary in the equipment where the spare unit must be used.

At the end of the commissioning phase or after an equipment data change, it is suggested to save the equipment data, e.g. on floppy disk, and store this floppy disk in the spare part stock pointing out the equipment it refers to Figure 7-1, “Repair form” (p. 7-13).

Repair form

To facilitate operation, data on the faulty unit must be reported on the form shown in Figure 7-1, “Repair form” (p. 7-13). The repair form must be filled-in with as much data as possible and returned to Nokia together with the faulty unit.

Figure 7-1 Repair form



NOKIA

REPAIR FORM

Fill in this form and affix it to the faulty unit to be returned to Nokia

TO BE FILLED IN BY THE SENDER

CUSTOMER NAME

ORDER NUMBER/CONTRACT NUMBER

SITE

BRANCH/UNIT/COUNTRY

SYSTEM/EQUIPMENT

PRODUCT RELEASE

EQUIPMENT SOFTWARE PART NUMBER

STATION/RACK

SUBRACK

SLOT

MNEMONIC

NOKIA PART NUMBER

SERIAL NUMBER

FAULTY UNIT SOFTWARE VERSION

FAULT PHASE

INSTALLATION / TURN ON

OPERATION

MAINTENANCE

REASON FOR REPAIR

CLEAR FAULT

DROP IN PERFORMANCE

INTERMITTENT FAULT

UPGRADE/QUALITY ALERT

TEMPERATURE FAULT

PRESUMED CAUSE

INTERNAL

EXTERNAL

LIGHTNING

AIR COND.

OTHER

FAULT STILL PRESENT AFTER REPAIR

DATE

NAME OF SENDER

COMMENTS

TO BE FILLED IN BY THE REPAIR OPERATOR

PROCESSING

NO FAULTS FOUND A

UPGRADE I

STANDARD REPAIRING B–D

NOT REPAIRABLE (REJECTED) M

QUALITY ALERT I

SUBSTITUTED S–X

FAULTS DETECTED

SOLDERING / WIRING C

COMPONENT F–L

ADJUSTMENT P

MECHANICAL V1

PRINTED CIRCUIT BOARD V1

DIRT V2

CORROSION V3

OTHER

NOTE : LETTERS ARE FOR FACTORY USE

COMMENTS

DATE

REPAIRING NUMBER

REPAIRING CENTRE

NAME OF REPAIR OPERATOR

8 Dismantling and recycling

Overview

Purpose

This chapter provides information on dismantling and recycling of the 1646 Synchronous Multiplexer.

Contents

General information

Wastes of electrical and electronic equipments

A new European directive was published on the 13th of February 2003 on wastes of electrical and Electronic equipment (Directive 2002/96/EC).

The general principle promoted by this directive is the manufacturer responsibility in the management of the wastes coming from the products put by them on the market.

The manufacturer responsibility now covers the end of life of the products sold.

This new split of responsibility has impacts on Nokia practices both as producer and owner of EEE equipment.

Effective August 13, 2005, Waste electrical and electronic equipment (e–Waste) directive sets rules in terms of operational and financial responsibility for the collection and treatment of electrical and electronic equipment in Europe.

9 Quality and reliability

Overview

Purpose

This chapter provides information about quality and reliability information for 1646 SM.

Contents

Nokia quality policy

Quality Policy

Nokia ensures that everything it does must be focused on becoming the trusted partner of its customers by:

- Delivering high quality, secure and reliable products, services, software and solutions the first time, every time, and on time - as promised.
- Continuously making improvements and looking for innovative ways to anticipate and fully meet the highest expectations of our customers.
- Counting on all employees to be personally accountable for putting the customer first and honoring the commitments we make.

Reliability program and specifications

Overview

The reliability program provides enhanced reliability and is implemented as an integral part of the Nokia Product Life Cycle (PLC) process. The reliability program is comprehensive, and includes activities such as setting and ensuring compliance with customer-focused system-reliability requirements, ensuring component qualification is consistent with customer environment and system design, assuring satisfactory component-attachment reliability, predicting failure rates of Field Replaceable Units (FRUs), making sparing recommendations, assessing reliability architecture, modeling system reliability, assuring satisfactory system-downtime performance, reducing hardware failure rates through Environmental Stress Testing (EST), and tracking field returns.

Design and development

During the design and development stage, reliability predictions, qualification and selection of components, definition of quality assurance audit standards, and prototype of critical areas of the system ensure built-in reliability.

Manufacturing and field deployment

During manufacturing and field deployment, techniques such as environmental stress testing, production quality audits, field-return tracking, failure-mode analysis, feedback and corrective-action further enhance the ongoing reliability improvement efforts on the 1646 SM.

General specifications

This section provides general reliability specifications for 1646 SM.

Mean time between failure

Mean time between failure (MTBF) is the mean duration of system hardware maintenance due to hardware failure. It does not reflect any service/traffic failure (service is to be protected by redundant hardware). The Mean Time Between Failures (MTBF) can be derived from the failure rate (FIT value) using the following formula. The failure rate here refers to the sum of all circuit packs in the system.

MTBF [years] = 10^9/ (FIT value x 365 x 24)

Mean time to repair

Mean time to repair (MTTR) is the average time needed to bring a failed system back to operation from the time that it cannot function as required, and is generally expressed with the unit of hours or minutes. The mean time to repair 1646 SM is predicted to be two hours. This time duration includes dispatch, diagnostic, and repair time.

Product design life

The product design life for 1646 SM is 10 years except for the fans. The fan has the design life of 7 years, and fan card (fan shelf) must be replaced before the end of lifetime.

Circuit pack failure rates

The “Circuit pack failure rates” (p. 9-4) provides an overview of the circuit packs fit rates. These numbers are steady state rates at a shelf room temperature of 25°C. The basic assumption is that the failure of any component results in a failure of the circuit pack. As SFPs are pluggable, their failure data rate is also listed and not included in circuit packs. The prediction method is by Telcordia SR332, method I (black box).

