Prepared (also subject responsible if other)		No.		
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OMS 3250

Product Description

OMS3250

SDH/OTH 10GB/S COMPACT MULTIPLEXER

Product Description

Issue 1

Document code: 4on-pd000075-e
Date of issue: 6 July 2004
Issue: 1
Comments:

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List of Abbreviations

ADM	Add-Drop Multiplexer
ALS	Automatic Laser Shutdown
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
AUX	Auxiliary (Unit, Channels, Services)
Bw7R	Bauweise 7R (local alarm scheme)
c	Contiguously concatenated signal (VC4-4c)
CIR	Committed Information Rate
CMISE	Common Management Information Service Element (provides services detailed in ISO9595, ISO9596 required by the NE application - OSI layer 7)
CMOX	CMISE over short stack
DCC	Data Communication Channel
DCF	Dispersion Compensation Fibre (also known as PDC)
DCS	Digital Cross–connect System
DWDM	Dense Wavelength Division Multiplexing
DXC	Digital Cross–Connect
EIR	Excess Information Rate EIR = PIR - CIR
EOW	Engineer Order Wire
EPL	Ethernet Private Line
ETSI	European Telecommunication Standards Institute
FastE	Fast Ethernet
FEC	Forward Error Correction
10GE	10 Gigabit Ethernet
GbE	Gigabit Ethernet
GE	Gigabit Ethernet
GFP	Generic Frame Procedure
GigE	Gigabit Ethernet
GMPLS	Generalised Multi Protocol Label/Lambda Switching
HPC	Higher order Path Connection
HO	High Order, means n x VC-4
IB FEC	In Band Forward Error Correction
IEEE	Institution of Electrical and Electronic Engineers
I/F	Interface
IP	Internet Protocol
ITU-T	International Telecommunication Union, Telecommunications Sector
LAN	Local Area Network
LAPS	Link Access Procedure SDH
LCAS	Link Capacity Adjustment Scheme (for Virtual Concatenated signals)
LCT	Local Craft Terminal
LO	Low Order, means n x VC-12 level or n x VC-3
LTU	Line Termination Unit
LVDS	Low Voltage Differential Signalling
MNR	Managed Network Release
MPLS	Multi-Protocol Label Switching
MS	Multiplex Section
MSH	Product name for Marconi SDH multiplexers
MSP	Multiplex Section Protection
MS SPRING	Multiplex Section Shared Protection Ring
MV36	Marconi Communications Element Level Management System
MV38	Marconi Communications Network Level Management System
NE	Network Element
NMS	Network Management System

OCH	Optical Channel (ITU–T G.709)
ODU	Optical Data unit (ITU–T G.709)
OH	Overhead
OOB FEC	Out Of Band Forward Error Correction
OPU	Optical Payload Unit (ITU–T G.709)
OSI	Open System Interconnection
OTH	Optical Transport Heirarchy
OTU	Optical Transport Unit (ITU–T G.709)
PDC	Passive Dispersion Compensation (also known as DCF)
PIR	Peak Information Rate
RS	Regenerator Section
RMON	Remote Network Monitoring
SAN	Storage Area Network
SDH	Synchronous Digital Hierarchy
SFP	Small Form-Factor Pluggable (Optical Transceiver)
SMC	System Memory Card, used in CCU to hold SW for all of the cards (compact flash disks)
SNC	Subnetwork Connection (previously known as Path Protection)
SNCP	Sub-Network Connection Protection
SOH	Section Overhead
SONET	Synchronous Optical Network
STM	Synchronous Transport Module
TE	Termination point
TEP1E	Transmission Equipment Practice 1E (customized local alarm scheme)
TM	Terminal Multiplexer
TMN	Telecommunication Management Network
U	Unit of measure for card slot width on the subrack, 1U = 5.08mm (0.2”)
UPSR	Unidirectional Path Switched Ring
v	Virtually concatenated signal (VC4-4v)
VC	Virtual Container
VCG	Virtually Concatenated Group
VCI	Virtual Channel Identifier
VLAN	Virtual Local Area Network (IEEE 802.1Q)
VPLS	Virtual Private LAN Service
VPN	Virtual Private Network
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing
XFP	Extended Form-Factor Pluggable (Optical Transceiver)

Foreword

The product information contained herein is independent of product release and does not refer to a defined product release.

The technical information provided in this document is offered, in good faith, as an indication of Marconi's intention to evolve its Optical Networks portfolio to meet the demands of the marketplace. Unless commercially agreed, the information contained herein should not to be taken as implying any commitment or obligation on the part of Marconi.

For details concerning availability and supported features please refer to the SDH Roadmap.

1 INTRODUCTION

The OMS3250 is a compact SDH/OTH DXC4/4 product which evolved from the MSH2K SDH DXC. A combined ODU and VC-4 switch fabric enables both wavelength services and higher order synchronous traffic to be switched simultaneously in the same network element. In addition the integration of a LO-VC switch permits the use of OMS3250 as a compact and cost-effective solution for those network nodes where, in conjunction with a wide HO-VC switch, the capability to groom a percentage of the traffic down to VC-3/VC-2/VC-12 level is required.

To cope with the more data-centric network, Ethernet interfaces and Layer 2 Switching are provided. Mapping is via GFP and LCAS can be used to manage the bandwidth. Data transport capabilities are further enhanced by the provision of SAN interfaces.

The OMS3250 incorporates a fully distributed, network aware control plane to support advanced, dynamic network architectures that require fast network restoration and customer driven routing. Both SDH management and the emerging GMPLS (Generalised Multi-Protocol Label Switching) control mechanisms are included in the realisation.

This document is intended to provide an overview of the product.

This product is based on advanced electronic technology and provides a multi-fabric product (i.e. support for TDM and Data). The OMS3250 can support a number of high speed optical and electrical interfaces and provide a 2048 x 2048 STM-1 equivalents switching capacity at HO-VC (i.e. 320G @ VC-4/4nc) with an optional LO-VC switching capability (Nx10G @ VC-3/2/12). The product is optimised to provide a high density compact DXC 4/4 at 2.5 Gbit/s and 10 Gbit/s interface rates.

Additionally the OMS3250 includes switching of optical ODUk (k=1,2) containers and can be equipped with OTM-0.k/1r.k interfaces (k=1,2 according to G.709).

Marconi OMS3250 is designed to support the migration of the transport network to the Optical Transport Network (i.e. OTN). Marconi has combined the SDH and OTN layers in the same equipment to provide the grooming and consolidation at the SDH layer with the flexibility of transparent services offered by the G.709 OTN layer. The possibility to perform ODUk and VC-n switching into a single switch platform, permits its use in a pure SDH network or in a pure OTN one or to merge in the same equipment an OTN and SDH network element. Without this unique functionality it would be necessary to build two layers in the network: one to consolidate and groom SDH traffic and one to switch in the OTN/ODU layer, each layer with its own nodes dedicated to provide flexibility. With OMS3250, the same network element can be used to assure flexibility to both the layers.

This functionality, in addition to other offered features (e.g. map VC-4 based SDH traffic into ODUk, ODUk multiplexing and transparently map CBR2G5/CBR10G into their respective ODUk containers), makes the OMS3250 an advanced gateway to the optical layer that can be used to build flexible networks and offer a very competitive set of services in a cost effective and efficient manner.

Combined with the possibility to have in-service scalability to enhanced switch platforms (i.e. OMS3250 can be upgraded in service to a port subrack for the OMS3260 (960 Gb/s) cross connect), OMS3250 offers a genuine future-proof network architecture, which can be scaled to meet the demands of tomorrows' network.

The OMS3250 shares interfaces and common units with the MSH64C/OMS3240 (SDH/OTH Compact Add-Drop Multiplexer) and MSH-ES/OMS3260 (SDH/OTH very high capacity cross-connect). This offers operators significant benefit in providing a family of products, which use the same slide-in units, thus providing reduced inventory and whole life costs.

1.1 SDH Hierarchy

OMS3250, when in HO-VC ADM/cross-connect configuration, provides the STM-1 to STM-64 interfaces and supports the following SDH hierarchy, as shown in Figure 1, in accordance with ITU-T G.707.

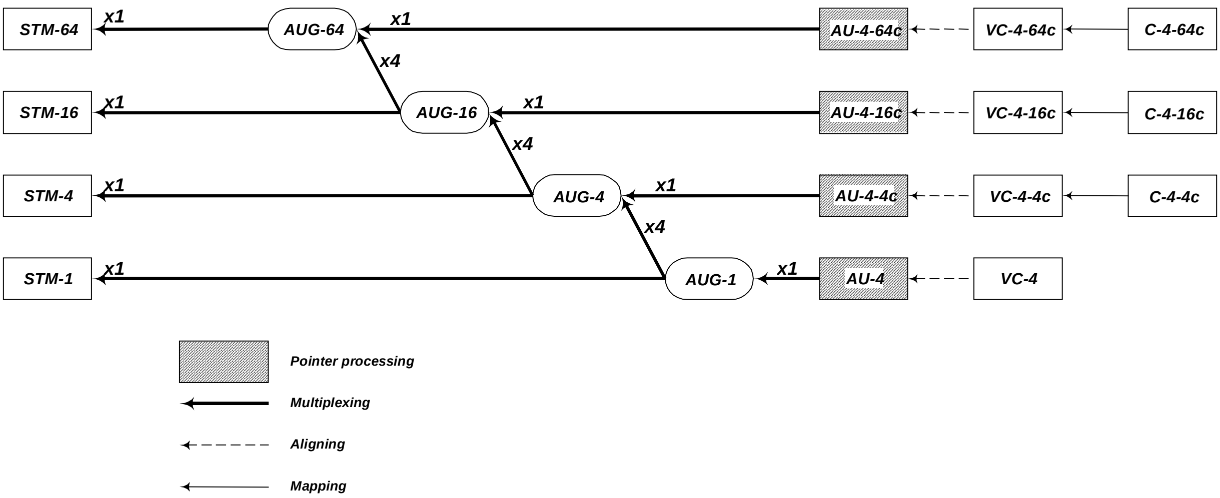
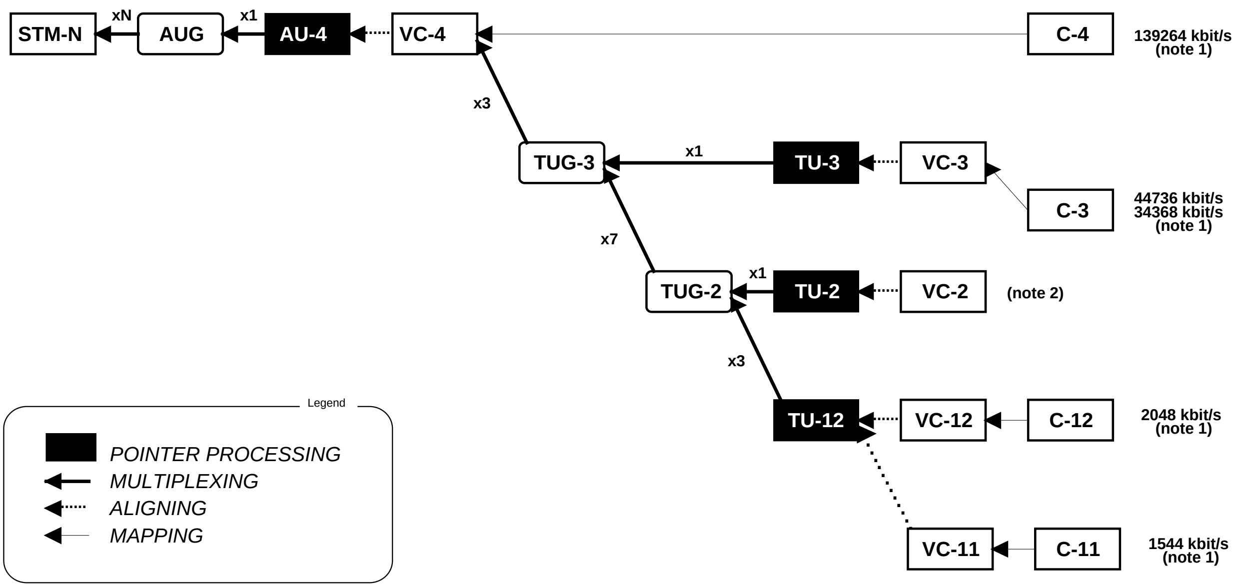


Figure 1: HO SDH Hierarchy

When configured to equip the optional LO-VC switch, the supported hierarchy is the following (Figure 2).



note 1: G.702 tributaries associated with containers C-x are shown. Other signals, e.g. ATM, can also be accomodated.
note 2: Virtual concatenation of VC-2 could be used for the transport of new services at non hierarchical bit rates

Figure 2: SDH Hierarchy

The optical interface parameters are compatible with the relevant specifications of ITU G.691 and G.957 or better. It is possible to increase the span of optical interfaces by using optical amplifiers.

The product also supports 'coloured' optical interfaces to facilitate interworking with Marconi DWDM equipment.

1.2 OTN Hierarchy

Additionally the OMS3250 equipment will also satisfy the ITU-T G.798 and G.709 requirements (as shown in Figure 3).

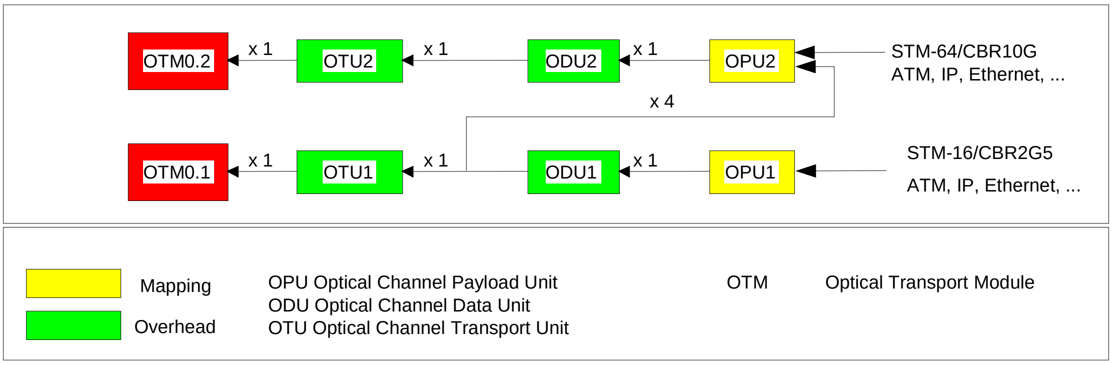


Figure 3: OTN (Optical Transport Network) Structure According To ITU-T G.709

2 CONFIGURATION

The OMS3250 subrack layout is illustrated below (Figure 4):

Figure 4: OMS3250 Subrack layout

The OMS3250 subrack is housed in a specially designed rack that allows full, unrestricted access to large fibre and cable management channels. The subrack mounting allows it to be mounted in most standard ETSI racks, however, due to the volume of optical connections Marconi strongly advises customers to use the specially designed rack especially if traffic is being presented to the switch at STM-1 or 4 rates.

The subrack can be configured as the following network elements.

- STM-64 DXC — Provides up to thirty-two (32) port STM-64 DXC, configured using single port single slot width STM-64 cards.
- STM-16 DXC — Provides up to one hundred and twenty-eight (128) port STM-16 DXC, configured using quad port STM-16 cards.
- STM-4 DXC — Provides up to two hundred and fifty-six (256) port STM-4 DXC, configured using octal port STM-4 cards. Up to 512 ports is supported using the Multirate card configured as 16xSTM-4.
- STM-1 DXC — Provides up to five hundred and twelve (512) port STM-1 DXC, configured using hexadecimal (16) port STM-1 optical or by using a mixture of 10 cards hexadecimal (16) port electrical STM-1 (LTU restricted) and 22 cards hexadecimal port optical STM-1.
- SDH/OTN DXC — Provides a mix of SDH (see previous configurations) and OTN interfaces with the ability to switch both VC4/VC4-nc and ODU

The OMS3250 supports combinations of the above configurations and can be enhanced to integrate a LO-VC ADM/DXC.

The MSH64R/256R regenerator subrack (10 Gb/s signal regenerator) is available for use in conjunction with the OMS3250 product. It can be equipped as a single or dual regenerator and uses the STM-64 units, configured in regenerator mode.

