RECOMMENDATION ITU-R S.1149-2

Network architecture and equipment functional aspects of digital satellite systems in the fixed-satellite service forming part of synchronous digital hierarchy transport networks

(Question ITU-R 201/4)

(1995-1997-2005)

Scope

This Recommendation addresses network architecture and equipment functions relevant for the design of synchronous digital satellite systems in the FSS forming parts of, or providing syhcronous interconnections between, transport networks based on the SDH.

A general architectural diagram of FSS systems with SDH network transport capability is introduced. The basic requirement is transparent transport of SDH signal elements (referred to as virtual containers) through the satellite system.

This Recommendation focuses on SDH functionalities in the satellite system synchronous baseband equipment (SBE) necessary to realize three different scenarios for satellite system integration in SDH transport networks.

The ITU Radiocommunication Assembly,

considering

a) that digital satellite systems of the FSS are constituent elements of public/private networks in which synchronous digital hierarchy (SDH)-based transmission technologies are deployed;

b) that ITU-T Recommendations G.707 and G.708 specify the network node interfaces (NNIs) for the SDH transport systems and reference all the other SDH Recommendations in ITU-T;

c) that ITU-T Recommendations G.803 and G.805 define the architecture of SDH transport systems in way that is independent of the transmission technology;

d) that ITU-T Recommendation G.780 defines the terminology of SDH and that ITU-T Recommendation G.783 specifies the characteristics of SDH functional blocks;

e) that ITU-T Recommendations G.702, G.703, G.704 and G.957 define the bit rates, the synchronous frame structures and the physical parameters of the electrical and optical interfaces of SDH systems;

f) that SDH timing requirements are covered in ITU-T Recommendations G.781, G.813, G.822 and G.825;

g) that ITU-T Recommendations G.831, G.784, G.773 and G.774 define the management capabilities of SDH, the management functions, the protocols, interfaces and the management information model from the network element viewpoint;

h) that integration with the telecommunications management network (TMN), defined in ITU-T Recommendation M.3000 – Overview of TMN Recommendations, is supported by these management recommendations and that the TMN Recommendations for SDH satellite systems are Recommendations ITU-R S.1250, ITU-R S.1251 and ITU-R S.1252;

j) that the performance of hypothetical reference digital paths (HRDPs) through SDH systems is defined in ITU-T Recommendations G.826 and G.828. With the corresponding ITU-R Recommendations being ITU-R S.1062 and ITU-R S.1521;

k) that the availability requirements for all transport systems are given in ITU-T Recommendation G.827 and the corresponding ITU-R Recommendations are ITU-R S.579 and ITU-R S.1522;

l) protection switching architectures are described in ITU-T Recommendations G.841 and G.842;

m) that ITU-T Recommendation G.861 – Radio and satellite SDH integration guidelines, describes the principles and guidelines for the integration of satellite and radio systems in SDH transport networks, including the concept of point-to-multipoint topologies;

n) that the inherent multidestination and multipoint capabilities of satellite systems provide significant operational advantages;

o) that Recommendations ITU-R F.750 and ITU-R F.751 define architectures, functional aspects, and transmission characteristics and performance of radio-relay systems in SDH-based networks;

p) that ITU-T Recommendation G.832 defines the method of transporting PDH elements over SDH systems but that interconnection and interworking between PDH and SDH networks may be handled differently within a satellite system providing that the external interfaces and functionalities are compatible with terrestrial systems;

q) that there are ongoing studies in ITU-R on transmission systems, their performance, multiple access methods and operation and maintenance (OAM) aspects,

recommends

1 that digital satellite systems in the FSS comply with the network architecture and equipment functional requirements described in this Recommendation to support their integration into SDH transport systems.

CONTENTS

Page

1 Introduction

1.1 Scope

This Recommendation addresses network architecture and equipment functions relevant for the design of synchronous digital satellite systems in the FSS forming parts of, or providing synchronous interconnections between, transport networks based on the SDH.

A general architectural diagram of FSS systems with SDH network transport capability is shown in Fig. 1. The basic requirement is transparent transport of SDH signal elements (referred to as virtual containers) through the satellite system.

This Recommendation focuses on SDH functionalities in the satellite system synchronous baseband equipment (SBE) necessary to realize three different scenarios for satellite system integration in SDH transport networks:

Scenario 1: SDH multiplex section

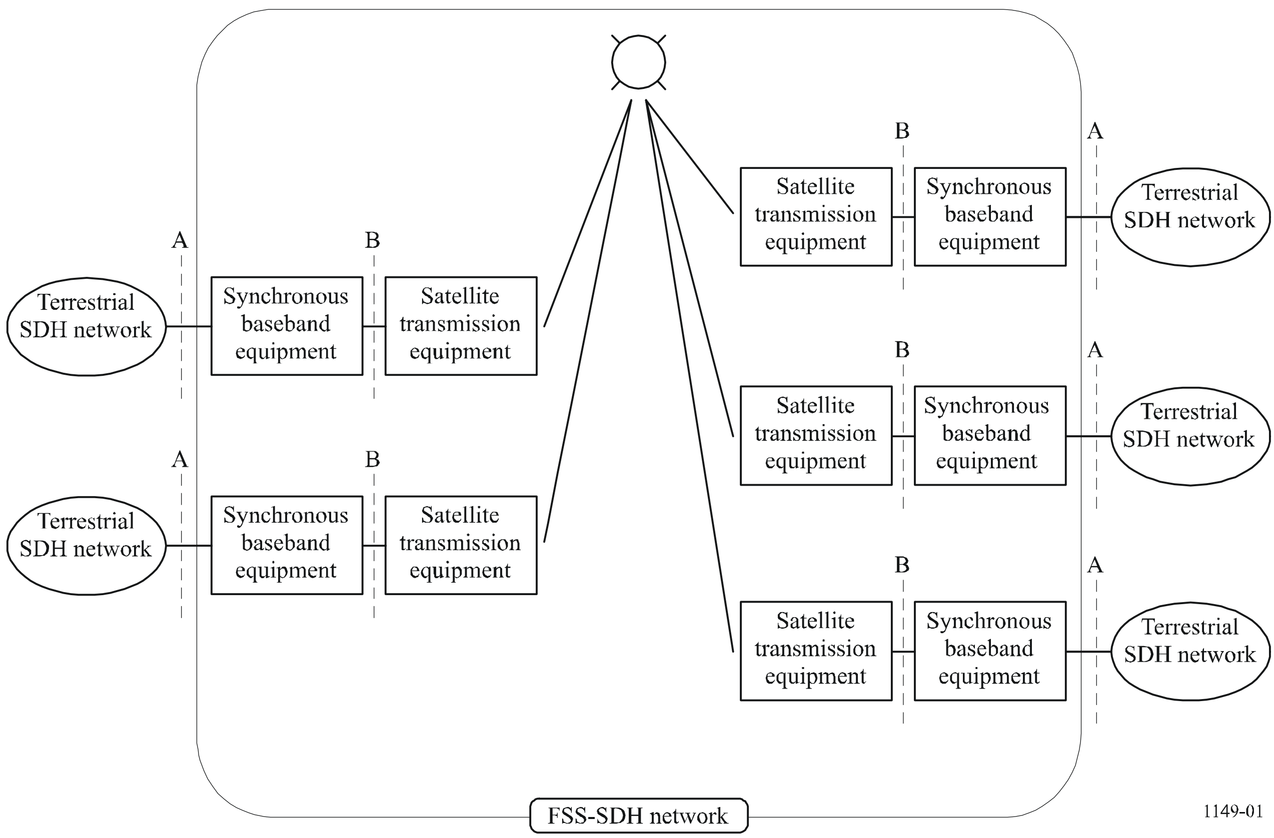
Scenario 2: wide-area single-rate cross-connect (common internal section bit rate of 51.84 Mbit/s)

Scenario 3: wide-area multi-rate cross-connect (a range of internal section bit rates <51.84 Mbit/s)

This Recommendation follows the "ITU-T Recommendation G.861 radio and satellite SDH integration guidelines".

FIGURE 1

General FSS-SDH network architecture



NOTE 1 – Synchornous baseband equipment and satellite transmission equipment are illlustrated as separate units for the purpose of explanation; they may be implemented physically as one unit.

NOTE 2 – Reference point A: open EI for scenario 1; NNI and NNRP for scenarios 2 and 3.

NOTE 3 – Reference point B: SRP and open SEI for scenarios 1 and 2, SRP and closed SEI for scenario 3 (see the "ITU-T Recommendation G.861 radio and satellite SDH integration guidelines").

The basic functions of the SBE are one or more of the following, depending on the scenario:

– perform SDH multiplex set of functions, adapted to satellite applications and dependent on scenario;
– conversion and adaptation of section and path layers to satellite system internal interfaces or reference points;
– establishment of section and possibly path layer asymmetrical multidestination connections, and support point-to-point symmetrical path layer cross-connected connections;
– perform specific section functions for signal transmission over the satellite medium;
– integration of SDH pointer and satellite system timing;
– SBE SDH multiplex based management functions.

The basic functions of the satellite transmission equipment are:

– modem functions;
– multiple access system protocols, procedures and their management functions;
– timing preservation.

1.2 Abbreviations

AIS: alarm indication signal

APS: automatic protection switching

AU: administrative unit

AUG: administrative unit group

BIP: bit interleaved parity

DCC: data communication channel

DXC: digital cross connect

EI: equipment interface

FDMA: frequency division multiple access

HOVC: higher order virtual container

HPA: higher order path adaptation

HPC: higher order path connection

HPOM: higher order path overhead monitor

HPT: higher order path termination

HSPA: higher order satellite path adaptation

HSPT: higher order satellite path termination

HSSA: higher order satellite section adaptation

HSUG: higher order supervisory unequipped generator

HSUM: higher order supervisory unequipped monitor

IOS: intra-office section

ISI: internal satellite interface

LOVC: lower order virtual container

LPA: lower order path adaptation

LPC: lower order path connection

LPOM: lower order path overhead monitor

LPT: lower order path termination

LSSA: lower order satellite section adaptation

LSUG: lower order supervisory unequipped generator

LSUM: lower order supervisory unequipped monitor

LT: line termination

MCF: message communications function

MDSS: multi-destination satellite server

MSA: multiplex section adaptation

MSOH: multiplex section overhead

MSP: multiplex section protection

MST: multiplex section termination

NNI: network node interface

NNRP: network node reference point

OAM: operation, administration and maintenance

OHA: overhead access

PDH: plesiochronous digital hierarchy

POH: path overhead

RDI: remote defect indication

REI: remote error indication

RSOH: regenerator section overhead

RST: regenerator section termination

SBE: synchronous baseband equipment

SDH: synchronous digital hierarchy

SEI: satellite equipment interface

SETPI: synchronous equipment timing physical interface

SETS: synchronous equipment timing source

S-IOS: satellite intra-office section

SOH: section overhead

SPI: synchronous physical interface

SRP: satellite reference point

SRT: satellite regenerator termination

SSOH: satellite section overhead

SSPI: synchronous satellite physical interface

SST: satellite section termination

SSTM-*n*: satellite synchronous transport module-*n*

STM-*N*: synchronous transport module-*N*

STUG-*ij*: satellite tributary unit group *ij*

TDMA: time division multiple access

TMN: telecommunication management network

TU: tributary unit

TUG: tributary unit group

VC: virtual container

VOW: voice order wire

1.3 Definition of satellite specific terms

HSPA: higher order satellite path adaptation – a higher order adaptation function within the satellite system synchronous baseband equipment.

HSPT: higher order satellite path termination – a higher order path termination function within the satellite system synchronous baseband equipment.

HSSA: higher order satellite section adaptation – a higher order section adaptation function within the satellite system synchronous baseband equipment.

ISI: internal system interface – a system specific internal interface which is not subject to standardization.

LSP: lower order satellite path – a lower order path through the satellite system.

LSSA: lower order satellite section adaptation – a lower order section adaptation function within the satellite system synchronous baseband equipment.

MDSS: multidestination satellite server layer – the layer in the model which represents the multidestination capability of the satellite transmission system.

SFCOH: satellite frame complementary overhead – an overhead to the baseband composite signal to accommodate satellite transmission system's OAM functions (e.g. modem alarms and VOW).

S-IOS: satellite intra office section – an SDH section which is internal to the satellite system and which may have multipoint topology. It may cover a wide geographical area.

SLT: satellite line terminal – performs normal RST, MST and MS APS functions on the satellite side of the NNI.

SRP: satellite reference point – the point between the synchronous baseband equipment and the satellite transmission equipment.

SSOH: satellite section overhead – the overhead used within the satellite section between the synchronous baseband equipment.

SSPI: satellite synchronous physical interface – the physical interface between the synchronous baseband equipment and the satellite transmission equipment.

SST: satellite section termination – the function where the section overhead may be manipulated.

SS-TDMA: satellite switched time-division multiple access – a fixed TDMA system with on-board burst-to-burst cyclic inter-beam connection reconfigurations.

SSTM-*n*: satellite synchronous transport module order *n* – similar to STM-*n* of terrestrial transport systems but consisting of STUG payload multiplex and satellite section specific overhead.

STUG-*ij*: satellite tributary unit group *ij* – similar to a terrestrial tributary unit group TUG but represents a new multiplexing stage in between the G.708 TUG-2 level and TUG-3/VC-3 level.

2 SDH transport network description

2.1 SDH multiplexing techniques

2.1.1 Basic structure

The basic SDH multiplexing techniques (bit rates, frame formats and structures) are described in ITU-T Recommendation G.707. The SDH multiplex hierarchy has a level 1 bit rate of 155.52 Mbit/s (STM-1) with several higher and some lower bit rates.

The bit rates listed in Table 1 constitute the current SDH but higher speeds may be added in the future:

TABLE 1

SDH hierarchical bit rates

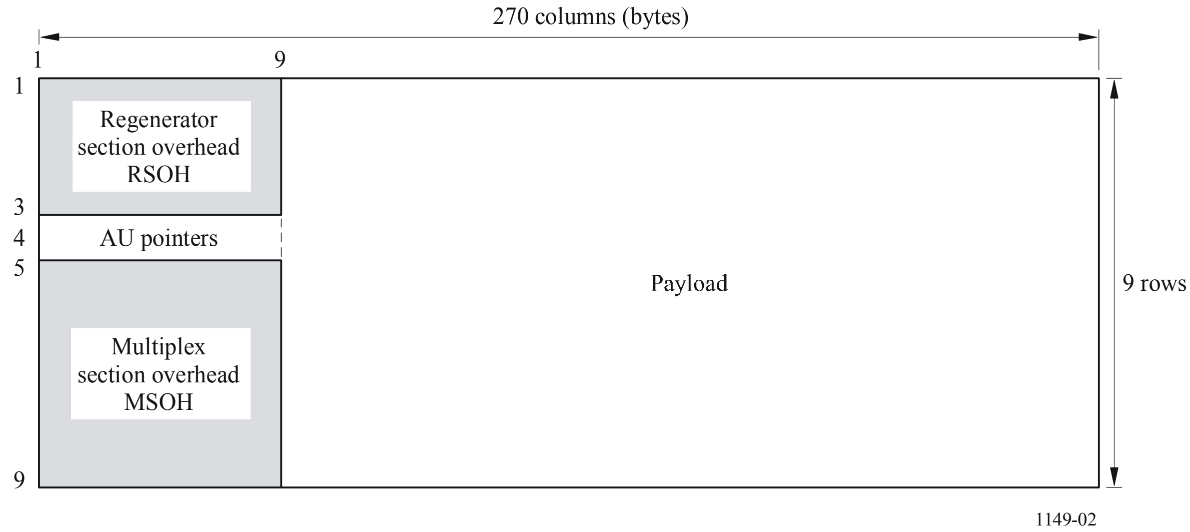
Identity	SDH level	Hierarchical bit rate (kbit/s)
STM-0	0	51 840
STM-1	1	155 520
STM-4	4	622 080
STM-16	16	2 488 320
STM-64	64	9 953 280
STM-256	256	39 813 120

NOTE – The specification of levels higher than 256 requires further study.

Figure 2 shows the basic 125 μs frame structure of the STM-1 signal in a 270 × 9 bytes matrix format. This SDH element is referred to as a virtual container (VC).

FIGURE 2

STM-1 (155.52 Mbit/s) frame structure



The smallest SDH synchronous tributary signal element defined in the STM-*n* multiplex is the primary rate bit-streams with the VC-11 running at 1.664 Mbit/s and the VC-12 (virtual container-12) running at 2.240 Mbit/s. End-to-end transparency at the VC level is available to the SDH system clients. Lower order paths (LOVC) and higher order path (HOVC) are defined, which can be flexibly configured and set up, through remote management operation, on a network-edge-to-network-edge, or node-to-node basis. HOVCs are either VC-4s or VC-3s. LOVCs are VC-2s, VC-11s and VC-12s.