SSY code (1646 SM R2.3)	Description	FITs at 25˚C room temperature
3KC17985AA	RSA-1646 2U SHELF	521
3KC17989AA	MAINBOARD 2U	1638
3KC17993AA	2U DC POWER -48V/-60V	94
3KC17997AA	FAN CARD	2239
3KC18001AA	SERVICE CARD	392
3KC17957AB	42XE1 120OHM BOARD	885
3KC17961AB	42XE1 75OHM BOARD	895
3KC17965AB	3XE3/T3 BOARD	413
3KC17969AC	1X1000MB/S EOS BOARD	634
3KC17973AC	8X100MB/S SWITCH BOARD	1048
3KC17953AB	2XSTM-1 SFP BOARD	508
3KC17977AB	2XSTM-4 SFP BOARD	534
3KC18142AA	4x STM-1 LINE CARD	393
3AL97348AA	HK EXTERNAL BOX	348
3KC18178AA	RSA-E1A EPS box 120 Ohm	82
3KC18178AB	RSA-E1B EPS box 75 Ohm	82
NA	SFPs	210
3KC18208AA	4XFX SWITCH BOARD	503

Spare part number overview

The number of spares for each Field Replaceable Unit (FRU) must be determined and maintained separately, based on that FRU's in-service population at each given location.

Recommended spare part numbers

The following tables indicate the number of circuit packs that are required for the customer to substitute the spare stocks based on the assumption of different lead time.

Lead time = 60 days

Table 9-1 Spare stocks data for 60 days lead time

SSY code	1 piece used	up to 5 pieces used	up to 10 pieces used	up to 50 pieces used	up to 100 pieces used	up to 500 pieces used	up to 1000 pieces used	up to 2000 pieces used	up to 5000 pieces used	up to 10000 pieces used
3KC17985AA	1	1	1	3	3	5	6	9	15	23
3KC17989AA	1	1	2	3	4	8	11	17	32	54
3KC17993AA	1	1	1	1	2	3	4	4	6	8
3KC17997AA	1	2	3	4	5	9	14	21	40	69
3KC18001AA	1	1	1	2	3	4	6	8	13	19
3KC17957AB	1	1	1	3	3	6	8	12	21	34
3KC17961AB	1	1	1	3	3	6	8	12	21	34
3KC17965AB	1	1	1	2	3	5	6	8	13	20
3KC17969AC	1	1	1	3	3	5	7	10	17	26
3KC17973AC	1	1	2	3	4	6	9	13	23	38
3KC17953AB	1	1	1	3	3	5	6	9	15	23
3KC17977AB	1	1	1	3	3	5	7	9	15	24
3KC18142AA	1	1	1	2	3	4	6	8	13	19
3AL97348AA	1	1	1	2	3	4	5	7	12	18
3KC18178AA	1	1	1	1	1	3	3	4	6	8
3KC18178AB	1	1	1	1	1	3	3	4	6	8
SFPs	1	1	1	2	2	4	5	6	9	13
3KC18208AA	1	1	2	3	4	6	9	13	23	38

Lead time = 90 days

Table 9-2 Spare stocks data for 90 days lead time

SSY code	1 piece used	up to 5 pieces used	up to 10 pieces used	up to 50 pieces used	up to 100 pieces used	up to 500 pieces used	up to 1000 pieces used	up to 2000 pieces used	up to 5000 pieces used	up to 10000 pieces used
3KC17985AA	1	1	1	3	3	6	8	11	19	31
3KC17989AA	1	2	3	4	5	10	14	22	43	75
3KC17993AA	1	1	1	1	2	3	4	5	7	10
3KC17997AA	1	2	3	4	5	11	17	28	55	97
3KC18001AA	1	1	1	3	3	5	7	9	16	25
3KC17957AB	1	1	2	3	4	7	10	15	27	46
3KC17961AB	1	1	2	3	4	7	10	15	28	46
3KC17965AB	1	1	1	3	3	5	7	10	16	26
3KC17969AC	1	1	2	3	4	6	9	12	22	36
3KC17973AC	1	1	2	3	4	8	11	17	31	52
3KC17953AB	1	1	1	3	3	6	8	11	19	30
3KC17977AB	1	1	1	3	3	6	8	11	19	31
3KC18142AA	1	1	1	3	3	5	7	9	16	25
3AL97348AA	1	1	1	3	3	5	6	9	15	23
3KC18178AA	1	1	1	1	2	3	4	5	7	10
3KC18178AB	1	1	1	1	2	3	4	5	7	10
SFPs	1	1	1	2	3	4	5	7	11	17
3KC18208AA	1	1	2	3	4	8	11	17	31	52

Quality certifications

Overview

Nokia's unified customer-centric Quality Management System is based on ISO 9001 and TL 9000 standards and facilitates process adherence and continual improvement to achieve business performance excellence.

All Product Groups and Corporate Functions operating under the Nokia brand must, at a minimum, be covered by the unified ISO 9001 certificate and, were driven by customer or competitive requirements, TL 9000 certified.

Quality Management System

The 1646 SM product family adheres to the Nokia Quality Management System (Nokia QMS) as described in the OMSN North America (NA) Product Realization (PR) Quality Manual. The Nokia QMS enables Nokia to demonstrate a global approach for quality management, deploy common processes, share lessons learned for improving efficiency and customer satisfaction, and achieve consolidated registration to international standards.

TL 9000

TL 9000 is a telecommunications industry-specific set of requirements and measurements for software, hardware and services. TL 9000 is built on existing industry standards, including ISO 9001. Conformance to TL 9000 constitutes conformance to corresponding ISO 9001 requirements. TL 9000 consolidates various industry requirements and customer requests for measurements; it reduces problems caused by multiple requirements and audits; and it standardizes reporting and use of supplier performance data through defined measurements. TL 9000 requires well-documented, implemented controls for design development, production, delivery, installation, and service. The primary purpose of TL 9000 is to ensure that manufacturers produce products with consistently high levels of quality and service.

Appendix A: Acronyms

Overview

Purpose

This appendix lists the acronyms used in this document and their expansions.