The regenerator subrack layout is shown below (Figure 5):

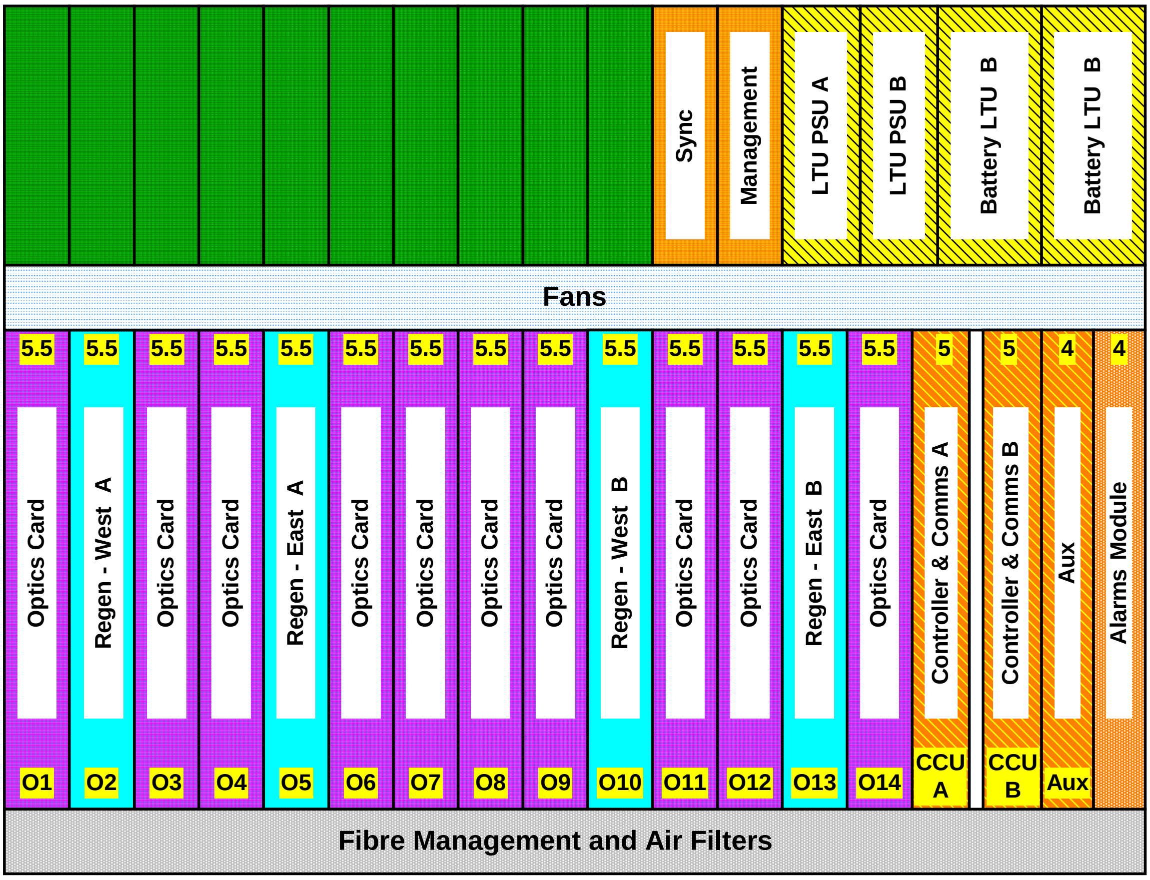


Figure 5: Regenerator Subrack layout

If additional optical units are required (e.g. Booster Amplifier, Preamplifiers), then there are eight spare slots on the lower shelf or, alternatively, they can also be fitted into any slot not occupied by a tributary unit.

If more optical units are needed, the Amplifier Extension subrack can be used (Figure 6).

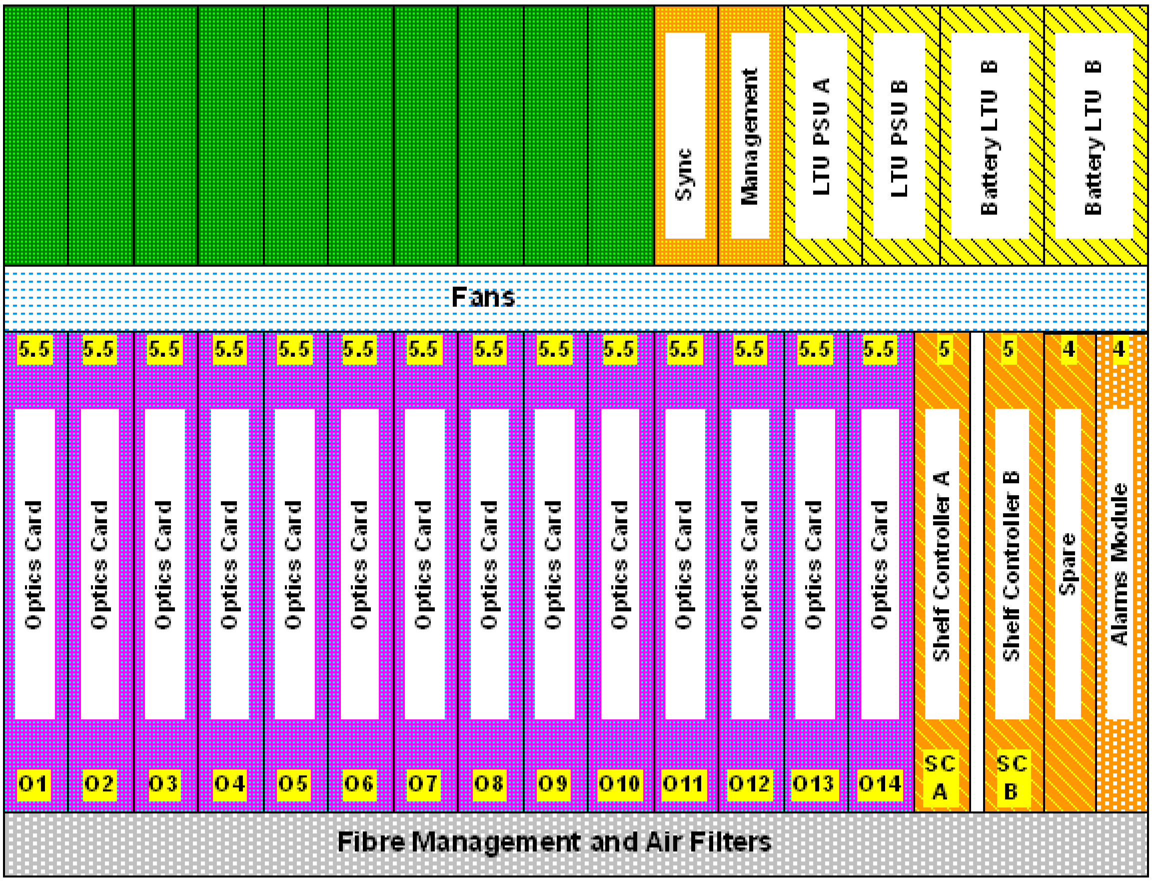


Figure 6: Amplifier Extension Subrack layout

This subrack is similar to the regenerator subrack but has no SMC flash disks in the Controller & Comms unit.

The two SMC flash disks (that plug into the Controller & Comms unit of the core and the regenerator subracks) store the application software and the database for the whole equipment; so they are not required in the extension subrack.

The Regenerator Subrack is a Network Element itself (for this reason it requires its own database and software), whilst the Amplifier Extension Subracks can be part of the OMS3250 and use the database and the software stored in the Controller & Comms unit of the OMS3250 core subrack.

3 TRIBUTARY INTERFACES

3.1 Interfaces and protection

OMS3250 can be equipped with compatible 'plug-in' units allowing access to different SDH, data and OTN signal interfaces.

The OMS3250 SDH and OTN interfaces are shown below (Table 1).

Interface	Signal Structure	Max no. of ports	I/F per unit
STM-1 el	ITU-T/G.707	160	16
STM-1 opt.	ITU-T/G.707	512	16
STM-4 opt	ITU-T/G.707	256 or 512[1]	8 or 16[1]
STM-4 opt C/V	ITU-T/G.707	128	4
STM-16 opt.	ITU-T/G.707	128	4
STM-16 opt C/V	ITU-T/G.707	32	1
STM-16 opt. CWDM[2]	ITU-T/G.707	128	4
STM-64 opt. grey	ITU-T/G.707	32	1
STM-64 opt. coloured	ITU-T/G.709	32	1
OTM- 0.1 / CBR2G5 Grey	Configurable ITU-T/G.709 ODU/VC-4/CBR Switching or CBR2G5	128	4
OTM- 1r.1 / CBR2G5 CWDM	Configurable ITU-T/G.709 ODU/VC-4/CBR Switching or CBR2G5	128	4
OTM- 0.2 / CBR10G Grey	Configurable ITU-T/G.709 ODU/CBR Switching or CBR10G	32	1
OTM-1r.2 ‘Coloured’	ITU-T/G.709 ODU/CBR Switching	32	1

Table 1: Max number of SDH/ODU interface access

Also, the OMS3250 supports standard data interface access as shown below (Table 2). OMS3250 is designed to support data cards in each traffic slot. Nevertheless the number of data interfaces depends on the number of VC-4v that each channel uses.

[1] Using the Multirate card, it is possible to equip up to 512 STM-4 interfaces (the Multirate card supports up to 16 STM-4 interfaces per card)

[2] Using SDH Multirate card with CWDM SFPs

Interface	Signal Structure	Max no. of ports		I/F per unit
		Data	STM-64	
Gigabit Ethernet	IEEE 802.3	270	5	10
10GbE	IEEE 802.3	16	16	1
Fast Ethernet	IEEE 802.3	368	1	20 / 8[3]
Escon/SBCON	X3.296	240	8	10
Fibre Channel	-	240[4]	8	10
Ficon	SA24-7172	160[5]	16	10
DVB-ASI	EN 50083-9	240	8	10

Table 2: Max number of Data interface access assuming data traffic is all aggregated onto STM-64 ports

In addition to SDH cards, with fixed rate/granularity (e.g. 4xSTM-16, 8xSTM-4, 16xSTM-1), OMS3250 can also be equipped with an extremely flexible SDH Multirate card; see paragraph 3.4.1.

Mixed tributary types can be configured.

According to ITU-T G.783/G.841 an optional automatic MSP 1+1 or 1:N is provided for all SDH interfaces: all the options specified for the "Multiplex Section Protection Protocol" can be used.

Multiple 2 Fibre/4 Fibre MS-SPRing according to ITU-T G.841 is supported using any STM-16/64 interfaces.

OMS3250 has 1:N (N≤4) tributary card protection on electrical STM-1 units, while tributary STM-N interfaces (electrical or optical) can be MSP 1+1 or 1:N protected. MSP 1+1 and 1:N are available on all slots configurable at port level.

The following table gives the capacity of OMS3250 in Gbit/s depending on the interface accesses:

[3] Provided by the L2 Aggregation Card, 20 FastE interfaces accessible for slots which have an associated LTU position or 8 interfaces accessible without an LTU position. The maximum number of FE interfaces depends on the SDH bandwidth which must be allocated; the table assumes the worst case that each FE port is mapped into 1 VC-4.

[4] Depending on the rate of the Fibre Channel clients (i.e. 1Gb/s, 530Mb/s or 265Mb/s) the used SDH bandwidth and, therefore the number of managed Fibre Channel interfaces can be different. For instance, the 1Gb/s Fibre Channel clients transport on SDH requires 6 VC-4v for each client. Therefore, in this case 160 Data clients and the relevant STM-n interfaces used for the transport saturate the OMS3250 capacity.

[5] The Ficon clients transport on SDH requires 6 VC-4v for each client. Therefore 160 Data clients and the relevant STM-n interfaces used for the transport saturate the OMS3250 capacity.

Tributary Interface	Unprotected Tributaries
STM-1 electrical (hexadecal)	25
STM-1 optical (hexdecal)	80
STM-4 (octal)	160 or 320[6]
STM-16 (quad)	320
STM-16 (single) C/V	80
STM-64 (single)	320
OTM-0.1 (quad)	320
OTM-0.2 (single)	320

Table 3: OMS3250 capacity in Gbit/s

3.2 Synchronisation Interfaces

Two dedicated outputs and two dedicated input interfaces are provided:

- 2048 kHz (G.703 sect. 13)
- 2048 kbit/s (framed/unframed G.706/G.703 sect. 9)

Electrical interfaces are available for synchronisation on OMS3250. In all cases the interfaces are independent.

3.3 Electrical Interfaces Characteristics

The characteristics for the tributary electrical interfaces are in compliance with the following ITU-T Recommendations:

- STM-1 according to G.703

OMS3250 supports the following electrical Data interfaces:

- Fast Ethernet 100BaseT;
- Gigabit Ethernet 1000BaseT.

3.4 Optical Interfaces Characteristics

The performance of the optical interfaces is in compliance with ITU-T G.691, G.957 or better. The provided optical interfaces, their attenuation ranges and maximum dispersion are as follows (NA means Not Applicable):

[6] Using the Multirate card, OMS3250 can reach the maximum capacity (320 Gb/s) also equipping all STM-4 interfaces (the Multirate card supports up to 16 STM-4 interfaces per card)

STM-1:	S-1.1:	0 - 12 dB	96 ps/nm
	L-1.1/L-1.2/L-1.3	10 - 28 dB	NA / NA / NA
STM-4:	S-4.1	0 - 12 dB	46 ps/nm
	L-4.1	10 - 24 dB	NA
	L-4.2 / L-4.3	10 - 24 dB	1600 ps/nm / NA
STM-16:	I-16	0 - 7 dB	12 ps/nm
	S-16.1:	0 - 12 dB	NA
	L-16.1:	10 - 24 dB	NA
	L-16.2 / L-16.3:	10 - 24 dB	1600 ps/nm / NA
STM-64:	I-64.1r	0 - 4 dB	3.8 ps/nm
	I-64.2r	0 - 7 dB	40 ps/nm
	S-64.1	6 - 11 dB	70 ps/nm
	S-64.2b	3 - 11 dB	800 ps/nm
	L-64.2b / L-64.3 (uses booster)	13 - 22 dB	1600 ps/nm
	V-64.2a (uses booster and preamp)	21 - 36dB	2400 ps/nm

A proprietary STM-64 long-haul card is also available, allowing a 20dB span without a booster.

Application designation: "I" Intra Office, "S" Short-haul, "L" Long-haul.

Suffix number:

- 1 indicates nominal 1310 nm wavelength according to G.652 fibre;
- 2 indicates nominal 1550 nm wavelength according to G.652 fibre for either short-haul and long-haul applications;
- 3 indicates nominal 1550 nm wavelength according to G.653 fibre (i.e. dispersion shifted fibre).

OMS3250 can be equipped with variable Booster Amplifier modules (two per core card) with power output ranges of +5 to +13 dBm and +12 to +18 dBm. Pre-Amplifier modules (two per core card) can also be equipped.

The following additional applications using boosters are available specifically for use on G.653 fibre:

STM-16:	V-16.3 (uses booster)	21 - 36 dB	1600 ps/nm
	V-16.3b17 (uses booster)	28 - 43 dB	1600 ps/nm
STM-64:	V-64.3 (uses booster and preamp)	21 - 37 dB	1600 ps/nm
	U-64.3b12 (uses booster and preamp)	23 - 39 dB	1600 ps/nm
	U-64.3b17 (uses booster and preamp)	28 - 44 dB	1600 ps/nm

For STM-64 opt. Interfaces, if Non-dispersion Shifted Fibre is used (i.e. G.652 fibre) fixed dispersion compensation fibre (DCF) is provided where required.

OMS3250 supports DWDM applications by integrating the following 10Gb/s units, both of which have transmit wavelengths tunable over 16 wavelengths with 50GHz spacing:

- 1xSTM-64 OOB FEC unit supporting a G.709 digital wrapper. This unit provides OTU2/ODU2/RS/MS termination and VC-4 switching;
- 1xOTM-1r.2 unit supporting OTU2 term, ODU1 multiplexing and ODU2/ODU1/VC-4 switching;

In addition OMS3250 is open to support CWDM 2.5Gb/s applications by integrating the 4xOTM-1r.1 unit (supporting OTU1 term and ODU1/VC-4 switching) or the SDH Multirate card. As these cards are provided with hot-pluggable optical transceivers, they can be equipped with SFP modules operating on different lambdas. 2.5Gb/s DWDM applications will also be possible using the same units when suitable SFPs become available.

The basic CWDM application consists of 4 or 8 unidirectional channels with wavelengths ranging from 1471nm to 1611nm with 20nm spacing according to ITU-T Recommendation G.694.2. The associated mux and demux filters are housed in external all-passive filter trays. The 8 channel CWDM filter is also available with an expansion port in order to provide channel upgrade with no traffic interruption, allowing more channels to be accommodated, up to 16 in total, depending on the fibre type and link characteristics. Both Short Haul and Long Haul CWDM modules are available, providing the applications defined in Recommendation G.695. A span loss of typically 22dB (or 21dB) can be achieved for an unamplified single span point to point 4 (or 8) channel configuration over standard G.652 fibre.