Network nodes in SDH are interconnected by multiplex sections, which in turn may consist of a number of regenerator sections. Internode management is facilitated by functions communicated within multiplex section overhead (MSOH). The allocation of section overhead (SOH) capacity and byte allocation are described in ITU-T Recommendations G.707 and G.784.

2.1.2 Sub-STM-1 multiplex signals for radio systems

SDH multiplex signal bit rates for systems operating at lower speeds than STM-1 have been added to SDH, see Table 2. Originally for satellite system transmission but later adopted by ITU-T for all transmission technologies. The interworking multiplexing tree is shown in Fig. 3, (which is derived from ITU-T Recommendation G.708 – Sub-STM-0 network node interface for the synchronous digital hierarchy (SDH).

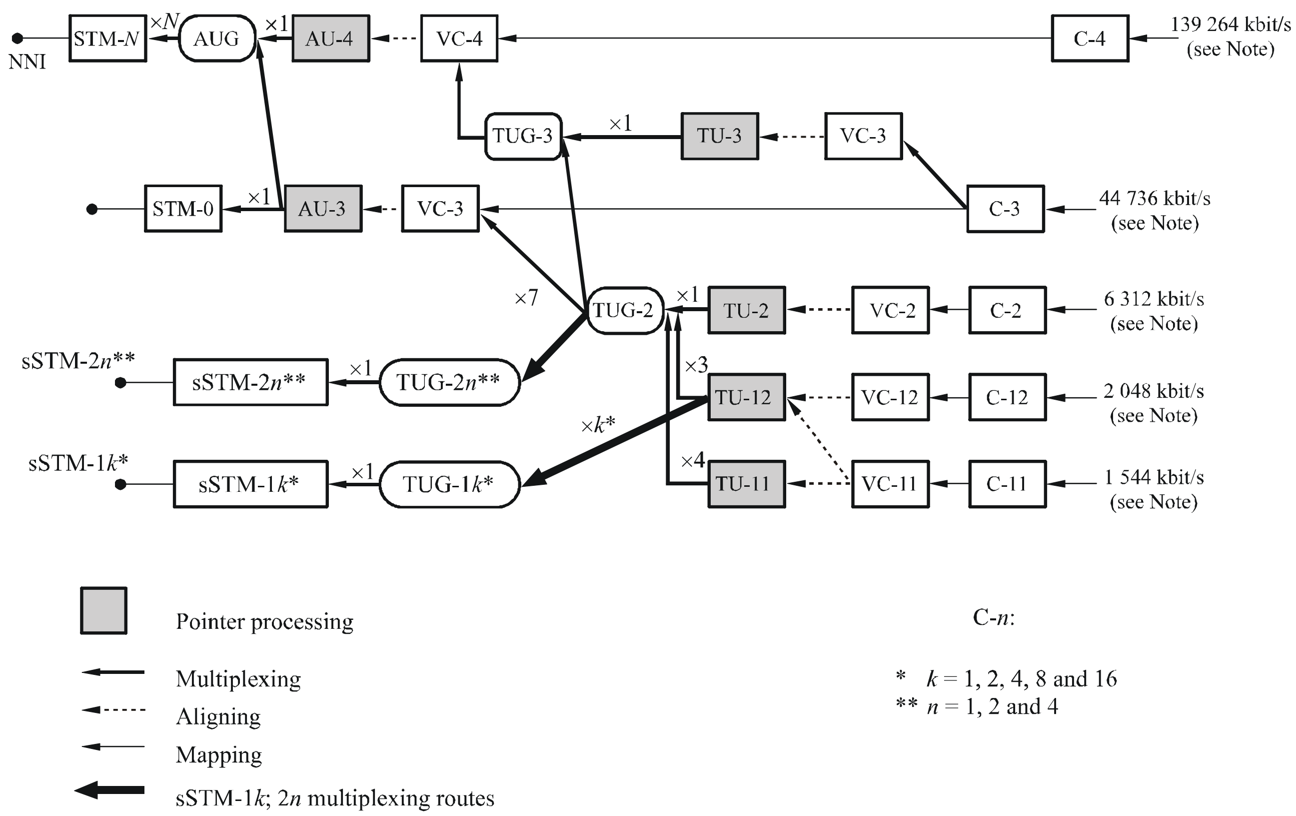
TABLE 2

Sub-STM-1 bit rates

STM type	STM bit rate (kbit/s)
sSTM-11	2 880
sSTM-12	5 184
sSTM-14	9 792
sSTM-18	19 792
sSTM-116	3 444
sSTM-21	7 488
sSTM-22	14 400
sSTM-24	28 224
STM-0	51 840
STM-1	155 052
STM-4	622 080
STM-16	2 488 320
STM-64	9 953 280

FIGURE 3

Demultiplexing/remultiplexing routes for constructing Sub-STM-1 signals



Note: G.702 tributaries associated with containers C-*x* are shown. Other signals, e.g. ATM, can also be accommodated.

1149-03

2.2 Layered network modelling

ITU-T Recommendation G.805 defines the concept of layered modelling for all transport networks independent of technology.

The following examples illustrate the layering concept as applied to the transport of ATM client traffic over SDH transport systems.

2.2.1 ATM supported on SDH layer networks

2.2.1.1 Figure 4 shows ATM supported on SDH.

The example shows two ATM virtual channel terminations interconnected with an ATM virtual channel switch/cross-connect and two ATM virtual path terminations interconnected with an ATM virtual path switch/cross-connect and a SDH higher-order path cross-connect at intermediate locations. All interfacing uses the SDH STM-N section layer network.

A five-layer network structure is shown:

– ATM I.361 virtual channel layer network;

– ATM I.361 virtual path layer network;

– SDH G.707 higher-order path (e.g. VC-4) layer network;

– SDH G.707 multiplex section layer network;

– SDH G.707 regenerator section layer network.

2.2.1.2 Figure 5 shows high-speed ATM being supported on multiple SDH tributaries.

This example might be particularly appropriate to the satellite environment.

The example shows an aggregate ATM cell stream that is supported through an ATM inverse multiplexer over a number of parallel G.702 primary rate paths, which in turn are supported over PDH and SDH. One ATM VP terminating equipment interfaces at the PDH rate to an SDH multiplexer. The other has an integrated SDH interface. In the ATM inverse multiplex the trail termination has been decomposed to portray the individual ATM inverse multiplex trails that support the VP network connection.

A nine-layer networks is shown:

– ATM I.361 virtual path layer network;

– Composite ATM inverse multiplex layer network;

– Individual ATM inverse multiplex layer network;

– PDH G.702 primary rate layer network;

– PDH G.703 intra-office section layer network;

– SDH G.707 lower order path layer network;

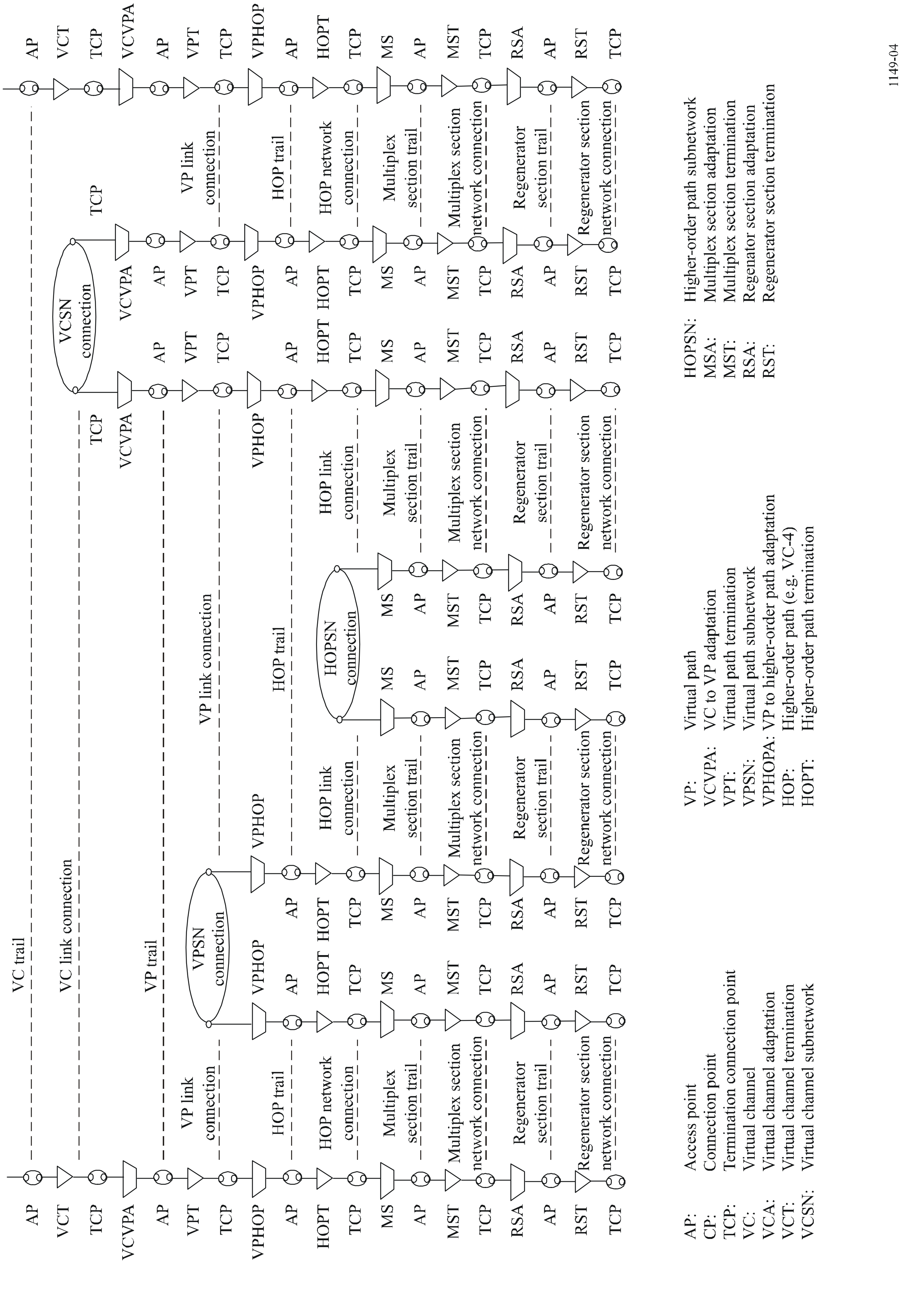
– SDH G.707 higher order path layer network;

– SDH G.707 multiplex section layer network;

– SDH G.707 regenerator section layer network.

FIGURE 4

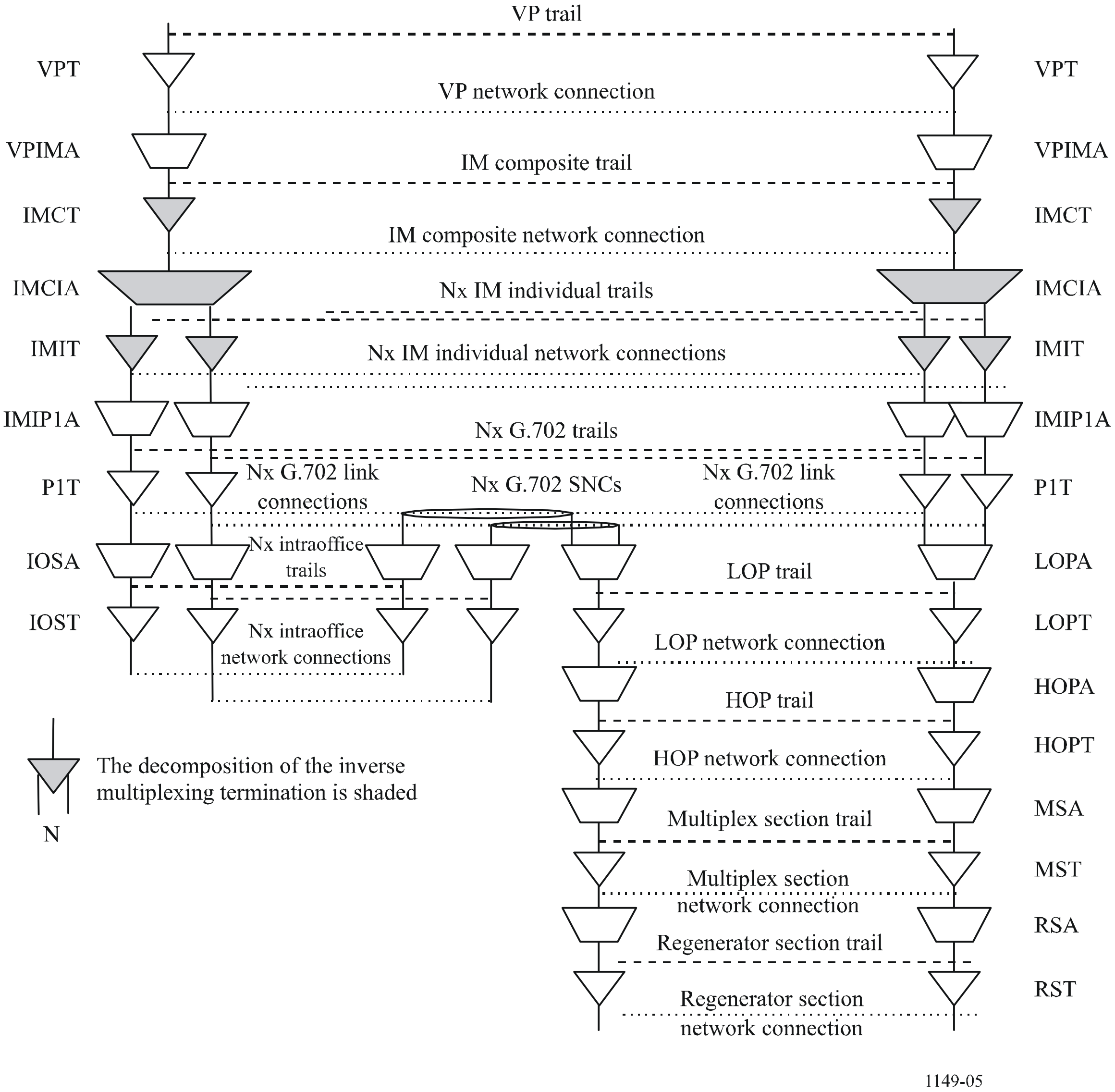
Application of the layered functional architecture to a case of ATM supported on SHD



AP: Access point
CP: Connection point
TCP: Termination connection point
VC: Virtual channel
VCA: Virtual channel adaptation
VCT: Virtual channel termination
VCSN: Virtual channel subnetwork
VP: Virtual path
VCVPA: VC to VP adaptation
VPT: Virtual path termination
VPSN: Virtual path subnetwork
VPHOPA: VP to higher-order path adaptation
HOP: Higher-order path (e.g. VC-4)
HOPT: Higher-order path termination
HOPSN: Higher-order path subnetwork
MSA: Multiplex section adaptation
MST: Multiplex section termination
RSA: Regenerator section adaptation
RST: Regenerator section termination

FIGURE 5

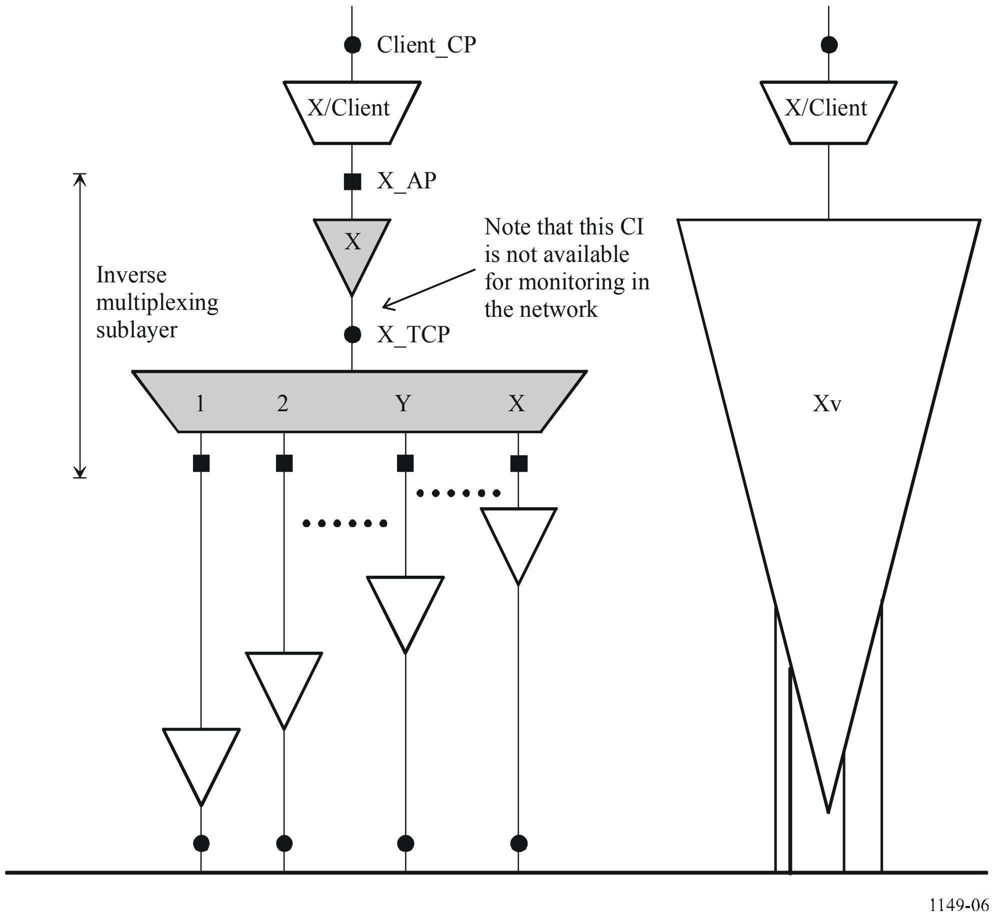
Application of the layered functional architecture to a case of an ATM inverse multiplexing



If the inverse multiplexing were applied at the SDH layer then it would be illustrated as in Fig. 6.

