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ERA/LVN/DGC (Anders Borg)		2000-07-06	B	

User Description, SDH Product Package

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Contents **Page**

1 Introduction

The increasing number of subscribers and the new wideband mobile services demand more bandwidth from the access transmission network. Despite of the introduction of statistical technologies like IP and ATM more bandwidth is still going to be needed. Many mobile operators are already upgrading parts of their transmission network from PDH to SDH.

The radio access network today is very much build on n*2Mbit/s relations, where n tend to increase rapidly. Different topologies are used but the star and tree configuration is very common. A low level of redundancy is build in the network in general. A lot of the connection at site is still handled manually in DDF. To reduce the number of 2Mbit/s links in the access network DXC 1/0 is used, consolidating the 64kbit/s TS in the links to increase the utilization.

With the introduction of SDH in switch and transmission equipment the network evolves towards ring & star topology. The network will be simple and easy to manage. The capacity in the network increases but with fewer interfaces. The DDFs will disappear and a lot of site specific problems will be solved. No manually configurations are needed, it is easy to rearrange the capacity in the network via the management system. New services can be added much easier than before.

In order to meet this demand for an SDH solution, a product package is introduced.

The SDH product package solution gives the following benefits:

- Gives SDH capabilities to the access network.
- The SDH product package is cost effective.
- Fast to install.
- Gives both new BYB 501 and installed BYB 202 SDH capabilities.
- Small size.
- Gives DXC 4/1 functionality.
- Reduction of hardware compared to system with 2 Mbps interfaces.
- Reduction of external cabling compared to system with 2 Mbps interfaces.
- Will be the foundation for the access network in the evolution towards 2G and 3G systems.
- Reduced O&M costs.
- Increased reliability.

The SDH PP have three types of configurations:

1 “Hub Site” configuration, for connection of base stations to the SDH network.

2 “BSC Site Mini” configuration, for connection of small BSCs to a one ring SDH network.

3 “BSC Site Maxi” configuration, for connection of large BSCs to a two ring SDH network.

Table 1 Overview on available configurations

Configuration	Line Interface	Tributary Interface		
	STM-1 Ports	2 Mbps ports	Protected 2 Mbps ports	STM-1 Ports
Hub Site	2	32	32	0
BSC Site Mini	2	63	32	2
BSC Site Maxi	4	126	32	4

The configurations and usage are described in later chapters.

2 Glossary

2.1 Concepts

L-1.1 Definition according to ITU-T specification G.957, (reference on page 59) see table 2.

Table 2

Application		Intra-office	Inter-office				
			Short-haul		Long-haul		
Wavelenght (nm)		1310	1310	1550	1310	1550	
Type of fibre		G.652	G.652	G.652	G.652	G652 G654	G.653
Distance[a] (km)		<=2	~15		~40	~80	
STM level	STM-1	I-1	S-1.1	S-1.2	L-1.1	L-1.2	L-1.3
	STM-4	I-4	S-4.1	S-4.2	L-4.1	L-4.2	L-16.3
	STM-16	I-16	S-16.1	S-16.2	L-16.1	L-16.2	L-16.3
a) These are target distances used for classification and are not a specification.							

2.2 Abbreviations and acronyms

A Allocations

ADM Add Drop Multiplexer

AIS Alarm indication signal

Anomaly See M.20, section 3.2.1, reference on page 59

APO	Allocated performance objective
ATM	Asynchronous Transfer Mode
AU	Administrative unit
AUG	Administrative Unit Group
BIP	Bit interleaved parity
BSC	Base Station Controller
BTS	Base Transceiver Station
BYB 202	Building practise for BSC releases up 6.1, called old BSC. The transmission interface on these BSCs is only 2 Mbps ETCs.
BYB 501	Building practise for BSC release 6.2 and up, called new BSC. Besides the 2 Mbps interface, these BSCs can be equiped with STM-1 SDH interface.
CAS	Channel Associated Signalling
CCS	Common Channel Signalling
CME20	Cellular Mobile Telephone System 20, GSM
CRC	Cyclic Redundancy Check
Defect	See M.20, section 3.2.2, reference on page 59
DEG	Degraded
DEGM	DEGraded defect Monitoring period
DEGTHR	DEGraded defect THReshold
DIP	Digital Path, Digital Path is the PCM system between the ETC and the distant exchange.
DPL	Degraded performance limit
DXC	Digital Cross Connect
DXX	Ericsson Cellular Transmission System
E1	2.048 Mbit/s interface
EDDF	Electronic Digital Distribution Frame
ERATE	Excessive bit error Rate
ES	Errored second
ESL	Errored Seconds Limit

ET	Exchange Termination, Exchange Terminal. The Exchange Terminal consists of hardware and software. The ET hardware part is connected to the switch and terminates a 2 Mbit/s PCM system.
ETC	Exchange Terminal Circuit. Exchange Terminal Circuit is the hardware part of the ET.
FAS	Frame Alignment Signal
FS	Function Specification
GSD	Group Switch Device
HP	Higher order path
HPA	Higher order Path Adaptation
HPC	Higher order Path Connection
HPOM	Higher order Path Overhead Monitor
HPT	Higher order Path Termination
HUG	Higher order path Unequipped Generator
ITU-T	International Telecommunication Union,Telecommunication Standardization Sector (formerly known as CCITT).
kbps	Kilobit/sec
LOF	Loss Of Frame alignment
LOM	Loss of multiframe
LOP	Loss of pointer
LOS	Loss of signal
LP	Lower order path
LPA	Lower order Path Adaptation
LPC	Lower order Path Connection
LPOM	Lower order Path Overhead Monitor
LPT	Lower order Path Termination
LUG	Lower order Unequipped Generator
Mbps	Megabit/sec
MFS	MultiFrame Structure

MS	Multiplex section
MSA	Multiplex Section Adaptation
MSOH	Multiplex Section Overhead
MSP	Multiplex section protection
MST	Multiplex Section Termination
MS-AIS	Multiplex Section - Alarm Indication Signal
MS-DEG	Multiplex Section - Degraded
OOF	Out Of Frame state
PCM	Pulse Code Modulation
PDH	Plesiochronous digital hierarchy
PLM	PayLoad Mismatch
POH	Path overhead
PSE	Protection Switching Event
RBS	Radio Base Station
RDI	Remote Defect Indication (Previously called Remote Alarm Indication)
REI	Remote error indication (former FEBE)
REFM	Remote End Fault indication, Multiframe structure(TS16 bit 6)
RFI	Remote Failure Indication
RST	Regenerator Section Termination
RR2-ES	Reset Report for Errored Seconds
RR2-SES	Reset Report for Severely Errored Seconds
RT	Reset threshold
RT1-ES	Reset Threshold for Errored Seconds
RT1-SES	Reset Threshold for Severely Errored Seconds
RTR	Reset threshold report

RTR1-ES	Reset Threshold Report for Errored Seconds
RTR1-SES	Reset Threshold Report for Severely Errored Seconds
SD	Signal Degrade
SDH	Synchronous digital hierarchy
SDH PP	SDH Product Package
SDIP	Synchronous digital path
SES	Severely errored seconds
SF	Slip Frequency
SF	Signal Fail
SMA	Designation for the SDH ADM product.
SMF	Sub-Multi-Frame
SMI	Suspect marked interval
SNT	Switching Network Terminal. Switching Network Terminal is an equipment connected to the switch.
SOH	Section Overhead
SPI	SDH Physical Interface
ST	Set threshold
ST1-ES	Set Threshold for Errored Seconds
ST1-SES	Set Threshold for Severely Errored Seconds
ST2-ES	Set Threshold for Errored Seconds
ST2-SES	Set Threshold for Severely Errored Seconds
STM	Synchronous transport module
STM-n	Synchronous Transfer Module level n
STM-1	Synchronous Transport Module level 1
TI	Time Interval (for SF supervision)
TIM	Trace identifier mismatch

TR1-ES Threshold Report for Errored Seconds

TR1-SES Threshold Report for Severely Errored Seconds

TR2-ES Threshold Report for Errored Seconds

TR2-SES Threshold Report for Severely Errored Seconds

TR Threshold report

TRC Transcoder Controller

TS Time Slot

TS0 Time Slot number 0

TS16 Time Slot number 16

TTI Trail Trace Identifier

TU-n Tributary Unit

TUG Tributary Unit Group

TU Tributary unit

UAS Unavailable state

UAV Unavailable event

UNEQ Unequipped

VC Virtual container

VC-n Virtual Container

3 Capabilities

3.1 Configurations

3.1.1 “Hub Site” configuration

The SDH Product Package “Hub Site” configuration consist of an SDH ADM (Add Drop Multiplexer) mounted in the transmission cabinet TMR 9202. This SDH ADM has 32x2 Mbps tributary interfaces for connection of the RBSs, these 2 Mbps ports are protected. On the line interface, the SDH ADM is equipped with two STM-1 optical interface boards. See the block diagram in figure 1.

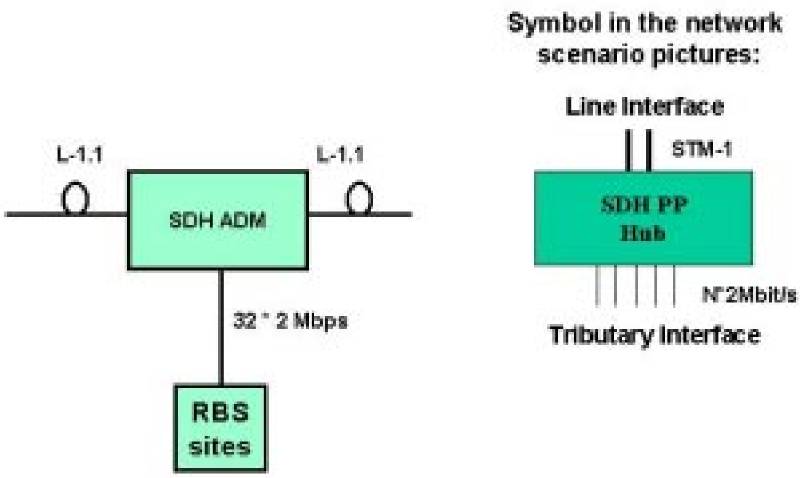


Figure 1 SDH Product Package "Hub Site".

The figure 2 shows the magazine layout for the SDH ADM with the different boards. The shaded areas with boards named with larger fonts, are the equipped positions.

In the first row there are:

- four positions (LTU 1A-D), for connection of the 2 Mbps signals
- one position for connection of power (POWER)

In the second row there are:

- positions for connection of Local Craft Terminal (LCT)
- positions for connection of user channels (AUX1&2-3&4)
- positions for connection of alarms (ALARMS)

In the third row there are electrical boards with all functions located:

- two optical line interface cards (LINE WEST A, STM-1 and LINE EAST A, STM-1).
- two switch cards handling the cross connections (SWITCH A, SWITCH B).

- two 2 Mbps tributary cards one working card with 32x2 Mbps ports and one standby card for protection of these 32x2 Mbps ports (TRIBUTARY 1, 32x2 Mbps, PROTECTION TRIBUTARY, 32x2 M).
- two cards for controlling the ADM (COMMS, MUX CONTROLLER).
- an auxiliary card for collection of external alarms (AUXILIARY 1).
- two power supply units for power feeding of the ADM (PSU A, PSU B). Each power supply unit can supply the whole ADM with power.

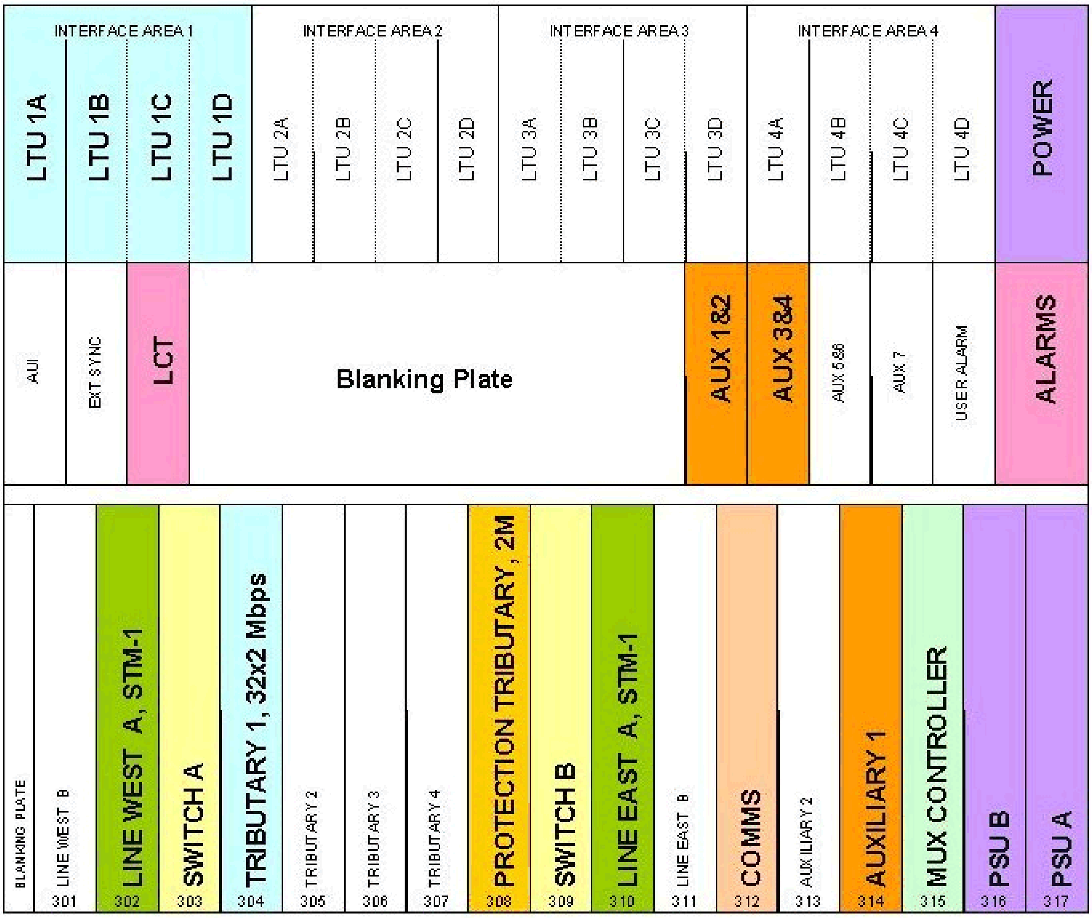


Figure 2 Magazine layout for the Hub site configuration.

The “Hub Site” cabinet TMR 9202, see figure 3 is equipped with power supply, the SDH ADM named SMA and all necessary cables and accessories for a complete installation.

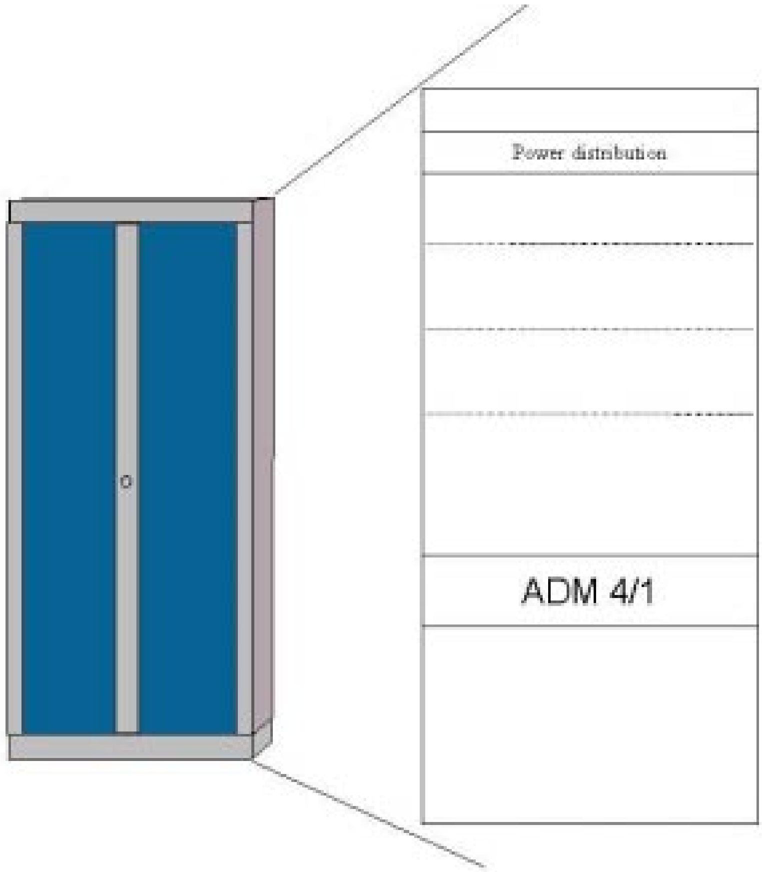


Figure 3 The TMR 9202 cabinet with “Hub Site” configuration.