The performance of the OMS3250 Optical Line Interfaces can be improved by the FEC function. The FEC would be particularly useful for long-distance systems that suffer from noise accumulation, optical non-linear effects and/or polarisation effects. In Band FEC code is desired to operate within SDH line rates and improves the BER performance. The FEC function can dynamically provide an evaluation of the system margins relatively to the required level of performance. If maintenance of the line appears to be necessary, it can then be planned before any effective degradation of the transmission.

The FEC function essentially comprises:

- FEC encoder in the transmitting Terminal equipment that accepts information bits and adds redundancy, producing encoded data at higher bit rate;

- FEC decoder in the receiving Terminal equipment that performs the error correction while extracting the redundancy to regenerate the data that was encoded by the FEC encoder.

Implementation of the In Band FEC (IB FEC) function uses a Hamming code without modifying the bit rate of the STM-64 line.

Both a proprietary IB FEC and IB FEC as defined in ITU-T G.707 are supported by OMS3250.

Implementation of the Out of Band FEC (OOB FEC) function uses the OTU-2 frame structure (as detailed in figure 11-1/G.709 and Table7-1/G.709) and is supported by OTM-m.2 (m=0, 1r) units.

It is possible to enable/disable the FEC function by a command entered by NMS or LCT.

For STM-64 opt. Interfaces, if Single Mode Fibre is used (i.e. G.652), passive dispersion compensation devices (PDC) can be provided for long distance applications (typically beyond 80 Km).

In case of fibre break an automatic laser shutdown is provided to avoid danger caused by the emission of laser light. The procedure for automatic laser shutdown and restart is based on ITU-T/G. 958 (Appendix 2) and on ITU-T/G.664.

As laser shutdown facility is implemented, as specified in ITU-T G. 958, Section 9.7.

If the Optical Amplifiers are equipped, an automatic power shutdown is provided. The procedures for automatic power shutdown and restart are based on ITU-T G. 681, Section 10 and on ITU-T G.664.

3.4.1 SDH Multirate card

Three variants of this card provide a maximum of 16, 8 and 4 ports respectively, where each port is equipped with hot-pluggable transceivers. Such transceivers are in the form of SFP modules supporting STM-1, STM-4 and STM-16 with different optical reaches as follows, thus providing a very high degree of flexibility both in terms of traffic management and fibre link length. Each port may be equipped at any time, even after the card has been put into service, without any impairment to the ports already configured.

- STM-1 S-1.1, L-1.1 or L-1.2
- STM-4 S-4.1, L-4.1 or L-4.2
- STM-16 I-16, S-16.1, L-16.1 or L-16.2

SFP electrical modules for STM-1 are foreseen when commercially available.

The SDH Multirate cards can be equipped and programmed to support many different configurations. In their basic form, the cards can be configured to support the following full, single-rate configurations (MULTIPORT functionality) which may also be used to replace previous SDH card types:

- 4xSTM-16;
- 8xSTM-4;
- 16xSTM-1

Then with the addition of a hardware key to enable the MULTIRATE functionality, mixed configurations with STM-1, STM-4 and STM-16 are also supported, with the constraint of not exceeding 1 x STM-64-equivalent bandwidth.

The following table summarises the maximum capacity for each variant of the card:

Card variant	Capacity in OMS3250 Slot
16 SPF sockets, Multiport	16 x STM-1
16 SPF sockets, Multirate	4 x STM-16 or 16 x STM-4 or 12 x STM-1 or a mix of STM-1/4/16
8 SPF sockets, Multiport	8 x STM-4
8 SPF sockets, Multirate	2 x STM-16 or 8 x STM-4 or 6 x STM-1 or a mix of STM-1/4/16
4 SPF sockets, Multiport	4 x STM-16
4 SPF sockets, Multirate	4 x STM-16 or 4 x STM-4 or a mix of STM-4/16

Table 4: Port capacities for each variant of Multirate card

The card variants support many combinations of mixed STM-1, STM-4 and STM-16 ports. For example, some of the many possible configurations for the 16 port MULTIRATE card equipped in an OMS3250 slot are listed below:

- 2 x STM-16 + 2 x STM-4 + 12 x STM-1
- 1 x STM-16 + 6 x STM-4 + 9 x STM-1
- 4 x STM-4 + 12 x STM-1

Marconi Multirate card represents the most flexible and cost-effective solution to provide STM-1/4/16 services. For instance, in a node where a low number of different STM-1el/STM-1opt/4/16 signals is required, the user is not forced to equip a card for each type of signal, with the risk to have multiple unused ports. The user can decide to use a single Multirate card to support the required mixed configuration and equip each port as it is required.

3.4.2 Gigabit Ethernet card

The Gigabit Ethernet cards provide point to point transport of data traffic over SDH delivered over industry standard Gigabit Ethernet (optical) interfaces.

The Gigabit Ethernet cards are available as tributary cards for the OMS3250.

Key points of the Gigabit Ethernet cards are:

- 4 x 1000BASE-SX, LX, LH and ZX interfaces (provided as SFP optical modules on tributary card) as per IEEE 802.3:
  - Short 850nm Multi-Mode Fibre: 500m
  - Intermediate 1310nm Single Mode Fibre: up to 5km
  - Long 1310nm Single Mode Fibre: up to 10km

  - Extra Long 1550nm Single Mode Fibre: up to 80km

- Supports LAN interconnect services (Transparent LAN Service - EPL)
- Cheaper interconnect option for the end user than adding TDM interfaces to his LAN switch/router
- Can upgrade host OMS3250 platform in service, without affecting other services
- Increase range of services and hence revenue from SDH delivery platforms
- No need for a separate LAN switch or router to provide the Gigabit Ethernet interface(s)
- Provide monitored delivery of Ethernet transport services (remotely accessible counters, giving service level information to the operator)
- No need for a separate LAN switch or router to monitor delivery performance
- Map each interface into n x VC-4 capacity across the SDH network
- Remotely configurable, in n x VC-4 steps, up to 1 Gigabit per Ethernet port (7 x VC-4)
- LAPS (X.86)/GFP-F used to map Ethernet frames into SDH
- Ethernet frames from each port can each be mapped into either a separate VC-4, or each into a VC-4-nv virtually concatenated payload, where n is 2 to 7
- LCAS supported;
- VC-4-7v provides Gigabit Ethernet transport throughput
- Alternatively, frames can be mapped from each port into a separate VC-4-4c link
- Transparent transport of VLAN frames
- SDH transport protection retained
- Gigabit Ethernet line protection is available

3.4.3 Multi-Protocol Data card

The Multi-Protocol Data card is a tributary card, providing 10 Multi-Protocol user interfaces or one 10 GbE user interface, which maps client signals into SDH Virtual Containers. The type and number of interfaces to be equipped is flexible through the use of pluggable modules (i.e. SFP and XFP). The card provides 11 Sockets: ten can be used when the card is configured as Multi-protocol, while one is dedicated to provide 10GbE services.

The types of client signals that can be configured for each Multi-Protocol user interface are divided into three main categories: Ethernet traffic (FastE and GbE), SAN traffic (ESCON/SBCON, Fibre Channel/FICON) and Digital Video (DVB-ASI).

Each client signal is mapped into a single Virtual Concatenation Group through GFP encapsulation. Framed GFP mapping is applied to FastE, GbE and 10 GbE. This type of mapping permits interworking with the Aggregation Data card. The card is open to support Transparent GFP mapping for GbE. Transparent GFP mapping is applied to SAN traffic and DVB-ASI.

The services offered by this card are the same as described in the previous section.

The bandwidth of the SDH Virtual Containers can be flexibly configured in order to carry efficiently Ethernet traffic. Furthermore LCAS bandwidth management protocol can be applied.

Depending on the client signal bandwidth, the GFP encapsulated signals can be transported in the following SDH containers: VC-4, VC-4-nv (n=1 to 64).

3.4.4 Aggregation Data card

The extensive usage of Ethernet connections across the SDH network requires the SDH network to increase functionality to match more and more with the Ethernet L2 needs. The Aggregation Data card covers these needs.

3.4.4.1 L2 transport

<u>Multiplexed Ethernet access:</u>

When a larger number of connections is required per SDH head end node and per core switch or router, using a simple point to point transport service across the SDH network, a break point will be reached in network and equipment costs.

At this site an Aggregation card – presenting these multiple connections as logical flows over a single physical interface – will become the more cost-effective solution. The benefits in utilising such a card include:

- Single connection to core switch/router means less cabling, which is then easier to handle and maintain in the equipment room.
- Single card to present several remote customers to the core switch/router, which means more remote customer served and/or fewer slots used.
- Installation and operational cost savings, as further logical connections can be added remotely once the single interface is installed – no need to make a return visit to add Ethernet link, or to cable multiple Ethernet links on day one.

<u>Ethernet multiplexing into SDH VCGs:</u>

When a number of flows all go (or can be designed to go) from a single site to another, the use of a dedicated VCG per Ethernet flow does not cover all possible services that can be present in the transported Ethernet signal. In the Ethernet Private Line, the service offered to the Ethernet flow can be characterised at SDH level for example via the different type of protection configured (not protected, LCAS protected, SNCP protected, re-routed, fast re-routed via GMPLS…) but in any case a dedicated bandwidth is allocated to it (CIR).

At both ends of the VCG trail (or just at one end if at the other end the flows are presented as aggregated to a core switch/router) an Aggregation card will allow more Ethernet flows to be multiplexed into a single VCG. The benefits in utilising such a card include:

- Increasing the granularity of the network service, no longer limited by the VC-12/VC-4 granularity; in a single VC more than one customer flow can now be transported;

- Increasing the number of services provided; not only a CIR can be set up for an Ethernet flow, but also an EIR can be set up in conjunction with the CIR or just as a unique agreed service.

- Increasing the network bandwidth usage; a service using the EIR can advantage of bandwidth available in a particular time period, optimising the overall usage of the SDH available bandwidth.

Mixed configurations of multiplexed Ethernet access and Ethernet multiplexing into SDH VCG can also be achieved.

These services are referred as virtual private line (EVPL)

In addition to these, the aggregation card covers EPL applications as in the 4xGigE card.

3.4.4.2 L2 switching

Layer 2 Switching introduces address learning mechanisms into the transport functions.

The SDH network no longer provides only private lines between local area networks, but also provides an Ethernet bridged network within the operator network.

This service is referred to as virtual private LAN service (EVPLAN).

The Aggregation card configured for the L2 switching function avoids the need for an external Ethernet switch device. The benefits in utilising such a card include:

- Increasing the level of service provided by the SDH operator to the Ethernet customer

- Installation and operational cost savings, as SDH and switching functions are concentrated in one site and one device.

The card has on Ethernet side 8 GigE plus 4 FastE/Eth interfaces on the front of the card and 12 additional FastE/Eth are provided in the LTU area. On the SDH side a bandwidth of 32 STM-1 equivalents is provided, giving a total capacity of 10G full duplex. The Ethernet flows are mapped SDH side via GFP-F into VCG that can be VC-4-nv, VC-3-nv and VC-12-nv, with or without LCAS.

Please note that the card is able to terminate trails both at VC-4 level and at LO-VC level, avoiding the use of the LO switch usage where all LO VCs pertaining the Ethernet flows are presented in the right number of VC-4s.

The card inter-works with Ethernet cards using GFP-F mapping across all platforms within the Marconi portfolio, both ‘mapper’ cards (i.e. providing just EPL, like 4xGigE or multiprotocol cards into OMS3240/OMS3250) and ‘aggregation’ cards.

According to the importance of high quality data networks for business applications the performance management is based on several mechanisms:

- on the SDH performance management according to ITU-T G. 826 and 829

- on the Ethernet port management counters based on RMON and RFC2665

- additionally SDH-class data transport performance and alarm management based on traffic measurements like packet loss and defect frames, which allows the monitoring of the complete customer traffic flow similar to the way it is already provided for SDH networks.

3.4.5 OTM cards

OMS3250 supports 10G and a 4x2G5 cards able to handle OTM-0/1r.k signals. The following types of cards are available:

- 4xCBR2G5/OTM-0.1;
- 1xCBR10G/OTM-0.2;
- 1xOTM-1r.2.

The first two types are double bit-rate cards. Each port of the card can be configured to accept two different signals from the line:

- CBR2G5 and CBR10G: signals with a Constant Bit Rate of 2 488 320 Kbit/s ± 20 ppm and 9 953 280 kbit/s ± 20 ppm respectively. Examples of these signals are the STM-16 or OC-48, for the CBR2G5, and the STM-64 or OC-192 signal, for the CBR10G, as defined in G.709;
- OTM-0.1 and OTM-0.2 signals as defined in G.709.

In addition a specific 'Coloured' 10Gb/s card version is available (i.e. 1xOTM-1r.2), while the equivalent for the 2.5Gb/s application (i.e. 4xOTM-1r.1) can be obtained by plugging a 'Coloured' SFP on the card.

The following figure shows a generic diagram of the features provided by the OTM-0.2/1r.2 card.

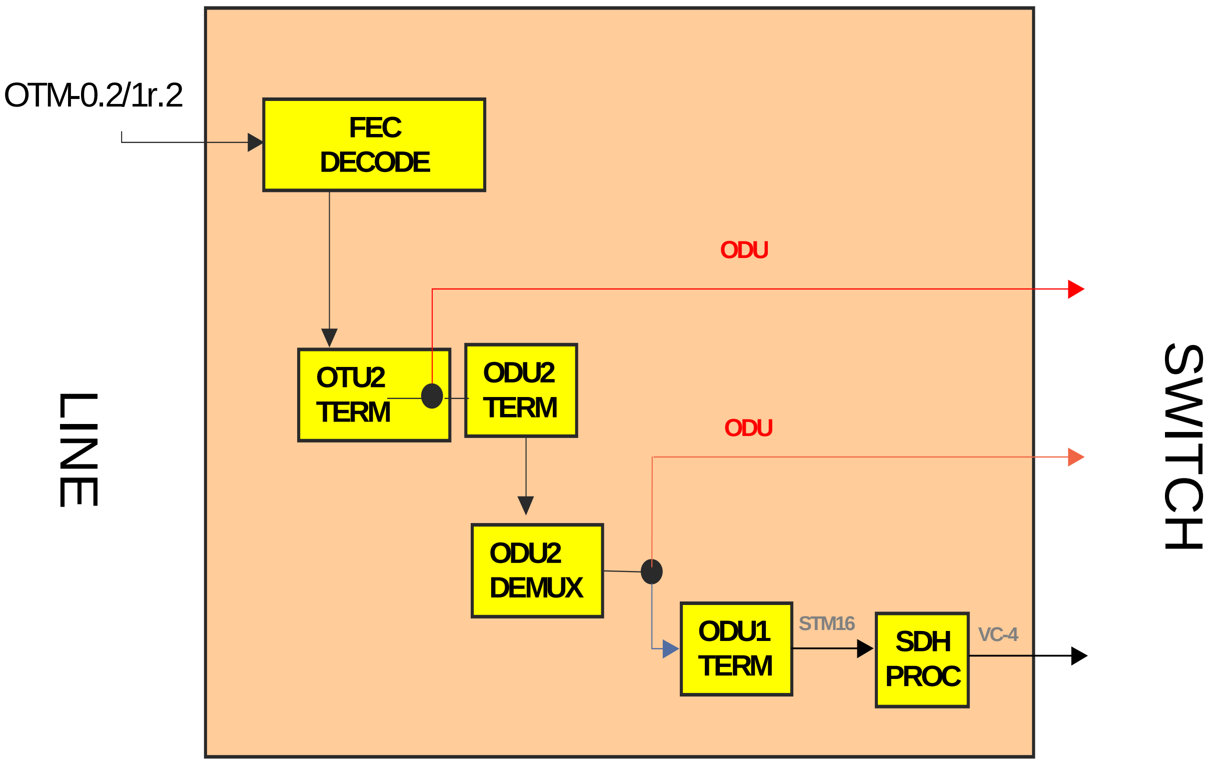


Figure 7: features provided by the OTM-0.2/1r.2 card

If CBR10G frame is received from the line side, the following signal processing is available:

- Mapping of CBR10G signal into ODU2 signal. In this case the equipment is used as gateway between the client and the OTN. The ingress card performs the mapping of the CBR10G signal into the ODU2 according to G.709. After the cross-connection the ODU2 is processed by the egress card to obtain an OTM-0.2/1r.2 signal. In the Switch to Line direction the CBR10G signal is extracted from the ODU2 received from the switching subsystem;

If OTM0.2/OTM1r.2 frame is received from the line side, the following signal processing is available:

- ODU2 cross-connection: In the Line to Switch direction the card first performs error correction decoding the G.709 RS FEC, if enabled, and then terminates the incoming OTU2 frame. The ODU2 is then passed to the switching core for cross-connection. In the Switch Side to Line Side direction the OTU2 frame is generated and, if enabled, FEC is encoded.