FIGURE 6

Inverse multiplexing sublayer



3 Applications of the FSS in SDH transport networks

3.1 Service aspects

To explain the advantages of employing satellite transmission technology in the SDH, three scenarios have been created and are described as the basis for the rest of this Recommendation.

Firstly some of the background technology of SDH is discussed to simplify the later description of the scenarios.

3.2 Network management aspects

With such an integration it should be simpler to include the satellite aspects in the overall SDH network management system and thus enhance the management functionality for the end user's benefit.

3.2.1 General

It is proposed to incorporate the SDH multiplex equipment functions as part of the satellite system synchronous baseband equipment.

This will facilitate commonality, accessibility, uniformity and integration and should also reduce costs of implementation.

3.2.2 SDH equipment and management functional blocks

The description methodology, of ITU-T Recommendation G.783 – Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks, is followed and the satellite system SDH equipment is defined as a collection of functional blocks, logically partitioned to facilitate the description of functions, operation and management. It does not impose nor imply any physical partitioning of implementations along the block boundaries. A generic functional block diagram of a satellite system SDH multiplex equipment including its management and timing functional blocks is given in Figs. 7a and 7b.

These figures include all functions required for the transport and management of user's traffic from one or more external ingress interfaces to one or more external egress interfaces.

Decomposition of FSS-SDH synchronous baseband equipment into selected functional blocks for the 3 network scenarios is described in § 5.1, 5.2 and 5.3.

FIGURE 7a

General functional block diagram of SDH based SBE
(transport functional blocks)

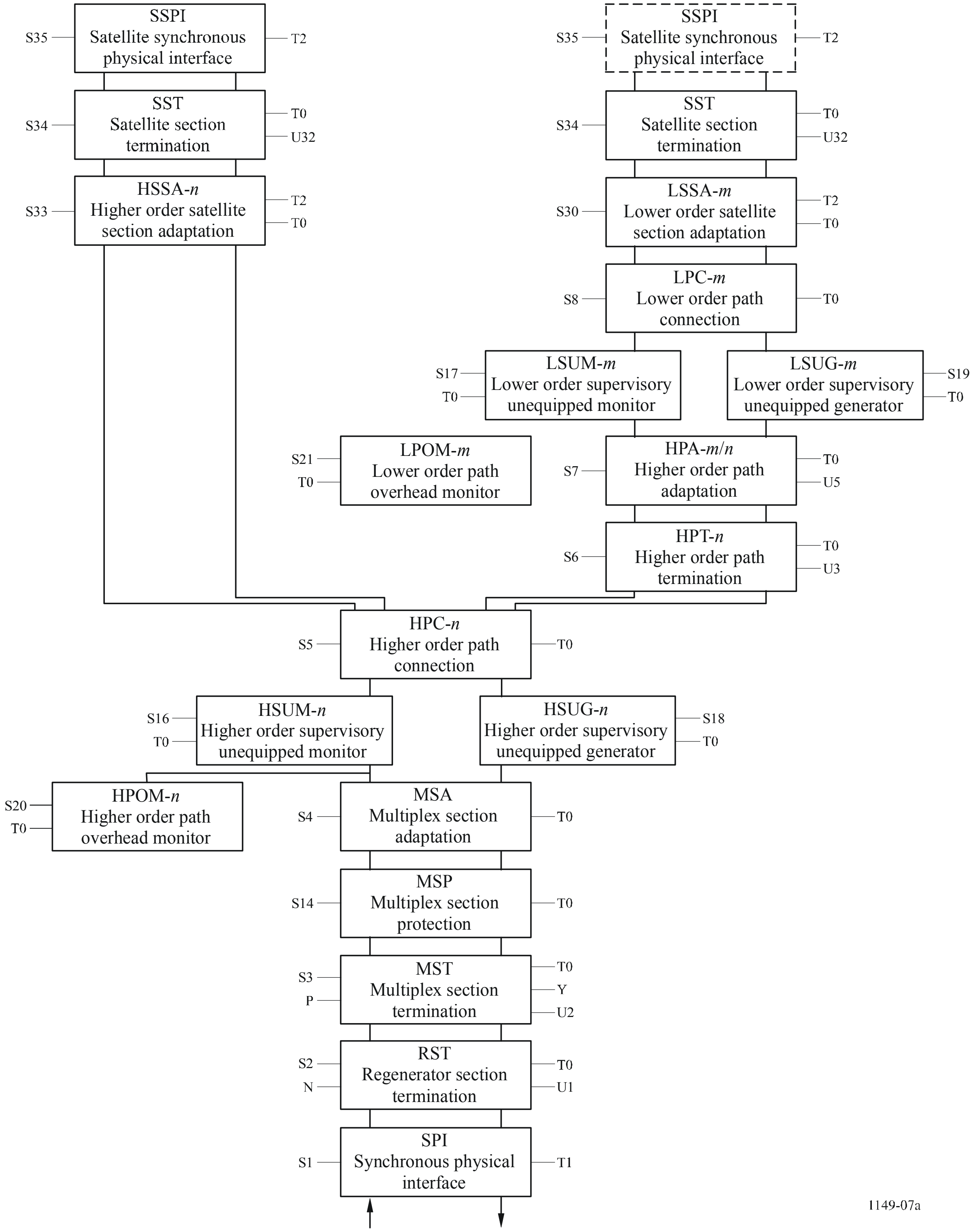
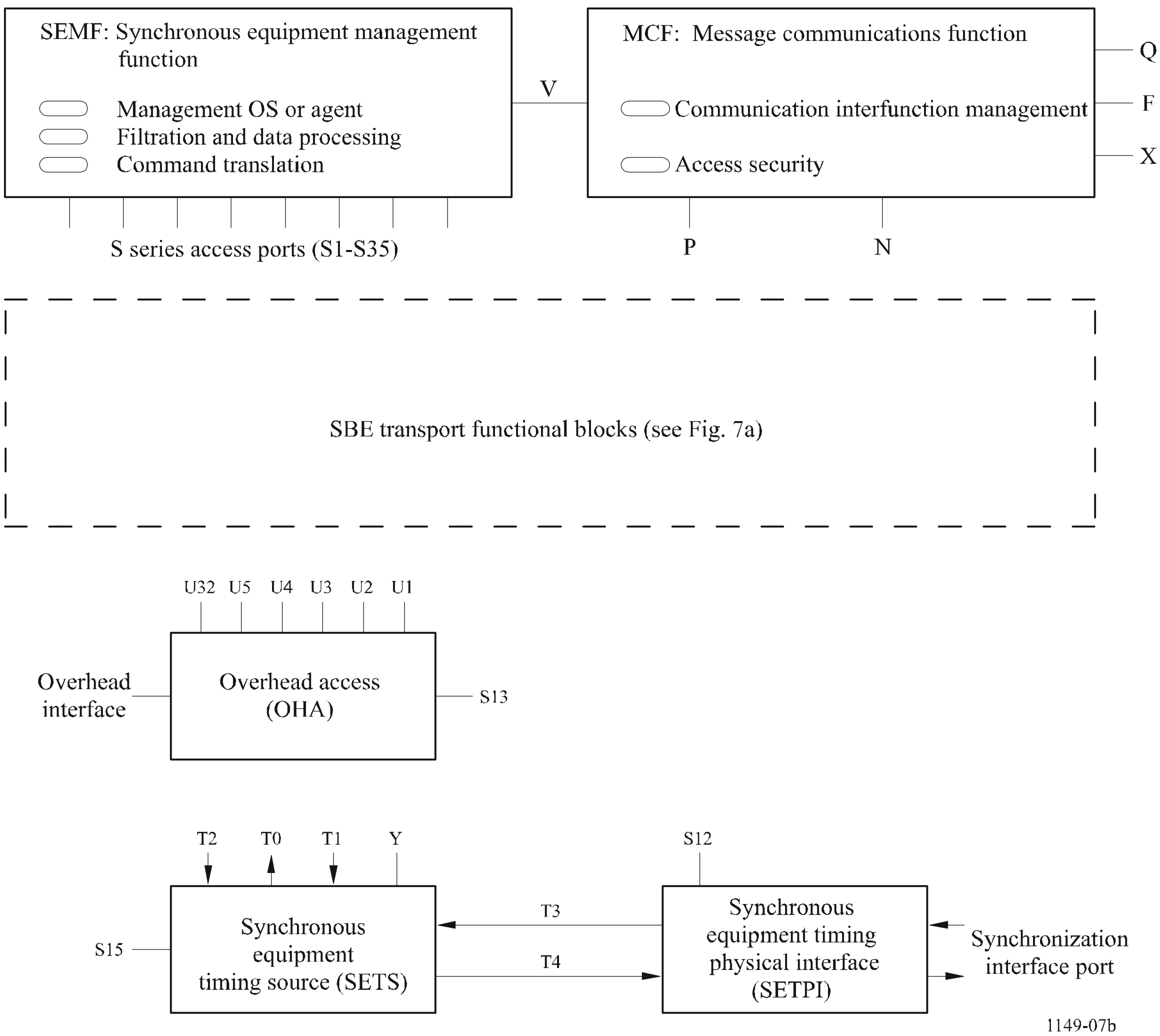


FIGURE 7b

General functional block diagram of SDH based SBE (timing and management functional blocks)



3.3 FSS system operational aspects

3.3.1 Multiplexing flexibility and efficiency

Use of the flexible SDH multiplexing techniques in the satellite system facilitates the realization of efficient multidestination operation.

3.3.2 Timing

Satellite motion buffers to remove Doppler timing variations are, in practice, combined with plesiochronous buffers. Table 3 gives the required satellite motion (Doppler) buffer sizes as a function of satellite orbit inclination. Complete removal of Doppler timing variations is only possible when these can be separated from clock drifts (the received satellite signals show the combined phase effects). This is possible when real-time satellite position information is available at the receive and possibly transmit ends (e.g. in SS-TDMA systems).

TABLE 3

Doppler buffer size as a function of satellite orbit inclination

Inclination (degrees)	Maximum Doppler (relative frequency)	Minimum buffer size (ms)
0.1	$\pm 1.8 \times 10^{-8}$	1.2
0.5	$\pm 4.0 \times 10^{-8}$	2.2
1.0	$\pm 6.7 \times 10^{-8}$	3.6
1.5	$\pm 9.4 \times 10^{-8}$	5.2
2.0	$\pm 1.2 \times 10^{-7}$	6.6
2.5	$\pm 1.5 \times 10^{-7}$	8.2
3.0	$\pm 1.6 \times 10^{-7}$	9.6

The SDH AU and TU pointer processing guarantees payload data integrity during controlled timing slips (plesiochronous interfacing) between two digital networks with different primary clock references. The benefit of SDH payload data integrity during controlled slips is gained by integrating the SDH pointer processing with Doppler processing, as described in § 5.1, 5.2 and 5.3.

4 FSS-SDH network scenarios, modelling and description

4.1 Digital sections (scenario 1)

4.1.1 Description

The SDH transport network perspective of this scenario is given in Fig. 1 of ITU-T Recommendation G.861.

As a point-to-point regenerator section operating at STM-1 (155.52 Mbit/s), access to the standard RSOH functions, such as BIP-8 error monitoring, DCC and voice order wires can be gained at the system SBE. Transparency to MSOH K1/K2 bytes permits multimedia automatic network level protection of mixed-media multiplex sections. The MST and MSP functions are at the extreme (terrestrial) ends of the interoffice MSs. Reference point A (Fig. 1) is an open interface (G.957 optical and G.703 electrical) at STM-1 rate, with the SBE acting as an SDH (satellite) regenerator terminals (SRTs).

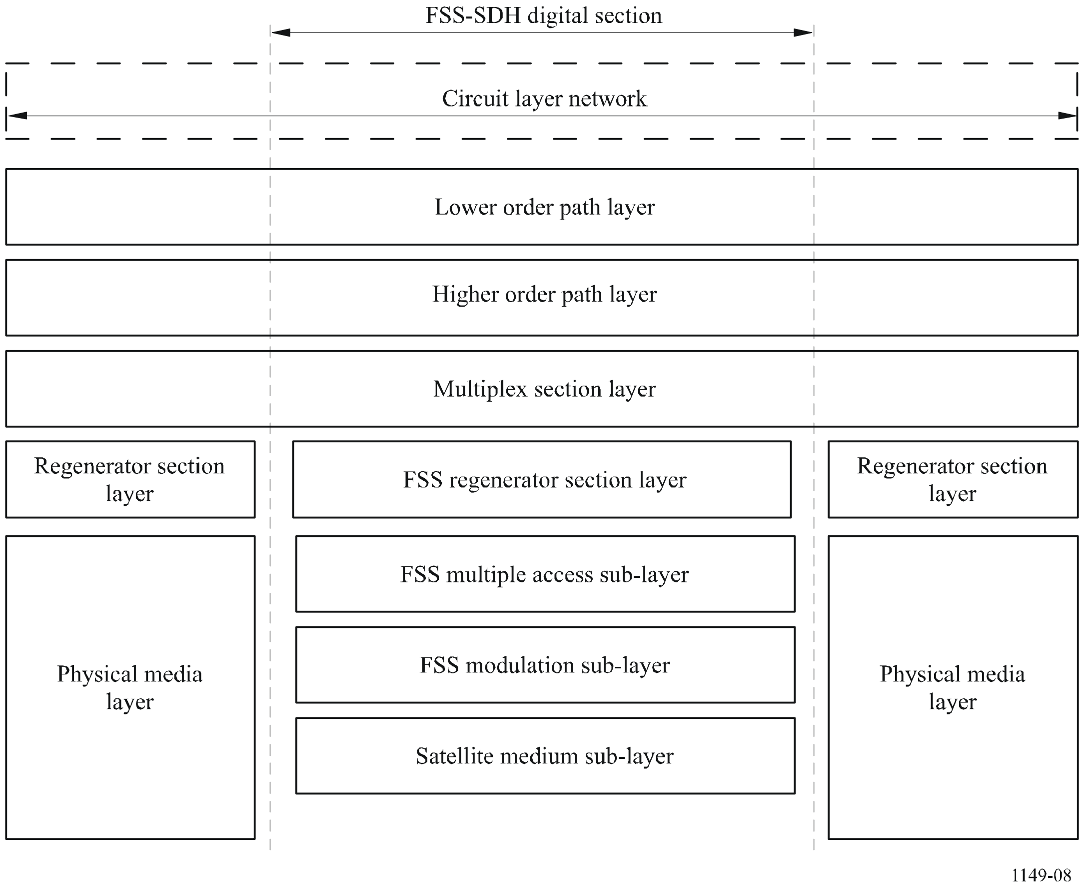
The "ITU-T Recommendation G.861 radio and satellite SDH integration guidelines" also allow radio and satellite synchronous digital sections operating at 51.84 Mbit/s, as well as within existing 140 Mbit/s PDH facilities through a G.732 type interworking multiplexer. The SDH signal conversion from STM-1 to reduced bit rate synchronous structures is a line terminal (LT) functionality. Multipoint/multidestination satellite operation is not part of this scenario.