3.1.2 “BSC Site Mini” configuration

The SDH Product Package “BSC Site Mini” configuration consist of an SDH ADM (Add Drop Multiplexer) mounted in a BYB 501 cabinet. This SDH ADM has 63x2 Mbps and one optical STM-1 tributary interfaces for connection to the BSC. The 2 Mbps ports are protected 32 at a time and the STM-1 interface is fully protected. On the line interface, the SDH ADM is equipped with two STM-1 optical interface boards. See the block diagram in figure 4.The STM-1tributary interfaces are used for connection to a BSC housed in BYB 501 mechanics, called “New BSC”. The 2 Mbps interfaces are used for connection to a BSCs 2 Mbps ports. The BSC housed in BYB 202 mechanics, is called “Old BSC” and has only 2 Mbps ports while the new BSC can have both 2 Mbps and STM-1 ports. The new BSC using the STM-1 interface see ET 155, SDH/STM-1 AXE Exchange Terminal, reference on page 61.

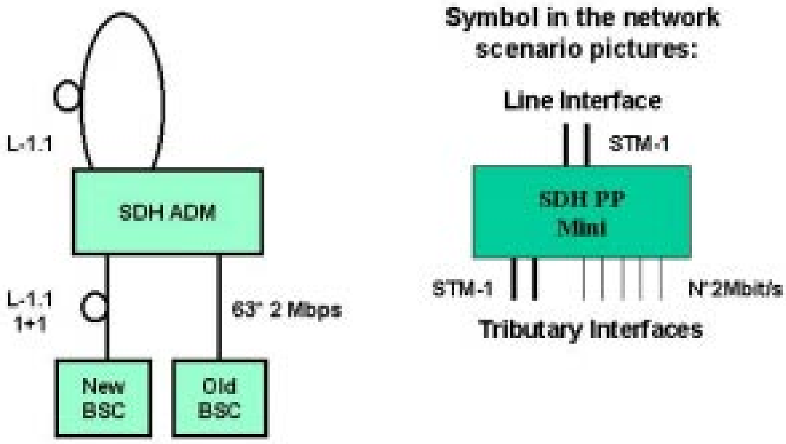


Figure 4 SDH Product Package BSC Site Mini.

The figure 5 shows the magazine layout for the SDH ADM with the different boards. The shaded areas with boards named with larger fonts, are the equipped positions. The SDH ADM used at BSC Site configurations is a larger variant than the one used in the Hub Site configuration.

In the first row there are:

- four positions (LTU 1A-D), for connection of the 2 Mbps signals.

In the second row there are:

- four positions (LTU 2A-D), for connection of the 2 Mbps signals.
- one position for connection of power (POWER).

In the third row there are:

- position for connection of (AUI).
- position for connection of Local Craft Terminal (LCT).
- positions for connection of user channels (AUX1&2-3&4).
- position for connection of alarms (ALARMS).

In the fourth and fifth row there are electrical boards with all functions located, fourth row:

- two STM-1 tributary cards one working card one with STM-1 port and one standby card for protection of this STM-1 port (HB TRIBUTARY A1-2.).
- two switch cards handling the switching functions (ROUTER A, ROUTER B).
- two 2 Mbps tributary cards one working card with 32x2 Mbps ports and one standby card for protection of these 32x2 Mbps ports (NB TRIBUTARY 1-2, PROTECTION TRIB.).
- one power supply unit for power feeding of the ADM (PSU A). Only two of three power supplies are enough to supply the whole ADM with power.

Fifth row:

- two optical line interface cards (LINE WEST A1 and LINE EAST A1).
- two switch cards handling the switching functions together with router A-B, (LINK A, LINK B).
- two cards for controlling the ADM (COMMS, MUX CONTROLLER).
- an auxiliary card for collection of external alarms (AUXILIARY 1).
- two power supply units for power feeding of the ADM (PSU B, PSU C). Each power supply unit can supply the whole ADM with power.

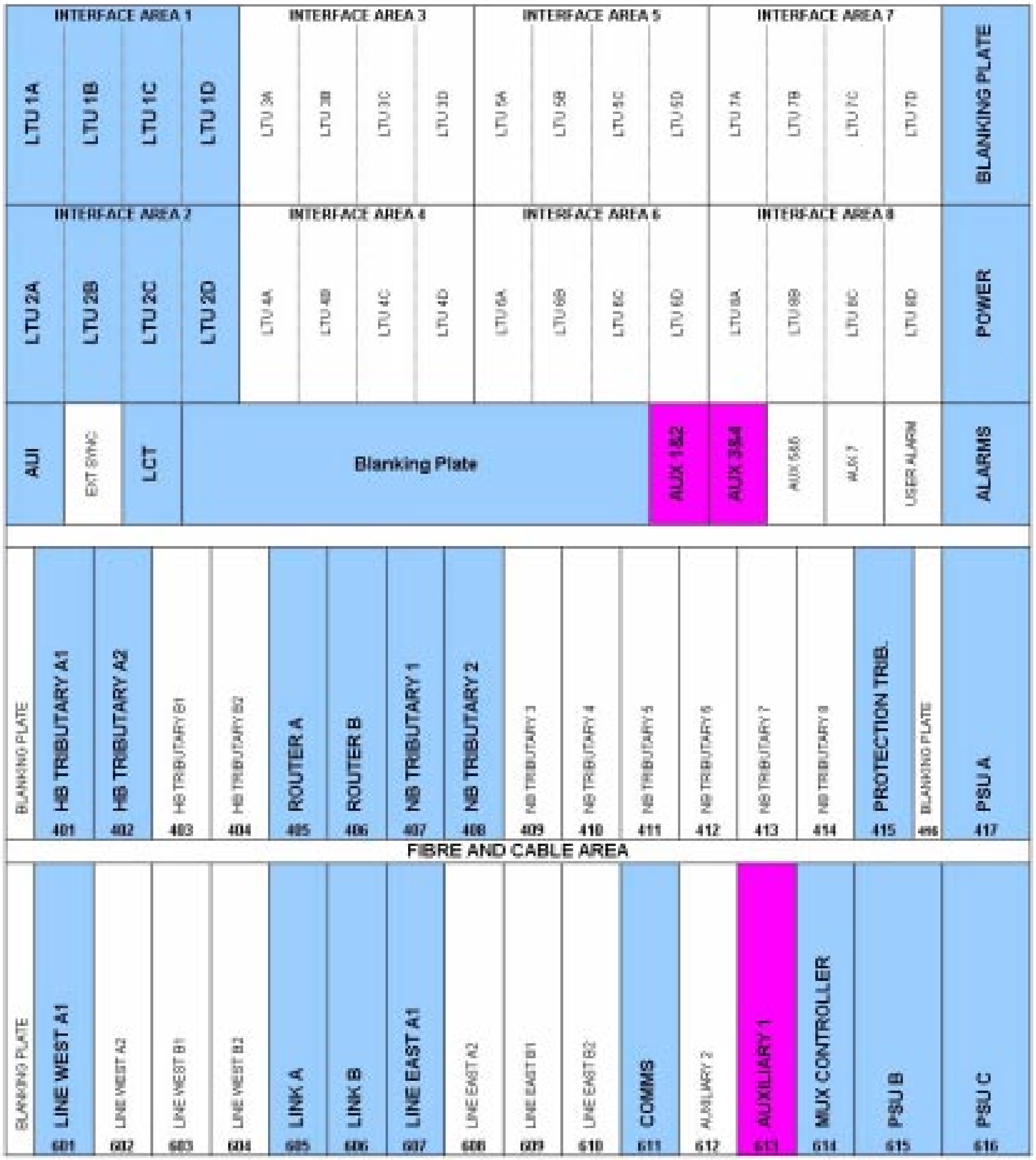


Figure 5 Magazine layout for the BSC Site Mini configuration.

The “BSC Site Mini” housed in a BYB 501 cabinet, see figure 6 is equipped with power supply, the SDH ADM named SMA and all necessary cables and accessories for a complete installation.

Figure 6 The BYB 501 cabinet with “BSC Site Mini or Maxi” configurations.

3.1.3 “BSC Site Maxi” configuration

The SDH Product Package “BSC Site Maxi” configuration consist of an SDH ADM (Add Drop Multiplexer) mounted in a BYB 501 cabinet. This SDH ADM has 126x2 Mbps and two optical STM-1 tributary interfaces for connection to the BSC. The 2 Mbps ports are protected 32 at a time and the STM-1 interfaces are fully protected. On the line interface, the SDH ADM is equipped with four STM-1 optical interface boards. See the block diagram in figure 7.The STM-1tributary interfaces are used for connection to a BSC housed in BYB 501 mechanics, called “New BSC”. The 2 Mbps interfaces are used for connection to a BSCs 2 Mbps ports. The BSC housed in BYB 202 mechanics, is called “Old BSC” and has only 2 Mbps ports while the new BSC can have both 2 Mbps and STM-1 ports. The new BSC using the STM-1 interface see ET 155, SDH/STM-1 AXE Exchange Terminal, reference on page 61.

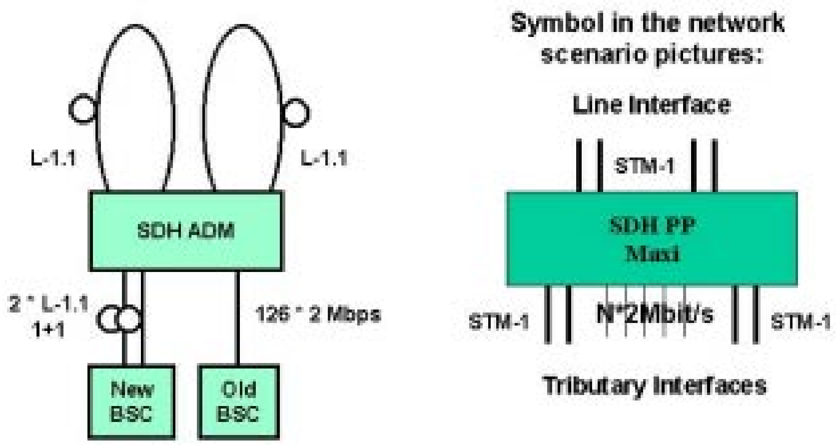


Figure 7 SDH PP BSC Site Maxi

The figure 5 shows the magazine layout for the SDH ADM with the different boards. The shaded areas with boards named with larger fonts, are the equipped positions. The SDH ADM used at BSC Site configurations is a larger variant than the one used in the Hub Site configuration.

In the first row there are:

- eight positions (LTU 1A-D, LTU 3A-D), for connection of the 2 Mbps signals.

In the second row there are:

- eight positions (LTU 2A-D, LTU 4A-D), for connection of the 2 Mbps signals.
- one position for connection of power (POWER).

In the third row there are:

- position for connection of (AUI).
- position for connection of Local Craft Terminal (LCT).
- positions for connection of user channels (AUX1&2-3&4).
- position for connection of alarms (ALARMS).

In the fourth and fifth row there are electrical boards with all functions located, fourth row:

- four STM-1 tributary cards two working card with STM-1 ports (HB TRIBUTARY A1-2) and two standby cards for protection of the STM-1 ports (HB TRIBUTARY B1-2).
- two switch cards handling the switching functions (ROUTER A, ROUTER B).
- four 2 Mbps tributary cards one working card with 32x2 Mbps ports and one standby card for protection of these 32x2 Mbps ports (NB TRIBUTARY 1-4, PROTECTION TRIB.).
- one power supply unit for power feeding of the ADM (PSU A). Only two of three power supplies are enough to supply the whole ADM with power.

Fifth row:

- four optical line interface cards (LINE WEST A1,B1, LINE EAST A1,B1).
- two switch cards handling the switching functions together with router A-B, (LINK A, LINK B).
- two cards for controlling the ADM (COMMS, MUX CONTROLLER).
- an auxiliary card for collection of external alarms (AUXILIARY 1).
- two power supply units for power feeding of the ADM (PSU B, PSU C). Each power supply unit can supply the whole ADM with power.

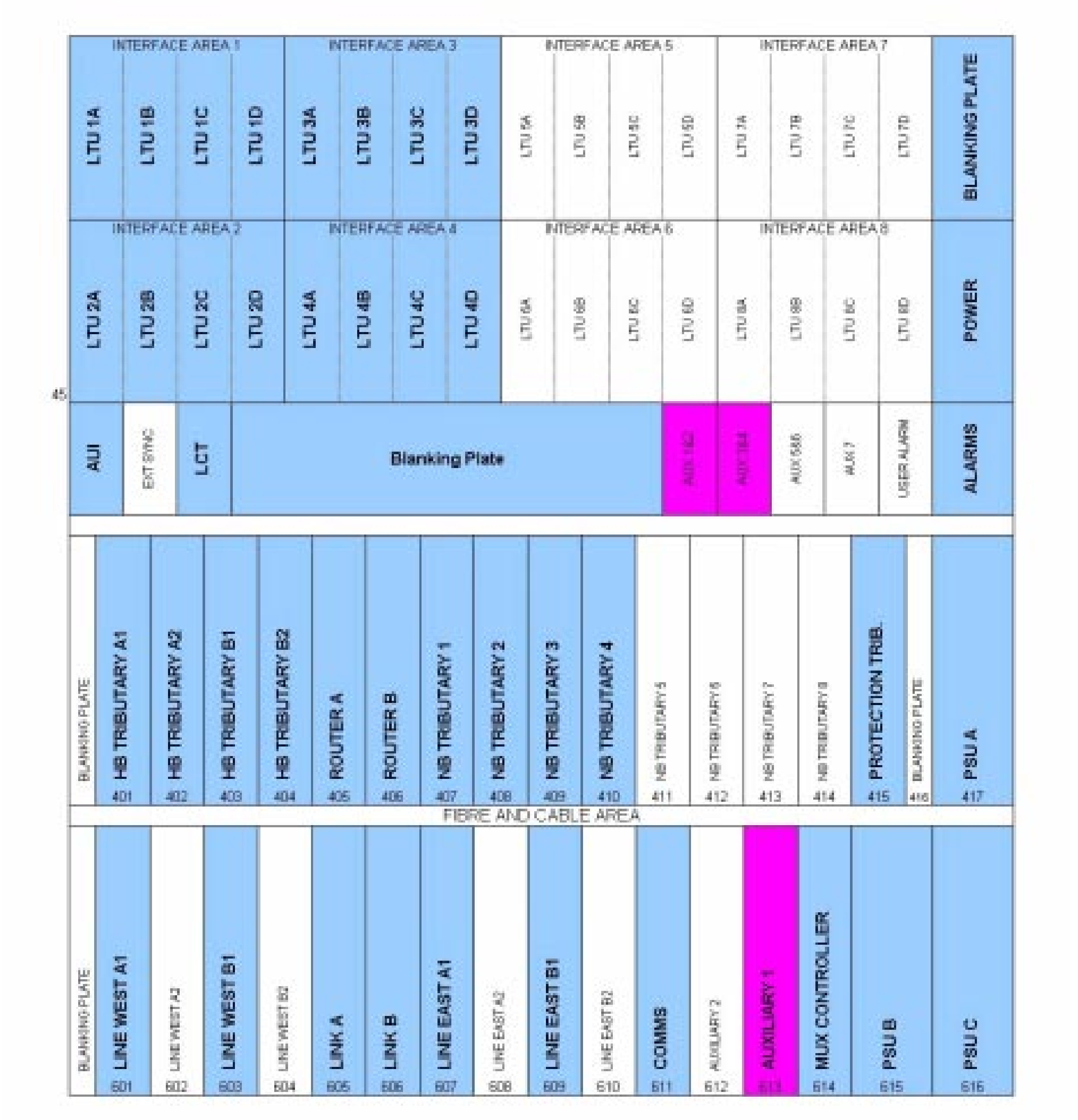


Figure 8 Magazine layout for the BSCSite maxi configuration.

The “BSC Site Maxi” housed in a BYB 501 cabinet, see figure 6 is equipped with power supply, the SDH ADM named SMA and all necessary cables and accessories for a complete installation.

3.2 SDH ADM functionallity

The SDH PP consists mainly of the SDH ADM. The ADM is a product called SMA, which is an Synchronous Add/Drop Multiplexer for use in networks based on the Synchronous Digital Hierarchy (SDH) multiplexing standard. Its application is in the adding and dropping of combined 2Mbit/s and 155Mbit/s (STM-1) tributary signals within an aggregate STM-1 (155Mbit/s) through traffic line signal. Interfaces are provided for operator monitoring/control from either a remote Equipment Management Operations System (EMOS) or from a Local Craft Terminal (LCT). Various options are offered for card, port and path protection schemes to meet network operator's requirements for circuit availability in a wide range of network topologies.

