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STANDARDIZATION SECTOR
OF ITU

G.784

(01/94)

GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS;

TERMINAL EQUIPMENTS

SYNCHRONOUS DIGITAL HIERARCHY (SDH) MANAGEMENT

ITU-T Recommendation G.784

Superseded by a more recent version

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation G.784 was revised by ITU-T Study Group 15 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 20th of January 1994.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

CONTENTS

Recommendation G.784

SYNCHRONOUS DIGITAL HIERARCHY (SDH) MANAGEMENT

(revised 1994)

The ITU-T,

considering

(a) that Recommendations G.707, G.708 and G.709 form a coherent set of specifications for the synchronous digital hierarchy (SDH) and the network node interface (NNI);

(b) that Recommendation G.781 gives the structure of Recommendations on multiplexing equipment for the SDH;

(c) that Recommendation G.782 describes the types and general characteristics of SDH multiplexing equipment;

(d) that Recommendation G.783 specifies the characteristics of SDH multiplexing equipment functional blocks;

(e) that Recommendation G.958 specifies digital line systems based on SDH for use on optical fibre cables;

(f) that it is expected that further Recommendations will be produced concerned with other SDH equipment types, e.g. digital cross-connects and radio systems;

(g) that Recommendation M.30 defines the principles for a telecommunications management network (TMN);

(h) that Recommendation G.773 defines the protocol suites for Q-interfaces,

recommends

that the management of SDH equipment should be organized in accordance with the details contained within this Recommendation.

1 Introduction

This Recommendation addresses management aspects of the synchronous digital hierarchy (SDH), including the control and monitoring functions relevant to SDH network elements (NE). The SDH management sub-network (SMS) architecture, SDH embedded control channel (ECC) functions, and SDH ECC protocols are specified. Detailed message sets are for further study.

The management of SDH equipment should be seen as a subset of the telecommunications management network (TMN) described in Recommendation M.30, and reference is made to Recommendation G.773 for the specification of protocol suites to be used at external (Q) management interfaces.

2 Abbreviations and definitions

2.1 Abbreviations

ACSE Association control service element

AITS Acknowledged information transfer service

APDU Application protocol data unit

ASE Application service element

ASN.1 Abstract Syntax Notation One

CC	Connect confirm
CLNP	Connectionless network layer protocol
CLNS	Connectionless network layer service
CMIP	Common management information protocol
CMISE	Common management information service element
CONP	Connection oriented network-layer protocol
CR	Connection request
CSES	Consecutive severely errored seconds
CV	Code violation
DCC	Data communications channel
DCN	Data communications network
ECC	Embedded control channel
ES	Errored second
FEBE	Far end block error
FLS	Frame loss second
FU	Functional unit
GNE	Gateway network element
IFU	Interworking functional unit
IP	Interworking protocol
IS	Intermediate system
ISO	International Organization for Standardization
LCN	Local communications network
MAF	Management applications function
MCF	Message communications function
MD	Mediation device
MF	Mediation function
MO	Managed object
MOC	Managed object class
NE	Network element
NEF	Network element function
NLR	Network layer relay
NNE	Non-SDH network element
NPDU	Network protocol data unit
NSAP	Network service access point
OAM&P	Operations, administration, maintenance and provisioning
OS	Operations system
OSF	Operations system function
OSI	Open systems interconnection
PDU	Protocol data unit
PJE	Pointer justification event
PPDU	Presentation protocol data unit
PSC	Protection switch count
PSD	Protection switch duration

PSN Packet switched network

QOS Quality of service

ROSE Remote operations service element

SAPI Service access point identifier

SDH Synchronous digital hierarchy

SMN SDH management network

SMS SDH management sub-network

SNDCF Sub-network dependent convergence function

SPDU Session protocol data unit

STM Synchronous transport module

SVC Switched virtual circuit

TEI Terminal end-point identifier

TMN Telecommunications management network

TPDU Transport protocol data unit

TSAP Transport service access point

UAS Unavailable second

UAT Unavailable time

UI Unnumbered information

UITS Unacknowledged information transfer service

2.2 Definitions

For the purposes of this Recommendation, the following definitions apply:

2.2.1 data communications channel (DCC): Within an STM-N signal there are two DCC channels, comprising bytes D1-D3, giving a 192 kbit/s channel, and bytes D4-D12, giving a 576 kbit/s channel. D1-D3 (DCC_R) are accessible by all SDH NEs whereas D4-D12 (DCC_M), not being part of the regenerator section overhead, are not accessible at regenerators. D1-D3 are allocated for SDH NE use. The D4-D12 channel can be used as a wide area, general purpose, communication channel to support TMN including non-SDH applications. This would include both communication between OSs and communication between an OS and a network element (including SDH network elements). The application of the D4-D12 channel requires study for general TMN applications and also for SDH network element management applications.

2.2.2 embedded control channel (ECC): An ECC provides a logical operations channel between SDH NEs, utilizing a data communications channel (DCC) as its physical layer.

2.2.3 SDH management network (SMN): An SDH management network is a subset of a TMN, responsible for managing SDH NEs. An SMN may be subdivided into a set of SDH management sub-networks.

2.2.4 SDH management sub-network (SMS): An SDH management sub-network (SMS) consists of a set of separate SDH ECCs and associated intra-site data communication links which have been interconnected to form an operations data communications control network within any given SDH transport topology. An SMS represents an SDH specific local communication network (LCN) portion of a network operator’s overall operations data network or TMN.

2.2.5 management application function (MAF): An application process participating in system management. The management application function includes an agent (being managed) and/or manager. Each SDH network element (NE) and operations system or mediation device (OS/MD) must support a management application function that includes at least an agent. A management application function is the origin and termination for all TMN messages.

2.2.6 **manager**: Part of the MAF which is capable of issuing network management operations (i.e. retrieve alarm records, set thresholds) and receiving events (i.e. alarms, performance). SDH NEs may or may not include a manager while SDH OS/MDs will include at least one manager.