4.1.2 Layered network model

The G.805 layered network model of the FSS-SDH digital section is given in Fig. 8. The model presentation is adapted to reflect transparency of the system to one or more layers of the interconnected terrestrial networks. The RS is shown terminated by the satellite transmission system, and the MS and all LOVC and HOVC signals are transported transparently.

FIGURE 8

Layered model of point-to-point FSS-SDH digital section at STM-1



4.2 Wide-area single-rate cross-connect (scenario 2)

4.2.1 Description

This scenario employs the wide-area visibility of the satellite to create a cross-connect function which operates internally at a single bit rate of 51.84 Mbit/s. The SDH transport network perspective of this scenario is given in Fig. 2 of ITU-T Recommendation G.861.

The cross-connect and other SDH equipment functions are replicated and distributed over various earth station locations SBEs, and system interfacing to the terrestrial SDH networks is through standard NNIs.

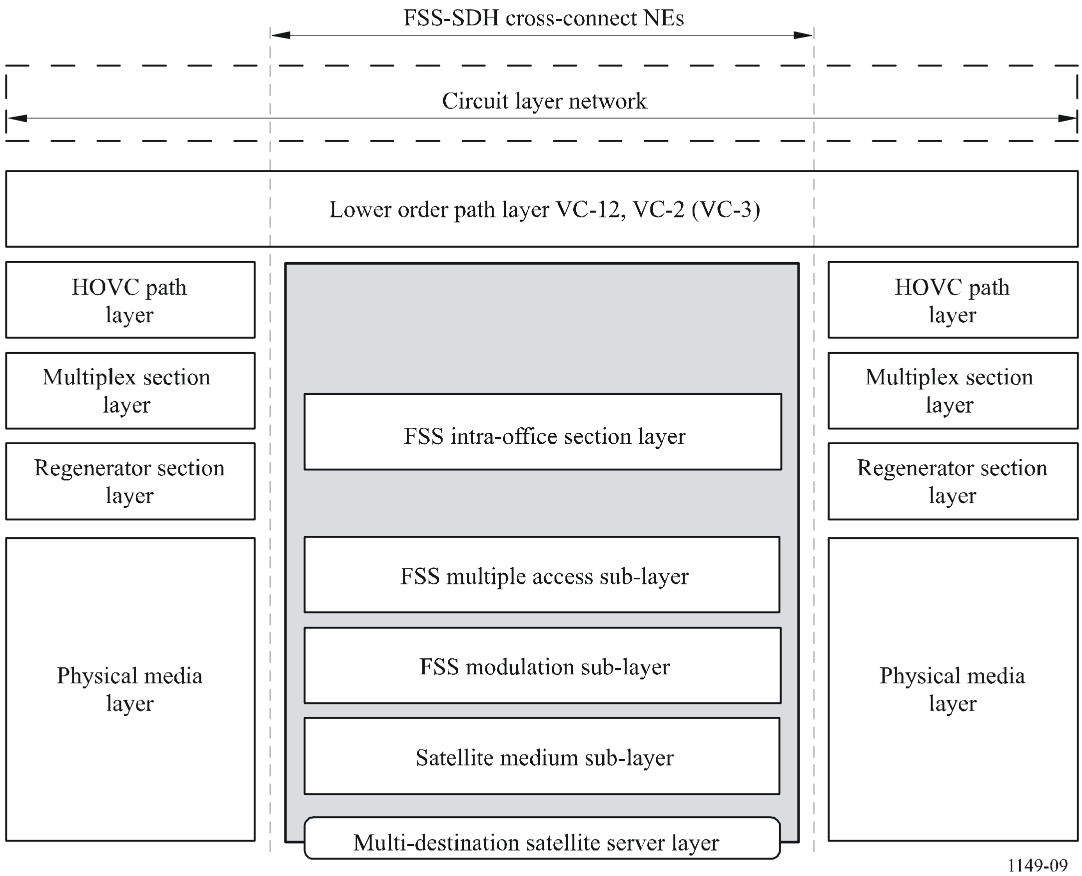
The SBE permits efficient byte-oriented (asymmetric) add/drop functions of payload traffic (VC-12, TUG-2) to/from SDH multiplex signals to support multidestination satellite operation. The internal cross-connect synchronous signal transport at STM-0 (51.84 Mbit/s) supports “medium” satellite routes, and implements both point-to-point and point-to-multipoint S-IOS. In multidestination operation, each SBE handles its SDH payload traffic within a single transmit and several receive unidirectional S-IOSs to/from multiple correspondents. The SBE is based on 51.84 Mbit/s synchronous multiplex equipment, modified to allow asymmetrical working across the satellite equipment interfaces (SEI at reference point B in Fig. 1). Across the terrestrial NNI (reference point A), the SBE as a SLT can perform normal RST, MST and MS APS functions. Transported client signals are VC-12, VC-2 and VC-3 point-to-point path layer connections. Standard path status monitoring, end-to-end tracing and BIP-2/8 error monitoring in the POH are carried transparently through the cross-connect.

4.2.2 Layered network model

The G.805 layered network model of the wide-area cross-connect is given in Fig. 9. The model presentation is adapted to reflect transparency of the system to one or more layers of the interconnected terrestrial networks. A MDSS layer is introduced to aid the modelling of system internal multi-destination connections at STM-0. The MDSS layer extends strictly from the bottom satellite medium sublayer, to the (sub)-layer boundary with the client layer network.

FIGURE 9

Layered model of scenario 2 with MDSS



MD trails in the MDSS layer provide link connections with simple point-to-point topology in the path layer networks. MD trails also lend themselves as servers of (future) complex point-to-multipoint connection topologies in the path layer networks.

SDH signal handling within the MDSS layer is characterized by:

– SDH signal element groupings to one common satellite route size (STM-0);

– asymmetries in number of directional satellite sections between communicating earth stations;

– restricted visibility from the externally terminated SDH network server trails.

Satellite networks formed within the MDSS layer are restricted to the FSS-SDH system, but provides transparency to G.805 type subnetworks in the path layer networks.

The highest server network sublayer with externally terminated trails is the VC-4 HOVC sublayer. RS, MS and VC-4 trails are terminated. Within the MDSS layer, VC-3 payload signals (and possibly lower order VCs) are unbundled, regrouped, and re-multiplexed into satellite section frames for multidestinational IOS transmission at STM-0 (51.84 Mbit/s) rate.

4.3 Wide-area multi-rate cross-connect (scenario 3)

4.3.1 Description

The SDH transport network perspective of this scenario is given in Fig. 2 of ITU-T Recommendation G.861.

This scenario has similar characteristics to scenario 2, i.e., wide-area replication and distribution of cross-connect and other SDH equipment functions over the systems' SBEs. Reference points A (Fig. 1) are standard NNIs, across which the SBE as a SLT performs normal RST, MST and MS APS functions. Internally across reference point B, the SBE supports asymmetrical VC-12, TUG-2 add/drop connection functions and S-IOS connections.

The cross-connect internal synchronous transport is over both point-to-point and point-to-multipoint S-IOSs, operating at a range of sub-STM-0 rates (carriage capability 1, 2, 3, 6, 9, 12, 15, 18 × VC-12s) defined in § 2.1.2 for "thin-route" satellite traffic. In multidestination operation, each SBE handles its SDH payload traffic within a single transmit and several receive unidirectional S-IOSs to/from multiple correspondents.

The SBE is a new generation of synchronous multiplex equipment developed for satellite systems. The SEIs (at reference point B in Fig. 1) are internal interfaces not defined in ITU-T Recommendations. Section 5.3 defines the SEI multiplex format and structure, and reduced S-IOS OH functionalities and allocation.

Transported client signals are VC-12 point-to-point path layer connections. Standard path status monitoring, end-to-end tracing, BIP-2 error monitoring in the POH are carried transparently through the cross-connect.

4.3.2 Layered network model

The G.805 layered network model of the wide-area cross-connect is given in Fig. 10. The model presentation is adapted to reflect transparency of the system to one or more layers of the interconnected terrestrial networks and to accommodate the internal MDSS layer.

SDH signal handling within the MDSS layer is characterized by:

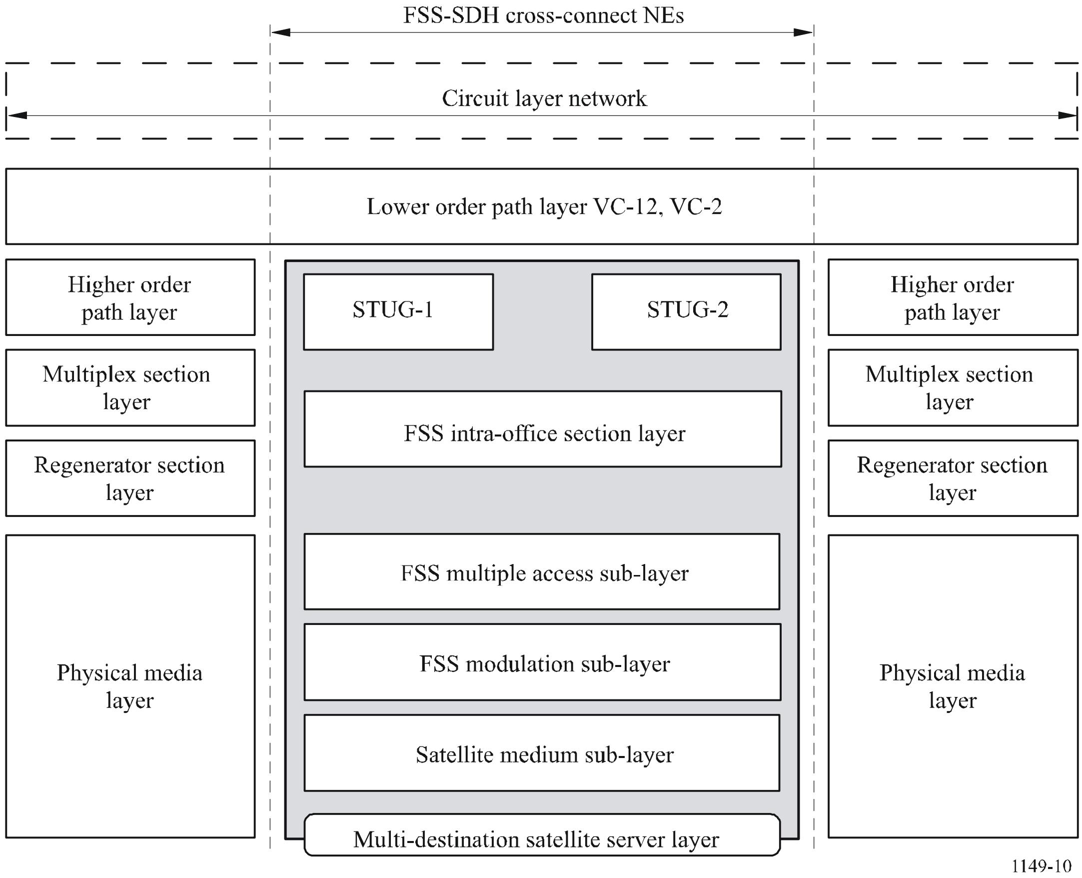
– SDH signal element groupings optimized to satellite traffic route sizes (STUG payloads);
– asymmetries in number and sizes of directional satellite sections between communicating earth stations;
– restricted visibility from the externally terminated SDH network server trails.

Satellite networks formed within the MDSS layer are restricted to the FSS-SDH system, but provides transparency to G.805 type subnetworks in the path layer networks.

In Fig. 10, the highest server network sublayer, at which external trails are terminated is the HOVC sublayer. RS, MS, VC-4 and VC-3 trails are terminated. Within the MDSS layer their LOVC payload signals are unbundled, regrouped, and re-multiplexed into satellite section frames for multidestinational IOS transmission at lower rates, defined in § 5.3.

FIGURE 10

Network layered model of scenario 3 with MDSS



5 FSS-SDH synchronous baseband equipment

5.1 SBE for SDH digital section (scenario 1)

The SBE generally consists of SDH physical interface termination, regenerator and multiplex section termination and HSSA. MS protection switching capability for the terrestrial links accessing the SBE is not a requirement in this scenario. HOVC and LOVC path tandem connection monitoring using the Z5 byte (VC-3, VC-4), and the Z6 byte (VC-2) is an optional capability.

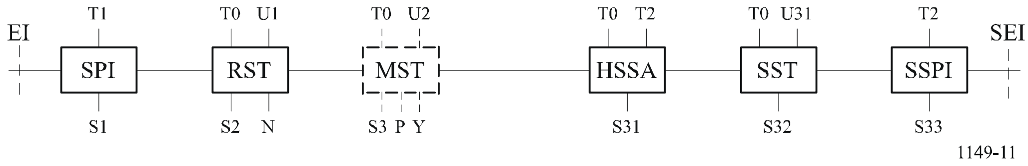
5.1.1 Digital section at 155.52 Mbit/s (STM-1)

In terms of equipment functional blocks defined in ITU-T Recommendation G.783, the minimum SBE functional configuration shall be as given in Fig. 11, which shows a select set of functional blocks of the generic block diagram (see Fig. 7a). As a regenerator section as part of an MS, the satellite system in principle does not terminate MS (MST is depicted as optional). RST function shall be used to locate and position AU pointer bytes in the frame to facilitate AU pointer processing in the HSSA for timing purposes (see § 5.1.3).

A modem function operating at the STM-1 rate of 155.52 Mbit/s is required for the satellite transmission equipment. No elastic Doppler buffer function is required in the modem equipment (see § 5.1.4).

FIGURE 11

SBE functional blocks for scenario 1 (STM-1)

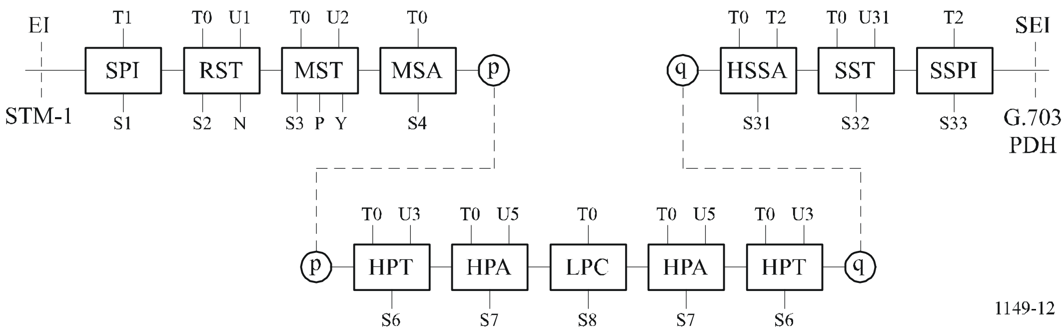


5.1.2 PDH embedded transmission of SDH signals

Satellite systems with PDH transmission capabilities at 34, 45 and 140 Mbit/s rates can be used to transport SDH signals embedded in PDH structures according to ITU-T Recommendation G.832. In terms of equipment functional blocks, the G.832 based SBE minimum configuration shall be as given in Fig. 12, which shows a select set of functional blocks of the generic block diagram (see Fig. 7a).

FIGURE 12

SBE functional blocks for scenario 1 (G.832 conversion)



Elastic (Doppler) buffer operation is preferably part of the HSSA (see § 5.1.4), and its inclusion in standard PDH satellite modem equipment is for further study.

5.1.3 Satellite digital section at 51.84 Mbit/s (STM-0)

ITU-T Recommendation G.708 defines the frame structure of a 51.84 Mbit/s synchronous signal for use in radio and satellite systems. The SBE functional blocks for the STM-N/STM-0 converter (an LT functionality) are generally similar to the G.832 SBE shown in Fig. 12, including the HSSA functionality described in § 5.1.4.

A modem operating at the STM-0 information rate of 51.84 Mbit/s, plus possible satellite function complementary overhead (SFCOH), is required. Elastic Doppler buffer operation is part of the HSSA, and thus is not required in the modem function (see § 5.1.4).