Contents

List of abbreviations

Abbreviation	Meaning
2WAY	Two Way Cross Connection
2WAYDCRR	Two Way Drop and Continue, Ring-to-Ring
2WAYPR	Two Way Protected Add Drog
ACD	Access Control Domain
ACL	Access Control List
ADM	Add/Drop Multiplexer
ADSL	Asymmetric Digital Subscriber Line
AGC	Automatic Gain Control
AID	Access IDentifier
AIM	Alarm Indication Message
AIS	Alarm Indication Signal
AIS-L	Line Alarm Indication Signal
ALS	Automatic Laser Shutdown
AND	Alarm on both station batteries
ANSI	American National Standards International
APD	Avalanche Photodiode
APS	Automatic Protection Switching
ARP	Address Resolution Protocol
AS	Alarm Surveillance
ASAP	Alarm Severity Assignment Profile
ASIC	Application Specific Integrated Circuit
ATM	Asynchronous Transfer Module
ATTD	Attended (alarm storing)
AU	Administrative Unit
AUG	Administrative Unit Group
AUOH	AU Pointer
AUX	Auxiliary
AU4	Administrative unit - level 4
B&W	Black and White

Abbreviation	Meaning
BE	Best Effort
BER	Bit Error Rate
BIP	Bit Interleaved Parity
BM	Bandwidth Manager
BNC	Bayonet Not Coupling
BOL	Beginning Of Life
BTV	Broadcast TV
BW	BandWidth
C	Storing command
C12/C3/C4	1st, 3rd and 4th level Container
CAC	Connection Admission Control
CBR	Constant Bit Rate
CC	Continuity Check
CCM	Continuity Check Message
CD	Chromatic Dispersion
CD-ROM	Compact Disc Read Only Memory
CE	European Conformity OR Customer Edge (device)
CFM	Connectivity Fault Management
CGI	Control and General Interface
Ch	Channel
CID	Card Identifier
CIR	Committed Information Rate
CLNP	ConnectionLess Network Protocol
CMI	Code Mark Inversion
CO	Central Office
COAX	Coaxial
COMD	Colorless Optical Mux/Demux circuit pack.
CoS	Class of Service
CPE	Customer premises equipment
CPI	Incoming parallel contacts
CPO	Outgoing parallel contacts

Abbreviation	Meaning
CPU	Central Processing Unit (referred to Controller equipment unit or Microprocessor)
CRC	Cyclic Redundancy Check
CRG	Clock Reference generator
CSF	Client Signal Failure
CT	Craft Terminal
CWDM	Coarse Wavelength Division Multiplexing
DA	Destination Address
DC	Direct Current
DCC	Data Communication Channel
DCE	Data Circuit Terminating Equipment
DCM	Dispersion Compensation Module
DCN	Data Communication Network
DDM	Digital Diagnostic Monitoring
DEMUX	Demultiplexer
DQCM	Distributed Queue Congestion Mangemeent
Diffserv	Differentiated Service
DNI	Dual Ring Interconnection
DQCM	Distributed Queue Congestion Mangemeent
DSLAM	Digital Subscriber Line Access Multiplexer
DTE	Data Terminal Equipment
DRI	Dual Ring Interconnection
DVB	Digital Video Broadcast
DVB-ASI	Digital Video Broadcast - Asynchronous Serial Interface
DWDM	Dense Wavelength Division Multiplexing
EC	Equipment Controller
ECC	Embedded Communication Channel
ECID	Enhanced Card IDentifier
ECT	Equipment Craft Terminal
EDFA	Erbium Doped Fiber Amplifier
EFM	Ethernet in the First Mile
EF	Expedited forwarding

Abbreviation	Meaning
EFCI	Explicit Forwarding Congestion Indication
EFEC	Enhanced FEC algorithm
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
EML	Element Management Layer
EOL	End Of Life
EOS	Ethernet Over SDH
EOW	Engineering Order Wire
EPD	Early Packets Discarding
EPS	Equipment Protection Switching
ERP	Ethernet Ring Protection
ESCON	Enterprise System Connection
ESD	Electrostatic discharges
ESI	End System Identifier
ESMC	Ethernet Synchronization Messaging Channel
E-SNCP	Electrical Sub-Network Connection Protection
ETB	Ethernet Bridge
ETH	Ethernet
ETS	Ethernet Transparent Service (or Ethernet Transport Service)
ETSI	European Telecommunication Standards Institute
EVC	Ethernet Virtual Connection
EXP	MPLS Experimental field
E2PROM	Electrically erasable programmable read only memory
F	Interface F (for Craft Terminal) or Fuse
FCS	Frame Check-Sum
FDB	Filtering Data Base
FDDI	Fiber Data Digital Interface
FDI	Forward Defect Indication
FE	Fast Ethernet
FEBE	Far End Block Error
FEC	Forwarding Equivalence Class
FEND	Far End

Abbreviation	Meaning
FEPROM	Flash Electrically erasable programmable read only memory
FERF	Far End Receive Failure
FFP	Fast Facility Protection
FICON	Fiber Connection
FIT	Failure In Time
FLC	First Level Controller
FOADM	Fixed Optical Add/Drop Multiplexer
FPGA	Field Programmable Gate Array
GCC	General Communication Channel
GE	Gigabit Ethernet
GFP	Generic Framing Procedure
GND	Ground
GNE	Gateway Network Element
GUI	Graphical User Interface
HDB3	High Density Bipolar Code
HDLC	High-level Data Link Control
HK	Housekeeping
HO	Higher Order
HOA	High Order Adaptation
HOI	High Order Interface
HOL	Head Of Line
HPA	High order Path Adaptation
HPC	High order Path Connection
HPT	Higher Order Path Termination
HPOM	High order Path Overhead Monitoring
HS	High Speed
HSUT	High order Supervisory Unequipped Termination
HTCA	High Order Tandem Connection Adaptation
HTCM	High Order Tandem Connection Monitoring
HTCT	High Order Tandem Connection Termination
HVC	HEC violation count
HW	Hardware

Abbreviation	Meaning
ICS	Item Change Status
ID	Identification signals
IF	InFlow
I/F	Interface
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronic Engineering
IGMP	Internet Group Management Protocol
ILA	In Line Amplifier
I-LAN	Intra-subsystem Local Area Network
ILOS	Input Loss Of ignal
IN	Input
IND	Indicative alarm
INT	Internal Local Alarms
I/O	Input/Output
IOC	Input Output Card
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Organism for standardization
ISPB	Intra Shelf Parallel Bus
ITU-T (*)	International Telecommunication Union-Telecommunication Sector
JE1	Joint Engineering
JF	Jumbo Frame
JRE	Java Runtime Environment
L3	Layer 3
LAG	Link Aggregation Group
LAN	Local Area Network
LAPD	Link Access Protocol D-channel
LB	Loop Back
LBM	Loop Back Message
LCAS	Link Capacity Adjustment Scheme
LCP	Link Control Protocol
LD	Line Driver