2.2.7 **agent**: Part of the MAF which is capable of responding to network management operations issued by a manager and may perform operations on managed objects, issuing events on behalf of managed objects. The managed objects can reside within the entity or in another open system. Managed objects from other open systems are controlled by a distant agent via a local manager. All SDH NEs will support at least an agent. Some SDH NEs will provide managers and agents (being managed). Some NEs (e.g. regenerators) will only support an agent.

2.2.8 **managed object (MO)**: The management view of a resource within the telecommunication environment that may be managed via the agent. Examples of SDH managed objects are: equipment, receive port, transmit port, power supply, plug-in card, virtual container, multiplex section, and regenerator section.

2.2.9 **managed object class (MOC)**: An identified family of managed objects that share the same characteristics, e.g. "equipment" may share the same characteristics as "plug-in card".

2.2.10 **message communications function (MCF)**: The message communications function provides facilities for the transport of TMN messages to and from the MAF, as well as facilities for the transit of messages. The message communications function does not originate or terminate messages (in the sense of the upper protocol layers).

2.2.11 **operations system function or mediation function (OSF/MF)**: A telecommunications management network (TMN) entity that processes management information to monitor and control the SDH network. In the SDH sub-portion of the TMN, no distinction is made between the operations system function and the mediation function; this entity being a MAF containing at least a manager.

2.2.12 **network element function (NEF)**: A function within an SDH entity that supports the SDH based network transport services, e.g. multiplexing, cross-connection, regeneration. The network element function is modelled by managed objects.

2.2.13 **operations system or mediation device (OS/MD)**: A stand-alone physical entity that supports OSF/MFs but does not support NEFs. It contains a message communication function (MCF) and a MAF.

2.2.14 **network element (NE)**: A stand-alone physical entity that supports at least NEFs and may also support OSF/MFs. It contains managed objects, a MCF and a MAF.

3 SDH management network

3.1 Management network organizational model

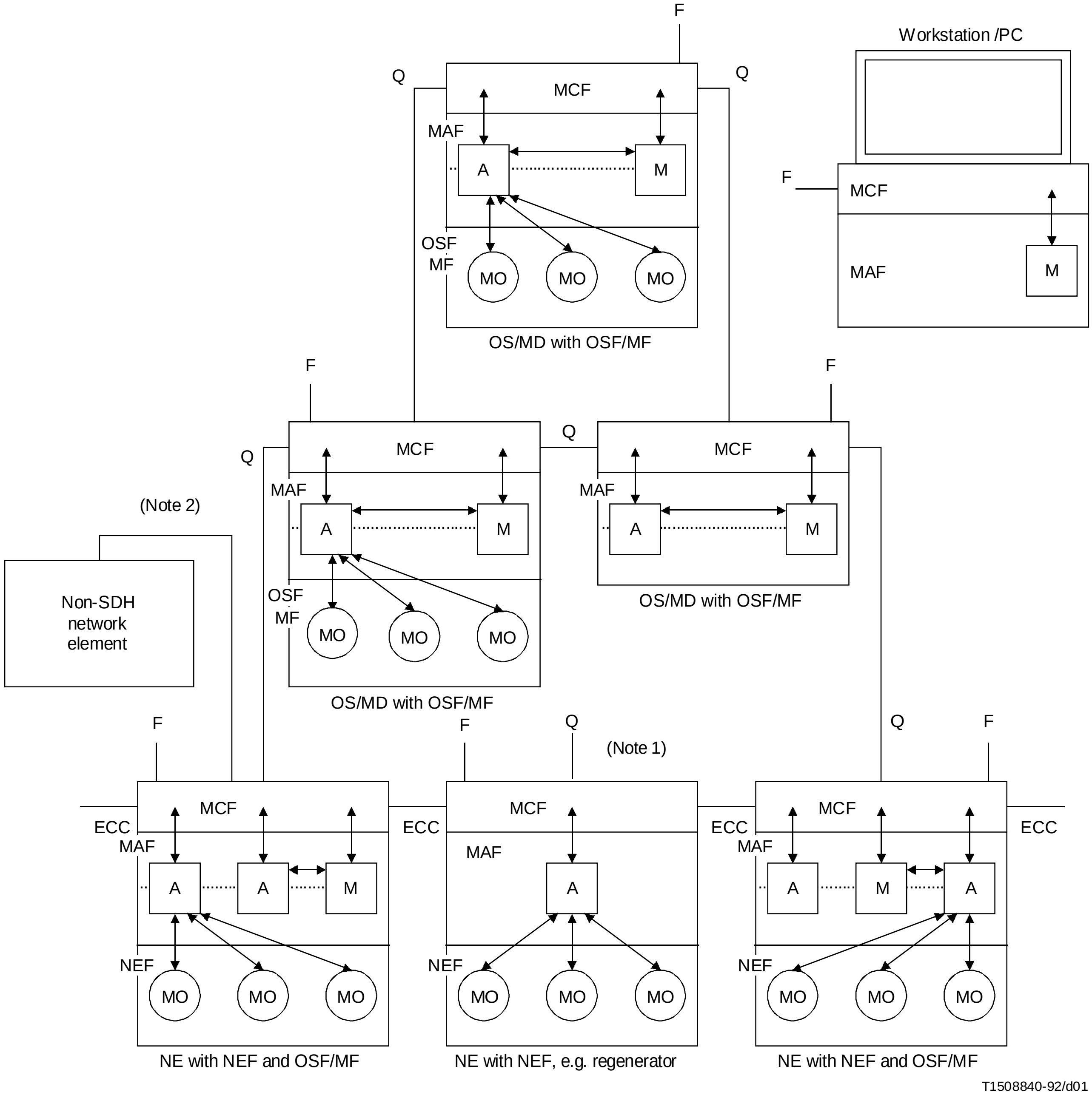
The management of an SDH network uses a multi-tiered distributed management process. Each tier provides a pre-defined level of network management capabilities. The lower tier of this organizational model (see Figure 3-1) includes the SDH NEs providing transport services. The management applications function (MAF) within the NEs communicates with, and provides management support to, peer NEs and mediation device(s) (MDs)/operations system(s) (OSs).

The communication process is provided via the message communication function (MCF) within each entity.

The MAF at each entity can include agents only, managers only, or both agents and managers. Entities that include managers are capable of managing other entities.