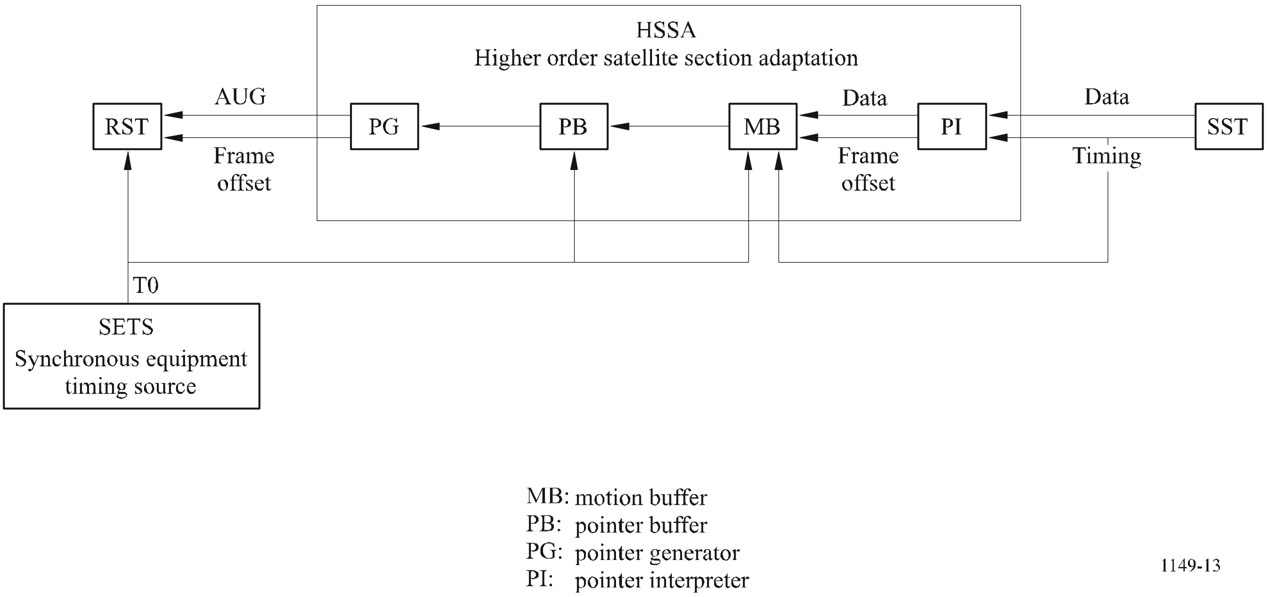
5.1.4 AU pointer processing and Doppler buffers

Data (SDH payload) loss due to plesiochronous clock differences between interconnected synchronous digital networks is avoided by the SDH justification mechanism controlled by the AU pointer processing. Motion buffers for the removal/reduction of phase variations due to satellite Doppler shall be integrated with the AU pointer regeneration in the SBE (receive side) as shown in Fig. 13 for the STM-1 case.

FIGURE 13

SBE integrated pointer and Doppler processing (STM-1)

(HSSA receive side)



Although the figure shows the pointer buffer (PB) and motion buffer (MB) as functionally distinct entities, they can be more efficiently implemented by a common physical element.

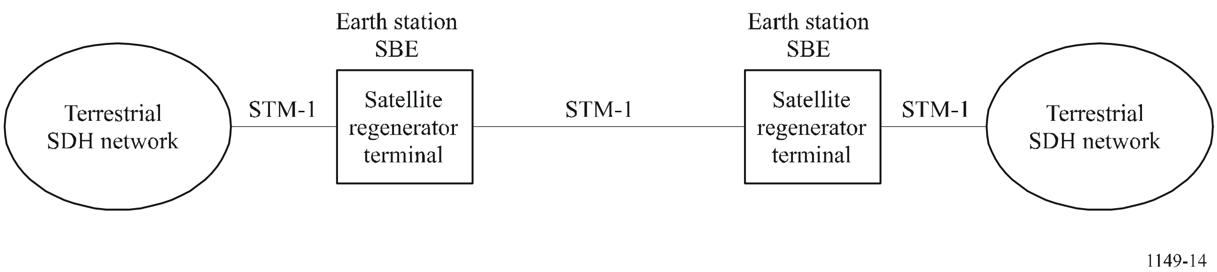
The basic algorithm of AU pointer processing is given in ITU-T Recommendation G.783.

SBEs based on ITU-T Recommendation G.832 may not be equipped with satellite Doppler compensation. In this case, the G.703 SEI shall include a dedicated interface to extend timing from the AU pointer processing in the SBE for Doppler buffer read-out in the satellite transmission equipment (modem). This is for further study.

5.1.5 Alarm conditions and consequent actions

FIGURE 14

Scenario 1 OAM model



The SBE shall detect loss of signal (LOS) or loss of frame (LOF) on the satellite section and indicate multiplex section alarm indication signal (MS AIS) to the downstream multiplexer of the terrestrial SDH network. In response to the MS AIS, the downstream multiplexer will send a multiplex section remote defect indication (MS RDI) signal in the backward direction to inform the upstream multiplexer of the far-end terrestrial SDH network that it has received a section AIS from the connecting satellite network.

The fault conditions and the appropriate consequent actions for scenario 1 are summarized in Table 4. LOS, LOF, AU-LOP, MS AIS and AU-AIS are defined in ITU-T Recommendation G.783.

TABLE 4

Fault conditions and consequent actions taken by the SBE in scenario 1

Interface	**Failure condition**	**Consequent actions taken by the SBE**[(1)]			
		Signal generated towards local terrestrial network		**Signal generated towards local SEMF**	**Signal generated towards remote SBE**
		MS AIS	**AU-AIS**		**MS AIS**
Local terrestrial network interface	LOS/LOF			Yes	Yes
Satellite network interface	LOS/LOF	Yes		Yes	
	AU-LOP		Yes	Yes	

(1) A “Yes” in a table entry signifies that the specified action shall be taken by the SBE as a consequence of the fault condition. A blank in a table entry signifies that the specified action shall not be taken by the SBE because either the fault condition is not visible to the SBE or no action is required from the SBE as a consequence of the fault condition.

The time interval between the detection of LOS/LOF and the transmission of section AIS, the duration of section AIS, and the time interval between the termination of LOS/LOF and the removal of section AIS are for further study.

5.2 SBE for wide-area single-rate cross-connect (scenario 2)

The SBE generally consists of SDH physical interface termination, RST and MST, HSSA, higher and lower order path connection functions (HPC and LPC). MS protection switching capability shall be provided on the terrestrial side of the SBE. HOVC and LOVC path tandem connection monitoring using the Z5 byte (VC-3, VC-4), and the Z6 byte (VC-2) is an optional capability.

The SBE shall extract HOVCs (VC-3s) and provide cross-connection of VC-3 signals under the control of network management. The SBE shall also terminate the higher order path overhead, and shall extract the lower order VC-12s from the tributary unit groups for some signals. The SBE will support cross-connection of the VC-12 signals under the control of network management. An example SBE asymmetric multidestination configuration with different destination traffic sizes is shown in Fig. 15. Multidestinational SBEs may have multiple transmit ports, which is an implementation matter.

FIGURE 15

SBE asymmetric MD configuration

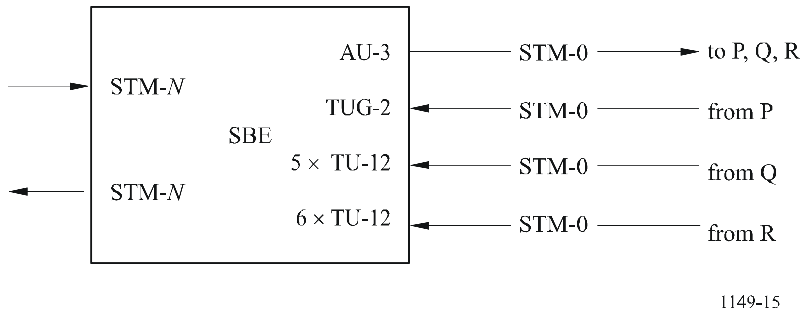


Figure 16 shows the SBE internal functional blocks.

The satellite section physical interfaces at 51.84 Mbit/s is FFS. (An alternative is to use the SONET 51.84 Mbit/s physical and electrical interface characteristics contained in Bellcore standard TR-TSY-000253.)

The HSPA functionality shall be:

Multiplexing and demultiplexing of LOVCs (VC-12, VC-2) and possibly HOVC (VC-3) and asymmetry reconciliation.

The HSSA functionality shall be:

– generation of AU pointers to form AU-3 signals according to ITU-T Recommendation G.707;
– adaptation of the outgoing signal to 51.84 Mbit/s synchronous signal for transport over the S-IOS;
– recovery of VC-3 signals and associated frame offset information from the received AU pointers;
– buffering AU-3 signals to remove/reduce Doppler effects without data loss.

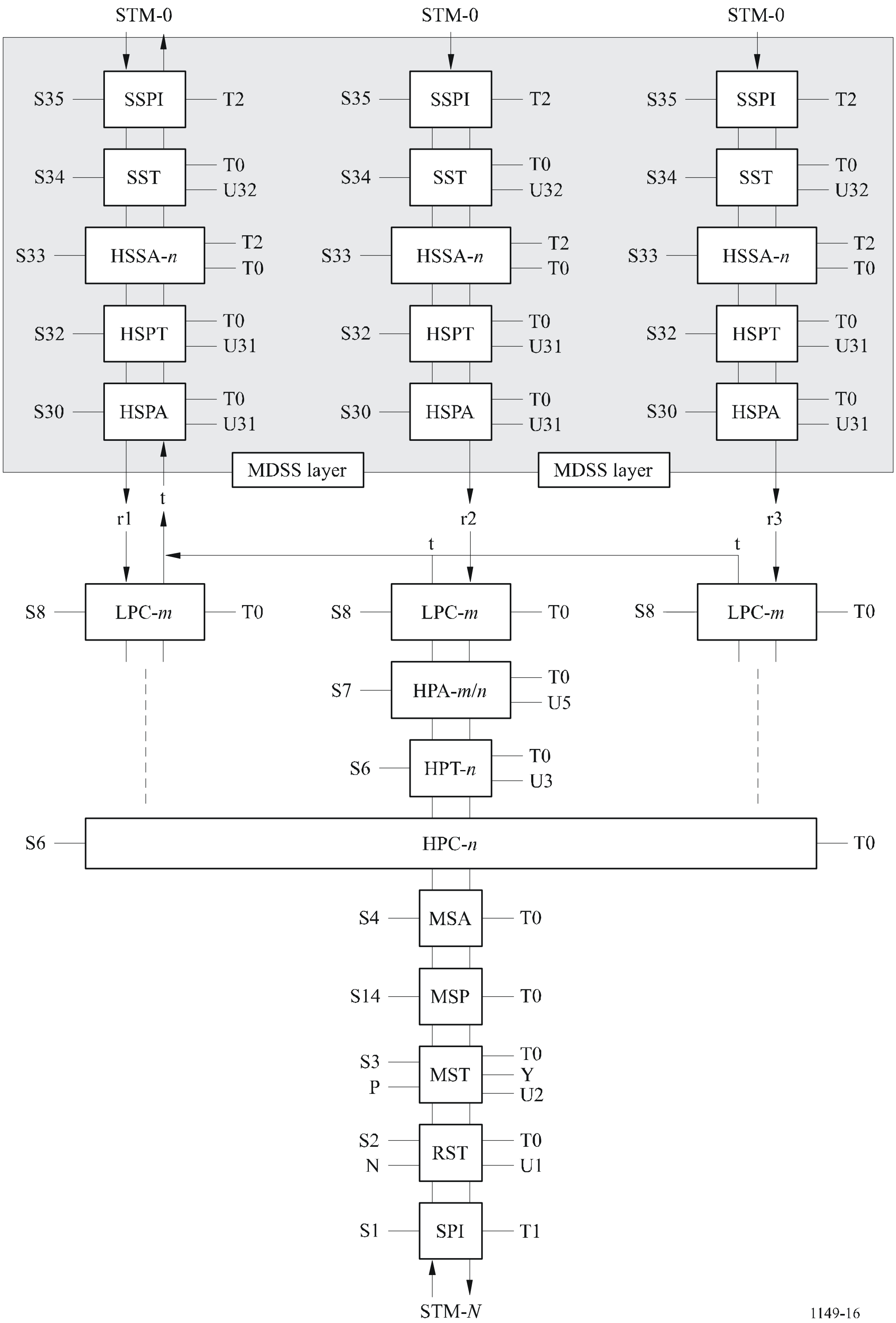
5.2.1 SSOH functions including multidestination for S-IOs

The SSOH is inserted/extracted at the HSPT satellite section termination point and it will support the following overhead functions for the S-IOS across the satellite subnetwork:

– error monitoring;
– remote error indication for multiple connections;
– remote defect indication for multiple connections;
– data communications channel (DCC) for multiple connections;
– VOW channel for multiple connections and conference calls;
– 500 µs multiframe alignment.

FIGURE 16

SBE functional blocks for scenario 2



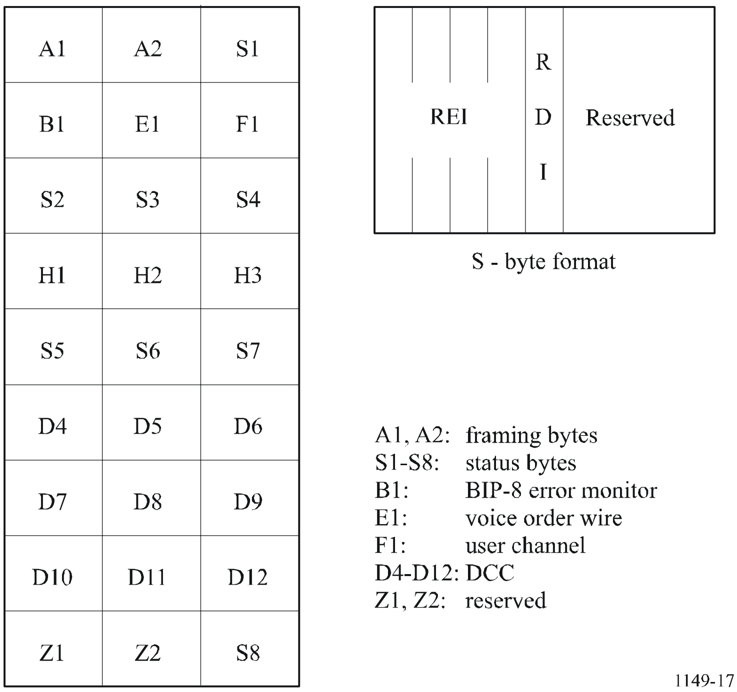
5.2.2 Section layer frame format and multiplex structure

The S-IOS frame structure of the STM-0 synchronous signal module is based on ITU-T Recommendation G.707.

Figure 17 shows STM-0 SOH byte re-allocation to accommodate addressing information for backward indications (RDI and REI) at the S-IOS layer for multidestination satellite operation.

FIGURE 17

STM-0 SOH byte reallocation for MD satellite operation



Each status or S byte in the header is assigned to a particular correspondent via management interactions. This byte shall carry the far end receive failure indication as well as four bits for far end block error reporting. This will allow a station to report to its correspondent the number of interleaved parity bits that do not meet the parity check in the BIP-*N* block of each frame. All Reserved bits are set to zero when they are not allocated.

The DCC protocol and message multiplexing mechanism as well as the method of addressing the DCC to a specific destination are described in Annex 1 to this Recommendation.

5.2.3 AU pointer processing and Doppler buffers

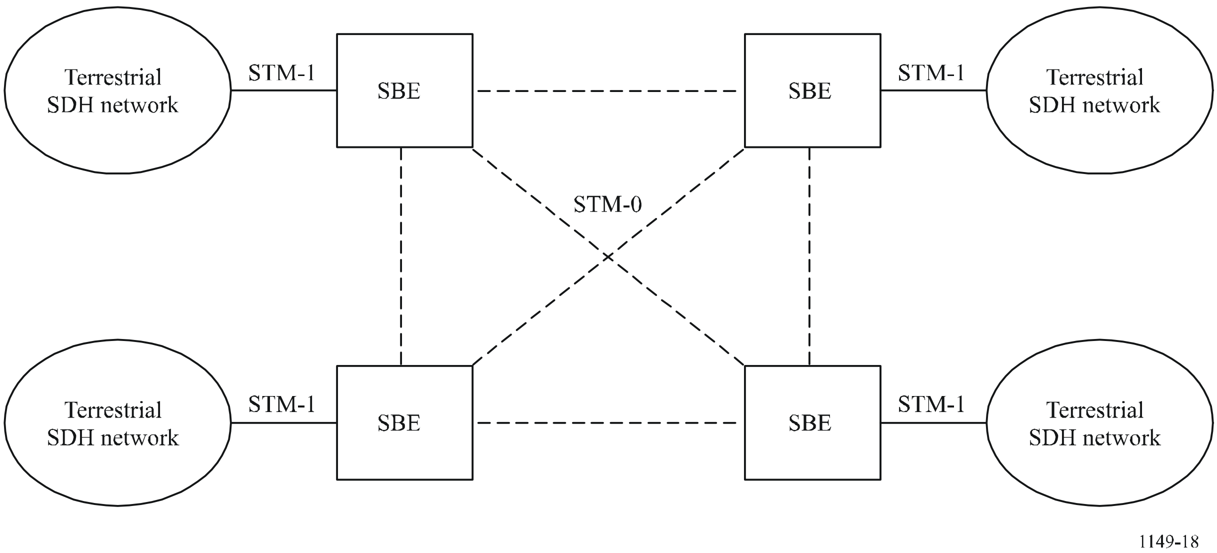
The same requirements as in § 5.1.3 apply for each individual receive side HSSA.