The major features of the SMA are:

- Its versatility allows it to be used as a terminal, add/drop, hubbing or cross-connect multiplexer. This offers the network operator greater planning flexibility, reduced training, spares holding and maintenance costs and greater potential for network evolution.
- Provides 2Mbit/s and 155Mbit/s (STM-1) access directly to a 155Mbit/s (STM-1) bearer. This allows the network operator to allocate bandwidth as and when required, thus providing a more responsive service and improved network efficiency.
- Provides full connectivity, including tributary-to-tributary switching for VC-4/3/2/1 granularity. The use of common STM-1 modules in either line or tributary positions affords great flexibility in configuring the equipment.
- Access of up to 256 x 2 Mbit/s.
- All the equipment is housed in a single sub-rack, conserving space and reducing power requirements.
- The flexibility of the SMA architecture makes it possible to up-grade the product to support STM-4 operation as the network evolves, facilitating growth in line with customer requirements.
- Many of the modules are used across the complete range of multiplexers from the SMA1 through to the SMA16c, thus simplifying ordering and maintaining operator familiarity. In addition the required spares holding is reduced and flexibility of deployment is increased.
- Tributary protection is incorporated on the actual tributary cards or LTU (as appropriate) and performed electronically, thus avoiding the necessity to provide additional space for a separate protection switching card.
- The Equipment Management Operations System (EM-OS) network management package allows operator control of the SMA1 from a centralised location.
- It has a comprehensive synchronisation capability, including the ability to synchronise from a 2Mbit/s tributary.
- Broadcast to support the delivery of uni-directional circuits to line and tributary positions.
- Byte synchronous mapping for the future proofing networks for 64 kbit/s switching.

The line card available in the SDH product packages are STM-1 Optical Line Card. On the tributary side the cards available are, 32x2 Mbps tributary card, unbalanced (75 ohms) or balanced (120 ohms) and STM-1 optical tributary card. The switchplane and the 32x2 Mbps card are protected as well as the power supply.

3.3 Network scenarios

The following networks are examples where SDH PP is realizing an SDH radio access network. With the ET-155 (see user description, SDH/STM-1 AXE Echange Terminal on page 61) and the SDH PP in the network, capacity can be managed completely from an O&M center, both for switch (MSC, BSC) and the transmission equipment. It is very easy to do re-configurations when the network growth and changes. Dependent on the EDDF (Electronic Digital Distribution Frame) functionality of the SDH PP there is no need to move cables at the sites, all changes is done remotely.

3.3.1 Network with BSC/TRC in BYB 202.

Example of a network with one STM-1 optical ring on the line interface. On the tributary side there are an MSC with STM-1 interface and an BSC in BYB 202 mechanics with 2 Mbps interfaces connected. In the figure 9, each line represents two optical fibers, one for the transmitt direction and one for the receive direction. Near the base stations there is a SDH PP Hub site configuration and at the BSC site there is a SDH PP Mini configuration. The number of used 2 Mbps connections are limited to the capacity of the STM-1 link, that means maximum 63, 2 Mbps connections. The ring structure enables protection of the traffic. That means protection against failures in the ring, as loss of 2 Mbps channels or cut off fibers. By using the protection mechanism it is possible to open the fiber ring without interrupting the traffic more than 50 msecs. This gives the possibility to add an another SDH PP to the ring. See explanation of the protection mechanisms in chapters 4.6 and 4.7.

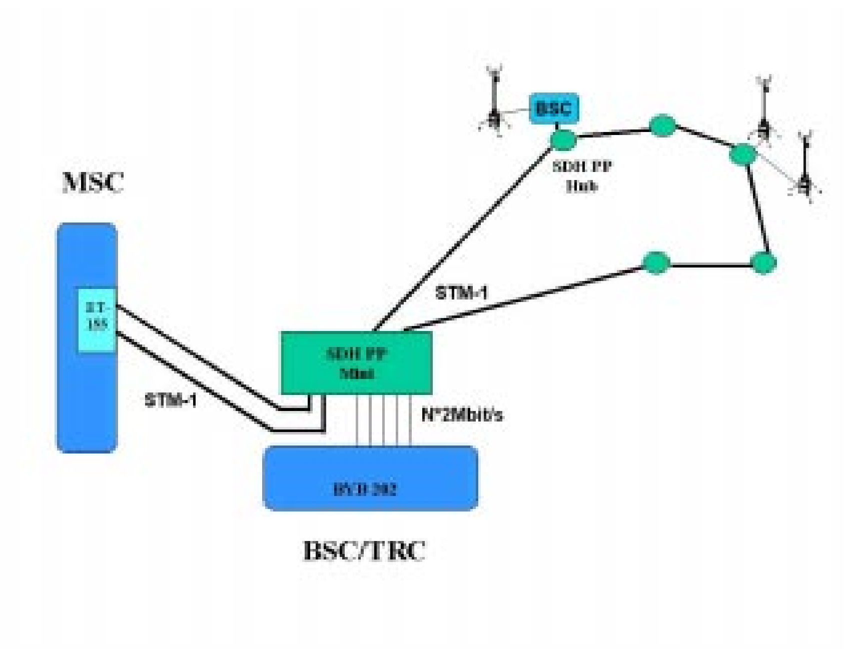


Figure 9 Network with BSC/TRC in BYB 202.

3.3.2 Network with BSC/TRC in BYB 202 and added an BSC/TRC in BYB 501.

This is the same network as in chapter 3.3.1 extended with one BSC/TRC in BYB 501, thus allowing a BSC/TRC split. The BSC/TRC 2 is added to the

SDH PP Maxi configuration without any interruption in the ongoing traffic. The new BSC/TRC 2 can then be configured and put into service and the 2 Mbps links one by one can be transfered to the new BSC/TRC.

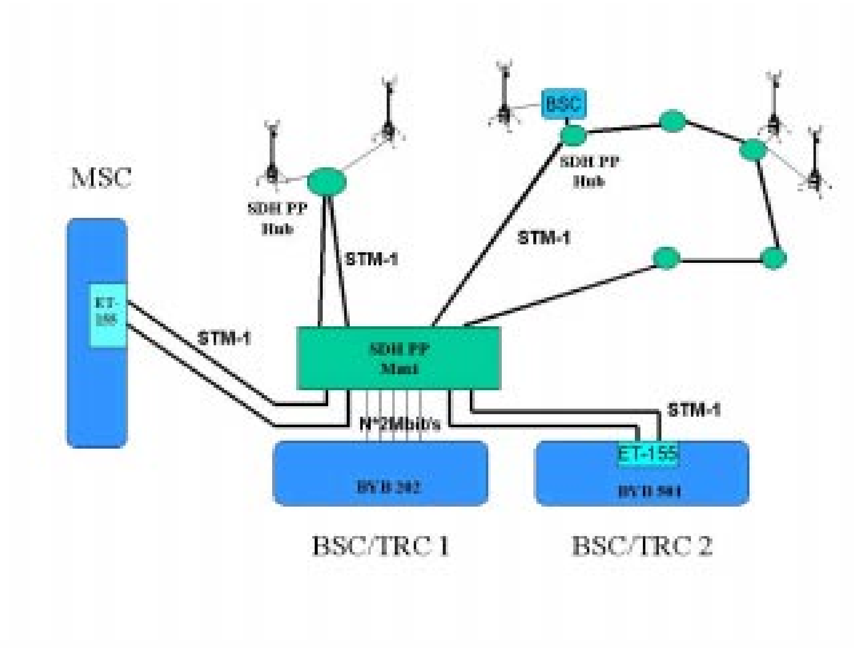


Figure 10 Network showing a BSC split.

3.3.3 Network with BSC/TRC in BYB 501.

The figure 11 shows a network with the SDH PP in a ring with BSC/TRC in BYB 501 mechanics and separate STM-1 connections between MSC and BSC/TRC.

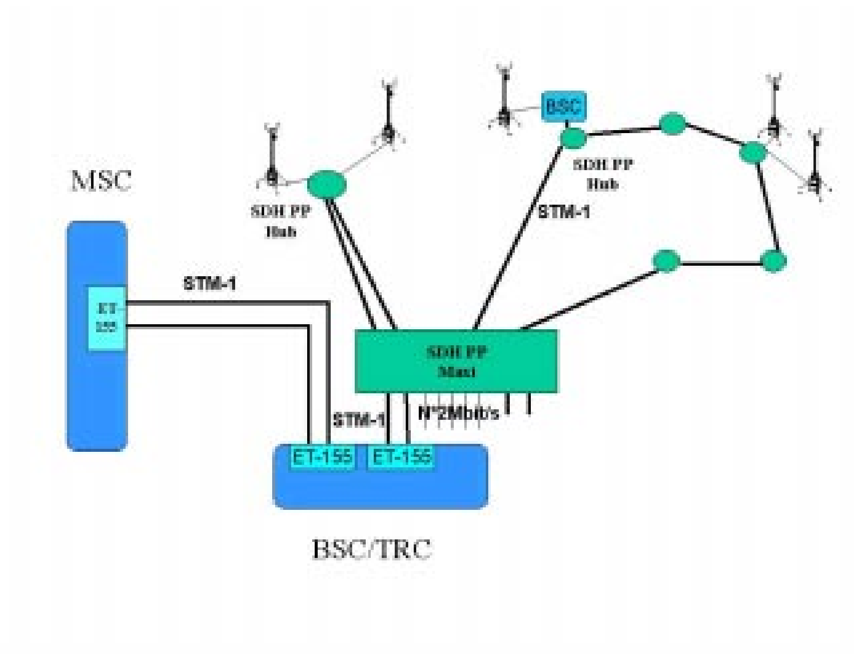


Figure 11

3.3.4 A pure STM-1 network with two BSC/TRCs for higher capacity.

The network from chapter 3.3.3 is expanded with one BSC/TRC for higher capacity and protected STM-1 connections to the MSC.

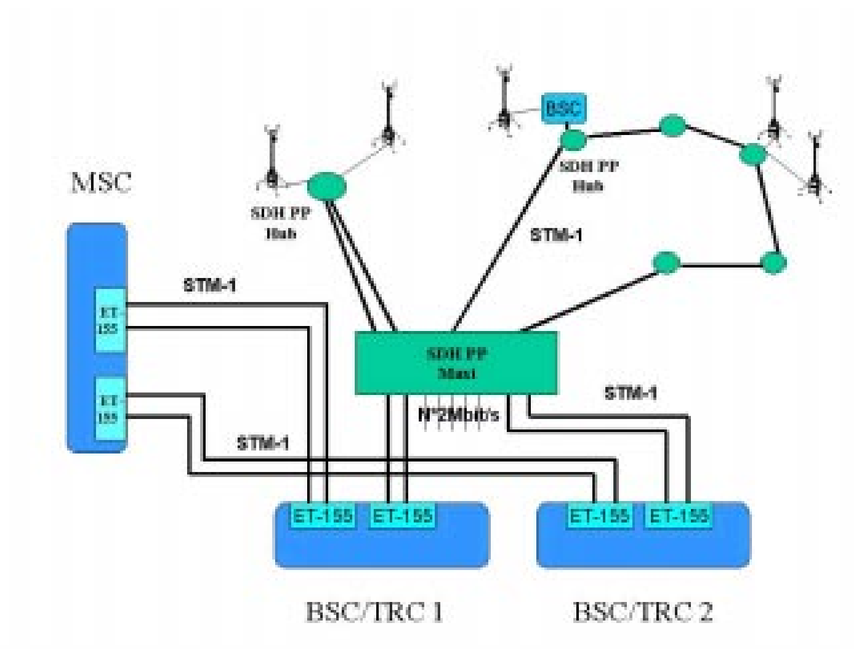


Figure 12

3.3.5 Network with an remote BSC in BYB 501.

This network uses the SDH PP Mini configuration in order to get STM-1 connection to the remote BSC. A BSC split can also be maintained as seen in the figure 13, where BSC/TRC 2 is added.

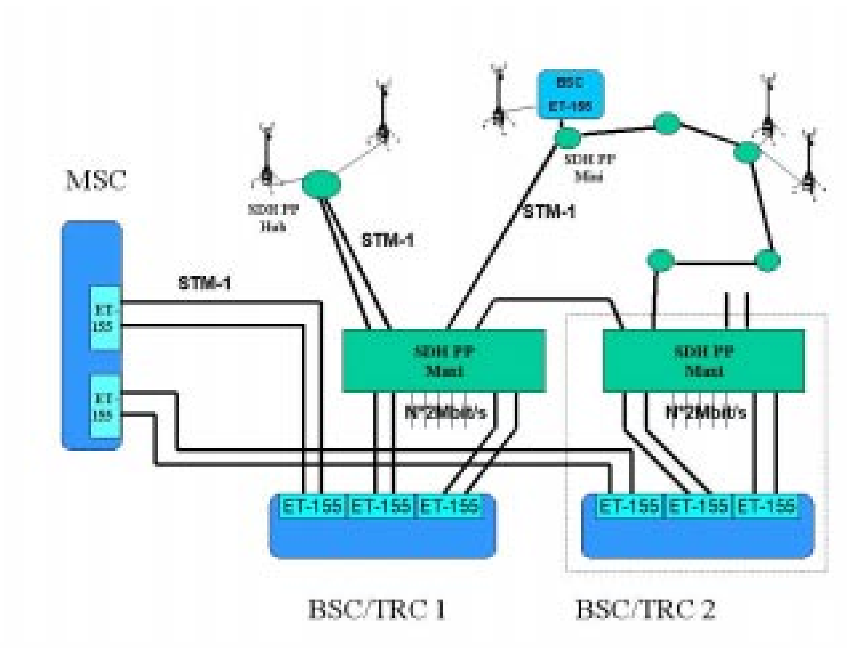


Figure 13

3.3.6 Two separate network connected together.

The figure 14 shows how two separate STM-1 networks are connected together.

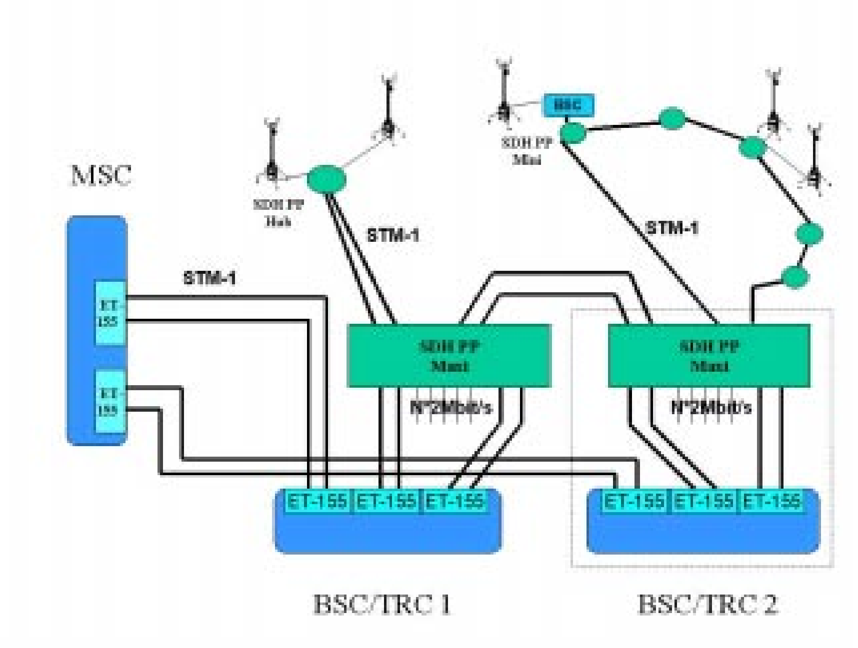


Figure 14

3.4 Upgrading of the SDH ADM

The SDH ADM configurations can be upgraded to STM-4 optical line interfaces and thus allowing to connect more capacity to the SDH line. The SDH ADM can be equipped with 1/0 cross connect functionality which gives a possibility for grooming the traffic and utilize the bandwidth more efficient. These functionalities are NOT included in this SDH product package, but will be added if ther are customer needs..

4 Technical description

This section describes the functionality of the SMA Add Drop Multiplexer (ADM). It is split up in the following issues:

- Supported standards.
- 2 Mbps tributary interface.
- STM-1 line and tributary interface including the multiplexing structure.
- Fault supervision.
- Quality supervision.
- Network protection.
- Equipment protection.

4.1 Supported standards

The main standards that are supported are ITU-T G.707-G709. It fulfils the requirements for various types of multiplexers according to ITU-T G.782. The interfaces to optical signals are described in G.957/8 and electrical signals are described in G.703/4. PDH signals are mapped into the appropriate SDH containers. It allows cross connects between any of its SDH or PDH ports. Cross connections is possible at VC12 and VC4 level. See the references on page 59 for a list over all the relevant standards.