- STM-64 termination/generation (option available only for the 'Coloured' version of the card). The ingress card extracts the STM-64 clients from the ODU2 and terminates it down to VC-4 level. In the switch to line direction the VC-4's received from the switch are assembled into an STM-64 and then mapped into ODU2 and subsequently into OTU2 together with FEC encoding (if enabled), in order to forward towards the line the outgoing OTN frame.

- ODU1 multiplexing. In the Line to Switch direction the card performs OTU2 termination and de-multiplexing of ODU2 into 4 x ODU1. At this point the card is able to perform on each ODU1 one of the following actions:

  - ODU1 cross-connection. The ODU1 is passed to the switching core. In the opposite sense the received ODU1 is multiplexed, with other three ODU1's, into a single ODU2 and then mapped into the outgoing OTU2 frame;

  - VC-n cross-connection. The card performs also the extraction of the STM-16 signal from the ODU1, and its termination down to VC-4 level. In the Switch to Line direction the card receives VC-n from the switching core, generates a STM-16 signal, maps it into the ODU1 and then performs ODU1 multiplexing.

Similar processing is available on the 4x2.5Gb/s card apart from the ODU multiplexing and the FEC processing (i.e. FEC decoding is always disabled, bit stuffing is used). In addition if the signal received from the line is STM-16, the port can be configured to perform the 'classic' SDH processing. On this card each port can be independently configured (e.g. two ports can be configured as OTM, while the other two as CBR2G5.

4 MAPPING & MULTIPLEXING FUNCTIONS

The Mapping and Multiplexing functions provide the capability of mapping, aligning and multiplexing bi-directional logical channels between the SDH physical interfaces. The Multiplexing structure used in the equipment is according to ETSI ETS 300 147 and ITU-T G.707.

OMS3250 can support the concatenation of up to sixty-four (64) contiguous AU-4s according to G.707, using concatenation indication.

OMS3250 also supports the concatenation of four or sixteen (4/16) contiguous AU-4s, by converting them into virtual concatenated AU-4s using the STM16/STM-4 contiguous to virtual conversion card (both VC-4-4c and VC-4-16c Contiguous to Virtual conversion are supported). The STM-16/4 C/V card, that uses hot-pluggable optical transceivers, can be configured as:

- 1xSTM-16 AU4-16c/16v or AU4-4c/4v converter;
- 4xSTM-4 AU4-4c/4v converter.

The use of this unit at the edge of a network permits a VC-4-4c/16c service to be provided even if the network doesn't support the routing of VC-4-4c/16c containers.

OMS3250 also allows the mapping of client signals over ODU according to G.709 and ODU multiplexing according to G.709.

SONET transport over SDH can be supported, ie STS-3c carried as AU-4, STS-12c carried as AU-4-4c, STS-48c carried as AU-4-16c and STS-192c carried as AU-4-64c. The SS bits in the AU-4 pointer can be configured to support this. Note, however, that AU-3/TU-3 conversion is not supported.

5 SDH SECTION AND PATH OVERHEAD BYTES PROCESSING

The Section and Path Overhead bytes are managed according to ITU-T G.707 and ETSI /ETS 300 417-1-1.

The OH bytes, depending on their main use, are categorised as follows:

- Dedicated to specific use: These bytes are processed as required by international standards;
- Accessible: These bytes are accessible to the user via dedicated interfaces, for the purpose of data transport;
- Settable: All these bytes can be set to the same values (all zeros or all ones) and ignored at the receiver.

The Accessible bytes are made available through the interfaces specified in Section 11 (Services) and can be chosen from the list below:

- all SOH bytes of the STM-1 signals;
- SOH bytes of the first STM-1 (i.e. having defined each SOH byte as S(a,b,c), a: 1..3, 5..9, b: 1..9, c: 1) of the STM-N signals;
- VC4 POH

5.1 SOH Bytes Description

5.1.1 Regeneration Section Overhead (RSOH)

A1, A2	FRAMING; they are used to define frame alignment
J0	SECTION TRACE IDENTIFIER; it identifies the access point where the STM-N signal is sourced
B1	REGENERATOR SECTION ERROR MONITORING; it is used for regenerator section error monitoring (BIP-8 parity check code)
E1	ENGINEERING ORDER WIRE; it may provide a 64 Kbit/s order wire channel for voice communication
F1	USER CHANNEL; it is reserved for user purposes
D1÷D3 (DCC_R)	DATA COMMUNICATION CHANNEL; it provides a 192 Kb/s data communication channel
Z0	SPARE BYTES are allocated for functions not yet defined
Others	RESERVED FOR NATIONAL USE;
	MEDIA DEPENDANT
	UNMARKED

5.1.2 Multiplex Section Overhead (MSOH)

B2	MULTIPLEX SECTION ERROR MONITORING; it is used for multiplex section error monitoring (BIP-Nx24 parity check code).
K1, K2 (b1÷b5)	AUTOMATIC PROTECTION SWITCHING CHANNEL; it is used for MSP and MS-SPRing protocol management.
K2 (b6÷b8)	MS-REMOTE DEFECT INDICATION MS-AIS; it is used for alarm indication and MS-SPRing protocol management
D4÷D12 (DCC_M)	DATA COMMUNICATION CHANNEL; they provides a 576 Kb/s data communication channel
E2	ENGINEERING ORDER-WIRE; it may provide a 64 Kb/s order-wire channel for voice communication
S1 (b5÷b8)	SYNCHRONISATION STATUS; they transport the SSM (Synchronisation Status Message)
M1	MS-REMOTE ERROR INDICATION; it transports the number of errors detected using B2 bytes
Others	RESERVED FOR NATIONAL USE;
	UNMARKED

5.2 POH Bytes Description

5.2.1 VC-4 / VC-4Xc / VC-4-Xv POH

J1	PATH TRACE; it is used to transmit repetitively a High Order Path Access Point Identifier
B3	PATH ERROR MONITORING; it is used for path error monitoring (BIP-8 parity check code).
C2	SIGNAL LABEL; it indicates the composition of the VC3/4 payload
G1	PATH STATUS; it conveys back to a path originator the path terminating status and performance
F2-F3	PATH USER CHANNEL; they are allocated for user communication purpose
H4	POSITION AND SEQUENCE INDICATOR; it provides a multi-frame and sequence indicator for virtual VC-4 concatenation
K3 (b1÷b4)	AUTOMATIC PROTECTION SWITCHING (APS) CHANNEL; they are provisionally allocated for APS signalling for network protection of High Order Path Level
K3 (b5÷b8)	SPARE; they are allocated for future purpose

N1	NETWORK OPERATOR; it has been allocated for tandem connection monitoring function

5.2.2 Connection Supervision Functions

OMS3250 has been conceived to support Higher Order Supervisory-Unequipped functionality.

The Higher Order Supervisory-Unequipped function comprises the atomic functions Higher Order Supervisory unequipped termination source (S*ns*_TT_So) and sink (S*ns*_TT_Sk), as they are defined by ITU-T revised Draft G. 783 Recommendation.

The Higher Order Supervisory-Unequipped function enables supervision of unassigned HO connections on VC-4 paths.

5.2.3 Tandem Connection Monitoring

OMS3250 is open to support VC-4 Tandem Connection Monitoring functionality according to ETSI /ETS 300-417-4-1.

A VC-4 Tandem Connection is set-up to provide monitoring for a segment of a path, e.g. from where a path enters an operator's domain until it leaves that domain or is terminated. Specific information is added by the source function at the ingress of the Tandem Connection. This information is then extracted together with other path overheads by the sink function and is used to establish defect detection and performance monitoring for the path segment associated to the Tandem Connection.

6 OTN OVERHEAD BYTE PROCESSING

The OTUk and ODUk Layers Overhead bytes are managed according to ITU-T G.709 and ITU-T G. 798.

7 CONNECTION SUBSYSTEM

The OMS3250 connection features, performed by the switching subsystem, are provided by HPC function, as defined by ITU-T G.783 Recommendation, allowing cross-connections at the following levels (as defined by ETSI):

- VC-4
- VC-4-4c (direct support or Contiguous to Virtual conversion)
- VC-4-16c (direct support or Contiguous to Virtual conversion)
- VC-4-64c (direct support)

and also ODU cross-connections at the following levels:

- ODU1
- ODU2

The switch unit consists of 4 cards (Master plus Slaves 1, 2 and 3) as illustrated in the figure below.

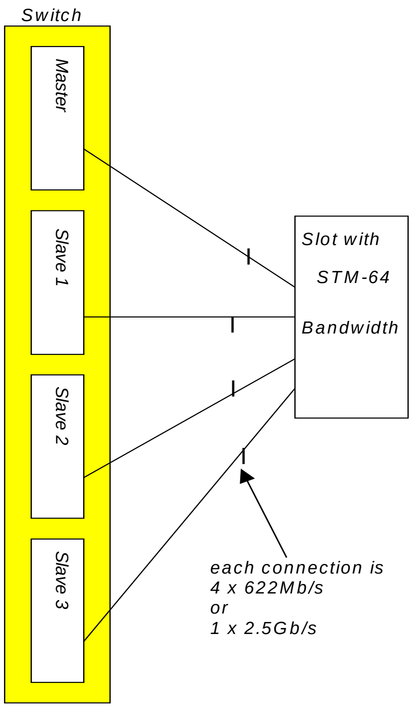


Figure 8: Transmission of payload to switch via the backplane

The switch can be duplicated for protection. The OMS3250 architecture allows up to 320Gbit/s (2048 x VC-4) physical connectivity to the switch plane.

The basic functions of the OMS3250 switching subsystem are:

NON-BLOCKING:	The probability that a particular connection request cannot be met is 0

FULL CONNECTIVITY:	It is possible to connect any input to each free output
TIMING TRANSPARENCY i.e. no slip:	Each outgoing switched channel contains the same timing information as it did at input port before switching
TIME SEQUENCE INTEGRITY (concatenated payloads):	Concatenated payloads are switched without breaking the time sequence integrity
ASSURED CORRECTNESS OF CROSS-CONNECTIONS:	Correct cross-connections between the right traffic ports

The switching subsystem can be configured to the following connection types:

- Unidirectional
- Bi-directional
- Broadcast
- Drop and Continue for SNCP
- Drop and Continue for MS-SPRing
- Loopback

7.1 LO-VC Switching

The integration of a LO-VC Switch inside OMS3250 permits Marconi to provide a compact and cost-effective solution for those networks nodes where, in conjunction to a wide HO-switch capacity, a LO-switch is required (Figure 9).

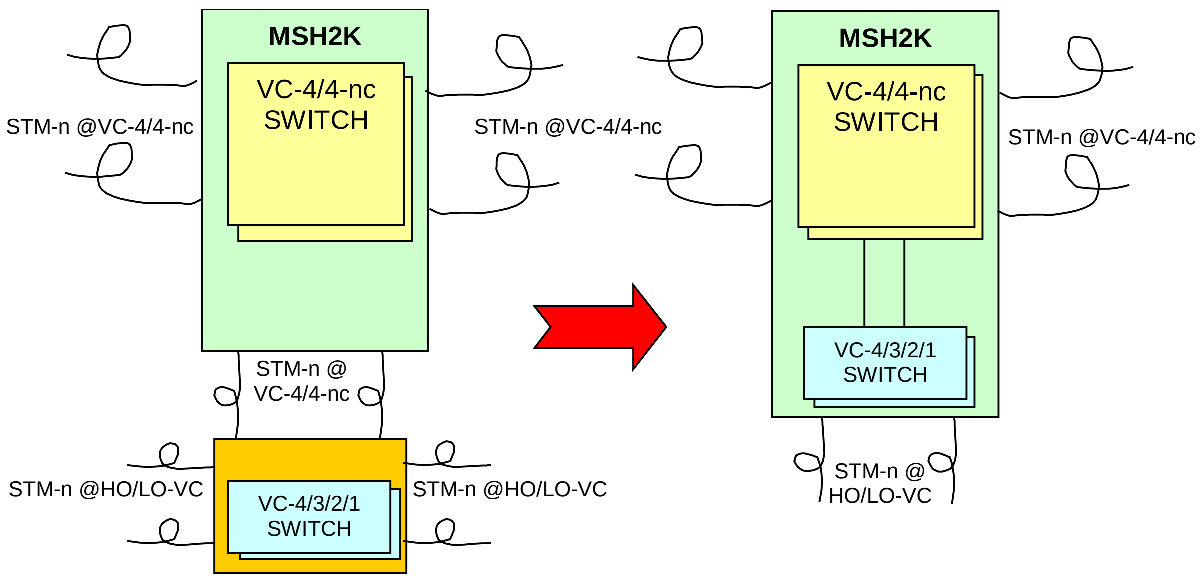


Figure 9: Evolution to the integrated LO switching

N dedicated cards, with a LO-VC switch on board, can be placed in any of the traffic slots. As the card consumes traffic capacity, the LO-VC Switch card performs SDH processing down to LO-VC level (i.e. included TU Pointer processing and LO-VC OH monitoring) of STM-n signals connected on the front of the unit.

The integration of a LO-VC Switch inside OMS3250 allows cross-connections down to VC-3, VC-2, and VC-12 levels and it is open to support VC-11 cross-connection as well.

Up to 8 Sockets are present on the card and can be equipped with different SFP modules to obtain the following configurations:

- 2xSTM-16;
- 8xSTM-4;
- 8xSTM-1

Mixed configurations with STM-1, STM-4 and STM-16 are also supported, with the constraint not to exceed 2 x STM-16-equivalent bandwidth.

The LO-VC Switch can be considered a hybrid card: it merges on the same card both the switching and the traffic processing features.

For redundancy purposes OMS3250 can be equipped with two LO-VC Switch cards (Unit A and Unit B): one of them shall operate as “Working” and the other as “Protection”. In addition, in order to provide the maximum availability each LO-VC Switch card is connected to both the "Working" and the "Protecting" HO-VC switching subsystem and cross connect the tributary traffic collected by the companion card: both Unit A and Unit B switch the traffic collected by W1,..Wn, E1,..En (Figure 10). The traffic collected by W1,..Wn is processed down to LO-VC level (i.e. TU pointer processing and LO-VC monitoring included) on Unit A, while the traffic collected by E1,..En is processed on Unit B. The two units then exchanges the processed data via backplane links, therefore the two Units of the LO-VC Switching subsystem must be fitted in precise slots of OMS3250 to provide the redundancy.

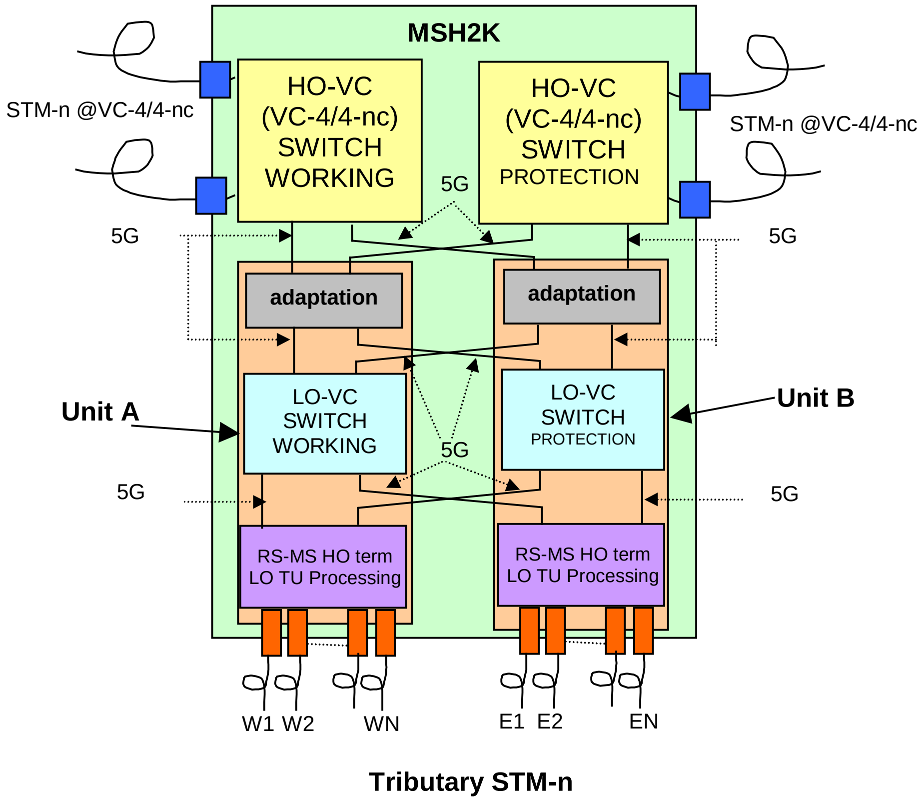


Figure 10: LO-VC Switch cards redundancy

The LO-VC Switching subsystem can offer the following services:

- Cross-connection at LO-VC level of TUG structured HO-VC received from the native STM-n units @VC-4/4-nc up to a capacity of 10G (i.e. 64x64 TUG structured VC-4). With this feature it is possible to groom and re-distribute the LO-VC contained inside a set of VC-4 received from the HO-VC switching subsystem and collected by the STM-n cards of OMS3250.