Abbreviation	Meaning
LDC	Local Data Controller
LEAF	Large Effective Area Fiber
LED	Light emitting diode
LER	Label Edge Router
LO	Lower Order
LOA	Lower Order Assembler
LOF	Loss Of Frame
LOI	Low Order Interface
LOM	Loss Of Multiframe
LOP	Loss Of Pointer
LOS	Loss of signal
LPA	Lower order path adaption
LPC	Lower order path connection
LPOM	Lower Order Path Monitoring
LPT	Lower order path termination or Loopback equipment side (local)
LSB	Least Significant Bit
LSP	Label Switched Path
LSR	Label Switched Router
LSUT	Lower order Supervisory Unequipped Termination
LT	Line Terminal or Link Trace
LTM	Link Trace Message
LTCA	Lower Order Tandem Connection Adaptaiton
LTCM	Lower Order Tandem Connection Monitoring
LVC	Lower Order Virtual Container
M	Tagblock or Alarm storing
MA	Maintenance Association
MAC	Media Acces Control
MAU	Medium Access Unit
MD	Maintenance Domain
MEF	Metro Ethernet Forum
MEG	Maintenance Entity Group
MEN	Metro Ethernet Network

Abbreviation	Meaning
MEP	Maintenance End Point
MFC	Message Communication Function
MIB	Management Information Base
MIP	Maintenance Intermediate End Point
MLM	Multi Longitudinal mode
MMF	Multi Mode Fibre
MP	Management Plane
mp2mp	multipoint-to-multipoint
MPLS	MultiProtocol label Switching
MS	Multiplex Section
MSA	Multiplex section adaptation or Multi-Source Agreement (transceiver)
MSOH	Multiplex Section Overhead
MSP	Multiplex section protection
MSPP	Multi Service Provisionable Platform
MST	Multiplex section termination
MTU	Maximum Transmit Unit
MUX	Multiplexer
NCP	Network Control Protocol
NE	Network Element
NEND	Near End
NES	Network Element Synthesis
NIM	Non Intrusive Monitoring
NML	Network Management Layer
NMS	Network Management System
NNI	Network to Network Interface
NRZ	No return to zero
NSA	Not Service Affecting
NSAP	Network Service Access Point
NURG	Not urgent alarm
OADM	Optical Add and Drop Multiplexer
OAM	Operation, Administration and Maintenance

Abbreviation	Meaning
OBPS	On Board Power Supply
OCH	Optical Channel
OC-x	Optical Carrier level x
OCM	Optical Channel Monitor
ODUk	Optical channel Data Unit, capacity k=1, 2, 3
O-E-O	Optical to Electrical to Optical
OF	OutFlow
OH	Overhead
OMS	Optical Multiplex Section
OMSN	Optical MultiService Node
OOF	Out Of Frame
OOS-AUMA	Out Of Service-AUtonomous and MAnagement
OPS	Optical Protection Switch
OPUk	Optical Channel Payload Unit, capacity k=1, 2, 3
OR	Logic sum/Loss of only one station battery
OS	Operation system
OSA	Optical Spectrum Analyzer
OSC	Optical Supervisory Channel
OSI	Open System Interconnection
O-SNCP	Optical - Sub-Network Connection Protection
OSNR	Optical Signal to Noise Ratio
OSPF	Open Shortest Path First
OT	Optical Transponder/Translator
OTH	Optical Transport Hierarchy
OTM-0.n	Optical Transport Module, single color, capacity n=1,2,3
OTN	Optical channel Transport Network
OTS	Optical Transmission Section
OTUk	Optical Channel Transport Unit, capacity k=1, 2, 3
P2MP	Point To Multi-Point
P2P	Point To Point
PC	Personal Computer
PCS	Physical Coding Sublayer

Abbreviation	Meaning
PCI	Peripheral Components Interface
PD	PhotoDetector
PDH	Plesiochronous Digital Hierarchy
PDU	Protocol Data Unit
PE	Provider Edge
PBS	Peak Burst size
PHB	Per Hop Behaviour
PHY	Physical layer interface
PIR	Peak Information Rate
PJE	Pointer Justification Event
PLL	Phase Locked Loop
POH	Path Overhead
PM	Performance Monitoring
PMA	Physical Medium Attachment
PMD	Physical Medium Dependent
PMMF	Physical Machine Management Function
POH	Path Overhead
POS	Packet Over SDH
PPI	Physical interface
PPP	Point to Point Protocol
PRBS	Pseudo Random Binary Signal
PSN	Packet Switched Network
PW	PseudoWire
PWE3	PseudoWire Emulation edge-to-edge
Q3/QB3	TMN Interface with B3 protocol. Interface towards TMN
QoS	Quality of Service
R	Reset command / General alarm
RAI	Remote Alarm Indication
RAM	Random Access Memory
RAS	Remote Access Service
RDI	Remote Defect Indication
RECC	Recommendation

Abbreviation	Meaning
RED	Random Early Discarding
REF	Reference
REI	Remote Error Indication
REL	Release
RI	Remote Inventory
RIBUS	Remote Inventory BUS
RMS	Root Mean Square
RNURG	Not urgent Alarm command. Lights up the relative rack red LED
ROADM	Reconfigurable Optical Add/Drop Multiplexer
RPR	Resilient Packet Ring
RSFEC	Reed-Solomon Forward Error Correction
RSOH	Regenerator Section Overhead
RST	Regenerator Section Termination
RSTP	Rapid Spanning Tree Protocol
RSVP	Resource Reservation Protocol
RURG	Urgent Alarm command. Lights up the relative rack red LED
Rx	Reception
SA	Service Affecting
SC	Shelf Controller
SCN	Signalling Communication Network
SCOT	Software Control Of Transmission
SCSI	Small Computer Serial Interface
SD	Signal Degrade
SDEE	SupporteD Entity Exists
SDH	Synchronous Digital Hierarchy
SEC	SDH Equipment Clock
SETG	Synchronous Equipment Timing Generation function
SF	Signal Fail
SFI	SERDES Framer Interface
SFP	Small Form Factor Pluggable module
SL	Signal Label
SLA	Service Level Agreement