Each tier in the multi-tiered organizational model can provide additional management functionality. However, the message structure should remain the same. A manager within an SDH NE may suppress alarms generated by one or more of its managed NEs due to a common failure, and replace them by a new alarm message, directed to the OS/MD, identifying the source of the problem. The new alarm message format will be consistent with other alarm messages.

The message format will be maintained as messages are elevated up the hierarchy, i.e. SDH NE to SDH NE messages will have the same structure as SDH NE to MD messages and SDH MD to OS messages.



MCF	Message communication function
MAF	Management application function
NEF	Network element function
ECC	Embedded control channel
A	Agent
M	Manager
MO	Managed object

NOTES

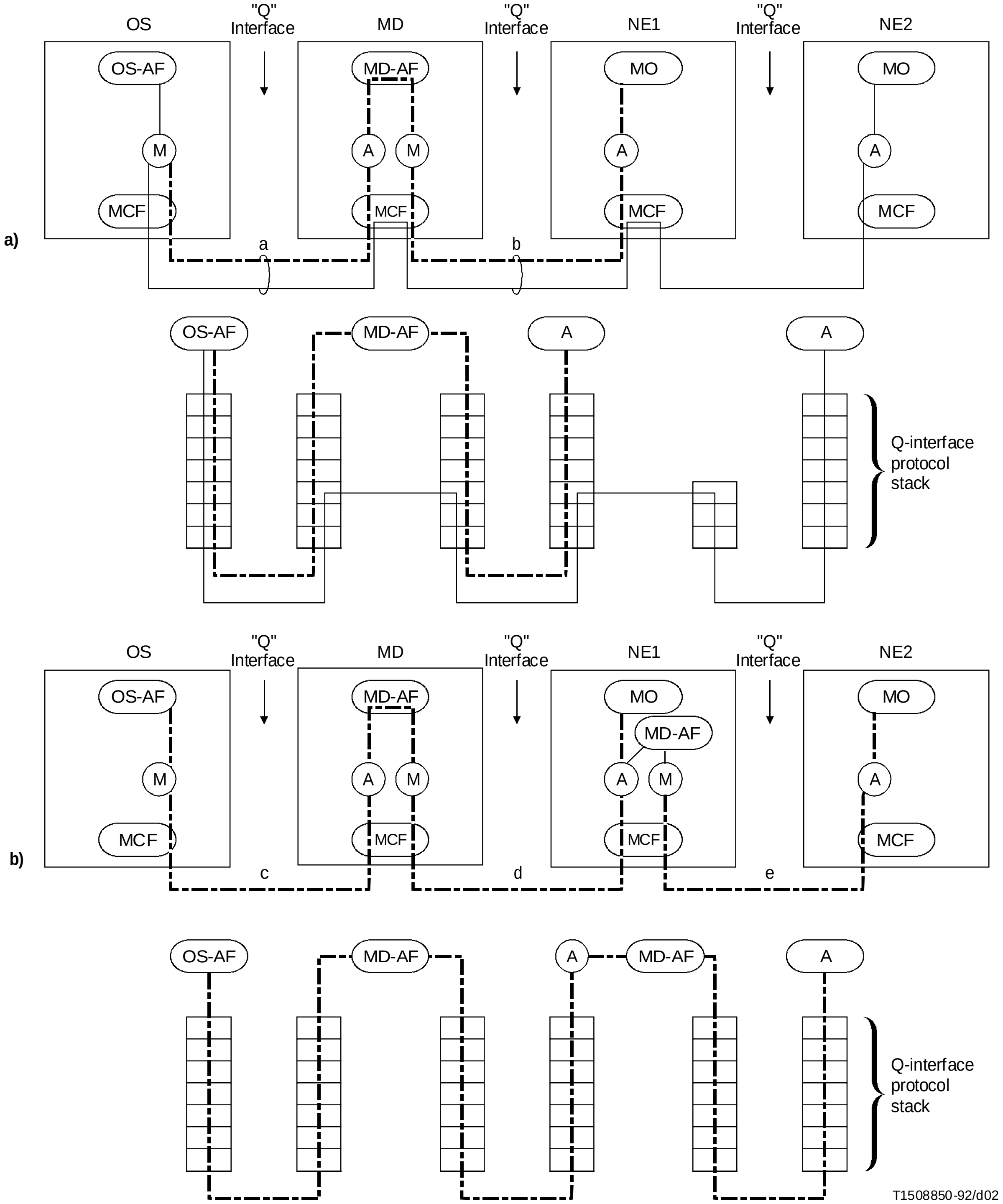
1 Use of this interface may be foreseen in some applications.

2 For further study.

3 The designation “Q” is used in a generic sense.

FIGURE 3-1/G.784

Management organizational model



OS	Operations system
MD	Mediation device
NE	Network element
OS-AF	OS-application function
MD-AF	MD-application function
MCF	Message communications function
A	Agent
M	Manager
MO	Managed object

FIGURE 3-2/G.784

SDH management examples

Figure 3-2a) illustrates examples of management communication using a Q-interface implemented in the MCF where logically independent communications are provided over a single physical interface:

– between a manager in the OS and two different agents; one in the MD and one in NE2 (interface a);

– between a manager in the MD and an agent in NE1; between a manager in the OS and an agent in NE2 (interface b).

Figure 3-2b) illustrates examples of management communication using Q-interface protocols implemented in the MCF:

– between a manager in the OS and an agent in the MD (interface c);

– between a manager in the MD and an agent in NE1 (interface d);

– between a manager in NE1 and an agent in NE2 (interface e).

3.2 Relationship between SMN, SMS and TMN

The inter-relationship between the SMN, SMS and TMN is shown in Figure 3-3. Figure 3-4 shows specific examples of SMN, SMSs and connectivities within the encompassing TMN.