4.2 2 Mbps tributary interface

This interface follows the normal DIP interface as described in user description Transmission E1, see reference on page 61. The document describes the frame structure, the functions for administration, quality and fault supervision.

4.3 STM-1 line and tributary interface

4.3.1 Multiplexing structure

The multiplexing structure of the STM signal defines the way the various lower order bit-rate signals are combined, together with supervisory data and pointers, to form the STM frame. It also defines, therefore, the access path whereby the SMA adds and drops tributaries, the points at which supervisory data can be accessed and the levels at which cross connections can be made.

Figure 1 illustrates the STM-1 structure (a subset of ITU Recommendation G709) and also shows the SMA access path.

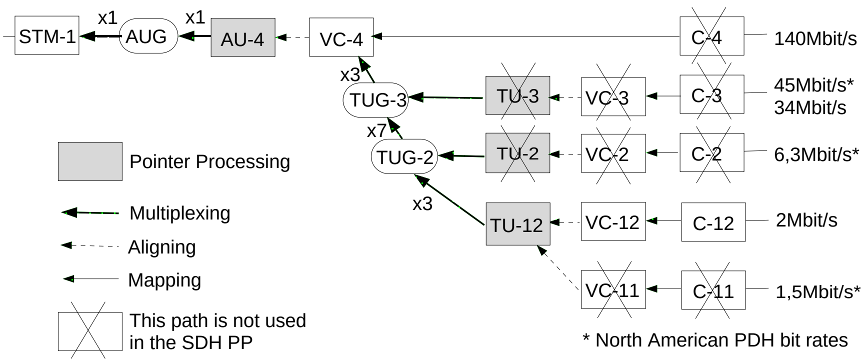


Figure 15 Multiplexing Levels

The multiplexing structure shown above is a sub-set of G.709 (as determined by ETSI) The structure is a hypothetical representation, showing all the possible signal and traffic levels that may be supported. In the SDH product package the only supported way is the 2Mbps interface, even if the other interfaces are achievable in the SMA equipment. This because of the fact that BSC only can handle VC12 tributaries.

The structure is made up as follows:

- The lowest level is a Container (C), into which the tributary signal is mapped.
- A Virtual Container (VC) is created when a Path OverHead (POH), carrying supervisory information, is added to the container data.
- The VC is re-timed (to SMA Clock) and a pointer added. This combination becomes a Tributary Unit (TU).

- Tributary Units are multiplexed together, via intermediate Tributary Unit Groups (TUG-2 & TUG-3), then to a higher order VC. The High Order VC also contains a POH, i.e a High Order POH.
- The High Order VC is re-timed (to STM-1 Line Clock) and a pointer added. This combination becomes an Administrative Unit (AU).
- A Section OverHead (SOH), carrying more supervisory information, is added to form the STM-1 signal frame.

Virtual Containers

The SMA handles Virtual Containers for bit rate VC-12, this is terminated to the 2 Mbps tributary card. They may be used when creating traffic paths (cross-connections) between STM-1 cards.

Overheads

The Path and Section overheads incorporate a number of bytes used for in-service monitoring of path and system performance. Path Over Heads provide for monitoring of individual Path (Higher Order and Lower Order) performance, some aspects allowing monitoring of remote elements. Section Over Heads provide for performance monitoring of the repeater and multiplex functions.

Pointers

A pointer is added to each virtual container. These pointers are used to adapt signals between different timing clocks used within the network. The pointer indicates the start of the VC within the Higher Order VC frame.

Tributary Units

The VC and associated pointer combination constitutes a Tributary Unit (TU), thus a VC-12 and its associated pointer is a TU-12.

Multiple Tributary Units are grouped together to form Tributary Unit Groups (TUGs). The method by which a TU-12 is grouped into TUGs is shown in figure 15 . Further details of the Multiplexing Structure can be found in ITU-T recommendation G.709, see reference on page 59. TU-12s are initially multiplexed into a TUG-2, seven TUG-2s are then combined to form a TUG-3. The TUG-3 is then multiplexed into a higher order Virtual Container, VC-4.

Administrative Units

The higher order VC (VC-4) has a pointer added to it to produce an Administrative Unit (AU-4). This is carried in the payload area of the STM-1 frame. The Section Overhead (SOH) bytes are added to the STM-1 signal.

The bytes of the SOH provide for a variety of ancillary functions associated with the transmission of the STM-1 data, e.g. for the SMA these functions include frame alignment bytes, error monitoring data and network communications channels.

An AU pointer is added to the VC-4 forming an AU-4. This AU pointer provides a method of allowing flexible and dynamic alignment of the VC within the AU frame. This pointer indicates the position of the VC-4 in relation to the AU 4 frame. The AU pointer constitutes the first 9 bytes of the STM-1 frame.

An Administrative Unit Group (AUG) is a group of AUs which are multiplexed together.

STM-1 Frame Structure

The figure 16 shows the structure of STM-1 frames in terms of payload, AU pointer and section overhead areas.

The STM-1 frame is 270 bytes by 9 bytes, with a frame period of 125 ms.

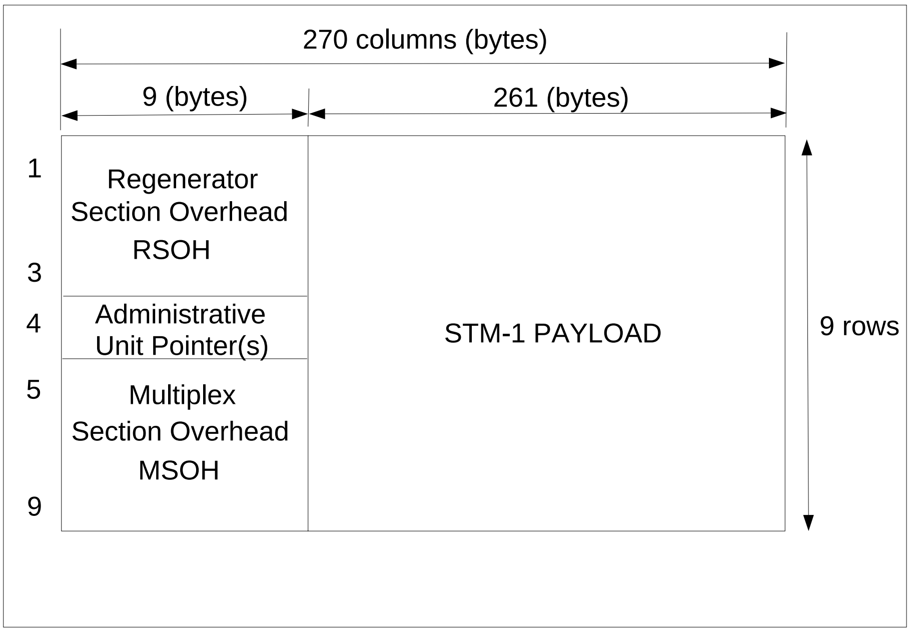


Figure 16 STM-1 Frame Structure

STM-1 section overhead

The STM-1 section overhead and the administrative unit pointer are shown in detail in table 3. reference G.707 (see reference on page 59.

Table 3 STM-1 Section Overhead (RSOH, AU-pointers and MSOH)

A1	A1	A1	A2	A2	A2	J0		
B1			E1			F1		
D1			D2			D3		
H1			H2			H3	H3	H3
B2	B2	B2	K1			K2		
D4			D5			D6		
D7			D8			D9		

D10			D11			D12		
S1					M1	E2		

A1 and A2 Frame alignment word.

B1 This byte is used for regenerator section error monitoring function.

B2 These bytes are used for a MS error monitoring function (MS-DEG).

D1 - D3 192 kbit/s regenerator section data communication channel.

D4 - D12 576 kbit/s MS data communication channel.

E1 and E2 Orderwire channels for voice communication.

F1 User channel.

H1 and H2 Adminstrative unit pointers.

H3 These bytes are used at negative AU-pointer justification.

J0 Regenerator section trace.

K1 and K2 (b1-b4) Automatic protection switching channel.

K2 (b5-b8) Bit 5 indicates protection algorithm used (MSP 1+1). Bit 6-8 is used for transmitting MS-RDI and MS-AIS.

M1 Used as a MS remote error indication. Conveys the count of interleaved bit blocks that have been detected in error by the BIP-24 (B2).

S1 Allocated for synchronization messages (fixed predefined pattern).

VC-4 Frame Structure

In figure 17 the STM-1 payload is shown in form of a VC-4 frame. The first byte in each row combine to make the VC-4 path section overhead.

Note Ref. G707 ch. 7.1 (see reference on page 59.

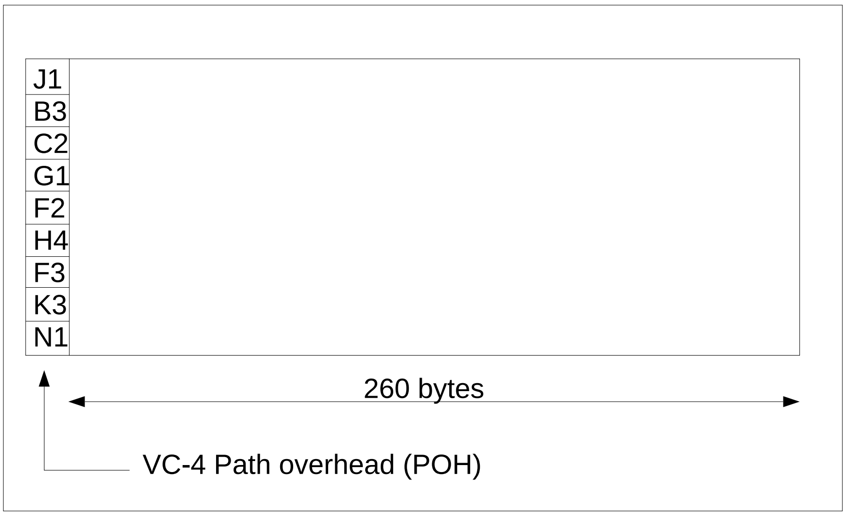


Figure 17 VC-4 Frame

J1 This byte is used to transmit repetitively a Trail Trace Identifier (TTI) so that a path receiving terminal can verify its continued connection to the intended transmitter. The TTI consist of a CRC-7 checksum (C1-C7,C1=MSB), a flagpattern (B7 in all bytes) and an access point identifier (API, 7 bits of byte 1 to 15).

B3 One byte is allocated for path error monitoring function (BIP-8 code) (HP-DEG).

C2 One byte is allocated to indicate the composition or the maintenance status of the VC-4.

The values for C2 should be:

- 00 - Unequipped or supervisory unequipped
- 01 - Equipped - non specific
- 02 - TUG structure
- 03 - Locked TU-n
- 04 - Asynchronous mapping of 34368 Kbit/s or 44736 Kbit/s into the container-4
- 12 - Asynchronous mapping of 139262 Kbit/s into the container-4
- 13 - ATM mapping
- 14 - MAN (DQDB) mapping
- 15 - FDDI mapping
- FE - Test signal
- FF - Undefined

G1 One byte is allocated to convey the path status and performance back to a VC-4 trail termination source as detected by a trail termination sink.

F2 This byte is allocated for user communication purposes between path elements (Tx=H'00, Rx ignored).

H4 This byte provides a generalized position indicator for payloads.

F3 This byte is allocated for user communication purposes between path elements (Tx=H'00, Rx ignored).

K3 This byte is used for APS signalling for Trail protection at the VC-4 path level (Tx=H'00, Rx ignored).

N1 This byte is used to provide a Tandem Connection Monitoring function (Tx=H'00, Rx ignored).

VC-12 mapping

In figure 18 it is shown that a VC-12 together with V1-V4 forms a TU-12 multiframe. V1 and V2, form the tributary unit pointer, which points to the start of the VC-12 frame. One TU-12 multiframe is transmitted in four STM-1 frames. Ref. 707 ch. 8.3 (see reference on page 59).

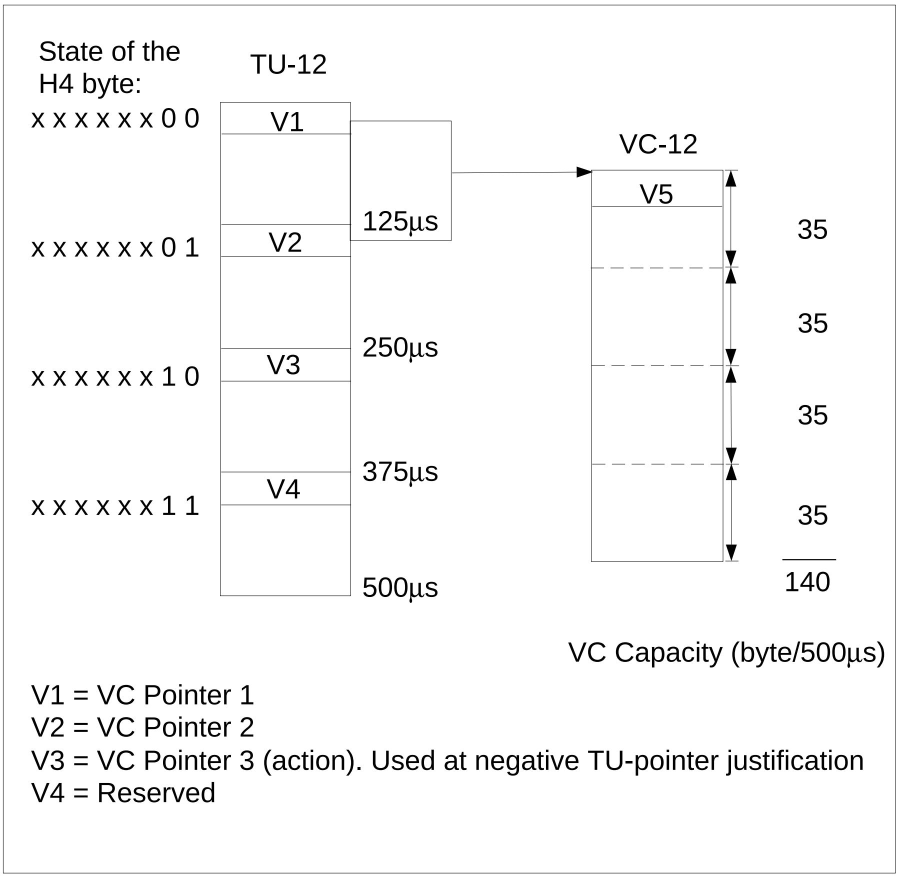


Figure 18 VC-12 Mapping in Multiframed TU-12

VC-12 Frame Structure

One 2048 kbit/s signal can be mapped into a VC-12 frame.

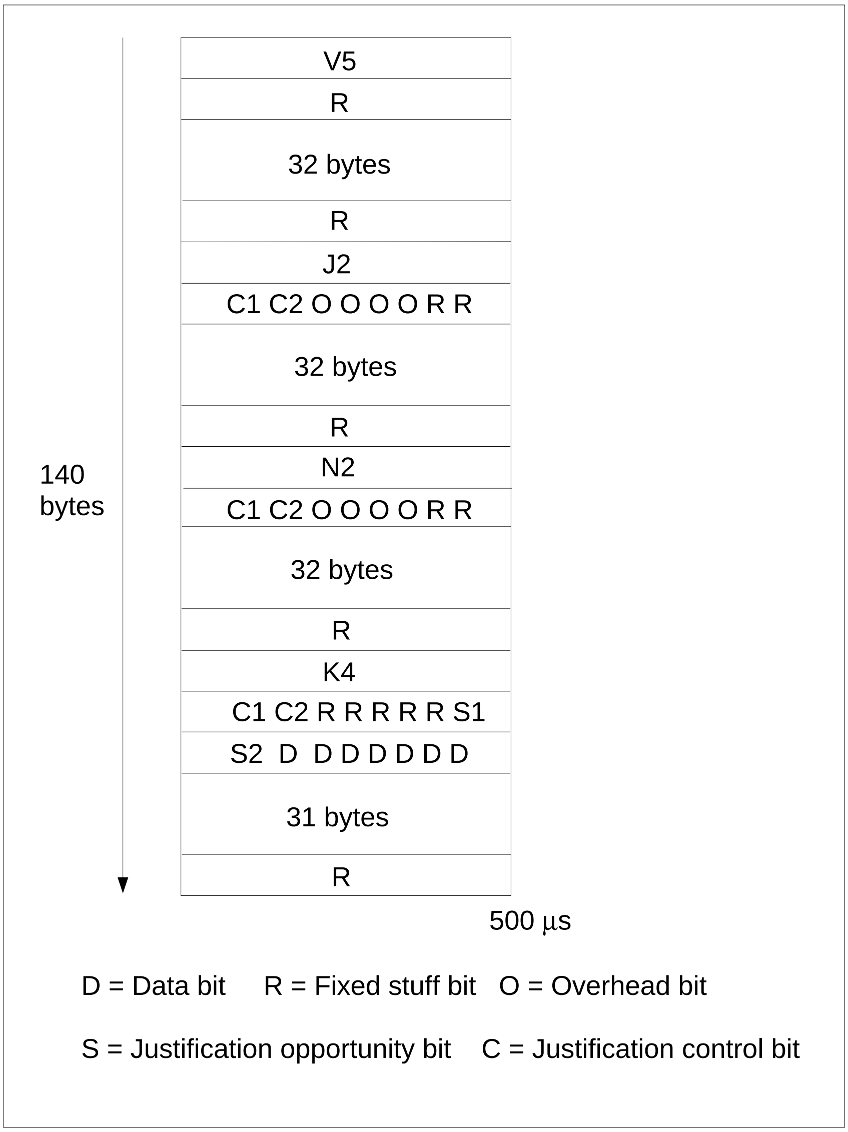


Figure 19 Asynchronous Mapping of 2048 kbit/s. The figure shows a 2048 kbit/s signal mapped into a VC-12 frame.