Abbreviation	Meaning
SLC	Second Level Controller
SLM	Single Longitudinal Mode
SMF	Single Mode Fibre
SNCP	Sub-Network Connection Protection
SNCP/I	Subnetwork Connection Protection Inherent
SOH	Section Overhead
SONET	Synchronous Optical Network
SP	Service Provider
SPI	Synchronous Physical Interface OR Serial Peripheral Interface
SRI	Single Ring Interconnection
SSF	Server Signal Fail
SPV	Supervision
SQ	Squelch
SSF	Server Signal Fail
STM-n	Synchronous Transport Module, level n
STP	Spanning Tree Protocol
SVID	Stacked Virtual LAN Identifier
STS-nc	Synchronous Transport Signal level n concatenation
SVLAN	Stacked VLAN
SW	Software
SyncE	Synchronous Ethernet
TANC	Remote alarm due to failure of all power supply units
TBD	To Be Defined
TCA	Threshold Crossing Alarm
TCP/IP	Transmission Control Protocol / Internet Protocol
TDM	Time Division Multiplexing
TE	Traffic Engeneering
TIM	Trace Identifier Mismatch
TL1	Translation Language level 1
TM	Traffic Manager
TMN	Telecommunication Management Network
TOR	Remote alarm indicating loss of one of the station batteries

Abbreviation	Meaning
TORC	Remote alarm due to a faulty/missing power supply unit
TP	Termination Point
TPD	Transponder
TRU	Top Rack Unit
TRX	Transceiver
TSD	Trail Signal Degrade
TSF	Trail Signal Fail
TSS	Transpor Service Switch
TTF	Transport Terminal Function
TTL	Time To Live
TU	Tributary Unit
TUG2/3	Tributary unit group, level 2,3
TUOH	Tributary Unit Overhead
TUP/UP	Equipment Controller remote alarm
TU12/TU3	Tributary unit level 12, 3
TX	Transmission
ULH	Ultra Long Haul
UNI	User to Network Interface
URG	Urgent
USM	User Services Manager
VC	Virtual Container
VCAT	Virtual Concatenation
VCG	Virtual Concatenation Group
VCXO/VCO	Voltage controlled oscillator
VC12/VC3/VC4	VC12/VC3/VC4
VID	Virtual LAN Identifier
VLAN	Virtual LAN
VLH	Very Long Haul
VMMF	Virtual Machine Management Function
VOA	Variable Optical Attenuator
VoIP	Voice over IP
VPN	Virtual Private Network

Abbreviation	Meaning
VSI	Virtual Circuit Instance
VT	Virtual Tributary, Virtual Transport
VTQ	Virtual Transport Queue
WAN	Wide Area Network
WC-WFQ	Work-Conservative WFQ
WDM	Wavelength Division Multipleing
WEEE	Waste Electric and Electronic Equipment
WFQ	Weighed Fair Queuing
WLA	Wavelength Adapter
WNC-WFQ	Work-Non-Conservative WFQ
W-RED	Weighed - Random Early Discarding
WTR	Wait To Restore
XC	Cross-Connection
XFP	10 Gigabit Small Form Factor Pluggable module

Definition	Meaning
ACT	Active: the entity is currently in use and has spare operating capacity for further usage demand. When applied to a facility entity, this value means that the entity is crossconnected (the entity is a constituent leg of a cross-connect) and additional crossconnect capacity can be applied, e.g., a 1-way cross-connect, a 2-way cross-connect but not with a 1-way bridge, a 56-leg conference connection but not with a 1-way bridge
Adjacent span	All ring nodes have a span on both sides. Each span is considered to be adjacent to the other.
AINS	Automatic In-Service: the entity is allowed to transition to the in-service state if it is operationally capable, e.g., a OC-3 transitions from OOS-AU,AINS to IS when all OC-3 alarm conditions have cleared
APS bytes	The K1 and K2 bytes of the SONET transport overhead of a line carrying protection channels are called APS bytes
APS Channel:	The medium used for communicating Automatic Protection Switching information between nodes. The K1/K2 bytes in the protection line serve this purpose
APS Request	The set of signals into an APS controller that determines it's behavior. An APS request can be either an externally initiated command or an automatically initiated command

Definition	Meaning
Bidirectional Switching	Switching mode in which a channel is switched to the protection line in both directions. Switching of only one direction is not allowed. Head-end to tail-end signaling is accomplished using the APS channel
Bridge	The action of transmitting identical traffic (SPE contents) on both the working and protection channels
BUSY	Busy: the entity is currently in use and has no spare operating capacity for further usage demand. When applied to a facility entity, this value means that the entity is crossconnected (the entity is a constituent leg of a cross-connect) and no additional capacity can be applied, e.g., a Test Access port is connected to another entity for test access
CoS	Forwarding behavior applied at node level either to a single traffic flow or to a bundle of traffic flows (traffic aggregate) which require specific end-to-end performances in order to meet application, customer or network expectations. It is defined by 3 performance objectives: Packet delay, Packet jitter and Packet loss
DCM	The Dispersion Compensation Modules (DCM) are fibered to the mid-stage access ports of the optical amplifiers to compensate for the dispersion present in the outside plant fiber
Drop and continue	When traffic on a given time slot is allowed to be dropped at more than one node, it is said to be "dropped and continued" at all terminating (not continue through) nodes between the node inserting the traffic and the last node terminating the traffic.
DSBLD	Disabled: the facility entity is prohibited from carrying traffic , e.g., the required supporting equipment is not provisioned
DWDM Channel	A service that is to be carried by the DWDM network
FAF	Facility Failure: the associated facility entity has failed, e.g., a LOS, LOF, AIS condition for OC-3 entities
Far End	Between the two NEs terminating a line facility, the one that receives an indication from the other that a condition (e.g. failure, command, etc) has occurred is referred to as the far-end with respect to that phenomenon
Head end	It is the optic unit or the NE where the line overhead is inserted. The head end executes the bridge to protection. For bidirectional switching, a node functions as the head end for the outgoing line and as the tail end for the incoming line on the failed span
ILA	An In-Line Amplifier (ILA) shelf. Two LDRX are used at a non-upgradeable ILA, one for each direction of transmission
Intermediate node	A node that is located between the nodes that are performing the bridging and the switching