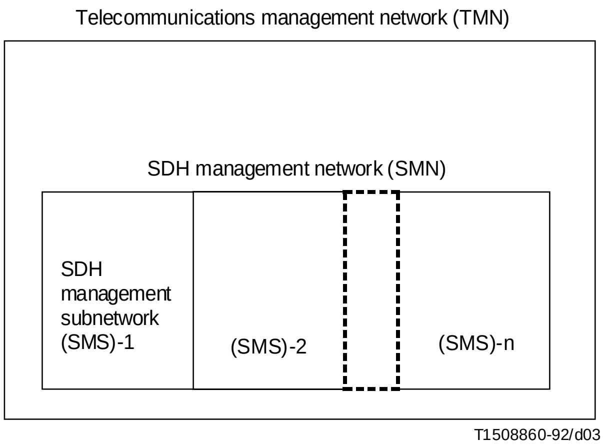


FIGURE 3-3/G.784

Relationship between SMN, SMS and TMN

The following subclauses describe the SMS in more detail, addressing:

– access to the SMS; and

– SMS architecture.

3.2.1 Access to the SMS

Access to the SMS is always by means of an SDH NE functional block. The SDH NE may be connected to other parts of the TMN through the following sets of interfaces:

1) workstation (F);

2) mediation device (a Q-interface);

3) operations system (a Q-interface);

4) non-SDH NE or site related information [interface(s) for further study].

The functionality required to be supported by the SDH NE will determine the type of Q-interface to be provided. For instance, the two main varieties of SDH NEs expected are the SDH NEs with mediation functions (MF) and “regular” SDH NEs. An example of the SDH NE with MF is shown in Figure 3-5. An example of a “regular” SDH NE is shown in Figure 3-6.

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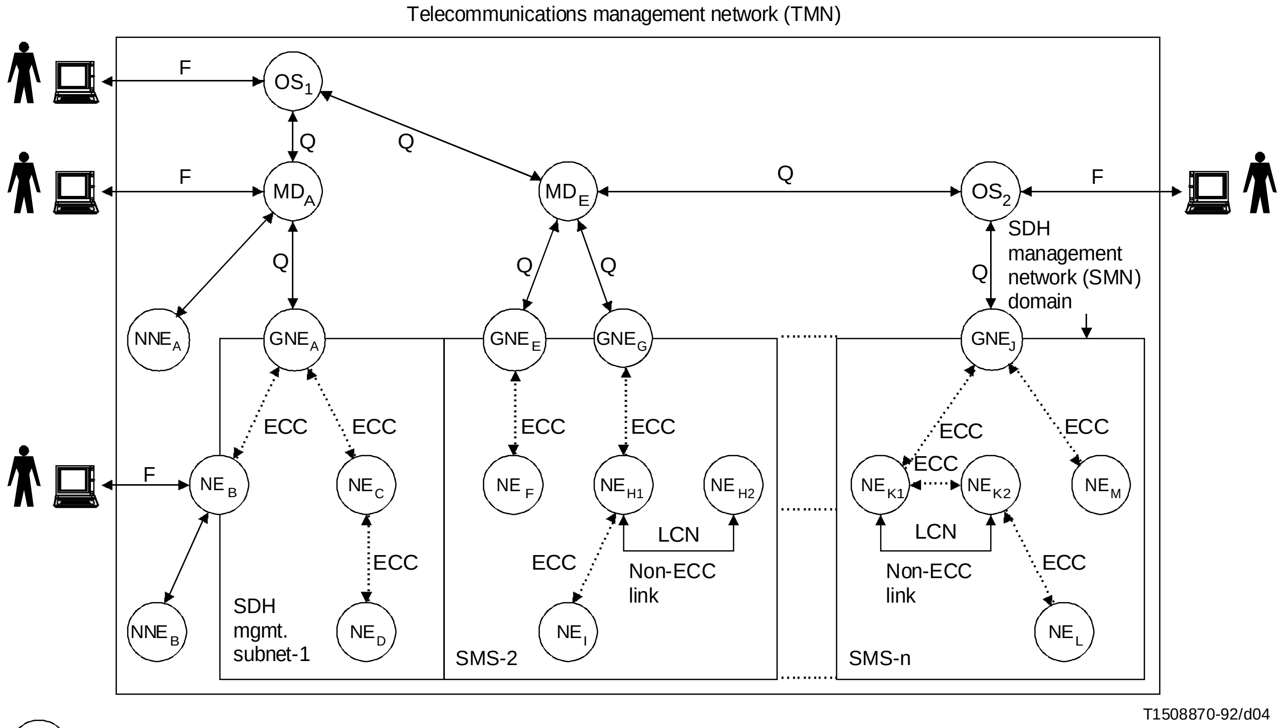


Communications blocks (OS, MD, GNE, NE)

Communications links using standard Q-interface protocol

SDH ECC

LCN Local communications network

GNE Gateway network element (see 3.3.1)

NOTE – The designation "Q" is used in a generic sense.

FIGURE 3-4/G.784

TMN, SMN, SMS model

3.2.2 SDH management sub-network architecture

In Figure 3-4 a number of points should be noted concerning the architecture of the SMS:

a) *Multiple NEs at a single site*

Multiple, addressable SDH NEs may appear at a given site. For example, in Figure 3-4 NEe and NEg may be collocated at a single equipment site.

b) *SDH NEs and their communications functions*

The message communications function of an SDH NE terminates (in the sense of the lower protocol layers), routes or otherwise processes messages on the ECC, or connected via an external Q-interface.

i) All NEs are required to terminate the ECC. In OSI terms, this means that each NE must be able to perform the functions of an end system.

ii) NEs may also be required to route ECC messages between ports according to routing control information held in the NE. In OSI terms, this means that some NEs may be required to perform the functions of an intermediate system.

iii) NEs may also be required to support Q- and F-interfaces.

c) *SDH inter-site communications*

The inter-site or inter-office communications link between SDH NEs will normally be formed from the SDH ECCs.

d) *SDH intra-site communications*

Within a particular site, SDH NEs may communicate via an intra-site ECC or via an LCN. Figure 3-4 illustrates both instances of this interface.

NOTE – A standardized LCN for communicating between collocated network elements has been proposed as an alternative to the use of an ECC. The LCN would potentially be used as a general site communications network serving both SDH and non-SDH NEs (NNEs). The LCN is part of the TMN and thus the specification of the LCN is beyond the scope of this Recommendation.