  In Figure 11 a general view of the processing inside the equipment is described: the STM-n unit @VC-4/4-nc receives from the line a TUG structured VC-4. If LO-VC switching is required, the HO-VC is cross-connected by the HO switch (1) to the slot where the LO SWITCH unit is equipped. The first action performed by the LO SWITCH unit is the termination of the VC-4 POH and the TU Pointer processing (2). After the cross-connection at LO-VC level (3), LO-VC are groomed again in a TUG structured VC-4 (4), and forwarded, via backplane links, to the HO switch. The VC-4 is then cross-connected (5) and sent to an STM-n @VC-4/4-nc unit. In the figure below only one LO SWITCH unit and only one HO-VC switching subsystem is presented for simplicity.

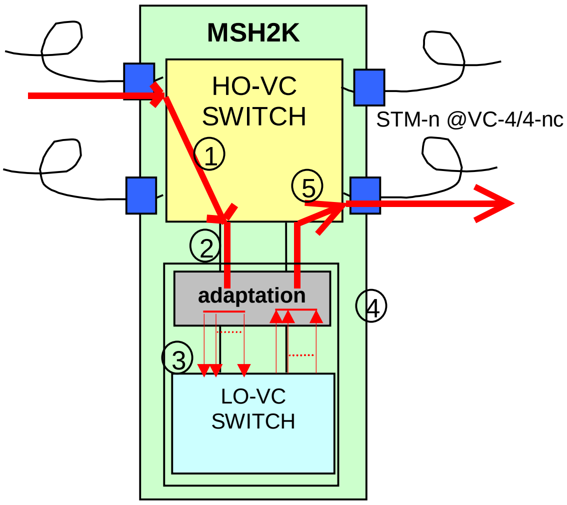


Figure 11: Processing inside the LO Stitching matrix

- Cross-connection at LO-VC level (and eventually at HO-VC level) of the traffic received from the "tributary" STM-n interfaces, directly mounted on both the LO-VC Switch cards is up to a capacity of 10G (i.e. up to 5G collected by Unit A and 5G collected by Unit B). In this way the LO SWITCH unit performs the classic features of a 4/1 ADM, integrated inside the OMS3250:
    - Ring closure, at LO-VC level, of the traffic received from two "tributary" STM-n interfaces; please note that in order to assure the protection in case of failure of one of the LO SWITCH units, the two STM-n interfaces, involved in the Ring protection, must be placed: one on Unit A, the other on Unit B
    - Collection of LO-VC distributed on different tributary STM-n interfaces and cross-connection. The LO-VC can be then re-routed to another tributary STM-n interface or can be groomed in TUG structured VC-4 and forwarded to the HO switching subsystem.

8 UPGRADE TO OMS3260

The upgrade of OMS3250 to a port subrack for OMS3260 (960 Gb/s capacity), involves the replacement of the Switch units with Switch interface units.

Each Switch interface unit is connected to the OMS3260 core via ribbon cables each containing 8 fibres (4Tx and 4Rx), the traffic transmitted is arranged into the proprietary internal frame.

Up to 24 port subracks can be added to OMS3260, each port subrack is allocated a shelf number (SN Id). This is configured and displayed on the alarm module.

Each Port Subrack can be provided with Expansion Subracks available for the OMS3250.

9 NETWORK APPLICATIONS AND PROTECTIONS

The OMS3250 cross connect system allows the connection of complex network configurations, such as rings, chains and stars. These topologies can also be mixed.

The switching functions and the range of possible tributaries allow flexible reconfiguration of the traffic as far as both the destination and the capacity of the transmitted circuits are concerned.

The possible protection features at network level are:

- MSP protection on STM-N line and tributary interfaces according to ITU-T/G.841;
- "Sub-Network Connection Protection", according to ITU-T/G.841, at VC-4 VC-4-Xc, VC-3, VC-2 and VC-12 level;
- "MS-SPRing" protection on STM-16 and STM-64 rings according to ITU-T/G.841.
- "Ring Interworking Protection", according to ITU-T/G.842;
- Fast Restoration via ASTN
- OTN Protections (i.e. ODUk SNC/I and SNC/N).

Also mixed protection can be applied, for example MS SPRING and SNC-P, MS-SPRing and Fast Restoration or ODUk SNC/x and SNC-P.

9.1 MSP protection

The MSP function provides protection for the STM-N signal against channel-associated failures within a multiplex section. All possible options specified for the "Multiplex Section Protection (MSP) Protocol" (bytes K1 and K2), as defined in ITU-T/G.783 and G.841, can be used.

The following criteria may be used at the receive end for switching to the protection path:

- Signal Fail (LOS, LOF, MS-AIS, Excessive BER) at section level;
- Signal Degrade (BER exceeds a preset threshold in the range of 10-5 to 10-9);
- Command from the Local Terminal or from ServiceOn Optical Element Manager and Management System.

On STM-1/4/16/64 tributary interfaces, MSP protection is available, using a 1+1 or 1:N architecture; with N up to 4.

When the MSP 1:N (N≥1) is provided, optional extra traffic is supported.

9.2 MS-SPRing Protection

OMS3250 equipment provides the MS-SPRing ("SDH Multiplex Section Shared Protection Ring") protection mechanism. Its general features are defined in ITU-T Rec. 803, while the complete description of the protocol can be found in ITU-T Rec. G.841. Both two and four fibre options are supported.

The MS-SPRing protocol manages the NUT (Non Pre-emptable Unprotected Traffic) as defined in the latest G.841 version.

The equipment can be configured for particular network applications to support multiple rings each protected by MS-SPRing.

MS-SPRing is characterised by dividing the total payload (in every STM-N link) equally into working and protection capacity. The working traffic is bi-directional over a single path (e.g. A-B and B-A in Figure 12). The protection capacity is shared by all the working sections and not dedicated to each connection on the ring.

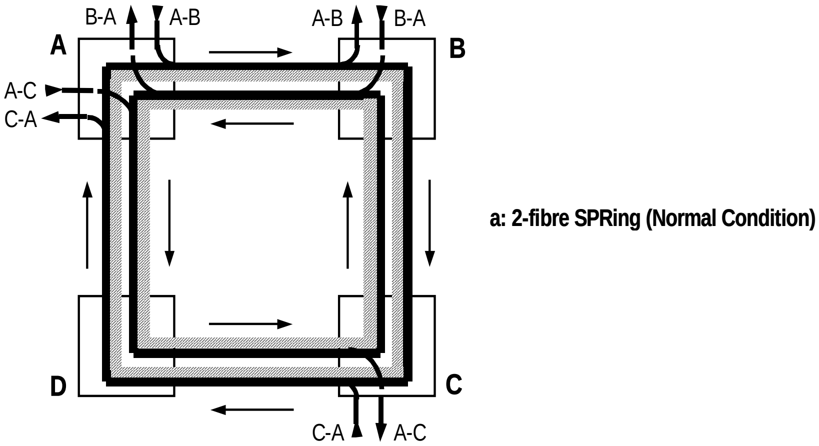


Figure 12: Two fibre MS-SPRing (Normal Condition)

In case of link or node failure a loopback is performed at the nodes adjacent to the failed link or node (see Figure 13 and Figure 14).

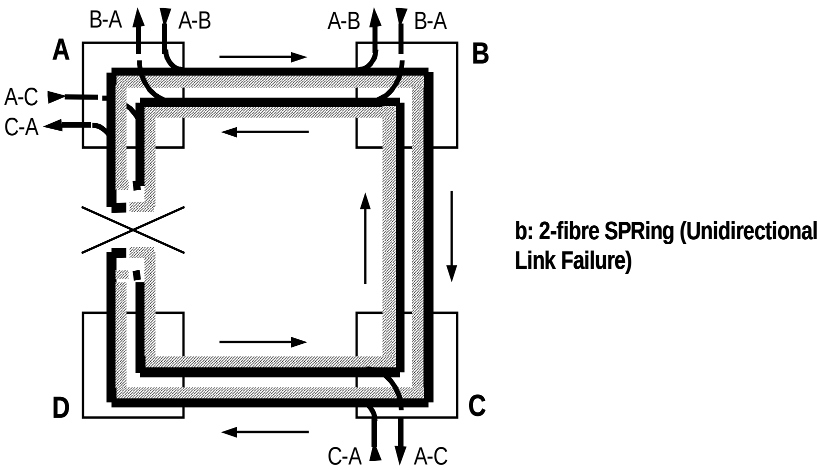


Figure 13: Two fibre MS-SPRing (Unidirectional Link Failure)

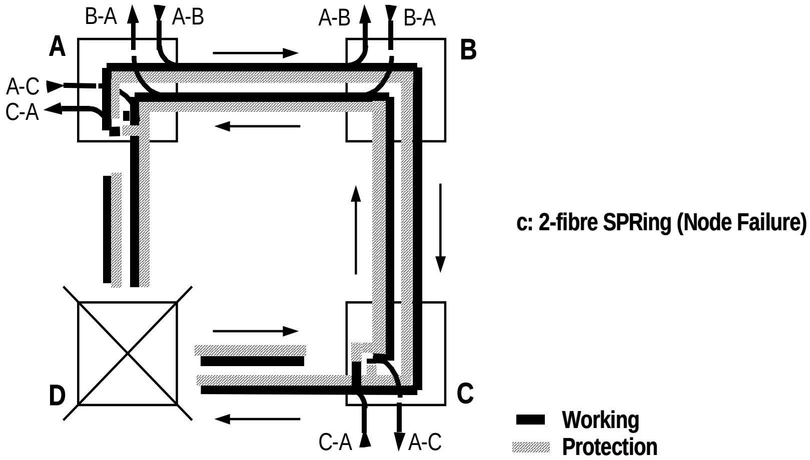


Figure 14: Two fibre MS-SPRing (Node Failure)

The relevant Switch Matrix Unit implements the loopback. The protection mechanism can be activated by the following criteria:

- Signal Fail at section level (LOS, LOF, MS-AIS, excessive BER);
- Signal Degrade (BER exceeds a preset threshold in the range of 10-5 to 10-9);
- Command from the Local Terminal or Element Manager.

All these procedures are managed by an appropriate APS (Automatic Protection Switching) protocol provided by K1, K2 bytes. As an option low priority traffic can be managed.

9.3 Ring Interworking Protection

Interworking SDH protection architectures provides an even greater degree of protection within a network. Ring interworking is accommodated in such a way that if two rings are connected at more than one node each, a failure at one of these nodes shall not cause loss of any service.

OMS3250 supports interworking between SNCP protected rings, MS-SPRing protected rings and mixtures of the two, according to ITU-T G.842.

Overlapping SNCP should be used as an alternative and simpler method.

9.4 OTN protection

OMS3250 supports the following types of protection architectures for an OTN network:

- Inherent Subnetwork Connection Protection (SNC/I) on ODUk (that is equivalent, for switching criteria point of view, to an OTUk Trail protection);
- Non-intrusive Subnetwork Connection Protection (SNC/N) on ODUk;

Each protection application makes use of pre-assigned capacity between nodes.

9.5 Sub-network connection protection

The "Sub-Network Connection Protection" is defined in ITU-T Rec. G.803 and ITU-T Rec. G.841.

When OMS3250 systems are connected in a subnetwork (e.g. a ring topology) the relevant VC-4 of the signal to be protected can be protected, by transmitting it from the input tributary to two output interfaces. At the receive side, the available or better-quality signal is selected.

The switching between the two directions is based on the following criteria:

- AU-AIS and AU-LOP alarms at the VC level (inherent monitoring);
- Error performances (BIP information), payload and routing correctness (Unequipped Signal and Trace Identifier) at the VC level (non intrusive monitoring);
- Command from the Local Terminal or from Element Manager.

In this way, the channel is protected against any single failure in the subnetwork.

The following ODUk protection architectures are supported:

- 1+1 unidirectional SNC/Nand SNC/I

  In these architectures, a permanent bridge is utilised at the transmit end. At the receiver end, a protection switch is realized by selecting one of the signals based on purely local information.

  For protection switching criteria, non-intrusive (SNC/N) or server layer (SNC/I) monitoring shall be used.

- 1+1 bi-directional SNC/Nand SNC/I

  In these architectures, a permanent bridge is utilised at the transmit end. At the receive end, a protection switch is realised by selecting one of the signals based on local or remote information. For protection switching criteria, non-intrusive (SNC/N) or server layer (SNC/I) monitoring is used.

  These types of protection use the automatic protection switching protocol (APS).

- 1:N an SNC/I protection

  In this architecture N working subnetwork connections that are to be protected share an additional subnetwork connection for protection purposes. In a normal condition, this protection capacity can be used to carry lower priority “extra traffic”. This extra traffic itself is not protected and is to be replaced by higher priority working traffic under failure conditions. This architecture requires the APS as protection control.

  For protection switching criteria, server layer (SNC/I) monitoring is used.

  The architecture can be unidirectional or bi-directional.

For 1+1 architecture the revertive or not-revertive mode of operations is available.

For each type of protection, manual external command is available to the operator.

9.6 OS Restoration

It is possible to perform network protection using rerouting. This protection scheme is mainly operated by the network management system using the capabilities of cross-connection reconfiguration offered by OMS3250.

Spare capacity is reserved on each link of a meshed network in order to provide alternative routes on which traffic can be transported. In case of cable break the traffic transported by the failed link is redirected along pre-programmed or on-line calculated alternative routes using the available reserved capacity.

9.7 Fast Restoration

As well as conventional SDH protection schemes the OMS3250 will support ITU-T (ASON/ASTN) based fast network restoration. This method of protection is particularly effective in mesh network architectures.

The OMS3250 will simultaneously support all SDH protection schemes and network restoration making it the ideal switching solution for operators wishing to migrate from one scheme to another. The Marconi solution offers full scalability to meet the needs of large operators who typically could have hundreds of dynamic elements in their networks.

Spare capacity is reserved on each link of a meshed network, in order to provide alternative routes on which traffic can be transported. In case of cable break the traffic transported by the failed link is redirected along pre-programmed or on-line calculated alternative routes using the available reserved capacity.

This protection scheme can be applied at any cross-connected level, i.e. VC4, VC4-nc and ODU.

10 AUTOMATIC SWITCHING TRANSPORT NETWORK with OMS3250

The OMS3250 family may be introduced into an existing network to provide a new layer of transport network where the concept of ASTN can be applied to achieve faster trail routing, connection set-up and tear down and fast network restoration.

All those operations are currently carried out by the traditional Network Management System with typical execution time in the order of minutes, while a distributed intelligence would allow the same operations to be carried out in hundreds of milliseconds.

The ASTN control plane will allow faster connection set-up thanks to improved automatic routing algorithms and signaling. Such mechanisms allow faster implementation of on-the-fly restoration mechanisms.

The distributed intelligence enables the first NE to recalculate the path and signal the restoration route throughout the network, thus implementing fast restoration mechanisms with the sharing of restoration resources.

UNI interfaces will also be available to support OVPN services and direct connection set-up and tear down from client interfaces.

The ASTN functionality has been realised in three phases:

1. Fully centralised implementation - The function is implemented in a fully centralised solution. UNI interface is implemented in the centralised application. All the network topology information is automatically handled by the function. This implementation can be applied to all network products (including legacy) without a network element field upgrade. Such a centralised solution is provided with NNI and NMI interface to allow interworking with the other control planes.

2. Centralised routing function, distributed routing protocol - A signalling protocol is implemented in the embedded software of the network elements, this will speed up the path implementation process. The signalling protocol is compatible with the traditional OSI based DCN. For some protection schemes, the network elements will also have the capability to store the alternate route without implementing it prior to failure occurrence. The path computation function will remain centralised.

3. Fully distributed implementation - Fully standard UNI interfaces are integrated in the network elements, thus avoiding the need for adapter devices. A fully distributed control plane is available directly in the network elements. This features a Link Management Protocol (LMP) for automatic neighbour discovery, an IP-based Link State Routing Protocol (OSPF-TE) for automatic topology and resource discovery and a signalling protocol with explicit routing capability (RSVP-TE). Centralised functions (e.g., client database) will continue to be supported.

11 EQUIPMENT ARCHITECTURE

11.1 Block Diagram

Figure 15 shows the general block diagram of OMS3250.