Definition	Meaning
IS, IS-NR	In_Service, Normal: the entity is capable and allowed to provide its provisioned functions. (IS and IS-NR are interchangeable)
IS-ANR	In_Service_Abnormal: the entity is capable of most functions, is allowed to provide its provisioned functions, but is operating in a degraded or abnormal state (e.g., nonalarmed BER Signal Degrade threshold crossing on an OCn or STS)
LPBK	Loopback: loopback activity is currently being performed on the entity.
NE	A configuration of 1850 equipment at a single site that is addressed as a single entity and is under the control of a single controller
OOS-AU	Out_Of_Service-Autonomous: the entity is not available for providing its provisioned functions but the entity is not intentionally suspended by external management command (from an OS or craft interface) from performing these functions. In general, the cause of the incapability is due to an unsolicited autonomous event detected in the system or in the associated network (e.g., OC-3 LOS detected)
OOS-AUMA	Out_Of_Service-Autonomous_and_Management: the entity is not available for providing its provisioned functions because an OOS-AU state transition has occurred and the entity is intentionally suspended by external management command (from an OS or craft interface) from performing its provisioned functions
OOS-MA	Out_Of_Service-Management: the entity is intentionally suspended by external management command (from an OS or craft interface) from performing its provisioned functions, but the entity may still be operationally capable of performing its provisioned functions
OPS	The Optical Protection Switch (OPS) provides the bridging and switching functions required for various optical protection applications
OSP	Outside Plant, the fiber optic cables connecting sites in the network
OT or OTU-2	The Optical Translator Unit (OT) provides the O-E-O signal conditioning and monitoring functions required for connection to the OMD. The OT can be tuned to any of the channel frequencies defined within the sytem. For more information refer to FM_DWDM_RRS. The OTU-2 board has the same line side functions as an OT but the client side connects to the switch matrix of the 1646 SM shelf.
Pass-through	The action of transmitting by a node exactly what is received by that node for any given direction of transmission. A pass-through can be unidirectional or bidirectional.
PMI	Performance Monitoring Inhibited: the performance monitoring function performed by the entity has been temporarily suspended

Definition	Meaning
PSI	Protection Switching Inhibited: the working entity is inhibited from automatic switching to protection, i.e., it is locked out from automatic protection
Pseudo-Wire (PW)	PW is an emulation of a basic native connectivity service, e.g. a Layer 1 and Layer 2 telecom service (non-IP protocols) over a PSN: • Layer 2: ATM, Frame Relay, PPP/HDLC, Ethernet • Layer 1: TDM (PDH), SDH • PSN: MPLS (most common), IP (v4 or v6), GRE, L2TPv3. PW are multiplexed over PSN Transport Tunnels (LSP) for vertical scalability. PW emulates a point-to-point link and provides a single service
QoS	The measure of transmission quality and service availability of a network. Before any QoS can be implemented successfully, the network infrastructure must be highly available. The transmission quality of the network is determined by the following factors: • Throughput or bandwidth • Delay or latency • Delay variation (delay jitter) • Loss or error rate
Random Early Detection (RED)	The queue's average occupancy is used as a parameter to a random function that decides whether packet discard is to be triggered. The probability of a packet-drop action increases as the average occupancy increases
Ring segmentation	When multiple ring switches are performed in response to multiple protection switch initiations, the original ring can be divided into two or more smaller rings. If more than a single pair of ring switches are performed on the original ring, the ring is said to be segmented
ROLL	Roll: the entity is currently under a roll operation. This state is a transitory state unless Manual rolling mode is being used
Round Robin (RR)	This scheduling scheme avoids queue starvation by cycling through the queues one after the other and transmitting one packet before moving on to the next queue. Empty queues are skipped, meaning that the scheduler operates in work conserving way, moving to the next queue in the sequence that has a packet to transmit (active queues)
SDEE	Supported Entity Exists: the entity is currently supporting other entities; deletion or state change of this entity will have impact on the service condition of the supported entities.
SGEO	Supporting Entity Outage: the associated supporting entity has failed or is out-of-service due to management action (OOS-MA or OOS-AUMA)

Definition	Meaning
SLA	The service contract between a customer and a service provider that specifies the forwarding treatment the customer should receive from the service provider network. A SLA normally includes: • Classification rules in order to identify user traffic flows • Traffic profiles specifying the temporal characteristics of traffic flows • Metering, marking, discarding, shaping rules to be applied to traffic flows • Performance requirements defined in terms of packet delay, jitter and loss
Span	NE to NE bidirectional link; one or more segments terminated by a NE at each end
STBYH	Standby-Hot: the entity is to back-up another entity and is synchronized with the backed-up entity. An entity with a hot standby status will be immediately able to take over the role of the backed-up entity without the need for initialization activity. An entity shall carry a STBYH SST when the protection switching state is no request (NR)
Squelching traffic	Replacing traffic by the appropriate path AIS to prevent misconnections. STS level squelching occurs only into and out of the protection channels (i.e., working channels are never squelched)
Squelch Map	The squelch map in a BLSR node contains, for each side and for each used working STS path (i.e., working STS path that is inserted, dropped, or passed through in that node), the source node ID of the STS path entering that node and the destination node ID of the STS path exiting that node
STBYS	Standby-Switched: the entity is normally STBYH but a switching state exists than will prohibit a protection switch. This is any other state besides NR, no request.
Switch	The action of selecting traffic from the protection channels rather than the working channels or from the protection channels to the working channels
Tail end	The optic unit or the NE where the line overhead is terminated. When a failure occurs on a line, the tail-end NE detects the failure and requests the bridge. For bidirectional switching, a node functions as the head end for the outgoing line and as the tail end for the incoming line on the failed span
Traffic Management or Traffic Processing	It refers to the ability of a network to provide improved service to selected network traffic over various underlying technologies. It uses a set of functions as a toolkit to differentiate network services based on measurable parameters: • Metering and Policing • Queuing and Traffic Congestion management • Scheduling