J2 This byte is used to transmit repetitively a Low Order Trail Trace Identifier (TTI) so that a path receiving terminal can verify its continued connection to the intended transmitter.

V5 Described in figure 20

K4 Automatic protection switching signalling at lower order path level.

N2 Allocated for Tandem connection monitoring.

V5 Byte Coding

In figure the V5 Byte contains is shown in details.

Note Ref. G707 ch.9.3.2 (see reference on page 59.

BIP-2		REI	RFI	Signal label			RDI
1	2	3	4	5	6	7	8

Figure 20 V5 Byte

BIP-2 Bit Interleaved Parity is used for error performance monitoring.

REI Remote Error Indication bit is set to '1' if one or more error where detected by the BIP-2 monitoring.

RFI Remote Failure Indication bit is set to '1' if a defect persist beyond the maximum time allocated to the transmission system protection mechanisms.

RDI Remote Defect Indication bit is set to '1' if AIS or LOS i detected.

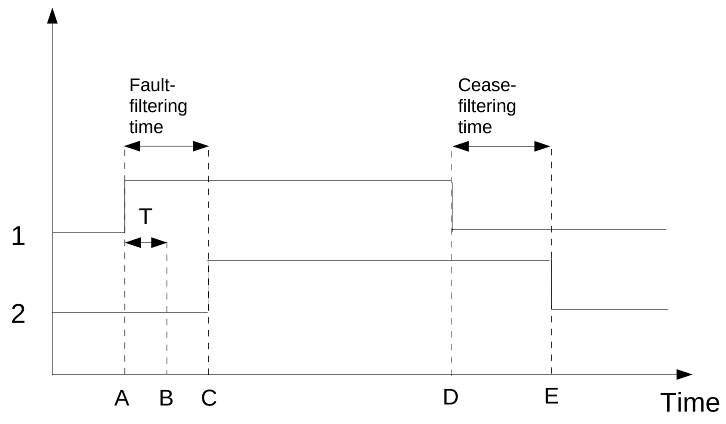
Signal Label

- 000 - Unequipped or supervisory unequipped
- 001 - Equipped - non specific
- 010 - Asynchronous
- 011 - Bit synchronous
- 100 - Byte synchronous
- 101 - Undefined
- 110 - Test signal
- 111 - Undefined

4.4 Fault Supervision

The purpose of Fault Supervision function is to detect transmission faults, take appropriate automatic actions to avoid traffic being set up on faulty equipment, and initiate alarm printouts.

The defects LOS, LOF, MS-AIS and MS-DEG initiates the network protection function, see figure 21.



1 = Defect detection
2 = Fault reporting

T = The time from a defect (LOS, LOF, MS-AIS and MS-DEG) is detected until a protection switch, if available, is performed. The time is less than 50 ms.

A = A defect is detected.
B = Protection switching is performed.
C = A failure is declared and alarm is initiated.
D = The defect is cleared.
E = The failure and the alarm is ceased.

Figure 21 Defect Filtering Times and Network Protection Switching

In figure 21 a summary of the Fault Supervision function is shown.

A defect is detected at point A. If this defect leads to sending of RDI and AIS (see table 5), sending is generated at this point.

The defects LOS, LOF, MS-AIS and MS-DEG will initiates the Network Protection function. If network protection is available, the Network Protection function switches the traffic to the standby MS. This network protection switch is done at point B.

When the defect has lasted longer than the fault filtering time, a failure is declared and an alarm is given to the operator, point C. The operator can set the fault filtering time, see Section 4.4.24.

At point D, the defect is cleared and sending of RDI and AIS is stopped.

When the defect has been cleared longer than the cease filtering time, the failure and the alarm is ceased, point E. The operator can set the cease filtering time, see Section 4.4.24.

4.4.1 Survey of Terms

4.4.2 SDIP Layers

The different layers within an Synchronous Digital Path (SDIP) and the relationship between them are shown in figure 22. It is possible to equip the SDIP with two MSs, where one MS is used for protection. The SDIP can also be equipped with one MS only, the SDIP is then working without protection. The SDIP also contains one HP and up to 63 LPs.

Survey of Terms

ES= Errored second is a one second period with one or more errored blocks or at least one defect.

HP= Higher order path. The term HP is used for VC-4 see figure 22.

LP= Lower order path. The term LP is used for VC-12 see figure 22.

MS= Multiplex section. A multiplex section is the trail between and including two multiplex section terminations.

PDH= Plesiochronous digital hierarchy. In this document PDH is used in order to address the 2 Mbit/s tributaries.

SDIP= Synchronous digital path. The term SDIP is used as a common term for the Multiplex Sections (MS), VC-4 and VC-12 layers of the SDH hierarchy.

SES= Severely errored second is a one-second period which contains 30% or more errored blocks, or at least one defect.

STM= Synchronous transport module. An STM is the information structure used to support section layer connections in the SDH. It consists of information payload and Section Overhead (SOH) information fields organized in a block frame structure which repeats every 125 µs. The information is suitably conditioned for serial transmission on the selected media at a rate which is synchronized to the network. The STM-1 is defined at 155 520 kbits/s.

Subobject = An SDIP, see figure 22, consists of Multiplex sections, VC-4 and VC-12s. These MSs, VC-4 and VC-12s are termed as the SDIP subobjects.

VC= Virtual container. A virtual container is the information structure used to support path layer connections in SDH. It consists of information payload and Path Overhead (POH) information fields organized in a block frame structure which repeats every 125 µs (VC-4) or 500 µs (VC-12).

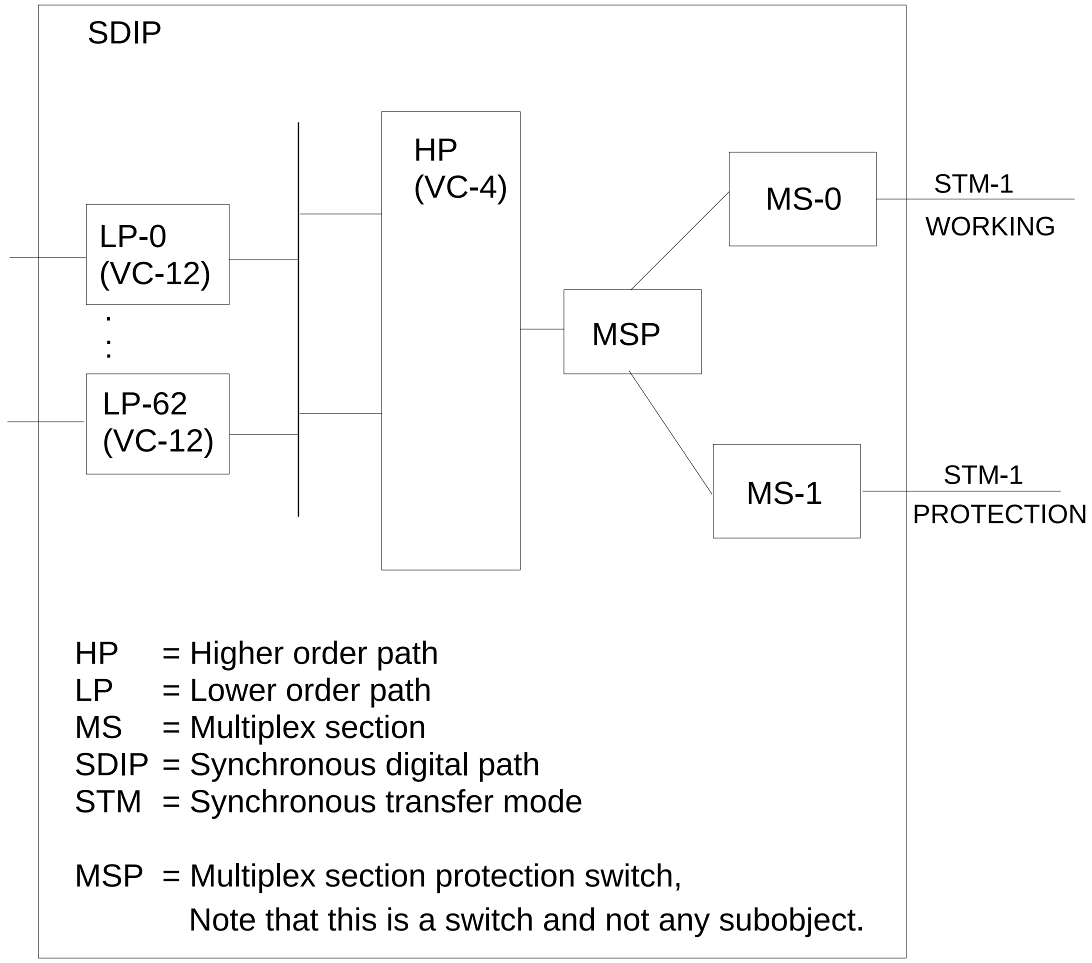


Figure 22 Relationship Between Layers and Subobjects in SDIP

4.4.3 Loss of Incoming Signal (LOS)

LOS defect is detected for both electrical and optical interfaces. The LOS defect ceases at frame alignment recovery.

4.4.4 Loss of Frame Alignment (LOF)

If the Frame alignment word, bytes A1 and A2, see table 3, has not been received for 4 consecutive frames then OOF (Out Of Frame) state is entered. If the OOF state persists for 3 ms +/- 0.25 ms, then LOF is detected.

When two consecutive Frame alignment words have been received the in frame state is entered. The LOF defect is cleared when the “in frame state” has persisted continuously for 3 ms +/- 0.25 ms.

4.4.5 Multiplex section - alarm indication signal (MS-AIS)

If at least five consecutive frames contains the 111 pattern in bits 6, 7 and 8 of the K2 byte, see table 3, the MS-AIS defect is detected. The MS-AIS defect is cleared if five consecutive frames contains any other pattern than 111 in bits 6, 7 and 8 of the K2 byte.

4.4.6 Multiplex section - degraded (MS-DEG)

The B2 bytes, see table 3, are allocated for the multiplex error monitoring function. Once every second, the number of errored blocks during the second is compared with the DEGTHR. If the number of errored blocks is equal or greater than DEGTHR, the one second is declared bad, otherwise it is declared good. The degraded defect is detected if DEGM consecutive bad seconds have occurred and cleared if DEGM consecutive good seconds have occurred. (The default value for DEGM are 3s and the default value for DEGTHR is 30%, these values can be changed by command).

4.4.7 Multiplex section - remote defect indication (MS-RDI)

If at least five consecutive frames contain the 110 pattern in bits 6, 7 and 8 of the K2 byte, see table 3, the MS-RDI defect is detected. The MS-RDI defect is cleared if five consecutive frames contain a cleared RDI signal.

4.4.8 Administrative unit - loss of pointer (AU-LOP)

The H1 and H2 bytes, see table 3, contain the AU pointer. The AU-LOP defect is detected if the pointer interpreter is in the LOP state, see ref. ETS 300 417-1-1 Annex B, on page 59. The AU-LOP defect is cleared if the pointer interpreter is not in the LOP state.

4.4.9 Administrative unit - alarm indication signal (AU-AIS)

The H1 and H2 bytes, see table 3, contain the AU pointer. The AU-AIS defect is detected if the pointer interpreter is in the AIS state, see ref. ETS 300 417-1-1 Annex B, on page 59. The AU-LOP defect is cleared if the pointer interpreter is not in the AIS state.

4.4.10 Higher order path - unequipped VC indication (HP-UNEQ)

The HP-UNEQ defect is detected if five consecutive frames contains the pattern H'00h in the C2 byte, see figure 17. The HP-UNEQ defect is cleared if the C2 byte contains a value greater than 0 in five consecutive frames.

4.4.11 Higher order path - trace identifier mismatch (HP-TIM)

The received TTI in the J1 byte, see figure 17, is compared to the expected TTI. If a mismatch occurs, the HP-TIM defect is detected. The HP-TIM defect is cleared when the received TTI and the expected TTI are identical again. HP-TIM can be turned on/off by command TPTII/TPTIE.

4.4.12 Higher order path - remote defect indication (HP-RDI)

If bit 5 of the received G1 byte, see figure 17 is set in five consecutive frames the HP-RDI defect is detected. The HP-RDI defect is cleared if bit 5 in the received G1 byte is cleared in five consecutive frames.

4.4.13 Higher order path - degraded (HP-DEG)

The B3 byte, see figure 17, are allocated for the Path Error Monitoring function. Once every second, the number of errored blocks during the second is compared with the degraded defect threshold (DEGTHR). If the number of errored blocks is equal or greater than DEGTHR the one second is declared bad, otherwise it is declared good. The degraded defect is detected if DEGM consecutive bad seconds have occurred. The degraded defect is cleared if

DEGM consecutive good seconds have occurred. (The default value for DEGM are 3s and the default value for DEGTHR is 30%, these values can be changed by command).

4.4.14 Higher order path - payload mismatch (HP-PLM)

The received C2 byte, see figure 17, is compared with the expected C2 byte. If a mismatch occurs then the HP-PLM defect is detected. The HP-PLM defect is cleared when the received C2 byte and the expected C2 byte are identical. However value “01- Equipped - non specific”,and “02 -TUG” will always be accepted when received.

4.4.15 Tributary unit - loss of multiframe (TU-LOM)

The TU-LOM defect is detected if two or more consecutive H4 bytes are mismatched for two consecutive multiframes. TU-LOM defect can be declared within 6 frames. When the alarm occurs, the internal H4 multiframe detector starts a search for a multiframe pattern immediately. Recovery occurs when four consecutive H4 byte values are detected.

4.4.16 Tributary unit - loss of pointer (TU-LOP)

The V1 and V2 bytes, see figure 18, contain the TU pointer. The TU-LOP defect is detected if the pointer interpreter is in the LOP state, see ref. [1] Annex B. The TU-LOP defect is cleared if the pointer interpreter is not in the LOP state.

4.4.17 Tributary unit - alarm indication signal (TU-AIS)

The V1 and V2 bytes, see figure 18, contain the TU pointer. The TU-AIS defect is detected if the pointer interpreter is in the AIS state, see ref. ETS 300 417-1-1 Annex B, on page 59. The TU-AIS defect is cleared if the pointer interpreter is not in the AIS state.

4.4.18 Lower order path - unequipped VC indication (LP-UNEQ)

The LP-UNEQ defect is detected if five consecutive frames contains the pattern 000 in the signal label in the V5 byte, see figure 19 and figure 20. The LP-UNEQ defect is cleared if the signal label contains a value greater than 0 in five consecutive frames.

4.4.19 Lower order path - trace identifier mismatch (LP-TIM)

The received trail trace identifier in the J2 byte, see figure 19, is compared with the expected trail trace identifier. If a mismatch occurs, the LP-TIM defect is detected. The LP-TIM defect is cleared when the received TTI and the expected TTI is identical again. LP-TIM can be turned on/off by command TPTIT/TPTIE.

4.4.20 Lower order path - remote defect indication (LP-RDI)

If bit 8 of the received V5 byte, see figure 19 and figure 20, is set in five consecutive frames the LP-RDI defect is detected. The LP-RDI defect is cleared if bit 8 in the received V5 byte is cleared in five consecutive frames.

4.4.21 Lower order path - degraded (LP-DEG)

The BIP-2 in the V5 byte, see figure 19 and figure 20, are allocated for the error performance monitoring function. Once every second, the number of errored blocks during the second is compared with the degraded defect threshold (DEGTHR). If the number of errored blocks is equal or greater than DEGTHR the one second is declared bad, otherwise it is declared good. The degraded defect is detected if DEGM consecutive bad seconds have occurred. The degraded defect is cleared if DEGM consecutive good seconds have occurred. (The default value for DEGM are 3s and the default value for DEGTHR is 30%, these values can be changed by command).