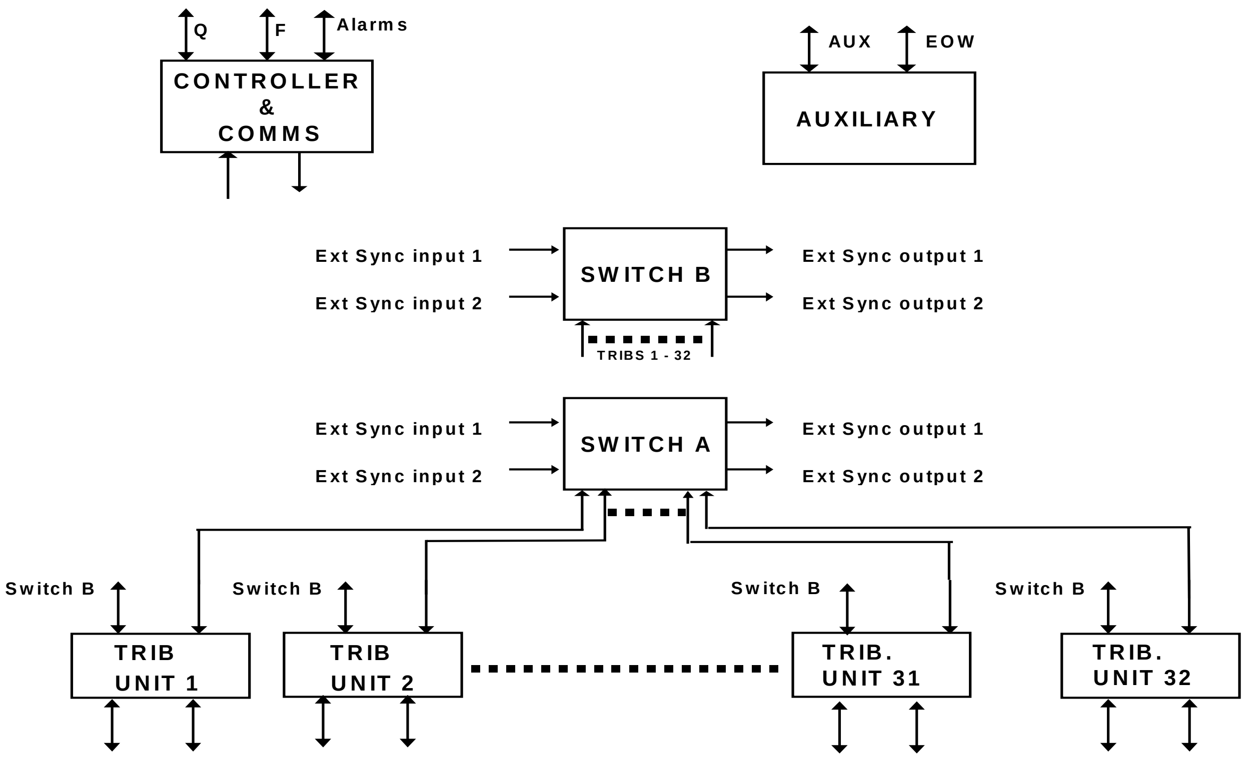


Figure 15: OMS3250 General Block Diagram

The units which constitute the OMS3250 are detailed in the following table:

Unit	QTY	Description
Primary Switch Unit	1	Constitutes the HO-VC switching subsystem whose functions are described in Section 7
Secondary Switch Unit	3	Constitutes the switching subsystem whose functions are described in Section 7
Tributary Unit	Up to 32	Provides the tributary interfaces according to the type of fitted units
Contr/Comms Unit	1 (including 2 SMC)	Provides the high level control of the equipment, the F (Local Craft Terminal) and Q interfaces, together with the access to the DCC channels.
Alarm Unit	1	Provides local alarm indications (power fail, temperature, ground contacts and rack alarms)

LO-VC Switch	Up to 32	Provides the LO-VC switching subsystem and tributary interfaces
LTU PSU	2	Provides derived voltage to the LTUs (also provides V.11/G.703 Auxiliary interfaces)
Battery LTU	2	Provides filtered subrack feed voltage to the cards LTU PSUs and fans.
Management LTU	1	Provides physical connectors for Q interface, F interface, and extension subrack (also provides EOW interface)
Sync LTU	1	Provides external synchronisation input and output interfaces (also provides Ground contact and rack alarm interfaces)
Fan tray unit	5 or 10	Maintains correct environmental temperature
Optional units		
Primary Switch Unit	1	Provides protection.
Secondary Switch Unit	3	Provides protection
Contr/Comms Unit	1 (including 2 SMC)	Provides protection.
Auxiliary Unit	1	Provides communication channels for service functions

11.1.1 SDH Tributary Units

In OMS3250, the SDH tributary units perform the following functions:

- optical/electrical interface;
- SOH insertion/extraction;
- AU-4 mapping/demapping;
- VC-4 POH supervision; this function can be activated/deactivated by the user;
- selection of one of the two data streams received from the switch by means of insertion/monitoring of check messages.

In order to guarantee a high level of availability the Electrical Tributary Unit can be card protected.

The card protection schemes are:

- two groups of electrical tributary cards can be 1:N protected, with N up to 4.
- 1:N card protection is REVERTIVE.

and are based on the following switching criteria:

- internal failure of the working unit;
- extraction of a working unit.

11.1.2 OTN Tributary Units

In OMS3250, these units perform the following functions:

- Optical interface;
- OTU/ODU/OPU Overhead management
- OTU sink/source termination
- ODU/OPU sink/source termination for Client Signal extraction or ODU multiplexing;
- CBR Client Signal mapping/demapping
- SOH on SDH Client Signal insertion/extraction;
- AU-4 mapping/demapping;
- VC-4 POH supervision; this function can be activated/deactivated by the user;
- selection of one of the two data streams received from the switch by means of insertion/monitoring of check messages.

11.1.3 HO Switch Unit

In OMS3250, this unit performs the following functions:

- cross connection at ODU1, ODU2, VC-4 and VC-4-Xc level;
- equipment timing;
- multiplex section protection (MSP);
- MS-SPRing protection
- Sub-Network Connection Protection;

In order to guarantee a high level of availability the Switch Unit can be 1+1 protected.

Switch fault detection is achieved through the insertion of check messages performed by the input working traffic card into traffic entering the switch (devoted bytes of the proprietary internal frame). The monitoring of the messages in the traffic leaving the switch is performed by the output working traffic card. Checking consists of:

- comparison between source port contained in the message and the expected one;
- parity checks

During normal working conditions the traffic is transmitted to both switches. In case of fault, the receiving traffic card selects the traffic from the error-free switch, raises an alarm and the Controller then disables the faulty switch.

The changeover between the two units is hitless.

11.1.4 LO-VC Switch Unit

In OMS3250, this unit performs the following functions:

- cross connection at VC-4/3/2/12 level;
- multiplex section protection (MSP);
- Sub-Network Connection Protection;
- SDH cross connection at VC-4/3/2/12 level;
- SOH and POH processing of the on-board STM-n interfaces;
- POH processing of the LO-VC received from the HO-VC switching subsystem;

In order to guarantee a high level of availability the Switch Unit can be 1+1 protected.

Switch fault detection is achieved through the check of diagnostic messages.

During normal working conditions the traffic is transmitted to both switches. In case of fault, the receiving traffic card selects the traffic from the error-free switch, raises an alarm and the Controller then disables the faulty switch.

11.1.5 Communication/Controller Unit

This unit supports the high-level control of the equipment as defined by G.783, the F and Q interfaces together with the access to the DCC/GCC channels as requested by G.784 and G798.

The Communication/Controller unit contains, in its not-volatile memory, the Software executables of the cards on the subrack and all the equipment configuration data.

11.1.6 Auxiliary Unit

This unit implements the OHA logical block according to G.783.

11.2 Internal Distribution Of Signals

The internal signals can be subdivided in:

- traffic signals;
- timing signals;
- control signals;

- Overhead;
- Power Supply.

In the following a detailed explanation for each type of signals is given for OMS3250.

11.2.1 Traffic signals

The traffic connections within the OMS3250 equipment are shown in Figure 16: the connection between the traffic cards and the switching matrices via the backplane uses 622M or 2.5G links, depending on the type of traffic card.

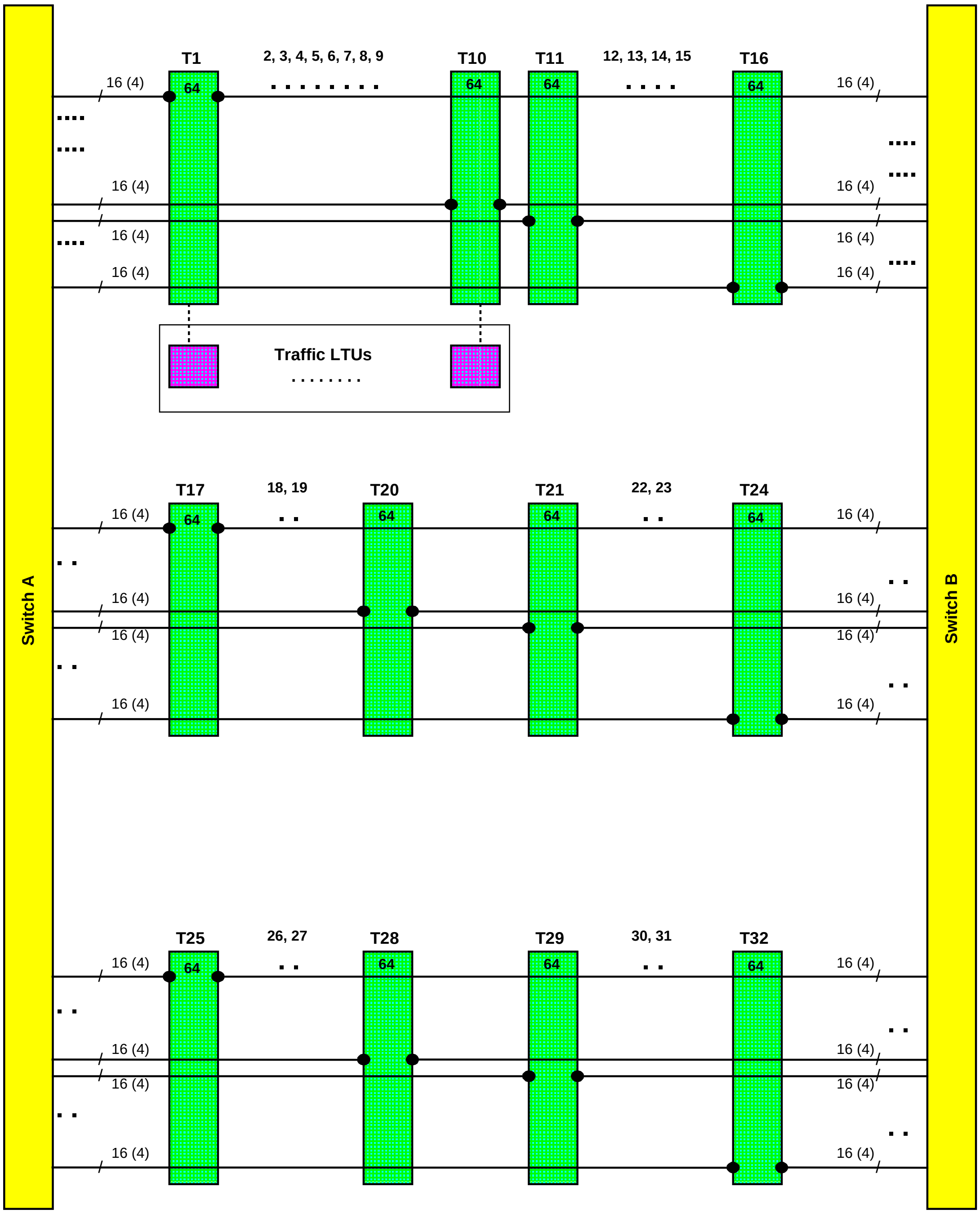


Figure 16: Distribution of Traffic Signals using 622Mb/s (or 2.5Gb/s) LVDS links

In OMS3250, the STM-N/OTM–x.n signal is processed by the Tributary card and passed to the Switch Unit that provides the connection functionality at the VC-4/ODUk level, routing the traffic to any of the tributary cards.

11.2.2 Timing signals

The distribution of timing signals is shown in Figure 17.

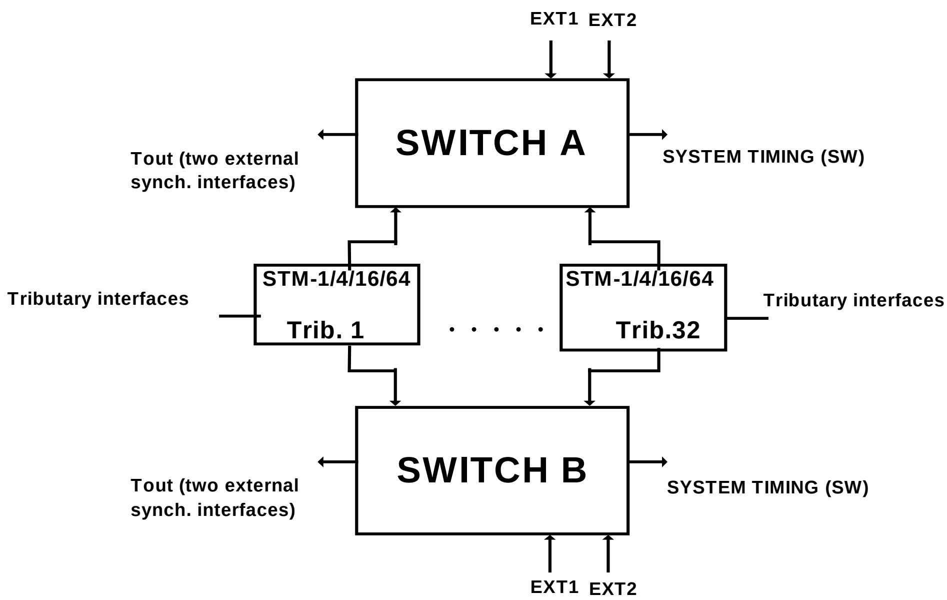


Figure 17: Distribution of Traffic Signals

In the OMS3250, two independent external synch source inputs are available. All of the possible synchronisation sources extracted from the traffic units go to each of the duplicated Switch Units. The actual system timing is derived from the working Switch Unit and is provided to all traffic cards. Also two external synchronisation outputs (TOUT, i.e. independent 2MHz / 2Mb/s signals) are derived from the working Switch Unit.

11.2.3 Synchronisation Status Messaging

The use of Synchronisation Status Messaging (SSM) method provides an indication of the quality of the timing in order to allow the selection and confirmation of the highest quality synchronisation source. The SSM/TM are transported by bits 5:8 of the first S1 byte as defined in Rec. G.707 (see section 9.2.2.11) for STM-N and by bits Sax1: Sax4 (x=4,5,6,7 or 8) of TS0 for T3 (external input) and T4 (external output) interfaces as defined in revised Rec. G.704 for G.704 2Mbit/s signal.

11.2.4 Control signals

The control signals are distributed in OMS3250 equipment as shown in Figure 18.