3.3 SMS topology and reference models

3.3.1 ECC topology for the SDH management sub-network

It is intended that this Recommendation should place no restriction on the physical transport topology to support the ECC. Thus it is expected that the supporting DCCs may be connected using string (bus), star, ring or mesh topologies.

Each SDH management sub-network (SMS) must have at least one element which is connected to an OS/MD. This is called a gateway network element (GNE) and is illustrated in Figures 3-5, 3-6 and 3-7. The GNE should be able to perform an intermediate system network layer routing function for ECC messages destined for any end system in the SMS.

NOTE – This is a specific instance of the general requirement that messages passing between communicating sub-networks shall use the network layer relay.

The communications function is illustrated in Figure 3-7. Messages passing between OS/MD and any of the end systems in the sub-network are routed through the GNE and, in general, other intermediate systems.

3.3.2 Message routing at SDH NE sites

The means of generation and administration of routing control information amongst communicating sub-networks and within sub-networks is detailed in 6.2.3.

3.3.3 SMS reference models

Reference models are particularly suited for test cases and for design verification and acceptance testing. The reference configurations in Figure 3-8 and Figure 3-9 are examples of test cases for SMS management. Examples of SMS connectivity are given in Figure 3-10.

Other variations of Figure 3-9 are also of interest as reference configurations; for example, on routes where the operator chooses not to implement the multiplex section protection (MSP) function, the ECCs would be provided on at least two SDH lines, and optionally on any remaining SDH lines of a particular route.

4 Information model

The information model is defined in Recommendation G.774 [13].

5 Management functions

This clause provides an overview of the minimum functions which are required to support inter-vendor/network communications and single-ended maintenance of SDH NEs within an SMS, or between communicating peer NEs across a network interface (see 5.1.1, 5.2.1, 5.3.1, 5.4.2). Single-ended maintenance is the ability to access remotely located NEs to perform maintenance functions.

Other management functions have been identified (see 5.1.2, 5.1.3, 5.1.4, 5.1.5, 5.2.2, 5.2.3, 5.4.1, 5.4.3, 5.5) and will be specified in the latter stages of the 1988-1992 ITU-T study period.

It should be noted that the management functions have been categorized according to the classifications given in Recommendation M.30.

Detailed specifications of the management functions, in terms of support objects, attributes and message specification, are given in Annex A.