4.4.22 Lower order path - payload mismatch (LP-PLM)

The received signal label in the V5 byte, see figure 19 and figure 20, is compared with the expected signal label. If a mismatch occur then the LP-PLM defect is detected. The LP-PLM defect is cleared when the received C2 byte and the expected C2 byte are identical. However value “001- Equipped - non specific”, and “010-Asynchronous” will always be accepted when received.

4.4.23 Fault Filtering Times

There are two filtering times associated with the fault detection.

- A defect is filtered specified period before a failure is declared. This fault filtering time can be set in the range 100 ms to 10 minutes in steps of 100 ms. Default value is 2.5 s.
- When the fault ceases, a cease filtering time is used in order to ensure that the fault has disappeared. This cease filtering time can be set in the range 100 ms to 10 minutes in steps of 100 ms. Default value is 10 s.

The fault filtering time and cease filtering time are both set by application parameters.

4.4.24 Alarm Filtering

Failures at the SDIP have the following priority, see table 4. The order of priority is based on ETSI/ITU Standards/recommendations.

Table 4 LOS has highest priority and LP-PLM has lowest. Defect in the column "Suppressing Failures" suppresses defect in the same column with lower priority.

	Suppressing Failures	No-suppressing Failures	Priority
MS	LOS		High
	LOF		
	AIS		
		DEG	
	RDI	RDI *)	
VC-4 (HP)	LOP/AIS *)		
	UNEQ		
	TIM		
		DEG	
	RDI		
	PLM		
	TU-LOM		
VC-12 (LP)	LOP/AIS *)		
	UNEQ		
	TIM		
		DEG	
	RDI		
	PLM		Low

*) LOP and AIS do not appear at the same time, they are mutually exclusive. RDI can be no-suppressing when network protection is available

LOS has highest priority and LP-PLM has lowest priority. Only defects in column "Suppressing Failures" will suppress defects of lower priority. If several "Suppressing Failures" are detected simultaneously, only the failure with highest priority is reported. Defects in the column "No-suppressing Failures" do not suppress any other defects. It is possible to have two active alarms at the same time, one alarm for "Suppressing Failures" and one alarm for "No-suppressing Failures". This means that for instance an MS-RDI and an MS-DEG alarm may be present at the same time for a given MS-object.

4.4.25 Actions at Fault Conditions

The maintenance actions specified in table 5 are taken as consequence of the detected faults.

A service alarm indication is generated to signify that the service is no longer available.

The prompt maintenance alarm indication is generated to signify that performance is below acceptable standards and that immediate maintenance attention is required locally. For a given fault condition, it is possible specify whether the prompt maintenance alarm is generated or not.

RDI is generated to notify the remote end about erroneous transmission towards the local end.

Table 5 Fault Conditions and Alarms Detected by SDH Fault Supervision

Anomalies and defects detected	Consequent actions			
Loss Of incoming Signal (LOS)	1f	2a	3b note	4 g note
Loss Of Frame (LOF)	1f	2a	3b	4g
MS-AIS	1f	2a	3b	4g
MS-DEG	-	2a	-	-
MS-RDI	1f	2a	-	-
AU-LOP	1	2a	3c	4
AU-AIS	1	2a	3c	4
HP-UNEQ VC indication	1	2a	3c	4
HP-TIM	1	2a	3c	4
HP-DEG	-	2a	-	-
HP-RDI	1	2a	-	-
HP-PLM	1	2a	3c	4
TU-LOM	1	2a	3c	4
TU-LOP	1	2a	3d	4
TU-AIS	1	2a	3d	4
LP UNEQ VC indication	1	2a	3d	4
LP-TIM	1	2a	3d	4
LP-DEG	-	2a	-	-
LP-RDI	1	2a	-	-
LP-PLM	1	2a	3e	4

1= Service alarm indication generated.

2= Prompt maintenance alarm indication generated.

3= RDI to remote end generated (see also b-e below)

4= AIS towards the switching stages generated.

a= The operator is able to set whether this alarm indication should be generated or not.

b= Remote defect indications generated to remote end for affected levels. If network protection switching is possible only MS-RDI is generated to remote end.

If MS-RDI is reported for an MS that is unprotected, the MS-RDI is treated as a suppressing defect. However, if MS-RDI is reported for an MS that is protected, the MS-RDI is treated as a no-suppressing defect. This is in order to be consistent with actions at remote end (which probably has detected LOS/LOF and therefore has terminated traffic on its side).

– MS-RDI
– HP-RDI
– LP-RDI
– PDH-RDI

c= Remote defect indications generated to remote end for affected levels

– HP-RDI
– LP-RDI
– PDH-RDI

d= Remote defect indications generated to remote end for affected levels

– LP-RDI
– PDH-RDI

e= Remote defect indications generated to remote end for affected levels

– PDH-RDI

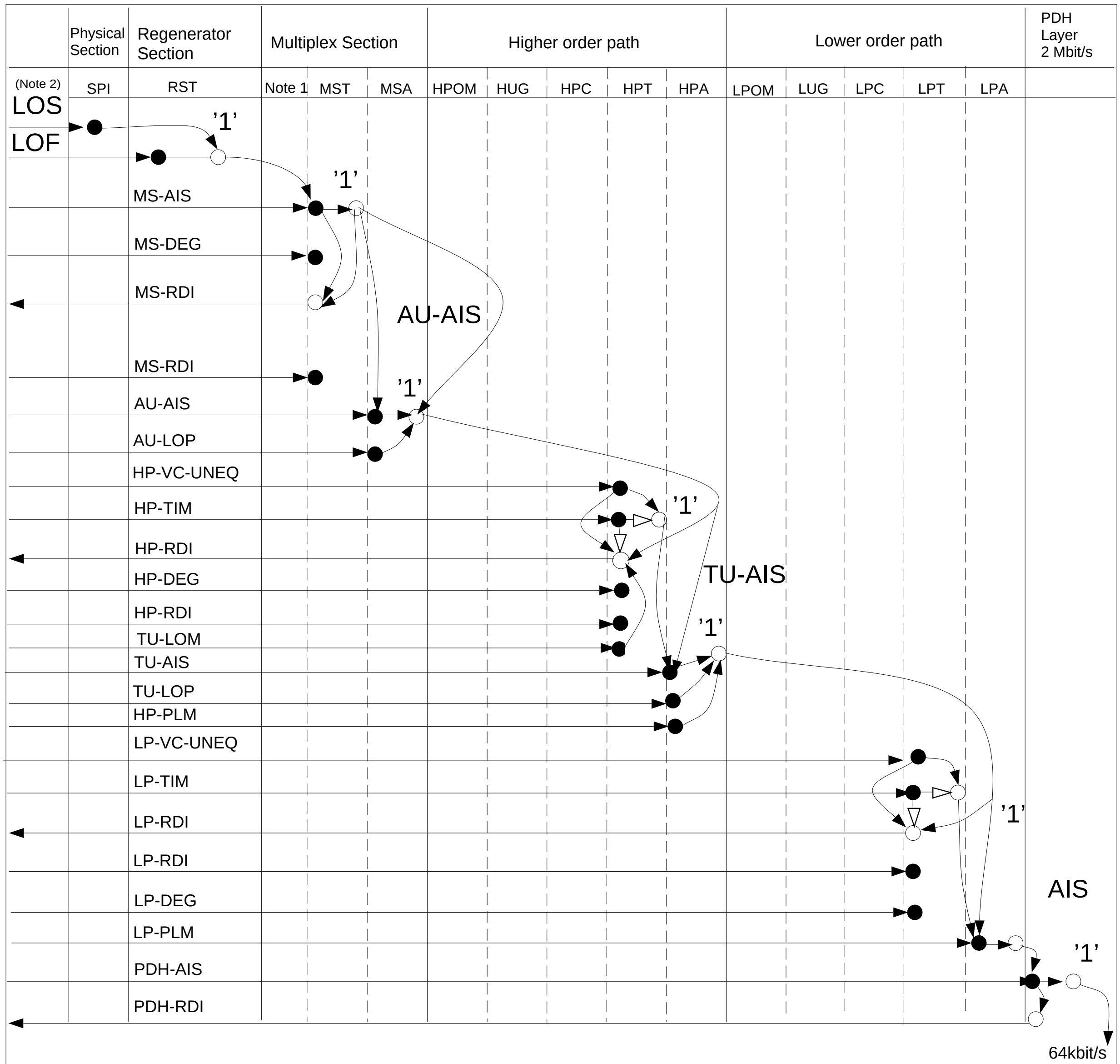
f= Service alarm indication is only generated if network protection switching was not possible.

g= AIS is only generated if network protection switching was not possible.

Note = LOS does not generate AIS or RDI. LOS suppresses LOF and all following defects. It is the LOF that follow upon the LOS that generates AIS and RDI.

For each layer of STM-1(physical-, regenerator-, multiplex-, higher order path-, lower order path- sections) maintenance signals are detected or generated. An alarm indication signal (AIS) is a signal sent against the switch as an indication that a defect or failure has been detected. A remote defect indication (RDI) is a signal to be returned to the remote end to inform that the near end has detected an incoming failure or is receiving AIS. The figure 23 shows the standardized maintenance signal interaction hierarchy for STM-1 without the network protection function.

Nr — *No.*		
89/1553-HSC 103 12 Uen		
Datum — *Date*	Rev	File
2000-07-06	B	



● Detection

○ Generation

'1' Insertion of all-ones (AIS) signal

▷ propagation (defect) can be turned on/off by command

► propagation

Notes:
1 This column represents the degenerate connection function present in a regenerator.
2 LOS does not generate AIS or RDI. LOS suppresses LOF and all following defects.
It is the LOF that will follow upon the LOS that generates AIS and RDI.

Figure 23 STM-1 maintenance signal interaction described without the network protection function. The open arrows are defect detections that can be turned on/off by operator command. In addition, the interaction between SDH and PDH is included.

4.5 Quality Supervision

4.5.1 Overview

The aim of quality supervision is to supervise the quality of the SDIP. That is in order to alert maintenance staff before the quality of the service is such that whole or part of the SDIP is considered faulty. Historical storage of quality data is included in the function.

4.5.2 Monitored Objects

Performance is monitored in the termination points of the multiplex section, higher order path, and lower order path of the SDH system. This means that performance is monitored for each subobject, that is the MS, HP and LP subobjects, within an SDIP.

4.5.3 Basic Performance Parameters

The performance of MS, HP and LP subobjects within an SDIP is monitored separately for incoming and outgoing direction. For each layer a certain set of anomalies and defects are defined, which leads to registration of an event of impairment. The event is registered as an Errored Second (ES) or a Severely Errored Second (SES), depending upon the severity of the impairment. ES and SES are the basic performance parameters, upon which the quality supervision is based.

The evaluation of error performance and availability performance is based on the processing of the basic performance parameters.

4.5.3.1 Near End or Far End Monitoring

Error performance is monitored by measuring various parameters in the incoming transmission direction. Incoming errors and defects are reported to the remote end by use of remote error indication, REI, and remote defect indication, RDI. Hence, by reading REI and RDI coming in to a termination point, it is possible to obtain a picture of the quality perceived in the remote end termination point.

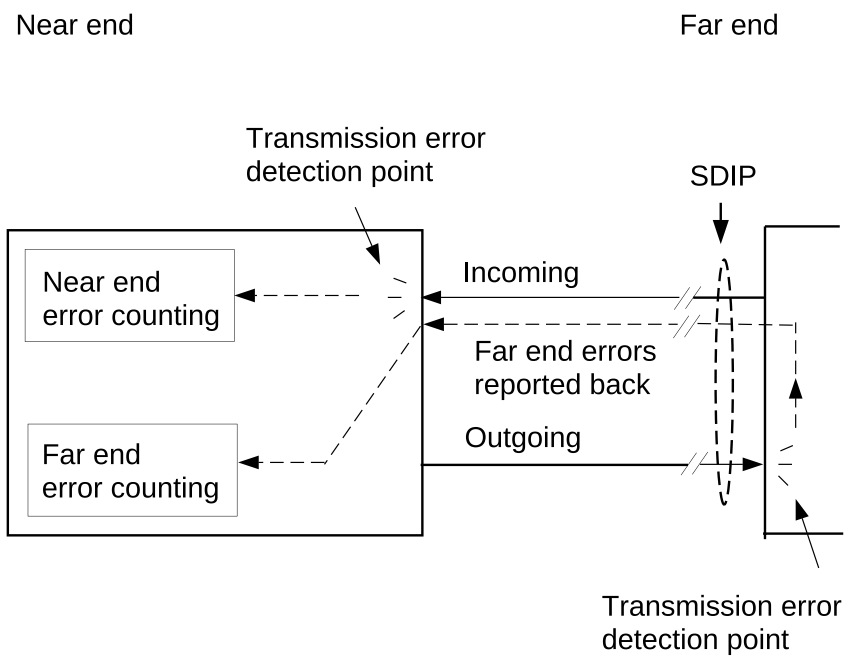


Figure 24 Counting of Errors for Near End and Far End

4.5.3.2 ES and SES Parameter Evaluation Criteria for the Multiplex Section Layer

Table 6

Anomalies and defects in one second	Interpretation for receive direction	Interpretation for send direction	Notes
>= 1 LOS	ES+SES	-	
>= 1 LOF	ES+SES	-	
>= 1 MS-AIS	ES+SES	-	
>= 1 MS-BIP-1 errors	ES	-	
>= 28800 MS-BIP-1 errors	ES+SES	-	Note 1
>= 1 MS-REI	-	ES	Note 2
>= 28800 MS-REI	-	ES+SES	Note 2 Note 3
>= 1 MS-RDI	-	ES+SES	

Note 1:

In order to be compatible with equipment not supporting MS-REI at remote end, MS-REI detection may be turned on/off by command. MS-REI detection is supported by default.

4.5.3.3 ES and SES Parameter Evaluation Criteria for the Higher Order Path Layer

Table 7

Anomalies and defects in one second	Interpretation for receive direction	Interpretation for send direction	Notes
>= 1 AU-AIS	ES+SES	-	
>= 1 AU-LOP	ES+SES	-	
>= 1 HP-TIM	ES+SES	-	
>= 1 HP-UNEQ	ES+SES	-	
>= 1 HP-BIP-8 errors	ES	-	
>= 2400 HP-BIP-8 errors	ES+SES	-	
>= 1 HP-REI	-	ES	
>= 2400 HP-REI	-	ES+SES	Note 1
>= 1 HP-RDI	-	ES+SES	

4.5.3.4 ES and SES Parameter Evaluation Criteria for the Lower Order Path Layer

Table 8

Anomalies and defects in one second	Interpretation for receive direction	Interpretation for send direction	Notes
>= 1 TU-LOM	ES+SES	-	
>= 1 TU-AIS	ES+SES	-	
>= 1 TU-LOP	ES+SES	-	
>= 1 LP-TIM	ES+SES	-	
>= 1 LP-UNEQ	ES+SES	-	
>= 1 LP-BIP-2 errors	ES	-	
>= 600 LP-BIP-2 errors	ES+SES	-	
>= 1 LP-REI	-	ES	
>= 600 LP-REI	-	ES+SES	Note 1
>= 1 LP-RDI	-	ES+SES	

4.5.4 Time Intervals

Both performance parameters, ES and SES, are counted during two time intervals, which are rectangular fixed windows with length 15 minutes and 24 hours respectively. The start and end time datum for the 15-minute (T1) and 24-hour (T2) intervals are the same for ES evaluation as for SES evaluation. Both the 15-minute and 24-hour intervals are synchronized to the exchange clock. In addition, the 15-minute interval is aligned with the 24-hour interval. That is the start of a 24-hour period is also the start of a 15-minute period.

The start and end time for the 15-minute period are the same from both ES and SES and must fall on the hour and at 15, 30 and 45 minutes after the hour.

The 15-minute measurement starts immediately when the supervised object, MS, HP or LP, is taken into service. Hence it may happen that the first interval will not be fully 15-minutes. If the first interval not is fully 15-minutes, it will be suspect marked.

The start and end time for the 24-hour period are the same from both ES and SES and must fall on a 15-minute window boundary. The start time of the 24-hour interval can be set by command in steps of 15-minutes. The default start time is 00.00.

4.5.5 Performance Levels

Three performance levels, acceptable, degraded and unacceptable performance level, are defined for ES and SES supervision.

Unacceptable or degraded performance level is entered when significant or gradual degradation in quality has been declared respectively.