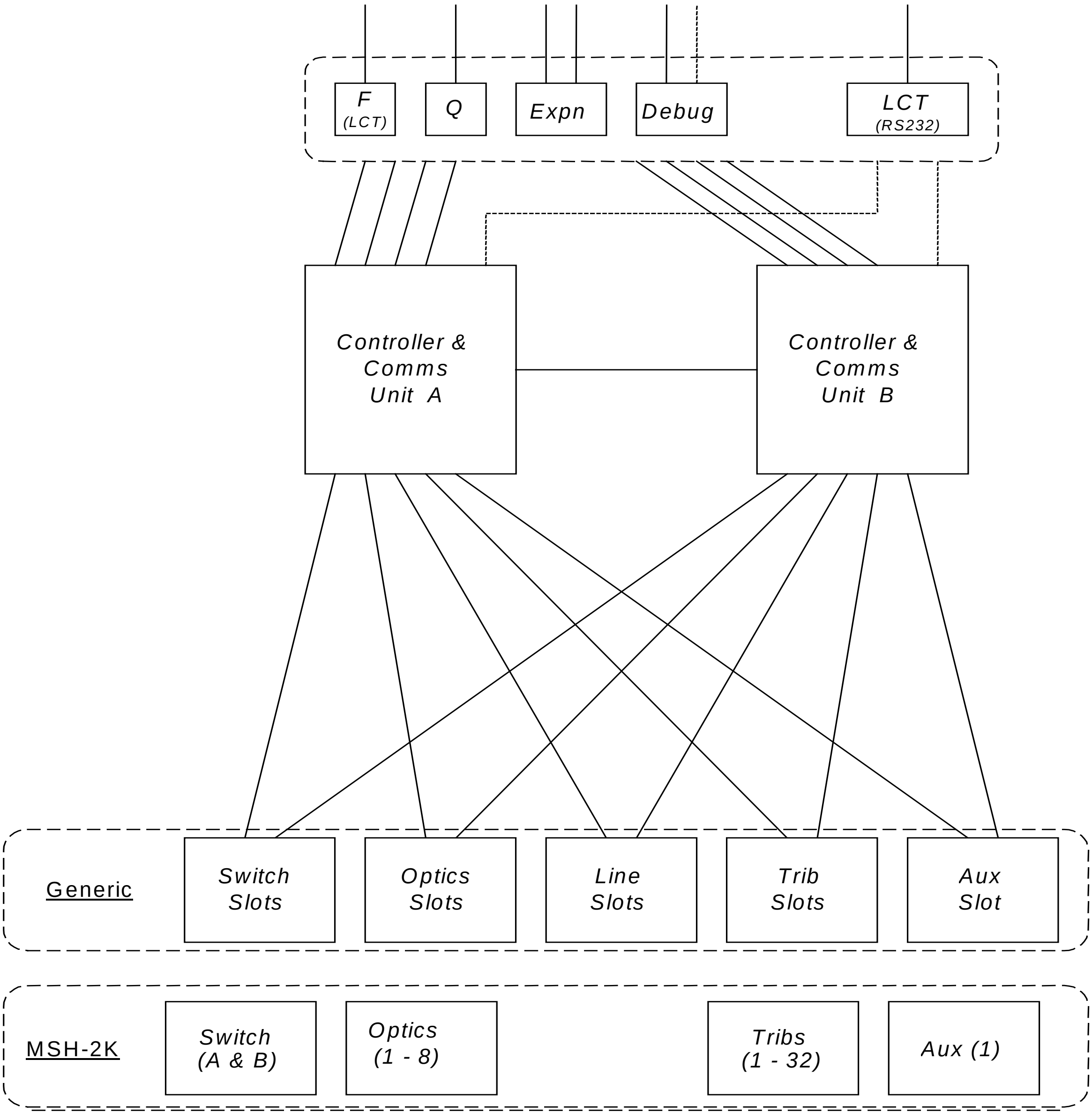


Figure 18: Distribution of Control Signals

The control functions of OMS3250 equipment are performed by the Controller and Communication unit and by the microprocessors on each unit. The Controller and Communication unit communicates, by means of a serial bus, with the microprocessors of all the equipment cards. It manages the whole equipment according to the control messages issued by the Local Controller (via F interface) or by the Element Manager (via Q or Qecc interfaces). As far as DCC/GCC channels are concerned, OMS3250 equipment is able to manage DCCR, DCCM, GCC1, GCC2 derived from any STM-N/OTM-k signal.

11.2.5 Overhead

The distribution of overhead bytes, ODU, SOH and POH, is shown in Figure 19.

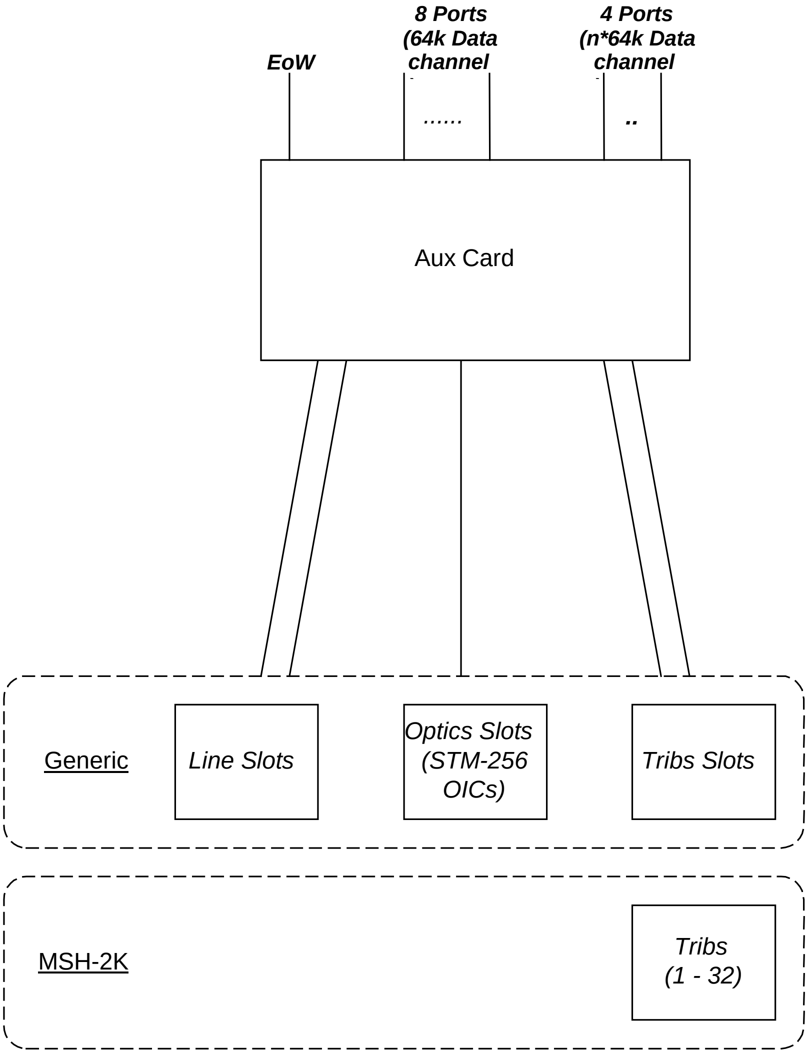


Figure 19: Distribution of OH Bytes

The transport of terminated SOH bytes uses various mechanisms.

- Bytes that need to be transported to/from the Comms card (e.g. DCC bytes) are packetised and transported over the Ethernet Comms Bus. (Figure 18)
- Bytes that need to be transported to/from the Switch (e.g. K1, K2, etc.) use the internal pseudo SOH (pSOH) associated with the traffic stream. (Figure 16)
- Bytes that need to be transported to the Aux card (e.g. E1, E2, F1, CMux-2 Aux bytes, etc.) use a dedicated OH bus. (Figure 19)

  Overhead bypass for bytes that would normally be transported to the Aux card (e.g. E1, E2, F1, CMux-Aux bytes1 & 2, etc.) are achieved by cross-connecting them on the Aux card.

The access to OH bytes is provided by the overhead distribution bus, which connects the traffic cards to the Controller/ Communications and Auxiliary cards.

11.2.6 Power supply

The power supply distribution is shown in Figure 20.

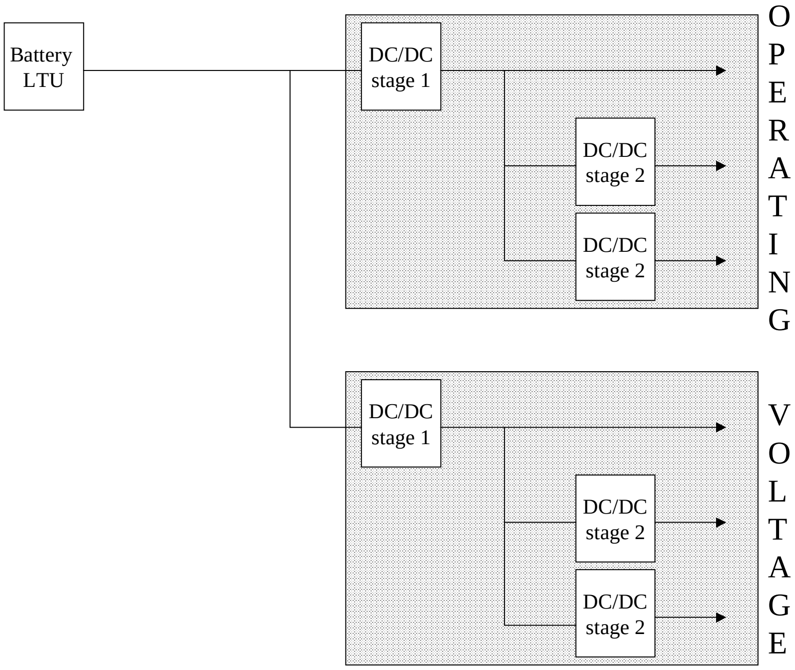


Figure 20: Power Supply Distribution

OMS3250 is powered from a 48/60v power supply, with external interface and filtering located on the Battery LTU.

A single voltage is supplied to all of the cards (and LTU PSU), that generate their required voltages via a two stage voltage conversion scheme using on-card DC/DC converters.

Stage 1 converter incorporates hold-up capacitors and supplies input voltage to the Stage 2 converters that supply operating voltages specific to card requirements.

All of the LTU modules will be powered from a DC/DC located on the LTU PSU. Both the Battery LTU and the LTU PSU can be duplicated for protection.

11.3 Card Slot Allocation

Figure 21 shows different equipping examples of the OMS3250.

Note: STM-1 electrical cards can only be fitted in the first ten (10) trib slots on the upper shelf this is because they require access to the LTUs.

Cards in slots T5 and T6 can be used as workers or offer 1:n (n=1..4) card protection in two groups:

Group 1 uses T1….T4 and associated LTUs as workers and T5 with it’s LTU as protection.

Group 2 uses T7….T10 and associated LTUs as workers and T6 with it’s LTU as protection.

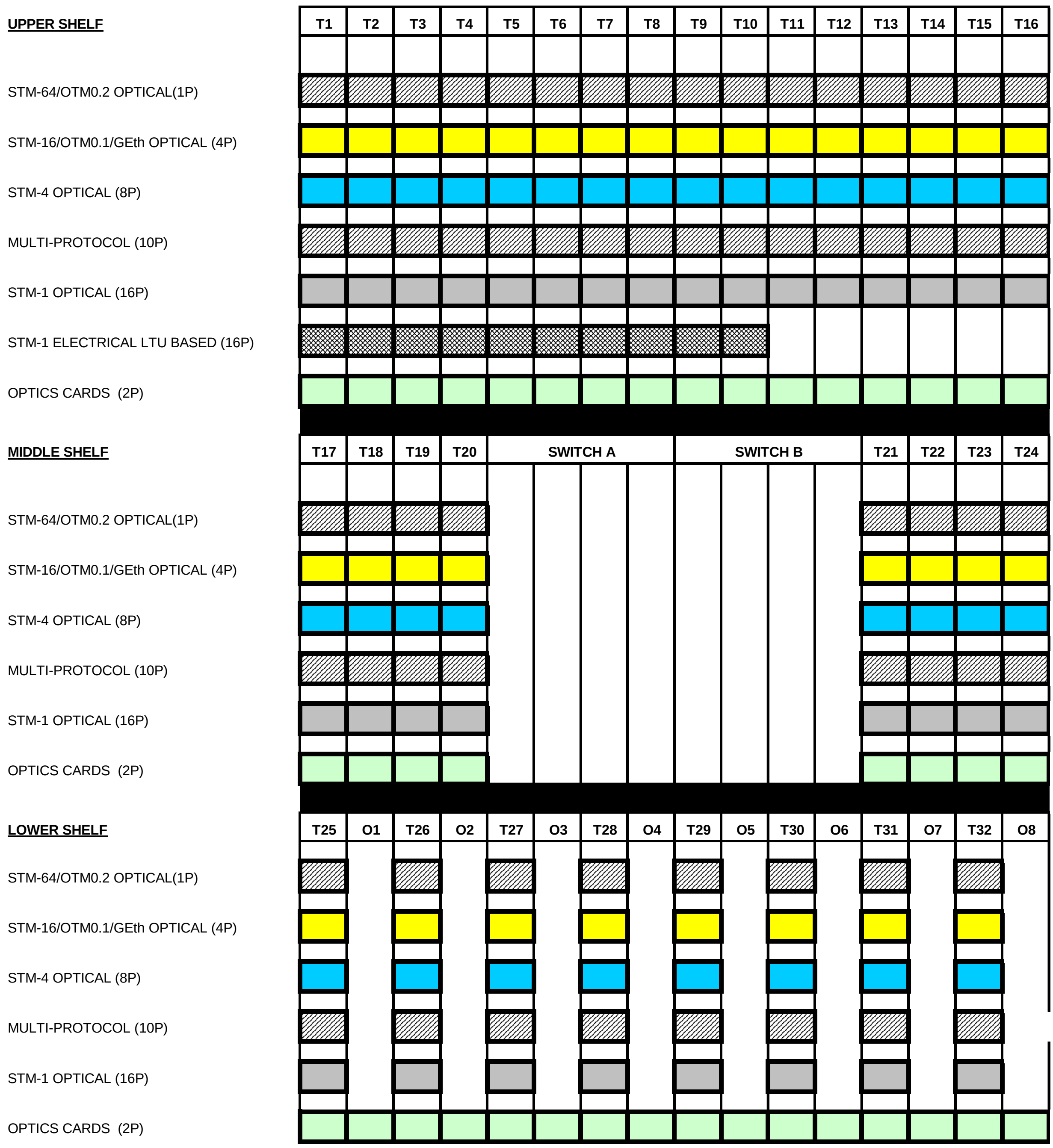


Figure 21: OMS3250 Card slot allocation

11.4 Mechanical Structure

OMS3250 is composed of one subrack designed according to the requirements of ETSI specification ETS 300-119-4 and is designed to fit within a rack designed according to the requirements of ETSI specification ETS 300-119-3.

The cards used are 220mm deep x 336.8mm high, Traffic cards are 5.5U wide (1.1” or 27.94mm), the other cards are either 4U or 5U (refer to Figure 4). All of these cards are compatible with the OMS3240 reducing the number of spares holding required.

The subrack has the following dimensions:

Height	1718 mm
Width	535 mm
Depth	280 mm

The subrack structure is made up of the following parts which are bolted together to form an integral structure:

- Two side panels, subrack supports, one back cover: they are made of aluminium sections and are screwed together to form the subrack structure. On the subrack supports one row of guides to equip the plug-in units are fixed
- Two cover grid: they are riveted on the top and bottom of the structure to ensure electrical shielding and heat transfer
- One printed wiring board (i.e. back panel): it is fastened immediately before the back cover. On the printed wiring board rows of connectors are fitted: the bottom rows comprise all the connectors for the plug-in units, the top row, all the connectors for the termination unit of the electrical interfaces optical fibre management: for running the optical fibres to the STM-N optical units
- Environmental Control Device: It is equipped to assist the thermal management of the subrack

Each subrack is designed to fit within a rack, designed according to the requirements of ETSI specification ETS 300-119-3. The rack has the following dimensions:

- Height 2200 mm;
- Width 600 mm; (900mm with fibre ducts)
- Depth 300 mm.

The equipment can also be housed in racks with different height (e.g. 2600 mm).

The rack can be accessed only from the front. It is made up of several mechanical parts which are bolted together to form an integral structure:

One top/base element: they are bolted to the vertical supports and consist of an aluminium section, varnished on the outer surface. They have three wide opening, one central and two side opening both used for exchange cable entry (if not used on the three openings a grid is fitted). On the base element four footed, screws that can be adjusted to compensate for any floor unevenness of up to 25 mm

Four vertical support: they are fastened to the inside corners to provide further strength

	for the rack. The two front vertical support bear 82 square holes (6.5 mm, spaced 25), for fixing the equipment subracks. All four supports also bear holes (4 mm) for fixing last item below
Two side panels and one rear panel:	they are bolted together
Two fibre ducts:	these are 150mm wide and are bolted on to either side of the rack to house the optical fibre
Rack alarm unit	it is assembled in a compartment at the front of the top element. The unit provides visual rack alarms and rack alarm re-transmission capabilities (by means of ground-contacts)
Power Distribution Panel (optionally):	it can be fixed in the rack to provide termination and distribution of separate power supply courses for each equipment in the rack.

At the top of the right vertical support is located the rack ground lug. All the four vertical supports, the base element and the top element are electrically connected to ensure ground continuity.

It is possible to locate the racks either back-to-back (double row), back to wall or side by side (single row).

11.5 Connectors

All interface connectors are available from the front of the equipment.

11.5.1 Optical Traffic Connectors

The optical standard connectors are:

- LC type for STM-1,Gigabit Ethernet and all the SFP modules;
- SC type for non-SFP STM-4/16/64 and OTNm.n.

The optical cables are routed directly to the front of the optical units, where the optical connectors are located.

11.5.2 Electrical Traffic Connectors

The standard electrical interfaces are available with the following range of connectors:

- 1.0/2.3 mm 75 ohm (for 155 Mbit/s interfaces)
- Sub-D connector for 120 ohm 2Mbit/s interfaces.
- RJ-45 for GbE and FE interfaces.