5.2.4 Alarm conditions and consequent actions

Figure 18 shows the scenario 2 OAM model.

FIGURE 18

Scenario 2 OAM model



The SBE shall detect LOS/LOF on the satellite section, and shall indicate to the downstream multiplexer of the terrestrial SDH network either the MS AIS, AU-AIS, or TU-AIS depending upon the number of AU/TUs affected; and shall indicate to the upstream SBE the satellite section S-IOS RDI signal.

The SBE shall detect loss of pointer (LOP) on the satellite section, and shall indicate to the downstream multiplexer of the terrestrial SDH network either the AU-AIS, or TU-AIS, and shall indicate to the upstream SBE either the HO-path or LO-path RDI signal depending upon the number of AU/TUs affected.

In multi-destination operation, the MS RDI signal is received by more than one upstream SBE; therefore, addressing of the upstream SBE, for which the MS RDI signal is intended, is necessary to ensure proper operation.

The fault conditions and consequent actions for scenario 2 are summarized in Table 5.

LOS, LOF, LOP and MS AIS are defined in ITU-T Recommendation G.783.

MS RDI, HO-RDI, LO-RDI, AU-AIS and TU-AIS are defined in ITU-T Recommendation G.707.

The time interval between the detection of LOS/LOF/LOP and the transmission of AIS and RDI signal, the duration of AIS and RDI signal, and the time interval between the termination of LOS/LOF/LOP and the removal of AIS and RDI signal are for further study.

5.3 SBE for wide-area multi-rate cross-connect (scenario 3)

The SBE generally consists of SDH physical interface termination, RST and MST, HSSA, higher order path termination and lower order path connection functions. MS protection switching capability shall be provided on the terrestrial side of the SBE.

HOVC and LOVC path tandem connection monitoring using the Z5 byte (VC-3, VC-4), and the Z6 byte (VC-2) is an optional capability.

TABLE 5

Fault conditions and consequent actions taken by the SBE in scenario 2

Interface	Failure condition	Consequent actions taken by the SBE[1]												
		Signal generated towards local terrestrial network						Signal generated towards local SEMF	Signal generated towards remote SBE					
		MS AIS	MS RDI	AU-AIS	HO-RDI	TU-AIS	LO-RDI		S-IOS AIS	S-IOS RDI	AU-AIS	HO-RDI	TU-AIS	LO-RDI
Local terrestrial network interface	LOS/LOF		Yes					Yes	Yes					
	MS AIS		Yes					Yes						
	MS RDI							Yes						
	AU-LOP				Yes			Yes			Yes		Yes	
	AU-AIS				Yes								Yes	
	HO-RDI													
	TU-LOP						Yes	Yes					Yes	
	TU-AIS												Yes	
	LO-RDI													
Satellite network interface	LOS/LOF	Yes[2]		Yes[3]		Yes[4]		Yes		Yes[5]				
	S-IOS AIS							Yes		Yes[5]				
	S-IOS RDI							Yes						
	AU-LOP			Yes[3]		Yes[4]		Yes				Yes		
	AU-AIS													
	HO-RDI													
	TU-LOP					Yes		Yes						Yes
	TU-AIS													
	LO-RDI													

(1) A “Yes” in a table entry signifies that the specified action shall be taken by the SBE as a consequence of the fault condition. A blank in a table entry signifies that the specified action shall not be taken by the SBE because either the fault condition is not visible to the SBE or no action is required from the SBE as a consequence of the fault condition.

(2) In multi-destination, applied when LOS/LOF occurs on all received signals.

(3) In multi-destination, applied on relevant AU signals.

(4) In multi-destination, applied on relevant TU signals.

(5) Includes addressing of the upstream SBE for which the MS RDI is intended (in multi-destination operation).

The SBE shall terminate the higher order path overhead, and shall extract the lower order VC-12s from the tributary unit groups. The SBE will support cross-connection of the VC-12 signals under the control of network management. An example SBE asymmetric multidestination configuration with different destination traffic sizes is shown in Fig. 19. Multi-destinational SBEs may have multiple transmit ports, which is an implementation matter.

FIGURE 19

SBE asymmetric MD configuration

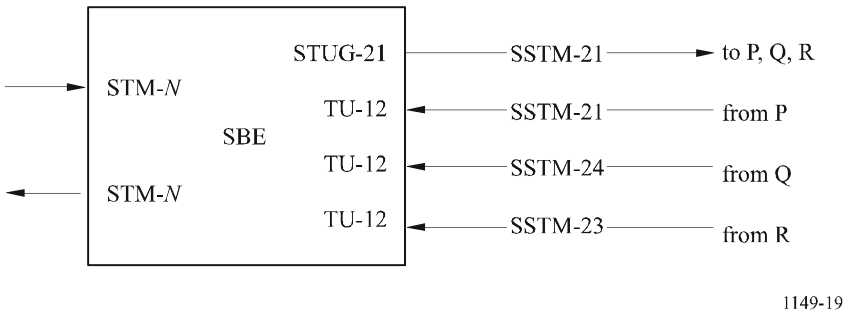


Figure 20 shows the SBE functional blocks. Multiplexing and demultiplexing of LOVCs to/from STUGs of different sizes, and MD asymmetry reconciliation are accomplished by the LSSAs.

SSPIs are either system dependent or may appear as open interfaces, i.e. the SBE and satellite transmission equipment may be integrated. In such cases, the SST interfaces directly with the multiple access system through ISIs.

The LSSA functions shall be:

– generate TU pointers to form TU-12 signals (identical to the TU pointer processing in the HPA function defined in ITU-T Recommendation G.783), and multiplex TUs into STUG;
– adapt the outgoing tributary unit group (STUG) signal to the SSTM-1/2*n* synchronous signals for transport over the S-IOS across the satellite network;
– recover VC-12 signals and their associated frame offset information by interpreting TU pointers from individual received STUG tributaries;
– buffer received TU-12 signals to remove effects of satellite Doppler without data loss.

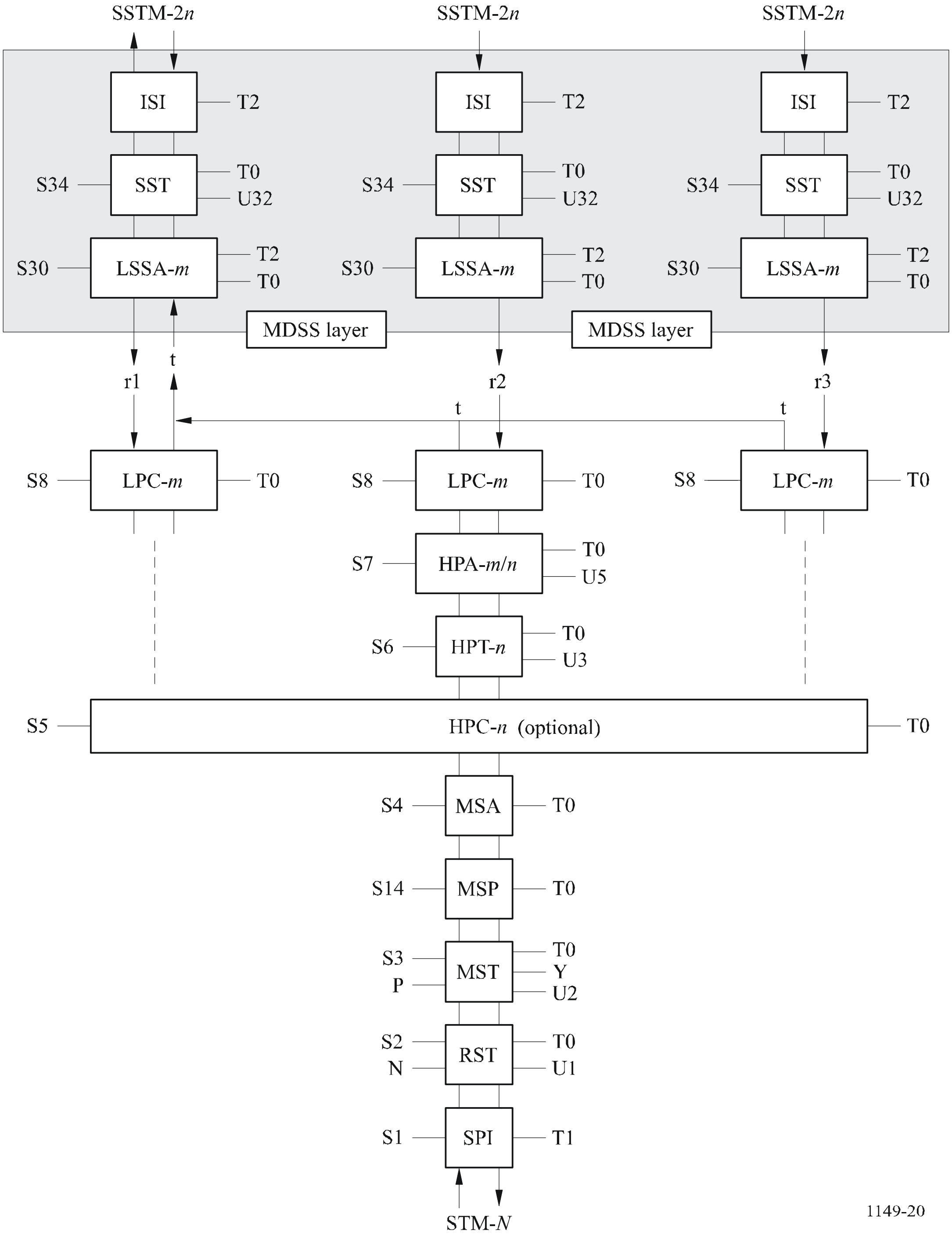
5.3.1 SSOH functions including multidestination for satellite intra-office sections

The SSOH will support the following overhead functions for the S-IOS across the satellite system:

– error monitoring,
– far end block error reporting for multiple connections,
– far end receive failure reporting for multiple connections,
– DCC for multiple connections,
– source trail tracing,
– voice order wire (VOW) for multiple connections and conference calls,
– VC-12 payload type,
– 500 µs multiframe alignment.

FIGURE 20

SBE functional blocks for scenario 3

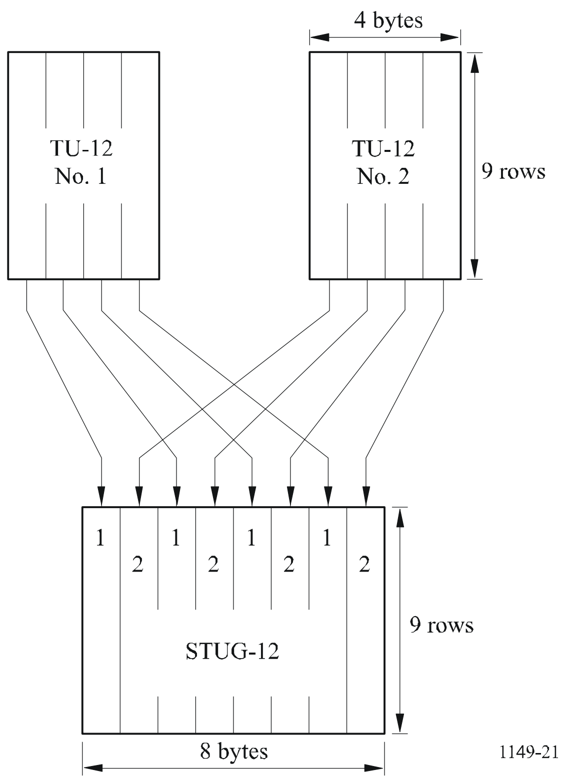


5.3.2 Satellite tributary unit groups 1/2 multiplex structures

STUG-1*n* (*n* =1, 2) signals are made up of one or two TU-12 signals respectively. A STUG-11 is equivalent to a TU-12 and a STUG-12 is made up of two, byte multiplexed, TU-12 signals as shown in Fig. 21.

FIGURE 21

STUG-12 format

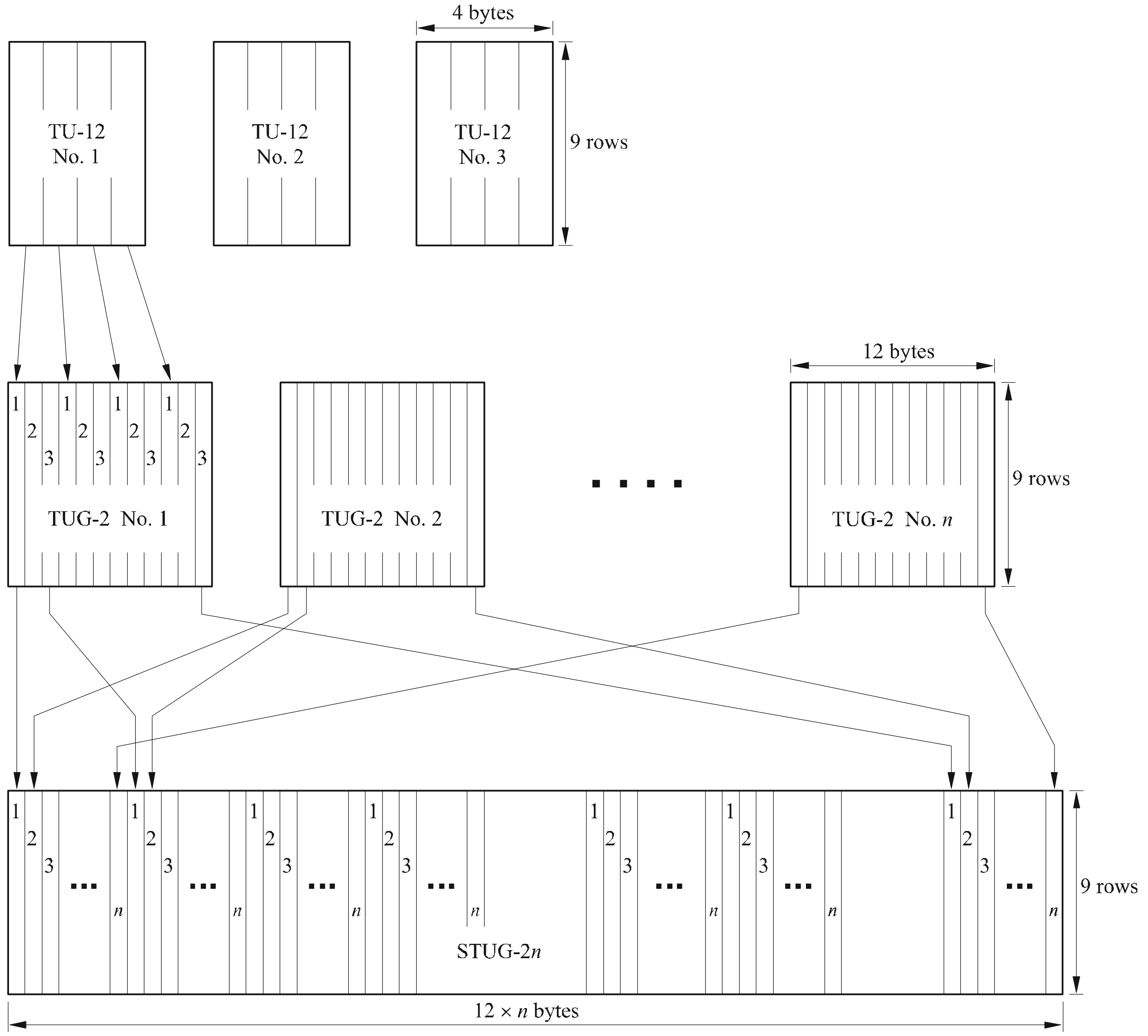


STUG-2*n* (*n* = 1-6) signals are made up from one to six TUG-2 signals, byte multiplexed.