- Unacceptable Performance Level is evaluated during fixed 15-minute time intervals (T1).
- Degraded Performance Level is evaluated during fixed 24-hour time intervals (T2).

The actual performance level is derived through the monitoring and thresholding of the basic performance parameters (ES and SES).

4.5.6 Thresholding and Reports

For both time intervals (15-minute and 24-hour), the basic performance parameters are counted in both transmission directions, in order to derive the actual performance level. Consequently, for each time interval (15-minute and 24-hour), there are two ES counters and two SES counters per MS, VC-4 and VC-12.

A threshold report is issued when either unacceptable or degraded performance level is entered. A performance level is entered if a threshold value is reached or crossed by the corresponding basic performance counter.

However, a fault alarm for an SDIP subobject will suppress threshold reports (both for unacceptable and degraded performance) for concerned SDIP subobject, corresponding subordinate SDIP subobjects on lower level SDH layers and for corresponding DIPs on PDH layer.

ES and SES are counted second by second to the end of the 15-minute interval independently on if a threshold report (alarm) has been issued or not. Then the counters are stored and reset to 0 (zero).

4.5.6.1 15-minute Measurements

In both transmission directions, ES and SES are measured during 15-minute intervals to determine whether the performance level is unacceptable or not. If a threshold for unacceptable performance is reached or crossed by the respective performance counter (incoming or outgoing ES or SES), a corresponding threshold report is given.

The default threshold values and the threshold value ranges are listed below. The values are the same for both transmission directions.

Table 9

Layer	Threshold	Default value	Value range
MS	ST1-ES	50 ES	0-900 ES
MS	ST1-SES	10 SES	0-900 SES
HP	ST1-ES	180 ES	0-900 ES
HP	ST1-SES	15 SES	0-900 SES
LP	ST1-ES	120 ES	0-900 ES
LP	ST1-SES	15 SES	0-900 SES

If the unacceptable performance level is reached in one 15-minute interval, the considered basic performance counter will be compared to a reset threshold at the end of subsequent 15-minute intervals. If the basic performance counter is below or equal to the reset threshold, a corresponding reset threshold report is given.

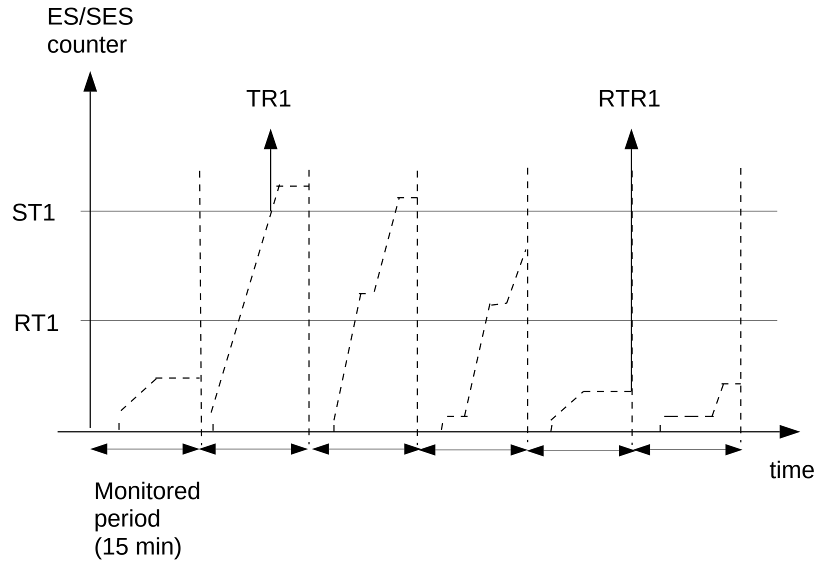
The default reset threshold values and the value ranges are listed below. The values are the same for both transmission directions.

Table 10

Layer	Threshold	Default value	Value range
MS	RT1-ES	0 ES	0-900 ES
MS	RT1-SES	0 SES	0-900 SES
HP	RT1-ES	0 ES	0-900 ES
HP	RT1-SES	0 SES	0-900 SES
LP	RT1-ES	0 ES	0-900 ES
LP	RT1-SES	0 SES	0-900 SES

The counters for ES and SES are compared to their respective set thresholds every second and to their respective reset thresholds at the end of each 15-minute interval.

The principles of thresholding in 15-minute intervals are illustrated in figure 25 below.



ST1	Set Threshold
TR1	Threshold Report
RT1	Reset Threshold
RTR1	Reset Threshold Report

Figure 25 Principles of Thresholding - Unacceptable Performance

4.5.6.2 24-hour Measurements

In both transmission directions, ES and SES are counted during 24-hour intervals to determine whether the performance level is degraded or not. If a threshold for degraded performance is reached or crossed by the respective performance counter (incoming or outgoing ES or SES), a corresponding threshold report is given.

The default threshold values and the treshold value ranges are listed below. The values are the same for both transmission directions.

Table 11

Layer	Threshold	Default value	Value range
MS	ST2-ES	7 ES	0-86400 ES
MS	ST2-SES	1 SES	0-86400 SES
HP	ST2-ES	223 ES	0-86400 ES
HP	ST2-SES	3 SES	0-86400 SES
LP	ST2-ES	56 ES	0-86400 ES
LP	ST2-SES	3 SES	0-86400 SES

The default threshold values for the different degraded performance limits are calculated according to formulas given by ITU-T M.2101, see reference on page 59. Degraded performance limits will have to be calculated for each configuration. The calculation of the default threshold values described in table 6 will now be shown. Parameters like distance of path (sum of all PCE =

Path Core Elements) and allocation Performance Objectives (PO) to each PCE considered.

MS

From table 3/M.2101:

PO.ES = 8% PO.SES= 0.1%

Estimated length: d = 1 km

From table 2B/M.2101:

Allocation: 0.2% (terrestrial)

Allocated Performance Objective (APO.ES)= 0.2% x 8% x 86400 = 14

APO.SES= 0.2% x 0.1% x 86400 = 1 (rounded off)

Degraded Performance Limit (DPL.ES) = 0.5 x APO.ES = 7

DPL.SES = 0.5 x APO.SES = 1 (rounded off)

VC4

From table 3/M.2101:

PO.ES = 8%

PO.SES= 0.1%

Estimated length: d = 500 km

From table 2A/M2101:

Allocations:

Terminating end: 2%

Terrestrial: 0.3%

Terminating far end: 2%

Sum Allocations% (A%) = 4.3%

APO.ES= 4.3% x 8% x 86400 = 297

APO.SES= 4.3% x 0.1% x 86400 = 4

DPL.ES = 0.75 x 297 = 223

DPL.SES = 0.75.4 = 3

VC12

From table 3/M.2101:

PO.ES= 2%

PO.SES= 0.1 %

Estimated length: d = 500 km

Allocations:

Terminating end: 2%

Terrestrial: 0.3%

Terminating far end: 2%

Sum A% = 4.3%

APO.ES= 4.3% x 2% x 86400 = 74

APO.SES= 4.3% x 0.1% x 86400 = 4

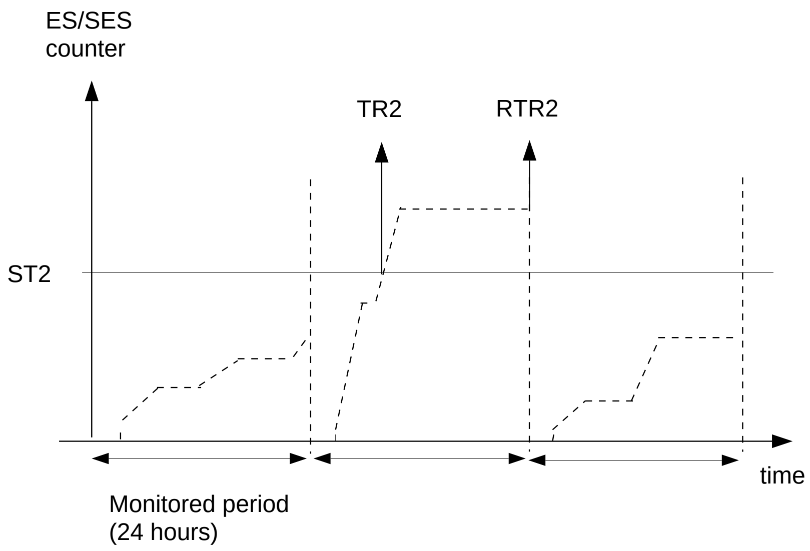
DPL.ES = 0.75 x 74 = 56

DPL.SES= 0.75 x 4 = 3

If the degraded performance level is reached in a 24-hour interval, a reset report is given at the end of the interval.

The counters for ES, and SES are compared to their respective thresholds every 15 minutes.

The principles of thresholding in 24-hour intervals are illustrated in figure 26 below.



ST2	Set Threshold
TR2	Threshold Report
RTR2	Reset Threshold Report

Figure 26 Principles of Thresholding - Degraded Performance

4.5.7 Transmission States

4.5.7.1 General

A synchronous digital path subobject (MS, HP or LP) can be in one of two transmission states:

- Unavailable State
- Available State

The transmission state is determined from filtered SES/non-SES data.

4.5.7.2 Transmission State Evaluation

The unavailable state filter is a 10-second rectangular sliding window with 1-second granularity of slide. The Unavailable State is declared at the end of 10 consecutive SES events. These 10 seconds are considered to be part of the unavailable time (UAS).

The available state filter is a 10-second rectangular sliding window, with 1-second granularity of slide. The Available State is detected at the end of 10 consecutive non-SES events, subsequent to detection of unavailable state. These 10 seconds are considered to be part of the available time.

The unavailable time for the SDIP subobject is defined as the time during which the SDIP subobject is in the unavailable state. During this time the ES and SES are not counted.

Upon detection of unavailable state for the SDIP subobject, an alarm is issued and the counter for the unavailable event (UAV) is incremented by 1. The unavailable time is counted in seconds. At entry and termination of unavailable state, the alarm and alarm ceasing are time stamped. The time stamps are related to the first of the unavailable or available seconds respectively. A counter for the current unavailable time in seconds is started.

Unavailable state alarm on lower level is suppressed by higher level alarms, hence an alarm on MS level will suppress alarms on corresponding VC-4, VC-12 and PDH level. Unavailable state alarm is also suppressed if a failure exists simultaneously on the same level or a higher level.

Unavailable time and unavailable events are counted in both incoming and outgoing direction (see figure 24) during the 15-minute and 24-hour time intervals. Their respective counters are reset at the end of each interval.

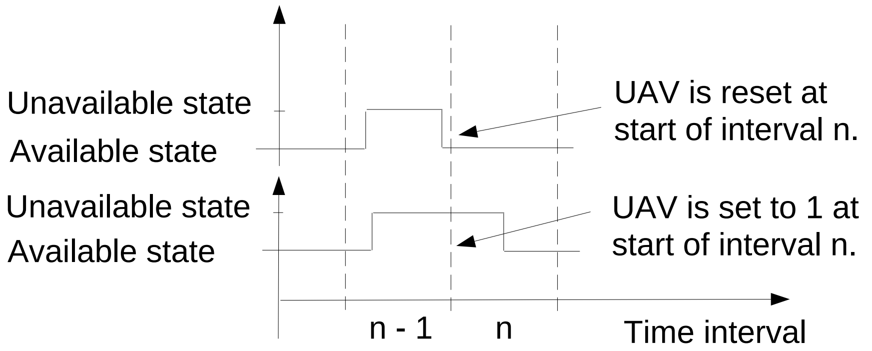


Figure 27 Illustration of Resetting and Setting of UAV Counter at Start of Each Interval

Actions are taken to ensure that threshold reports (alarms) are correctly generated and ES/SES available state counters are correctly processed during changes in the transmission state. This implies that:

- All threshold reports (alarms) are delayed by 10 seconds.
- At detection of unavailable state for the SDIP subobject, ES and SES counters are decremented by the number accumulated during the last 10 seconds.
- At detection of available state, the ES counters are incremented by the actual number of ES events during the last 10 seconds.

The rules for determining the unavailable second parameter for the SDIP subobject and for inhibiting other parameter counts during unavailable time is illustrated in figure 28.

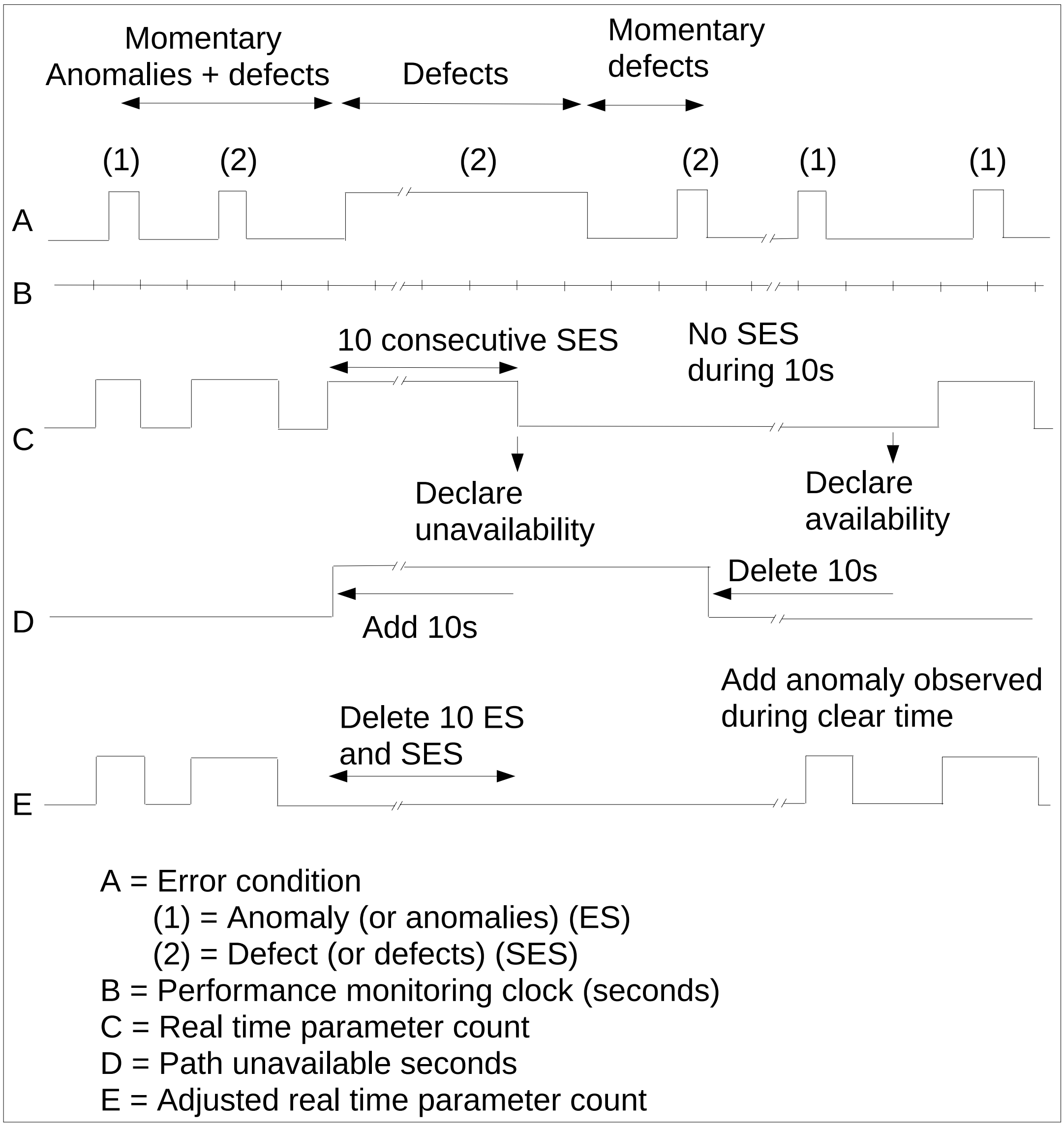


Figure 28 Illustration of Performance Monitoring Inhibiting During Unavailable Time

Note: In the figure error conditions are considered in one transmission direction only.

4.5.8 Suspect Intervals

In case an interval does not contain correct data for some reason, the interval is suspect marked. The reason that an interval does not contain correct data can be due to a restart or a blocking from superior individuals. Also, if the quality supervision functions are reset by command and the system clock is changed, the ES and SES counters may not be correct in the affected intervals.

For a suspect 15-minute interval, historical data are replaced by a “S” which indicates a suspect interval. Printing of current data will show the actual counter values. The data in the suspected 15-minute intervals are accumulated to the 24-hour data. For a suspect 24-hour interval a flag is set to indicate one or more corrupted 15-minute intervals within the 24-hour interval.