11.5.3 Other Connectors

2 Mbit/s or 2 MHz Synch. input	1.0/2.3 mm 75ohm /120 ohm symm. pair
2 MHz / 2 Mb/s Synch. output	1.0/2.3 mm 75 ohm /120 ohm symm. pair
Q interface	The following types may be made available: • Sub-D 15 pins (ISO 4903), for ISO 802.3 10base5 (Thick Ethernet) • BNC, for ISO 802.3 10base2 (Thin Ethernet) • RJ45 for 10baseT
F interface	Sub-D 9 pins (ISO 4902)
Power Supply	Due to the high current requirements the battery cables (25mm sq. cable with M8 crimp terminal) are bolted to the Battery LTU;
Alarms (Rack summary)	Sub-D 9 pins (ISO 4902)
Alarms (ground contacts)	Sub-D 37 pins (ISO 4902)
Auxiliary data channels	64 kb/s, G.703 Sub-D 25 pins (ISO 2110), 64 kb/s, V.11 Sub-D9 pins (ISO 4902)
EOW	Bantham Jack
EOW extension	Sub-D 9 pins (ISO 4902)

11.6 Cables

Following types of cables are used to connect the equipment with external devices (e.g., DDF, ODF):

- pair cable with separate shielding of each pair;
- pair cable with shielding of several pairs;
- co-axial cables (3002 co-ax cable (NOM O/D 3.5mm)7);
- optical cable (maximum O/D 2.5mm1);

[7] These are recommended in order to support a fully fibred system

- DC-power cable.

The design of fibre management areas is such as to let access to individual fibre circuits for splicing, connectorising, removal or re-routing without affecting working fibres.

12 ALARMS

Alarms raised by OMS3250 and the related processing are based on ITU-T G.783, G.784 and G.798 requirements.

12.1 Unit Alarm Displays

Individual, on unit, unit failure indication is provided.

Each unit in the shelf contains at least two LEDs on the front:

- LED 1: RED

  This LED indicates the unit fault condition.

  It is local alarm scheme dependant, for example:

  - with MSH alarm scheme, the Red fault LED is lit on the equipment card, if the fault is a category INT fault.
  - with Bw7R if a Red fault LED is lit on an equipment card, it indicates a fault on the actual equipment card (possibly requiring change of equipment card).
  - with TEP1E if a Red fault LED is lit on an equipment card, it indicates a traffic or equipment fault.

- LED 2: GREEN

  This LED indicates the currently operating units.

  - Correct internal power levels;
  - Microprocessor in operation (if applicable).

A means of testing the LEDs is provided.

12.2 Rack Alarm Displays

The rack alarm indications are:

- RED Lamp (summary urgent alarm);
- GREEN Lamp (summary not-urgent alarm);
- YELLOW Lamp (reminder indication);
- General Rack Alarm (summary alarm and reminder) ground contacts;

The management of these lamps is performed according to the selected alarm scheme.

12.3 Alarm Processing

Alarms from each unit are collected and processed by the Communications/Controller unit, which performs the following functions:

- alarm inhibition;
- assignment of a category (e.g. urgent, not-urgent) to each alarm;
- alarm reduction (in case an alarm occurs for a specific transport layer, the consequential alarms on the transported streams are removed);
- alarm filtering, logging and reporting: capability to select the alarm destination (to Element Manager and/or to the local alarm log and/or to the local terminal - the operator will be informed that an alarm exists);
- ground contacts driving;
- rack alarm interface driving.

All above-mentioned alarm processing functions can be configured via Element Manager or Local Terminal.

A cyclic local alarm log is available within the equipment. It is able to store al least 200 alarm messages.

Alarms can be either indicated through lamps/ground contacts, or sent to the local terminal or to the Element Manager.

Alarm outputs can be customised using the Local Terminal or from the OAM&P, an example scheme of indications and functions that are provided by the Communications/Controller unit is as follows:

- Any alarm indication ("ANY"): RED
- Reminder indication ("MEM"): YELLOW
- Urgent alarm indication ("URG"): RED
- Not urgent alarm indication ("NURG"): RED
- Internal alarm indication (“INT”): RED
- External alarm indication ("EXT"): RED
- Indicative alarm ("IND"): YELLOW (for alarms such as RDI and AIS)
- Indication of abnormal condition (“ABN”): YELLOW
- Local receive attention push button;
- Lamp test push button.

Input and Outputs Ground contacts are also available.

The power fail (or out of range) takes top priority and it is present even in the absence of Communications/Controller Unit.

Different solutions can be implemented, depending on the requirements of the Operator.

13 PERFORMANCE MONITORING AND MANAGEMENT

13.1 SDH Performance monitoring

The transmission quality on tributary interfaces is monitored in accordance with ITU-T G.784 and G.828.

The monitoring of performance parameters is based on the evaluation of errored blocks (EB). The parameters that are related to the performance monitoring are provided in the following:

- BBE (Background Block Error);
- ES (Errored Second);
- SES (Severely Errored Second);
- OFS (Out of Frame Second);

Furthermore the following additional parameters can be optionally monitored:

- CSES (Consecutive SES);
- UAS (Unavailable Seconds);
- AU PJE (Negative/Positive Administrative Unit Pointer Justification Events).

All these parameters are evaluated and stored, during available time, in 15 min and 24 h registers according to G.784 requirements.

Such performance data is available to the System Manager (operator) (see Equipment Management).

13.2 OTN performance monitoring

As required by ITU-T G.798 and ITU-T draft recommendation G.optperf, performance Monitoring can be carried out at the following layers of a signal transported in an OTN network:

- <u>Ochr to OTUk Adaptation layer (Performance on Forward Error Correction).</u>

  The number of corrected bits are counted over 1 second and reported to the management system at the end of the second, unless TSF, dAIS, dLOM or dLOF are present.

- <u>OTUk Termination based on SM overhead bytes information.</u>

  Performance on OTUk Termination is specifically created to enable the monitoring of the performance of an end-to-end OTUk trail. Both Near End and Far End performance monitoring can be enabled. For both directions the following parameters can be collected: ES, SES, BBE, UAS, CSES, IAE (one second period in which at least one dIAE defect is detected).

- <u>ODUkP Termination or Monitoring based on PM overhead bytes information.</u>

Performance on ODUkP Termination (Monitoring) are specifically created to enable the monitoring of the performance of an end-to-end (or part of an) ODUk path. Both Near End and Far End performance monitoring can be enabled. For both directions the following parameters can be collected: ES, SES, BBE, UAS, CSES.

14 SERVICES

Communication channels for service functions are provided using STM-N overhead bytes. All SOH and POH associated accessible bytes are made available in conformity with Recommendation ITU-T G.707 at the optional Auxiliary subsystem connectors in order to allow customisation of service transport, according to different specifications.

These functions are performed on the equipment by the optional Auxiliary Unit.

The following type of services and interfaces are available:

- EOW using E1/E2 bytes with 2 wire analogue interface;
- Data channels transported by standard interfaces.

14.1 Engineering Order Wire (EOW)

This service allows the audio connection between all the equipment connected by STM-N signals, making use of a standard telephone with DTMF signalling. The EOW channel uses the E1/E2 bytes. A protocol may be used to provide omnibus or selective call. An embedded EOW channel procedure is implemented to provide an automatic restoration mechanism in ring architectures in case of failure.

The interface for the EOW is a standard 2 wires analogue interface with DC current feed, hook status detection and DTMF signalling.

A 4 wire analogue/digital interface is available to extend the EOW by means of another 4 wire analogue/digital interface with similar characteristics. This connects, via an EOW, two equipments, that do not communicate by traffic (Figure 22).

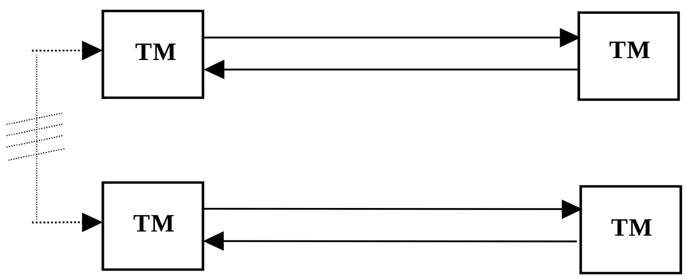


Figure 22: Example of the use of EOW Extension interfaces

14.2 Data channels

These services allow a point-to-point data connection between the two network elements that terminate the relevant accessible overhead bytes.

The available interfaces are:

8 × 64 Kbit/s G.703 codirectional interfaces for the tributary side;

4 × (N×64) Kbit/s V.11 contradirectional interfaces for the line side[8]

8 *n can be 1,3,9; 3 or 9 in order to transport either DCC_R or DCC_M*

15 GENERAL OPERATING FEATURES

The equipment assists the operators in a lot of common tasks, defined as general operating features, related with:

- equipment use;
- plug-in unit handling;
- fault maintenance (self diagnostic);
- recovery from faults;
- equipment robustness;
- inventory.

15.1 Equipment Use

The equipment supports the operator during installation and provides useful facilities like manual restart, software and hardware consistency check, the possibility of upgrading system functionality without disturbing the traffic.

15.2 Plug-in Unit Handling

Replacement of one plug-in unit with one of the same type does not require any reconfiguration on any of the other units on the shelf while the newly inserted unit is automatically configured as the extracted one.

Removal and insertion of the units are reported to the management system.

15.3 Fault Management (Self Diagnostic)

Built-in diagnostic facilities identify the single unit that needs changing or the faulty interface, for all faults occurring within the equipment or detectable at its interface.

This operation is carried out automatically using non-intrusive monitoring inside the network element.

Management and operation of the diagnostic facilities are available both from a remote location and from local operation. The equipment is capable of:

- automatically transferring an alarm report with data about the failure to a remote management centre immediately on detection of a failure;
- automatically switching on fault the functionality to the protection units, if duplicated units are fitted.

15.4 Recovery From Faults

A failure in the control unit does not cause traffic outage or affect the operation of network protection. The control unit contains and updates a complete and accurate Management Information Base that corresponds to the hardware state of the equipment.

15.5 Equipment Robustness

The equipment is designed in order to protect the system data against unintentional modifications and to avoid faults or configuration changes occurring in limited portions of the system causing any functional degradation in the remaining parts of it.

15.6 Inventory

The equipment maintains a record of all its component units. Each equipment is modelled as a collection of managed objects as detailed in ITU-T Rec. G.774 SDH Information Model.

The equipment performs the following features:

- the Electronic Inventory Data is automatically updated; at all times it is the current record of all the parts forming the equipment;
- all inventory information held by the equipment are accessible by the LCT and NMS;
- physical details (e.g. code, serial number, version) of all the hardware and software parts which form the equipment are stored.
- the storage of inventory data within the equipment is non-volatile;
- all inventory information relating to a network element can be accessed remotely.

16 EQUIPMENT MANAGEMENT

OMS3250 can be monitored and controlled through:

- F interface: to a local terminal;
- Q interface: to ServiceOn™ Optical Element Manager; the provided interface is type CLNS1 (Ethernet), The new generation SDH/OTH equipment (OMS3240, OMS3250 and OMS3260) implement a standard based Q3 agent, but only the first four layers of the communication stack will be used to carry the management information with sensible improvements in the bandwidth usage. This proprietary implementation, namely CMOX, exploits the capability to carry the CMISE over the transport layer directly.
- Qecc (from line or tributary SDH interface): as defined by ITU-T/ G.784.
- GMPLS: the control plane on OMS3250 is able to support GMPLS functionality.

The provided OAM&P functions are in accordance with ITU-T/G.784. In particular it is possible to perform:

- configuration management:
- provisioning (configuration of all equipment characteristics, e.g. internal channel routing);
- protection switching management;
- installation;
- fault (maintenance) management:
- alarm surveillance (collection, filtering, reporting);
- testing (equipment and connections);
- performance management:
- performance data collection;
- performance data reporting;
- general functions (e.g. security, software download).

The equipment supports the ITU-T/ETSI standard information model.

More precisely, OMS3250 is designed to support the information model based on:

- ITU-T Recommendations M.3100, G.774;
- ETSI ETS 300 304, ETS 300 371.

The OMS3250 can be managed by a computer system dedicated to the administration of SDH/OTH equipment and allows functionality that deal with the data to be modifiable by the Operations System.

The main features of these functions are the following:

- equipment configuration is set and notified at card level and software download and version control is offered on all cards;

- Protection Switching Feature, line protection, path protection and card protection can be configured and notified to the management, to meet the service availability target;

- Performance monitoring is carried out continuously by the equipment: it allows evaluation of the quality of the links both at section and path level and gives an indication in advance of potential degradation of the service.

Physically, OMS3250 is managed through an Ethernet Local Area Network. Bridge/routers are used to provide interworking between the LAN and Wide Area Networks (Leased Lines). The WAN shall be connected when the equipment is remotely located. If the equipment is close to the Operations System, there is no need of routers and WAN connections.

17 TECHNICAL SPECIFICATIONS

17.1 Electrical Environment

The equipment is in compliance with: .... EEC Council Directive 89/336/EEC;

.... ETS 300 386-2 (EMC/EMI/ESD).

The requirements are met by the subrack alone and do not rely on any features of the rack.

17.2 Climatic and Mechanical Environment

17.2.1 General

The minimal classes of environmental conditions, their severity and general definitions are specified according to ETSI ETS 300-019-1-0.

17.2.2 Storage Endurance

Storage endurance minimal requirements are according to ETSI ETS 300 019-1-1, Class 1.2, "Not temperature controlled storage locations".

The climatic environmental limits for normal storage conditions are:

Temperature: from -25 to 55°C;

Relative humidity: from 10% to 100%.

17.2.3 Transport Endurance

Transport endurance minimal requirements are according to ETSI ETS 300 019-1-2, Class 2.3, "Public Transportation".

The climatic environmental limits for normal transport conditions are :

Temperature: from -40 to 70 °C;

Relative humidity: up to 95%.

17.2.4 Environmental Endurance For Indoor Operation

Weather-protected stationary use endurance minimal requirements are according to ETSI ETS 300 019-1-3, Class 3.2, "Partly temperature controlled locations".

The climatic environmental limits for normal operating conditions are:

Temperature: from -5 to 45 °C;

Relative humidity: from 5% to 95%.

17.3 System Performance

17.3.1 Error Performance

The general error performance is that no errors are introduced into traffic by the equipment under the most adverse environmental and operational conditions specified.

17.3.2 Transmission Delay

The delay times for a transmission signal from its input to its output for multiplexing functions is $\leq$ 125 µs

17.3.3 Jitter Characteristics

According to:

Input jitter and wander tolerance………… ITU-T/ G. 823, 824, 825 requirements;

Maximum output jitter and wander………… ITU-T/ G. 783 requirements;

Jitter and wander transfer………………… ITU-T/ G. 783, 958 requirements.

17.4 Power Requirements (according to ETSI ETS 300-132)

The equipment operates without pre-setting in the range -38.4 to -72 V, suitable for the battery voltages (supplied by two separate fuse protected and diode connected parallel lines).

Supply voltages: .... -48V +/- 20%

.... -60V +/- 20%

The power supply from Vac mains (duplicated) is also possible by using external AC/DC converters suitable for rack mounting and located on a different shelf.

The earthing is in accordance with ETSI standard ETS 300 253.

17.5 Synchronisation

Synchronisation sources available:

Independent external reference input

Either:

- 2 MHz G.703-13
- 1.5Mb/s framed G.703-5

- 1.5 Mb/s unframed G.703-5
- 2 Mb/s framed G.703-9, G.706
- 2 Mb/s unframed G.703-9);
- Recovered line timing via STM-N line Units;
- Recovered tributary timing derived STM-N tributary interface;
- Internal oscillator on the Switch Unit (stability better than 4.6 ppm. acc. to G.813).

Two independent synchronisation outputs are available.

Either:

- 2 MHz G.703-13
- 1.5Mb/s framed G.703-5
- 1.5 Mb/s unframed G.703-5
- 2 Mb/s framed G.703-9, G.706
- 2 Mb/s unframed G.703-9);

17.6 Power Consumption

Power consumption from the battery:

Example configs:

Maximum 32xSTM-64	approx. 2.7 kW
Maximum 32xSTM-16	approx. 2.5 kW
Maximum 32xSTM-4	approx. 2.5 kW
Maximum 32xSTM-1	approx. 2.0 kW
Mixture 8 of each STM-n	approx. 2.4 KW

17.7 Safety

17.7.1 General

The equipment is designed not to cause any harm or danger to personnel installing, maintaining or operating the equipment, and not to produce any damage to the network or other equipment connected to it.

The equipment complies with the following safety standards:

- EN 60950 (for information technology equipment)
- EN 41003 (for equipment to be connected to telecommunication network)
- IEC 364 (for electrical installations of buildings)
- IEC 825 (for laser products)

17.7.2 Optical safety requirements

The automatic laser shutdown function complies with ITU-T G.958/G.664.

End of Document