Byte multiplexing of TU-12s to form TUG-2s and byte multiplexing of TUG-2s to form an STUG-2*n,* is shown in Fig. 22.

FIGURE 22

STUG-2*n* format



1149-22

5.3.3 Satellite section layer frame structures

FIGURE 23

SSTM-1 structure

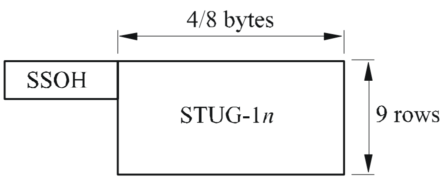
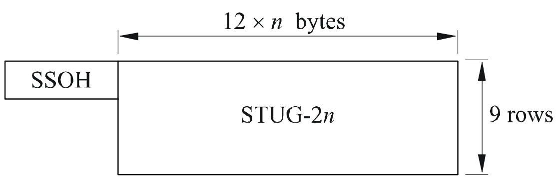


FIGURE 24

SSTM-2 structure

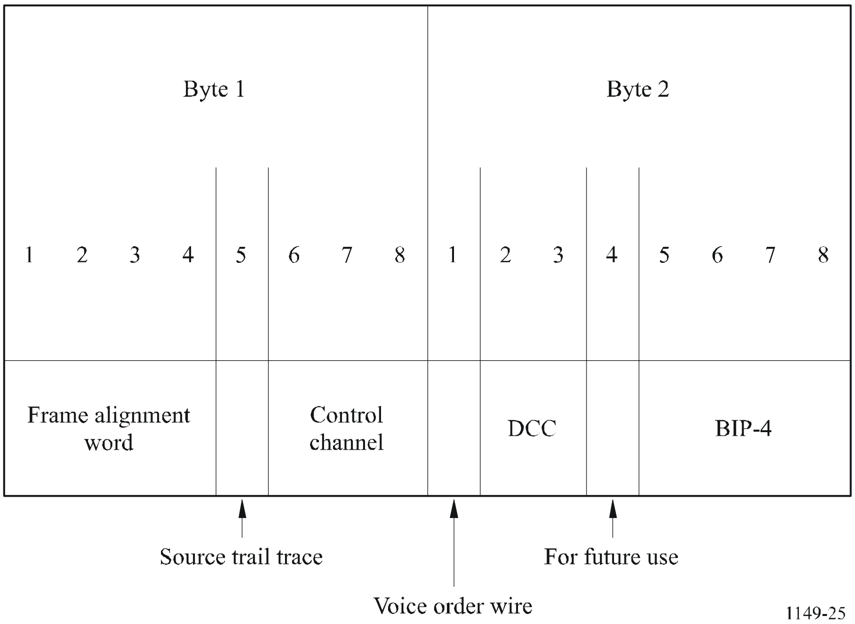


1149-23-24

5.3.4 SSOH allocation

FIGURE 25

SSOH structure



The SSOH contains 2 bytes transmitted every 125 µs. The allocation of bits within the SSOH is as follows:

Frame alignment word FAW (32 bits, 4 bits per frame)

The FAW synchronizes the receiving SST to the start of the SSTM frame. Particular 4 bits patterns of the FAW are used to indicate the start of a 1 ms multiframe (CC frame), used for the control channel and source trail trace, and the start of the 500 µs multiframe pointing to the first V1 byte of the STUG multiplex payload.

The exact method of synchronization is an implementation matter.

The FAW pattern is 32 bits in length and the default value when expressed in Hex format is A04E9EC5.

Other carefully chosen 32 bits sequences could be employed in special circumstances by the default sequence should be used wherever possible.

Source trail trace (8 bits, 1 bit per frame)

The source trail trace indicates to the receiving destination(s) the identity of the origination station. Thus the receiving station can verify its continued connection to the intended transmitter. This information element employs a 1 ms frame (8 × 125 µs) over which the origin trail trace bits are collected. Every 125 µs a single bit is transmitted creating an 8 bit address unique to each station within the network. The addresses are assigned as part of the network configuration process.

Control channel (24 bits, 3 bits per frame)

The control channel conveys alarm and service messages, and enables payload reconfiguration. The control channel mechanism is described in § 5.3.5.

Voice order wire (VOW) (1 bit per frame)

This bit is used for VOW communication providing a 8 kbit/s encoded voice channel. The VOW channel is addressed to one or more destinations to support conferencing facility. The call set-up and clearing including addressing are performed using the service messages supported by the control channel.

DCC (2 bits per frame)

These bits are used to form a 16 kbit/s DCC. The DCC is addressed to one or more destinations. The DCC protocol and message multiplexing mechanism as well as the method of addressing the DCC to a specific destination are described in Annex 1.

For future use (1 bit per frame)

1 bit of the SSOH is reserved for future use.

BIP-4 (4 bits per frame)

These bits are used to transmit a BIP-4 value computed over all bits of the previous SSTM frame.

5.3.5 Control channel mechanism

The control channel (CC) contains 3 bits transmitted every 125 µs. The control channel employs a 1 ms CC frame (8 × 125 µs) over which bits are collected. A complete CC message consists of 24 bits.

Each CC message specifies an action to be taken at the following 1 ms CC frame boundary. If no new action is to be taken at the next CC frame, a refresh mechanism shall refresh the last commands transmitted on a per destination basis.

NOTE 1 – The exact definition of the refresh mechanism is for further study.

The information content of one CC message collected over a period of 1 ms CC frame is organized as follows:

FIGURE 26

SSOH control channel structure

1 2 3 4 5 6	7 8	9 10 11 12 13 14	15 16	17 18 19 20 21 22	23 24
Alarm destination number	Alarm message type	Service destination number	Service message type	VC-12 payload No.	VC-12 payload type

1149-26

Alarm destination number (bits 1-6)

This field conveys the destination number for which alarm information is transferred. Destinations from 1 to 63 can be addressed although currently no more than 18 destinations can be active (SSTM-26). The number 00000 specifies that all destinations are addressed (broadcast). The type of alarm is transmitted in the next field.

In each 1 ms control frame one alarm for one destination can be transmitted. If more than one alarm exists, the alarms shall be transmitted in the order of their detection or in ascending destination number.

Alarm message type (bits 7-8)

Up to four different alarm types can be specified. Currently the following messages are used:

00 REI start

01 REI stop

10 RDI start

11 RDI stop.

Service destination number (bits 9-14)

This field conveys the destination number for which a service message is transferred. Destinations from 1 to 63 can be addressed although currently no more than 18 destinations can be active (SSTM-26). The number 00000 specifies that all destinations are addressed (broadcast). The type of service message is transmitted in the next field.

In each 1 ms control frame one service message for one destination can be transmitted. If more than one service message is required, the service messages shall be transmitted in ascending destination number.

Service message type (bits 15-16)

Up to four different service message types can be specified. Currently the following messages are used:

00 VOW call start

11 Stop

01 Reserved

10 Reserved.

VC-12 payload number (bits 17-22)

This field conveys the VC-12 payload number within an SSTM-1*n* or SSTM-2*k* frame. Payload numbers from 1 to 63 can be specified although currently no more than 18 payloads can exist (SSTM-26). The number 00000 indicates that all payloads are specified. A VC-12 payload can be set to various types of transport thus enabling future applications such as compression, billing information, etc.

VC-12 payload type (bits 23-24)

Up to four different VC-12 payload types are specified.

00 Set VC-12 payload to equipped

01 Set VC-12 payload to un-equipped

10 Set VC-12 payload to ATM cells

11 Reserved.

5.3.6 Section bit rates

TABLE 6

Sub-STM-1 synchronous signal, payload, SSOH and bit rates

Designation	Payload		SSOH	S-IOS
	Composition	Rate (kbit/s)	Rate (kbit/s)	Rate (kbit/s)
SSTM-11	1 × TU-12	2 304	128	2 432
SSTM-12	2 × TU-12	4 608	128	4 736
SSTM-21	1 × TUG-2	6 912	128	7 040
SSTM-22	2 × TUG-2	13 824	128	13 952
SSTM-23	3 × TUG-2	20 736	128	20 864
SSTM-24	4 × TUG-2	27 684	128	27 812
SSTM-25	5 × TUG-2	34 560	128	34 688
SSTM-26	6 × TUG-2	41 472	128	41 600

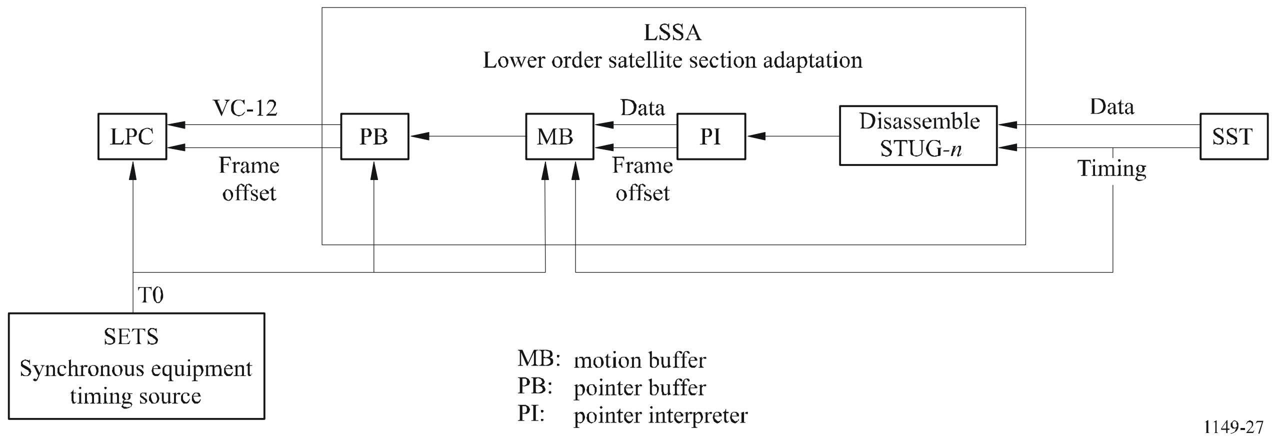
NOTE 1 – The need for a higher maximum SSTM-2*n* is for further study.

5.3.7 Pointer processing and Doppler buffers

Data (SDH payload) loss due to plesiochronous clock differences between interconnected synchronous digital networks is avoided by the SDH justification mechanism controlled by the TU pointer processing. Motion buffers for the removal/reduction of phase variations due to satellite Doppler shall be integrated with the SDH TU pointer processing in the SBE (receive side) as shown in Fig. 27.

FIGURE 27

SBE integrated TU pointer and Doppler processing (LSSA receive side)



Although the figure shows the pointer buffer (PB) and motion buffer (MB) as functionally distinct entities, they can be more efficiently implemented by a common physical element.

The basic algorithm of TU pointer processing is given in ITU-T Recommendation G.783.

5.3.8 TU pointer byte interleaving

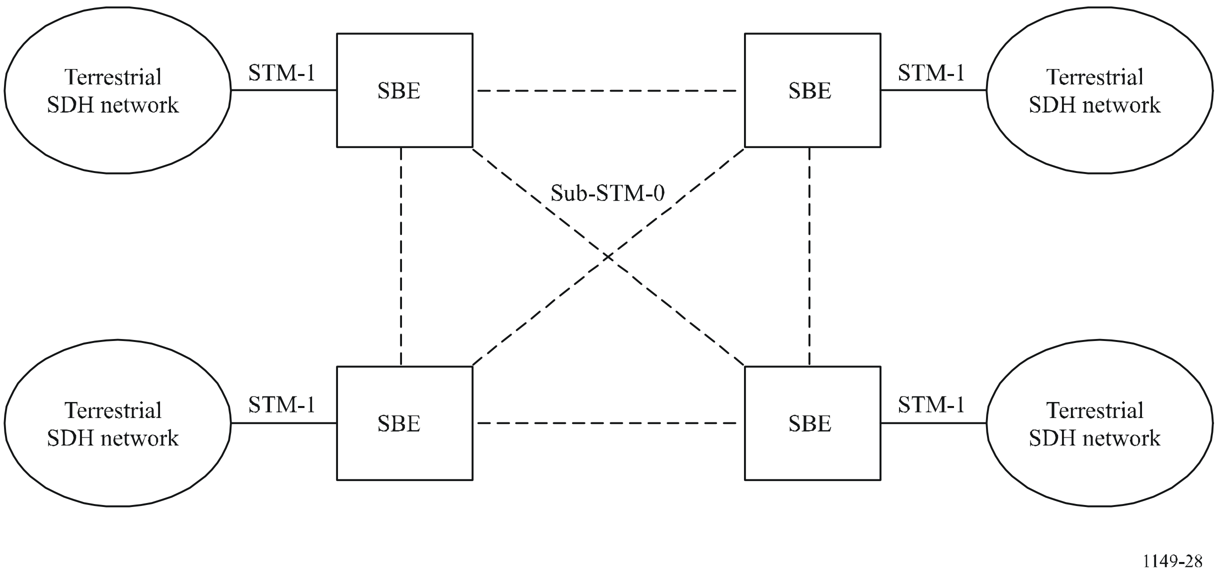
Additional protection against satellite transmission error bursts shall be provided by byte interleaving the TU pointer bytes in the LSSA. The interleaving algorithm is for further study.

5.3.9 Alarm conditions and consequent actions

Figure 28 shows the scenario 3 OAM model.

FIGURE 28

Scenario 3 OAM model



The SBE shall detect LOS/LOF on the satellite section, and shall indicate to the downstream multiplexer of the terrestrial SDH network either the MS AIS, AU-AIS, or TU-AIS depending upon the number of AU/TUs affected, and shall indicate to the upstream SBE the satellite section S-IOS RDI signal.

The SBE shall detect LOP on the satellite section, and shall indicate to the downstream multiplexer of the terrestrial SDH network the TU-AIS, and shall indicate to the upstream SBE the LO-RDI signal.

In multi-destination operation, the satellite section RDI signal is received by more than one upstream SBE; therefore, addressing of the upstream SBE for which the satellite section RDI signal is intended, is necessary to ensure proper operation.

The fault conditions and consequent actions for scenario 3 are summarized in Table 7. LOS, LOF, LOP and MS AIS are defined in ITU-T Recommendation G.783. MS RDI, HO-RDI, LO-RDI, AU-AIS, TU-AIS are defined in ITU-T Recommendation G.707.

The time interval between the detection of LOS/LOF/LOP and the transmission of AIS and RDI signal, the duration of AIS and RDI signals, and the time interval between the termination of LOS/LOF/LOP and the removal of AIS and RDI signal are for further study.

TABLE 7

Fault conditions and consequent actions taken by the SBE in scenario 3

Interface	Failure condition	Consequent actions taken by the SBE[(1)]										
		Signal generated towards local terrestrial network						Signal generated towards local SEMF	Signal generated towards remote SBE			
		MS AIS	MS RDI	AU-AIS	HO-RDI	TU-AIS	LO-RDI		S-IOS AIS	S-IOS RDI	TU-AIS	LO-RDI
Local terrestrial network interface	LOS/LOF		Yes					Yes	Yes			
	MS AIS		Yes			Yes		Yes				
	MS RDI							Yes				
	AU-LOP				Yes			Yes			Yes	
	AU-AIS				Yes						Yes	
	HO-RDI											
	TU-LOP						Yes	Yes			Yes	
	TU-AIS										Yes	
	LO-RDI											
Satellite network interface	LOS/LOF	Yes[(2)]				Yes[(3)]		Yes		Yes[(4)]		
	S-IOS AIS							Yes		Yes[(4)]		
	S-IOS RDI							Yes				
	TU-LOP					Yes[(3)]		Yes				Yes
	TU-AIS											
	LO-RDI											

(1) A "Yes" in a table entry signifies that the specified action shall be taken by the SBE as a consequence of the fault condition. A blank in a table entry signifies that the specified action shall not be taken by the SBE because either the fault condition is not visible to the SBE or no action is required from the SBE as a consequence of the fault condition.

(2) In multi-destination, applied when LOS/LOF occurs on all received signals.

(3) In multi-destination, applied on relevant TU signals.

(4) Includes addressing of the upstream SBE for which the MS RDI is intended (in multi-destination operation).

Annex 1

SSOH DCC serial channel protocol

Introduction

An SDH transport system may pass through several network operator management domains as illustrated in Fig. 29 with the DCC carried management messages being terminated at each network management boundary. These management messages pass between manager systems and management agents. The management agents translate these messages into network element level measurements or actions. Thus the management view of a network is just a collection of management intelligences and their associated management information bases (MIBs) which contain the description of the objects under management, as shown in Fig. 30.