<table>
<tr><th>Definition</th><th>Meaning</th></tr>
<tr><td>Traffic Profile</td><td>A characterization of the packet sizes and arrival times of a traffic flow. The compliance level with the traffic profile is assessed for each packet:
1. Green = full compliance
2. Yellow = partial compliance
3. Red = non-compliance
Packet delivery performance is based on compliance level:
• Green: frame delivered with performance level as specified by the SLA for the CoS instance
• Yellow: frame delivered, but SLA for the CoS instance does not apply
• Red: frame not delivered (discard).
Traffic Profile Parameters
• Committed Information Rate (CIR) expressed as bits per second
• Committed Burst Size (CBS) expressed as bytes
• Peak Information Rate (PIR) expressed as bits per second
• Peak Burst Size (PBS) expressed as bytes.</td></tr>
<tr><td>Transparent DWDM Link</td><td>A single channel within a contiguous series of one or more DWDM links terminated by OT’s</td></tr>
<tr><td>TRM</td><td>Terminated: the facility entity has been given termination parameters, i.e., the entity has been connected and its path has been terminated (as a result of the connection) or the parent entity has been terminated as a result of its subentities being connected. For SONET line entities, this state indicates that the entity is supporting cross-connections</td></tr>
<tr><td>TS</td><td>Test: a Test Access activity is currently being performed on or by this entity</td></tr>
<tr><td>UAS</td><td>Unassigned: the entity has not been assigned with the necessary provisioning data. No service activity or maintenance activity (including monitoring, testing, or service recovery) is permitted in this state since the necessary data has not been assigned</td></tr>
<tr><td>Unidirectional Switching</td><td>Switching mode in which the selection decision for the service line is made independently of the Far-End node’s switch state. The APS channel is not used to coordinate switching activity between the nodes for a 1+1 APS</td></tr>
<tr><td>VCAT</td><td>Virtual Concatenation Path is Active. This means the entity is part of VCG and is allowed to carry traffic</td></tr>
<tr><td>VCIDLE</td><td>Virtual Concatenation Path is Idle. This means the entity is part of VCG and is not allowed to carry traffic</td></tr>
</table>

Definition	Meaning
WDM Core Optics	The circuit packs that transport or process the OMS and OTS. Within this document the acronym OMS is defined as Optical Multiplex Section and the OTS is defined as Optical Transport Section as defined in ITU-T Recommendation G.798. The OMS function combines the individual optical channels (OCH) into a common fiber signal. The OTS function combines the OMS signal with the OSC signal for transport onto the outside plant fiber
WDRR (Weighted Deficit Round Robin)	It is an extension to the round-robin scheduling and allows for relative bandwidth allocation to queues. WDRR assigns each queue a Weight (W) given by a fixed quantum (Q) and a variable deficit (D): • Q reflects the long-term average number of bytes the queue is requested to send at each round • D is initialized to zero and is reset to zero whenever a queue is emptied, to avoid credits accumulation that could cause unfairness
WFQ (Weight Fair Queue)	It schedules packets based on the weight ratio of each queue. Weight is assigned to each queue according to the network traffic management policy
WRED (Weighted Random Early Detection)	It indicates the modification of the random function based on packet context (weighting). Additional information from the packet's context may select one of multiple packet discard functions. For example, a packet marked for exceeding a rate policing may be subject to a more aggressive discard action than other packets assigned in the same queue
WRK	Working: the entity is currently providing service as part of a protection group (e.g., selector is selecting this entity in a UPSR configuration)

Appendix B: General information on customer documentation

Products, product releases, versions, and customer documentation

A product is defined by the network hierarchical level at which it is used and by the whole of performance and services for which it is meant.

A product evolves through successive product releases, which are the real products marketed for their delivery at a certain release availability date. So, a product release defines a set of hardware components and a software package which, as a whole, identify the possible network applications and the equipment performance for which the specific product release has been designed, engineered, and marketed.

In some cases, a product release has further development steps, named versions, that are introduced to improve or add some functionality (mainly software) over to the previous version, or for bug fixing purposes.

A product release has its own standard customer documentation, composed by one or more documents.

A new version of a product release may or may not produce a change in the status of the customer documentation set, as described in "Updating document" (p. B-4).

Document supply to Customers

Documents are not automatically delivered with equipment with which they apply. The number of documents per unit to be supplied must be decided at the contract level.

Aims of standard customer documentation

Standard customer documentation, referred to hereafter, is always meant as plant-independent.

Plant-dependent documentation, if specified by the contract, is subject to commercial criteria based on content, format, and supply conditions. Plant-dependent documentation is not discussed in this document.

Standard hardware and software documentation is meant to provide customers with the information necessary to install, commission, operate, and maintain the equipment according to Nokia Laboratory design choices.

In particular, the content of documents associated with software applications focus on the explanation of the man–machine interface and the operating procedures allowed. Maintenance is covered to the faulty PCB location and replacement level.

Consequently, design documentation (like PCB hardware design and production documents and files, software source programs, programming tools, etc.) is not supplied to customers.

Hardware-specific documents (usually the "Technical Document") and software-specific documents (usually the *User Provisioning Guide*, see Related Product Information section) are not part of the standard documentation set because they are not necessarily impacted by product changes.

For example, only the Technical Document might be revised because of hardware configuration changes (for example, replacing one unit with another that performs the same function but has a different P/N).

On the other hand, the *User Provisioning Guide*, see Related Product Information section, may be updated because of a new software version. Changes in software versions do not impact the Technical Document as long as it does not imply hardware modifications.

Both document types can be updated to improve content, correct errors, etc.

Updating document

The documents associated with this product release are listed in Related Product Information section. Each document is identified by the following:

- The name of the product-release (and version when the document is applicable to the versions starting from it, but not to the previous ones).
- The document name.
- The document Part Number (P/N).
- The document edition (usually first edition = 01).
- The document issue date. This date on the document does not refer to the date of print but to the date on which the document source file was finalized and released for the production.

Changes introduced in the same product-release (same document P/N)

The edition and date of issue might change on future document versions for the following reasons:

- Only the date changes (pointed out in the Table of Contents) when modifications are of an editorial nature and do not change the technical content of the document.
- The edition, hence the date, is changed because modifications impact the technical content. In this case:
  - The changes from the previous edition are listed in “Reason for revision”.
  - revision bars on the left of the page in updated chapters indicate modifications in text and drawings

Changes that impact the technical content of the document cause the edition number to increase (for example, from Ed.01 to Ed.02). For minor updates (for example, for corrections), documents retain thier edition but an extra letter is appended to the version (for example, from Ed.02 to Ed.02A). Version character/letters can also be used for draft or proposal editions.

> **Note:** *NOTES ON DOCUMENTS RELEVANT TO SOFTWARE APPLICATIONS*
>
> Documents relevant to software applications (typically the *User Provisioning Guide*, see Related Product Information section are not updated when the new software version distributed to customers implies man-machine interface changes or in case of slight modifications to procedures.
>
> Moreover, screen shots and figures in documents do not run with releases; they are not updated to reflect current product release versions if the screens or figures are unchanged.

Supplying updated documents to customers

Supplying updated documents to customers who have already received previous issues is submitted to commercial criteria.

By updated document delivery, it is meant the supply of a complete copy of the document new issue (supplying errata-corrige sheets is not envisaged).