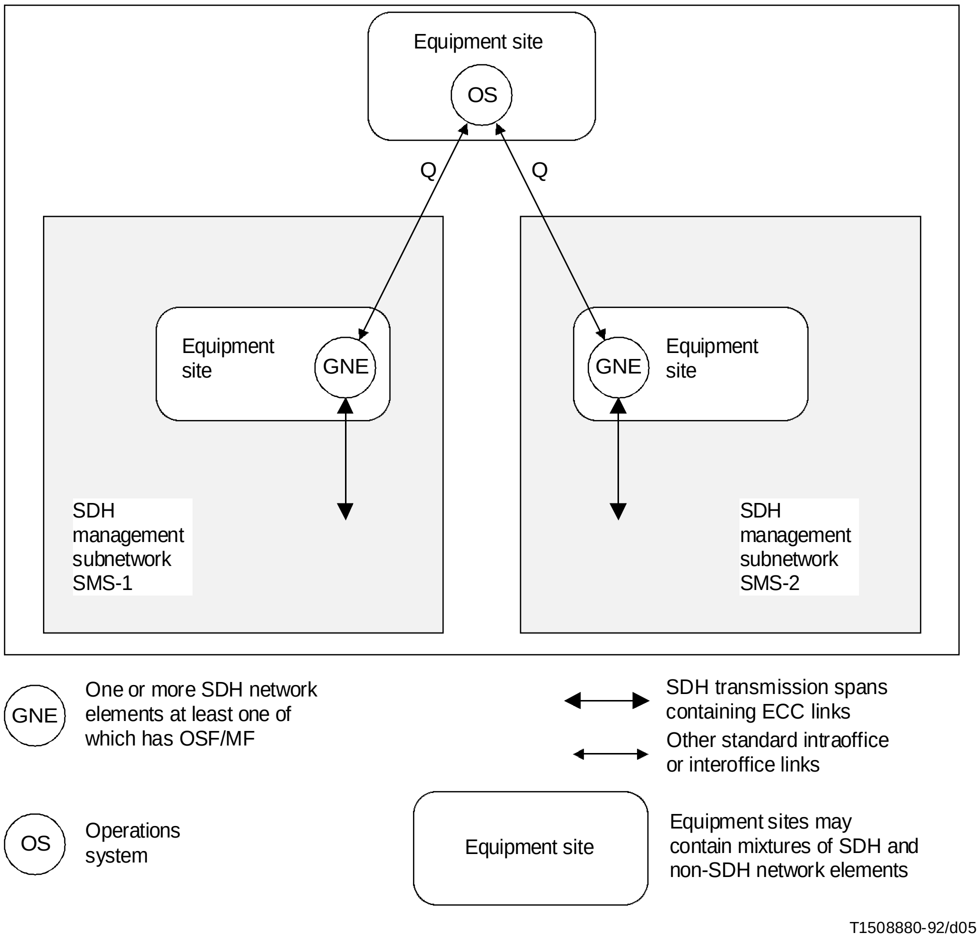


FIGURE 3-5/G.784

SDH ECC topology for sites containing SDH NE with OSF/MF functionality

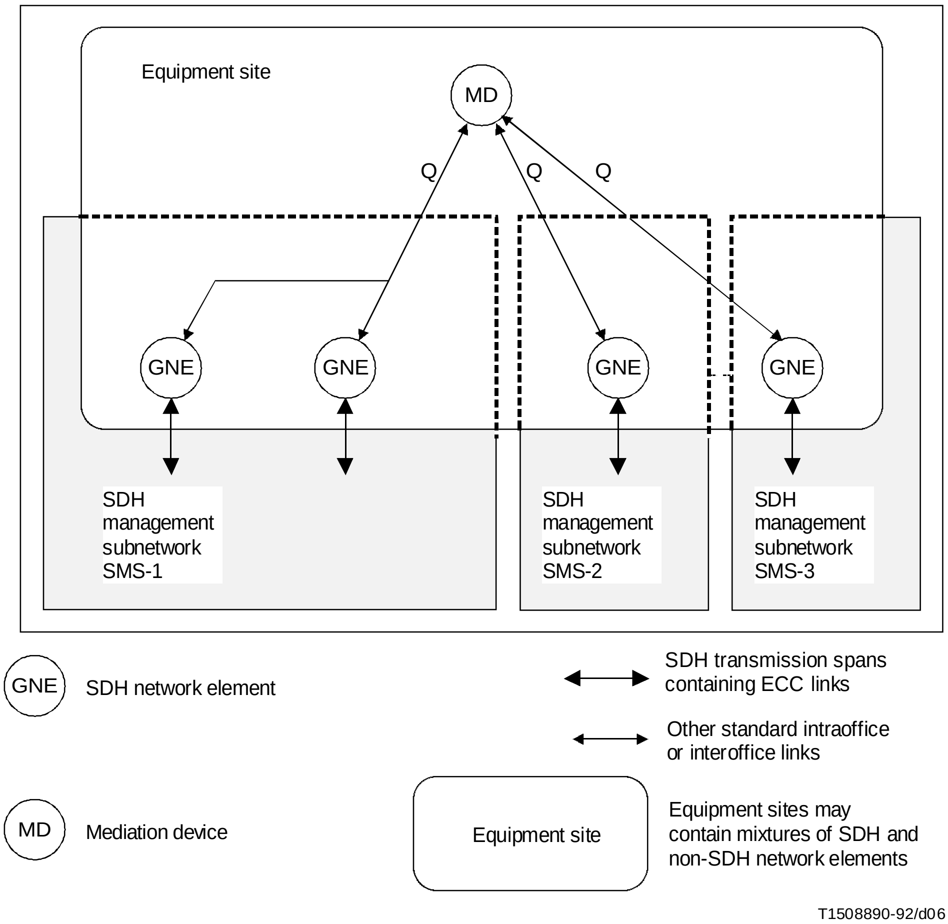
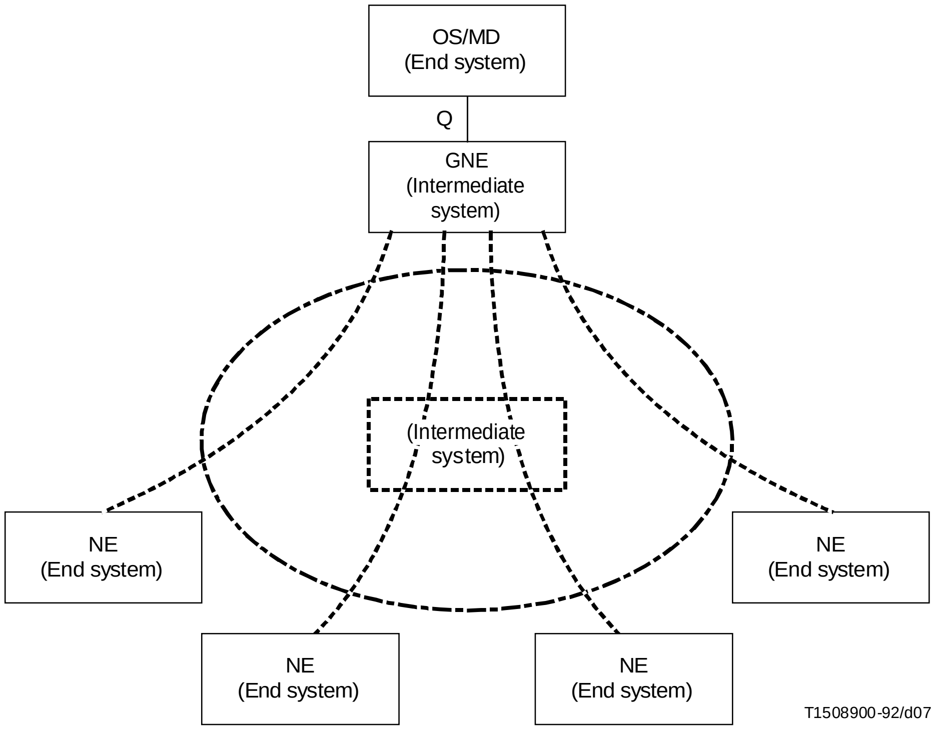