4.5.9 Historical Storage of Quality Data

For each subobject it is possible to store and print the quality data: ES, SES, UAS and UAV.

These quality data can be stored and printed for :

- 1 current 15-minute interval
- n recent 15-minute intervals
- 1 current 24-hours interval
- 1 recent 24-hours interval

where n is set by an application parameter in the range of 1 to 96 with 16 as guiding value. ES, SES, UAS and UAV is counted separately for both incoming and outgoing transmission direction (see figure 24). Hence, for both 15-minute and 24-hour intervals there are:

- 1 Near end ES counter for each subobject
- 1 Far end ES counter for each subobject
- 1 Near end SES counter for each subobject
- 1 Far end SES counter for each subobject
- 1 Near end UAS counter for each subobject
- 1 Far end UAS counter for each subobject
- 1 Near end UAV counter for each subobject
- 1 Far end UAV counter for each subobject

In addition to the counters there is a flag used to tell whether the 24 hour interval has been suspectmarked or not.

The recent register is used as a stack. At the end of a 15-minute period, the content of the current register is transferred to the first of the recent registers. When all of the recent registers are full, the oldest register values are discarded.

The storage function may be initiated and ended per SDIP by command. The connection status may also be printed to display on which SDIPs the function is active or passive.

The stored quality data may be printed by command..

4.6 Network Protection

There are several forms of protection that can be applied in order to minimize any loss of traffic. The following protection mechanims are supported:

- Multiplex Section Protection (MSP).
- Network and Sub Network connection protection (SNC Protection).

- Equipment and card protection.

Reference is made to autonomous, manual, revertive and non-revertive modes of operation, the characteristics of which are as follows.

Autonomous Mode

The SMA takes action to rectify a defect by invoking a protection mechanism without operator intervention. This mode can be enabled/disabled by the operator.

Manual Mode

The protection mechanism is invoked by the operator via the Network Management Interface (NMI). It can be used in place of autonomous operation or to override any action taken while in the autonomous mode.

Revertive Mode

In revertive mode, the original conditions are reselected when its quality has been restored.

Non-revertive Mode

In non-revertive mode the 'new' conditions will continue to be used even if the original has been restored to normal working. The original conditions will only be reselected in the event of degradation of the condition currently in use.

Protection details can be entered either from the Equipment Manager or the Local Craft Terminal. The following options are displayed on the appropriate 'connections' screen:

Switch protection:

- Forced switch A
- Forced switch B

Card,MSP and SNC Protection:

- Force switch traffic to working channel.
- Force switch traffic to working channel.
- Force switch traffic to protection channel.
- Manual switch traffic to working channel.
- Manual switch traffic to protection channel.

If forced switching is applied, it automatically takes priority over manual switching.

Multiplex Section Protection (MSP)

Multiplex Section Protection (MSP) is provided for both line and tributary ports. The protection for the line interface is not included in the SDH PP, but is described here in order to explain the different protection mechanisms. It safeguards against failure of the transmission link and/or failure of the module terminating the transmission path. The same multiplexed signal is transmitted from/to two ports, connected to main and standby fibres interconnecting SMAs, such as shown in figure 29. The receiver selects between the two paths between multiplexers A and B so that if the specified main bearer is detected as having failed or degraded it switches to the standby bearer. Changeover is normally effected within 50ms (total switching time).

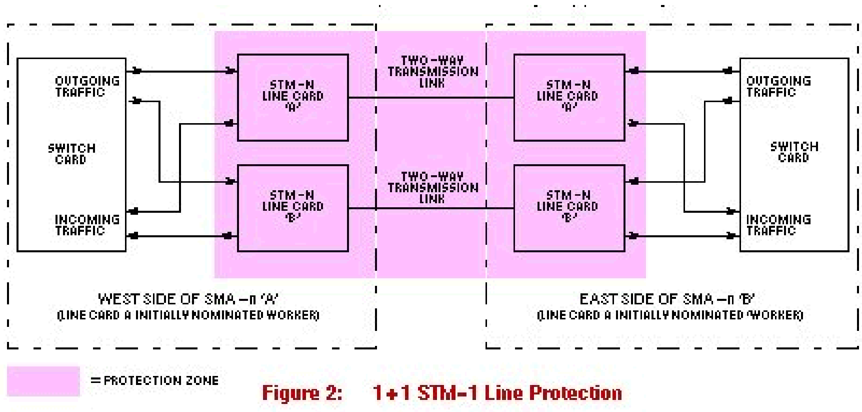


Figure 29

This form of protection can be invoked either autonomously or by manual operator intervention.

Traffic Connection Protection

Traffic can be protected using both directions around a ring to safeguard against the failure of any intermediate point in the ring, forming network connection and sub network connection protection.

Sub Network Connection (SNC) Protection

This form of protection is referred to as line-to-line VC or TU protection. SMA offers tributary-to-tributary protection (for minor rings subtended from the main ring) and also tributary-to-line protection (for traffic originating from a remote multiplexer terminating on two nodes within the ring-"dual-parenting").

This protection mechanism is applicable to ring configurations and is available for VC-12, VC-3 and VC-4 levels. In the ring configuration shown in figure 30, traffic can be transmitted between SMA-4s in the network utilising the two available routes around the ring. Protection is provided between the SMA-4 at which the tributary signal is inserted into the network and the point at which the tributary signal is extracted from the network. At the transmit end, TU traffic from a single tributary port is presented to both East and West STM-N Line Cards to provide transmission in both directions round the ring. The signal input to a tributary card can be either an electrical signal input to a plesiochronous trib card or it may be embedded within an STM-N signal input to an STM-N tributary card. In both cases the signal, as a VC-n, is processed as a TU-n and is then passed to the Switch Unit. The Switch Unit switches the TU-n to an output port feeding one of the STM-N line cards. If TU-n protection is enabled, then the Switch Unit will also switch the same TU-n to the port feeding the STM-N line card in the opposing line direction. At the point at which the channel is dropped, the TU-ns are received simultaneously by the two STM-N Cards (East and West) and passed to the Switch Unit. The Switch Unit will normally extract the TU-n from the worker channel and route it to the appropriate tributary card. If the worker channel

TU-n is below the preset (programmable) standard the TU-n will be extracted from the protection channel.

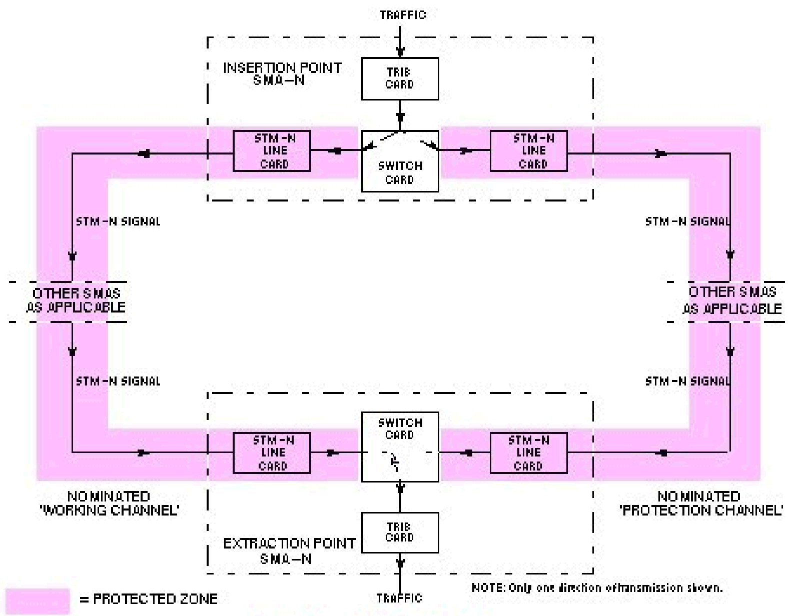


Figure 3: SNC Protection

Figure 30 SNC Protection

4.7 Equipment Protection

Equipment and Card Protection Equipment and card protection provide safeguards against internal failures. Equipment level protection is provided as an option for the switch, tributary, and power supply functions. 1 for N protection is offered at all PDH rates and STM-1 electrical where N is up to 8 for 2 Mbit/s and up to 7 for all other rates. When protection is invoked, all channels on the protected card are switched. The STM-1 module can be protected on a 1 + 1 MSP basis as described earlier.

2Mbit/s (see figure 31) and STM-1(see figure 32) Tributary Cards 1 : N tributary protection is operated internally on the SMA and safeguards against the failure of a 2Mbit/s and a STM-1Tributary Card, . The signal is cabled to one physical tributary port of the LTU, whence it is connected to two sets of buffers: one set on the card designated to provide that interface and the other set to the right hand side. The buffers on the designated card buffer the port to the tributary card circuitry. Those on the adjacent card buffer the same port to duplicated tributary card circuitry on the card placed in the protection tributary card slot. This is done via the protection bus. The buffers can be enabled/disabled on command from the Multiplexer Controller Card. The SMA provides eight PDH tributary positions. A ninth tributary position is available for 1 in N tributary protection when used with the 2Mbit/s tributary card. A specific protection tributary position is not used for higher order tributary cards. The scheme can be either manually or autonomously operated. When used autonomously, the protection is always non-revertive.

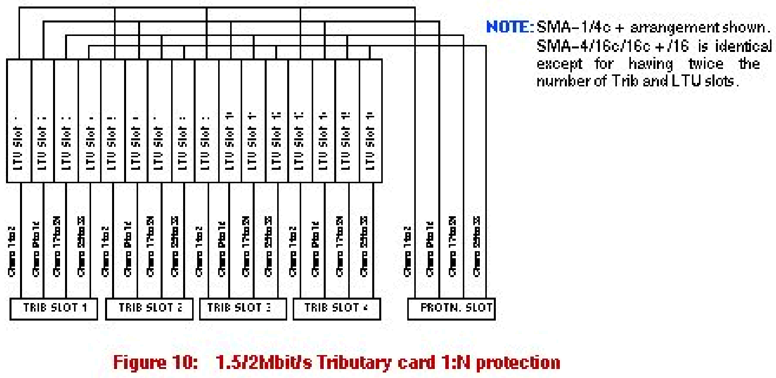


Figure 31 2 Mbps Tributary card 1:N protection

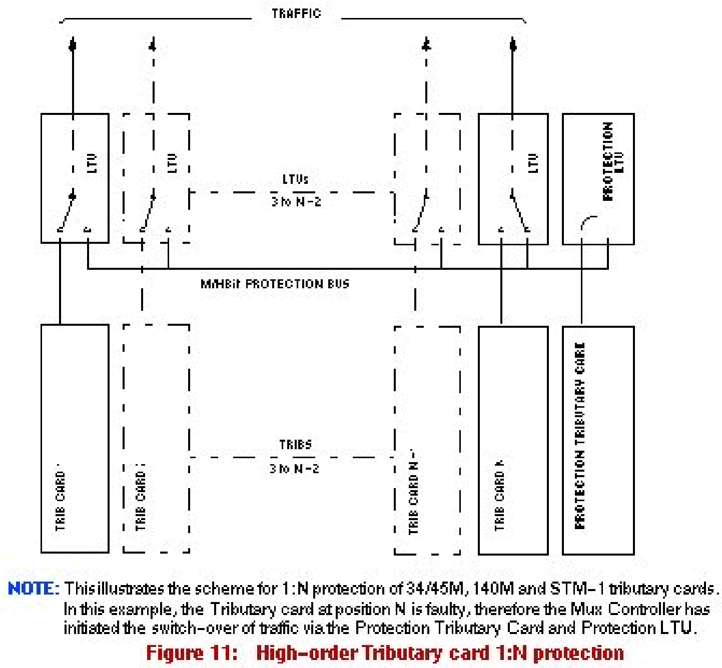


Figure 32 STM-1 Tributary Card 1:N Protection

Switch Unit Protection Switch Unit Protection is operated internally on the SMA, see figure 33. Duplicated Switch Units ensure that the SMA is still capable of carrying traffic in the case of a Switch Unit failure. This protection scheme is illustrated in Figure 41.When a second Switch Unit is fitted to the SMA, it duplicates the functionality of the working Switch Unit. It is configured by the Mux Controller Card to cross-connect traffic and derive synchronisation in exactly the same way as the working unit. Each STM-1 Line and Tributary Card carries duplicated internal interfaces, one for each of the Switch Units. If Switch Unit failure occurs, each traffic-carrying card that detects such a failure will automatically select its traffic from the other Switch Unit. Switch Unit Protection can be autonomously or manually controlled. PSU Protection Power Supply Unit Protection is achieved by utilising three PSUs supplying power to the sub-rack simultaneously and independently.

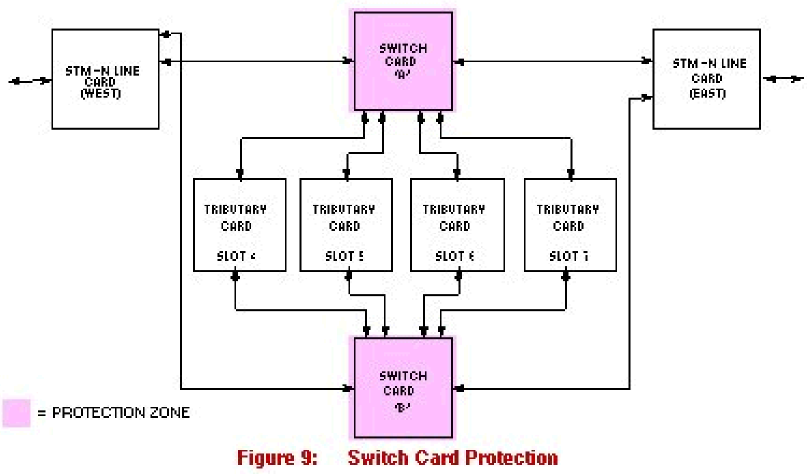


Figure 33 Switch Card Protection

4.8 Main changes in Ericsson GSM system R8.0 / BSS <R8>

This is a new feature in BSS R8.0.

5 Engineering Guidelines

6 Parameters

6.1 Main controlling parameters

6.2 Parameters for special adjustments

6.3 Value ranges and defaults values

7 References

1 ITU-T Recommendation G.703(1991), Physical/Electrical Characteristics of Hierarchical Digital Interfaces.

2 ITU-T Recommendation G.704 (07/95), Synchronous Frame Structures used at 1544, 6312, 2048, 8488 and 44763 kbit/s Hierarchical Levels.

3 ITU-T Recommendation G.706 (1991), Frame Alignment and Cyclic Redundancy Check (CRC) Procedures Relating to Basic Frame Structures Defined in Recommendation G.704.

4 ITU-T Recommendation G.707 (03/96) "Network Node Interface for the Synchronous Digital Hierarchy (SDH)"

5 ITU-T Recommendation G.708 (06/99), Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)

6 ITU-T Recommendation G.732 (1988), Characteristics of Primary PCM Multiplex Equipment Operating at 2048 kbit/s.

7 ITU-T Recommendation G.775 (11/94), Loss Of Signal (LOS) and Alarm Indication Signal (AIS) Defect Detection and Clearance Criteria.

8 ITU-T Recommendation G.782,

9 ITU-T Recommendation G.783 (04/97) "Characteristics of Synchronous Digital Hierarchy (SDH) Equipment Functional Blocks"

10 ITU-T Recommendation Q.822 (04/94) “Stage 1, Stage 2 and Stage 3 description for the Q3 interface - Performance management”

11 ITU-T Recommendation G.826 (08/96) “Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate“

12 ITU-T Recommendation G.957 (06/99), Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.,

13 ITU-T Recommendation M.20 (10/92), Maintenance philosophy for telecommunication networks.

14 ITU-T Recommendation M.2100 (07/95), Performance Limits for Bringing-Into-Service and Maintenance of International Digital Paths, Sections and Transmission Systems.

15 ITU-T Recommendation M.2101.1 (04/97) “Performance limits for bringing-into-service and maintenance of international SDH paths and multiplex sections”

16 ITU-T Recommendation M.2120 (04/97) “PDH Path, Section and Transmission System and SDH Path and Multiplex Section Fault Detection and Localisation Procedures”

17 ETSI Specification ETS 300 417-1-1 "Transmission and Multiplexing (TM); Generic functional requirements for Synchronous Digital Hierarchy (SDH) equipment. Part 1-1: Generic processes and performance".

18 ETSI Specification ETS 300 417-2-1 "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 2-1: Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) physical section layer functions".

19 ETSI Draft Specification ETS 300 417-3-1 "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 3-1: Synchronous Transport Module-N (STM-N) regenerator and multiplex section layer functions".

20 ETSI Draft Specification ETS 300 417-4-1 "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 4-1: Synchronous Digital Hierarchy (SDH) path layer functions”.

21 User Description, SDH/STM-1 AXE Exchange Terminal

22 User Description, Transmission E1