Changes due to new product version

A new product version changes the document P/N and the edition starts from 01.

In this case, the modified sections of the document are not listed.

Customer documentation on CD-ROM

In the following sections, 'CD-ROM' is used to refer to the 'Customer Documentation on CD-ROM'

Contents, creation, and production of a CD-ROM

In most cases, a CD-ROM contains, in read-only electronic format, the documents for one product release (or version) for a particular language.

In other cases, a CD-ROM can contain documentation for different product releases (or versions) for a particular language.

As a general rule:

- CD-ROMs for Network Management products do *not* contain:
- Installation Guides
- documentation of system optional features and related software that are not available for purchase from Nokia.
- CD-ROMs for Network Elements products do *not* contain:
- documentation of system optional features (for example, System Installation Guides for racks and related hardware) that are not available for purchase from Nokia.

A CD-ROM contains guides and documents for a particular product/release in .pdf format. Bookmarks and hyperlinks are included to aid navigation. The resulting master CD-ROM is electronically transferred to the appropriate department for distribution to customers.

The information contained on CD-ROMs and in paper documents for a given product/release is identical.

Suitable checks are made to ensure a virus-free product.

Use of the CD-ROM

The CD-ROM can be used both in PC and UNIX WS environments.

The CD-ROM starts up automatically with autorun; the Index and other hyperlinks help navigate the documents. ReadMe notes are also included on the CD-ROM.

In order to open the .pdf documents, Adobe Acrobat Reader Version 4.0 (minimum) must be installed on your system. The customer is responsible for obtaining and installing the correct version of Adobe Acrobat Reader.

Once the correct version of Reader is installed, users have the option of reading the documents on their PC/WS, installing documents to their PC/WS, or printing all documents or selected documents/sections to a local printer.

CD-ROM identification

Each CD-ROM is identified by the following:

1. External identifiers (imprinted on the CD-ROM):

- The name of the "product release(s)" (and "version" if applicable)
- Text indicating the language(s)
- The CD-ROM Part Number)
- The CD-ROM edition (usually first edition=01)
- internal identifiers - a list of files and documents (with P/Ns and editions) included on the CD-ROM

CD-ROM updating

The list of source document P/Ns-editions indicated in the previous section (C.5.3 point 2), in association with the CD-ROM's own P/N-edition, is also loaded in the Nokia-INFORMATION-SYSTEM as a structured list.

Whenever a new edition of any document is released in the Nokia archive system, a check in the Nokia-INFORMATION-SYSTEM is made to identify the list of CD-ROMs that must be updated to include the new editions of these guides/documents.

This causes the planning and creation of a new edition of the CD-ROM.

Updating of CD-ROMs always follows, with a certain delay, the updating of the single documents composing the collection.

Appendix C: Conformance statements

Conformance statements

The following conformance statements apply to this product:

Class 1 laser statement

This product complies with D.H.H.S. radiation performance standards 21 CFR, 1040.10, for a Class 1 laser product.

FCC Part 15

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy. If the equipment is not installed and used in accordance with the guidelines in this document, the equipment may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at the expense of the user.

Packaging collection and recovery requirements

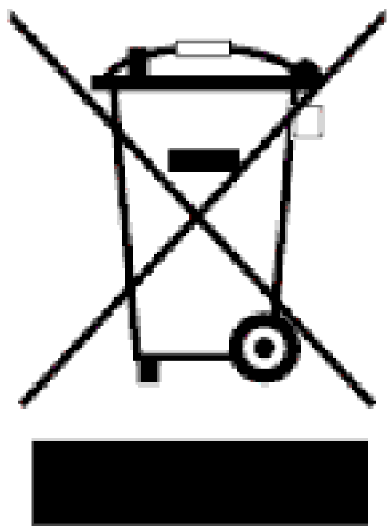
Countries, states, localities, or other jurisdictions may require that systems be established for the return and/or collection of packaging waste from the consumer, or other end user, or from the waste stream. Additionally, reuse, recovery, and/or recycling targets for the return and/or collection of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

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

Recycling/take-back/disposal of products and batteries

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

Note 1: For electronic products put on the market 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.



Note 2: For batteries put on the market in the European Union, a chemical symbol Hg (mercury), Cd (cadmium), or Pb (lead), or a combination of those symbols, beneath the cross-out wheeled bin indicates that the battery contains the corresponding heavy metals.

Cd Pb

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

For information regarding take-back of equipment by Nokia or for more information regarding the requirements for recycling/disposal of a product, perform the following:

- Contact your Nokia account manager.
- Contact Nokia Asset Recovery (mailto: asset.recovery@nokia.com).
- Contact Nokia Global Sustainability (mailto: sustainability.global@nokia.com).
- Visit Nokia Protecting the Environment (http://company.nokia.com/en/our-activities/protecting-the-environment).

Appendix D: Document issue history

Overview

Purpose

This appendix provides reference material for the *1646 Synchronous Multiplexer (SM) Release 2.3 User Provisioning Guide*.

Contents

Reissue history

Purpose

The following paragraph describes the reissue history of this document:

Issue history

The document changes for Release 2.3 are shown in the following table:

Table D-1 Document changes for Issue 7, March 2016

Feature/enhancement	Location
IP over DCC: Updated that the feature *IP over DCC* is supported.	"Management" (p. 5-93)
FAN BOARD and **POWER BOARD**: Updated the item code for the boards.	"Mechanical characteristics" (p. 4-18)

Table D-2 Document changes for Issue 6, July 2015

Feature/enhancement	Location
General characteristics Updated SDH applied standards	"General characteristics" (p. 4-2)
Environmental conditions Updated Electromagnetic compatibility (EMC) norms section	"Environmental conditions" (p. 4-20)

Table D-3 Document changes for Issue 1 through Issue 5, October 2014

Feature/enhancement	Location
Equipment configuration Updated Maximum access capacity table.	"Equipment configuration" (p. 3-3)
Parts List	"Parts list" (p. 3-6)
Mechanical characteristics	"Mechanical characteristics" (p. 4-18)
P4FXS Added the unit description for P4FXS.	Figure 3-11, "P4FXS front panel" (p. 3-9)

Table D-3 Document changes for Issue 1 through Issue 5, October 2014 (continued)

Feature/enhancement	Location
Units front view Updated the P4FXS front panel graphic.	"Units front view" (p. 3-7)

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