FIGURE 3-6/G.784

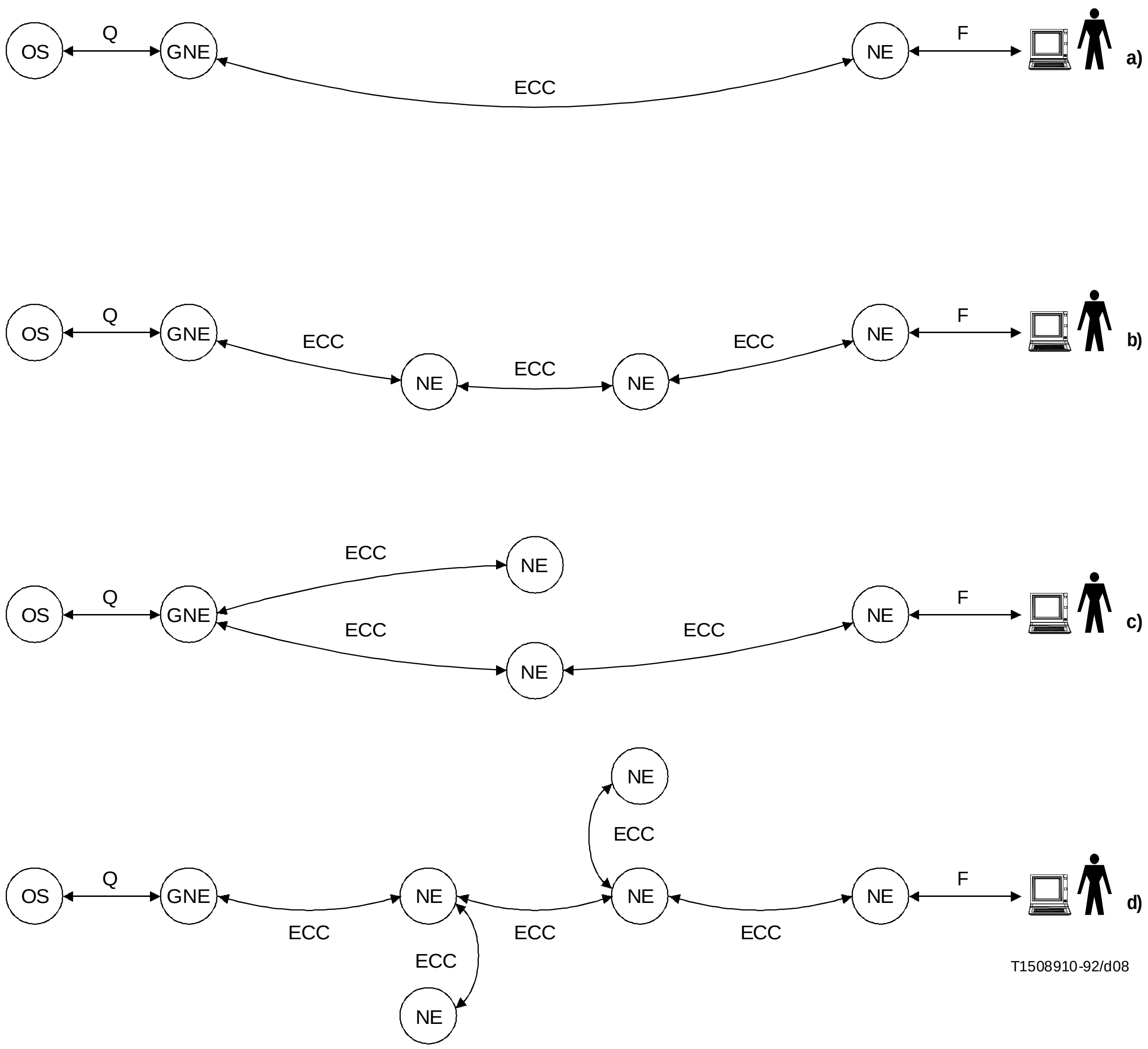
SDH ECC topology for sites with mediation devices



GNE Gateway network element

FIGURE 3-7/G.784

The concept of intermediate and end systems



GNE Gateway network element
NE Network element

NOTE – The ECCs are assumed to be protected by a 1 + 1 protection system whenever possible.

FIGURE 3-8/G.784

Reference models for ECC configuration

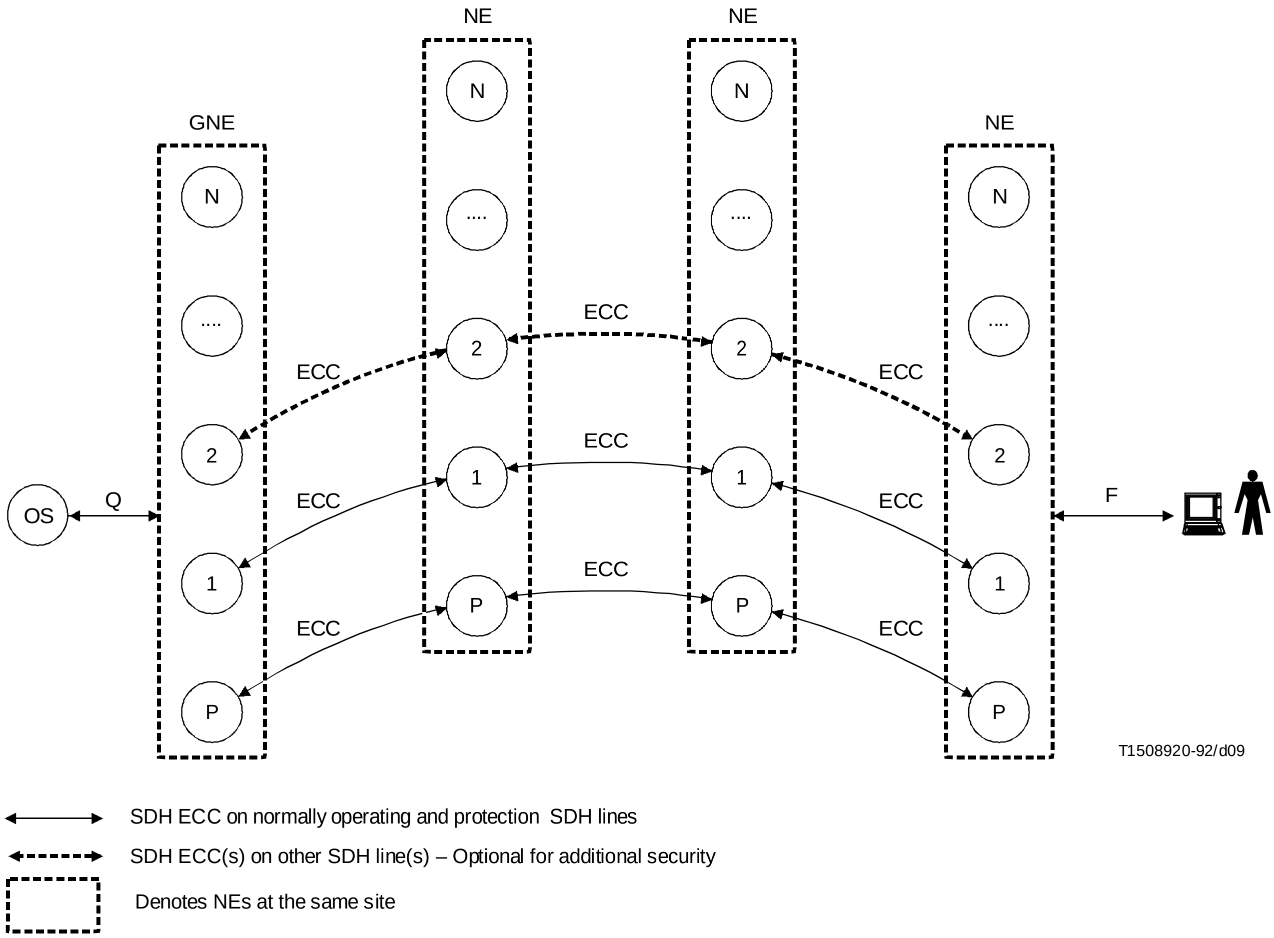


FIGURE 3-9/G.784

Reference models showing the provision of 1 + 1 protected ECC on a 1:n SDH line system