1 The serial channel protocol

To provide more flexible support for the management features of SDH transport networks, the DCC bytes are employed to form a serial communications channel to carry management messages.

Such a channel requires a protocol stack. A lower layer protocol to correct errors, provide flow control and support addressing and a higher layer protocol to support statistical multiplexing and identify message types.

Higher layer control functions such as the message queueing algorithm and the concatenation of longer messages strings are outside the scope of this Recommendation.

Given that the transmission media will be a geostationary satellite and that the transmission speed may increase, as more facilities are added, to several hundred kbit/s, then it is recommended that the service specific connection oriented protocol (SSCOP), is employed as the layer 2 protocol. SSCOP is defined in ITU-T Recommendation Q.2110 (previously Q.SAAL).

To be consistent with the way SSCOP is used in the new Q.2100-series of ITU-T Recommendations, a special simple version of the service specific coordination function (SSCF) is defined for this SDH application based on the contents of ITU-T Recommendation Q.2130 SSCF for the UNI of the B-ISDN.

The signals between the SSCF element and the SSCOP element as illustrated in Fig. 31 are those listed in Table 8.

FIGURE 29

Management domains

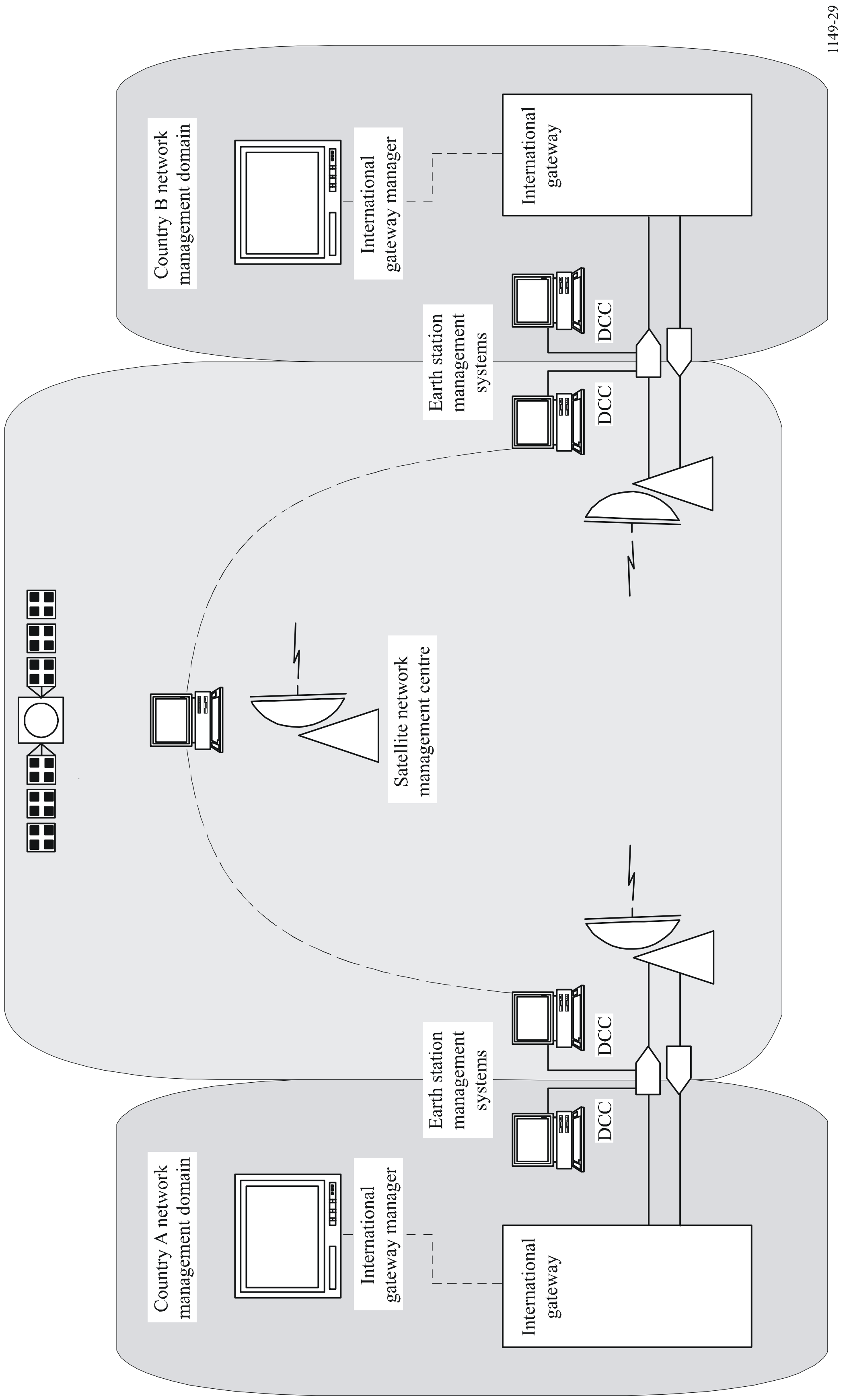


FIGURE 30

The management view of a network

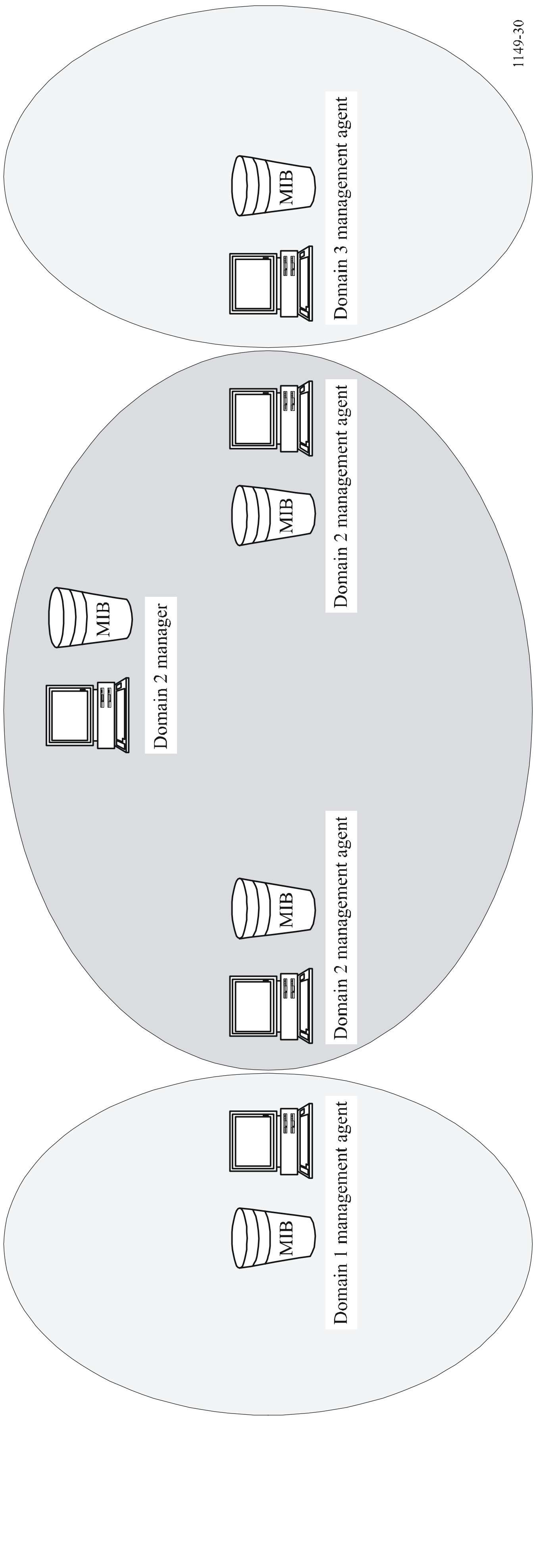


FIGURE 31

Protocol element relationship

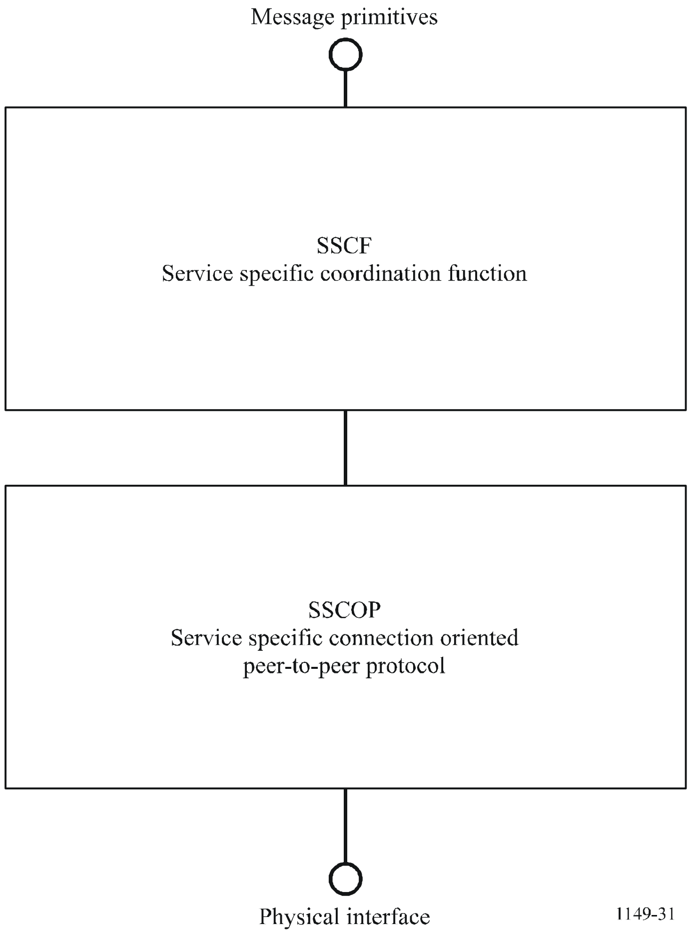


TABLE 8

Signal name	Function	Contents
ESTABLISH	To establish assured information transfer	None
RELEASE	Termination of connection	None
DATA	Assured transfer of data	Data string for transfer
RESYNCH	Resynchronizes one direction of transmission	
ERROR	A response indicating that SSCOP needs help	Cause number
UNIT DATA	To transfer non-assured data	Data string for transfer e.g. J0
RELEASE BUFF	A command to clear all buffers	

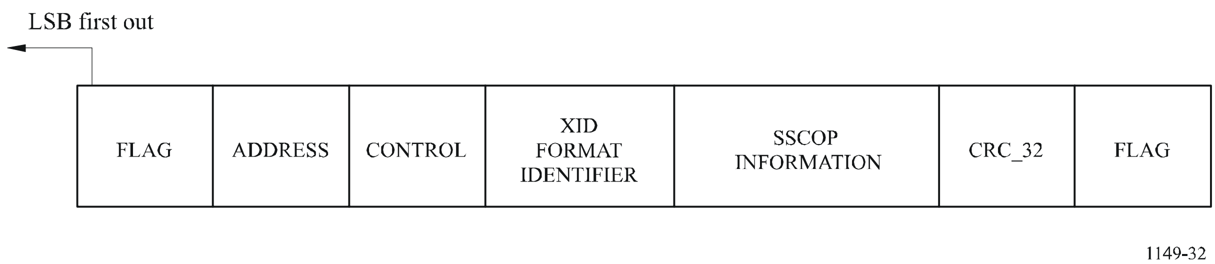
Unless otherwise indicated all these signals can be either requests or responses. Full details of signal structures, state tables and SDLs are given in ITU-T Recommendations Q.2110 and Q.2130. UNIT DATA transfers do not require initialization of the protocol via ESTABLISH/RELEASE states.

1.1 Physical layer

SSCOP is designed to operate on top of various different physical layers. In this application the physical layer is a non-contiguous string of bytes which have no restrictions on their contents, and with byte synchronization provided by the SSOH structure. Onto this base has to be applied a method for forming and synchronizing a frame structure and a method for detecting errors. Thus it is recommended that the frame structure and the frame delimiting process, using unique flag bytes, as defined in ISO Standards 7776 and 8885 for the XID frame are adopted including the use of the optional 32 bit CRC for error detection. The XID format identifier shall be 84H which is allocated in ISO 4335 (see Fig. 32).

FIGURE 32

SSOH DCC signal frame format



SSCOP replaces the related protocol procedures defined in ISO 4335. For example, there is no need for a SABME/UA exchange to initialize a link layer. This is consistent with the normal usage of XID frames which may be exchanged “prior to data link establishment” and avoids duplication of the SSCOP establishment process.

The XID frame is composed of a number of fields which are defined in Table 9.

TABLE 9

Field name	Value	Usage
FLAG	01111110	At least one flag between frames
ADDRESS	11100111	Mandatory
CONTROL	11110101	Mandatory
FORMAT ID	00100001 (84H)	Mandatory
INFORMATION	SSCOP information	At least 8 bytes of SSCOP address information
CRC_32	Dependent on frame contents	Mandatory

The order of bit transmission is least significant bit (LSB) first.

1.2 Special SSCF for SDH transport systems

1.2.1 The message primitives supported at the interface to the top of the SSCF are:

TABLE 10

Signal name	Function	Contents
ESTABLISH	Establish connection to distant terminal	None
RELEASE	Release connection	None
DATA	Transfer data in assured mode	Data string
UNIT DATA	Broadcast data in non-assured mode	Data string e.g. J0

1.2.2 SSCOP timers

TABLE 11

SSCOP timer	Duration (s)
TIMER_POLL	0.7
TIMER_NO-RESPONSE	2
TIMER_KEEP-ALIVE	2
TIMER_IDLE	10
TIMER_CC	1.5

1.2.3 SSCOP parameters

TABLE 12

SSCOP parameter	Description	Value
Max SD/UD/MD-PDU length	Maximum number of bytes per PDU information field	2 048
Max UU field length	Maximum number of bytes in UU field	1 024
MaxCC	Maximum number of retransmissions of BGN, END, ER, or RS PDUs	20
MaxPD	Max of VT(CC) before sending a poll	16
MaxSTAT	Max number of list elements in a STATPDU before it is segmented	67 (default)
Clear-buffers	Permission to clear buffers on connection release	Yes
Credit	Management message	Yes initially

2 Multipoint operation

To extend the definition of the serial channel to include point-to-multipoint topology with each branch having its own assured data transfer service requires that SSCOP supports multiple state-machines, one for each leaf. This mode of operation is not yet defined for SSCOP but it only requires the addition of two address fields in the SSCOP protocol data units (PDUs), one for the source address and the other for the destination address. The interface definition is extended by simply including an address field in the ESTABLISH, RELEASE and DATA messages:

TABLE 13

Signal name	Function	Contents
ESTABLISH	Initialize connection to given address list	Address list
RELEASE	Release connection to given address list	Address list
DATA	Transfer data in assured mode to given address list. Note this address list must be within the establishment address list	Address list data

The address length is 4 bytes and employs T.51 alphanumeric codes.

The SSCOP PDU is 32-bit aligned and trailer oriented, i.e., the protocol control information is at the end of the PDU.

The source address 32-bit field and destination address 32-bit field are the first two fields in that order in the PDU information field.

3 Message structure for the serial channel

3.1 Presentation standard

The serial channel will employ 8 bit bytes coded according to ITU-T Recommendation T.51.

The LSB is transmitted first.

3.2 Message structures

The message structure will be based on ITU-T Recommendation X.209 which defines a simple type, length, variable (TLV) style of message. ITU-T Recommendation X.209 also defines a content description byte which is not required in this application. Thus all messages will start with a two byte header; type, length, followed by the variable part of the message.

Examples of the Type code tables for the current generation of SDH are shown in Table 14.

TABLE 14

SOH Type codes (example)

00	Reserved and protected from access by end users
01	Reserved and protected from access by end users
02	J0 byte content
03	Reserved and protected from access by end users
04	S1 byte bits 1-4 content
05 to 0C	Reserved and protected from access by end users
0D	D bytes content (this code may never be used as each individual kind of traffic which uses a serial channel should have its own Type code)
0E to FF	Reserved and protected from access by end users

A single byte "length byte" is defined as this limits the length of messages and avoids blocking of the serial channel by overly long messages. Multibyte length fields are used in other applications but are not allowed here. It is the responsibility of the transmitter to control the priority of the messages. There is nothing in the message protocol to indicate priorities.

The Type byte is the first byte of the contents of the SSCOP PDU. In this multipoint version of SSCOP this will be the byte after the destination address.

The speed of the serial channels (the number of bytes involved) does not effect the message structures or the protocol.