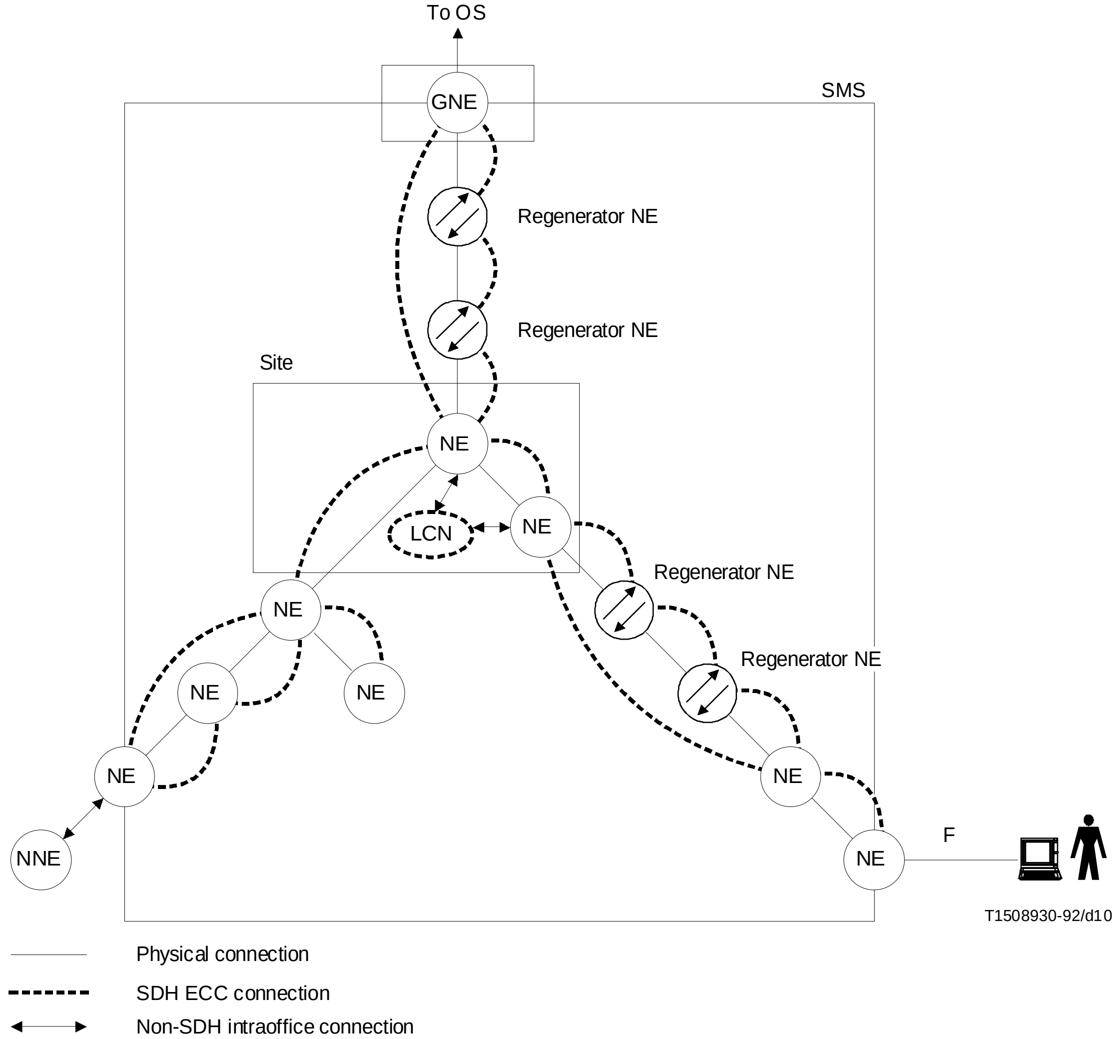


FIGURE 3-10/G.784

Examples of SMS connectivity

5.1 General functions

5.1.1 Embedded control channel (ECC) management

In order for SDH NEs to communicate they must manage the ECC. The ECC management functions defined below are examples of functions required to be supported with ECC messages:

a) retrieval of network parameters to ensure compatible functioning, e.g. packet size, timeouts, quality of service, window size, etc.;

b) establishment of message routing between DCC nodes;

c) management of network addresses;

d) retrieval of operational status of the DCC at a given node; and

e) capability to enable/disable access to the DCC.

5.1.2 Security

For further study.

5.1.3 Software

For further study.

5.1.4 Remote log-in

For further study.

5.1.5 Time-stamping

Events, performance reports and registers containing event counts that require time-stamping shall be time stamped with a resolution of one second. The time shall be as indicated by the local real time clock of the NE. The required accuracy and precise details of the time-stamping of events/reports relative to UTC is the subject of further study.

(A maximum value in the range 1 to 10 seconds is being considered.)

5.2 Fault (maintenance) management

5.2.1 Alarm surveillance

Alarm surveillance is concerned with the detection and reporting of relevant events and conditions which occur in the network. In a network, events and conditions detected within the equipment and incoming signals should be reportable. In addition, a number of events external to the equipment should also be reportable. Alarms are indications that are automatically generated by an NE as a result of certain events and conditions. The OS shall have the ability to define which events and conditions generate autonomous reports, and which shall be reported on request.

The following alarm-related functions shall be supported:

- autonomous reporting of alarms;
- request for reporting of all alarms;
- reporting of all alarms;
- allow or inhibit of autonomous alarm reporting;
- reporting on request status of allow or inhibit alarm reporting.

A summary of alarm conditions is given in A.2.

5.2.2 Alarm history management

Alarm history management is concerned with the recording of alarms. Historical data shall be stored in registers in the NE. Each register contains all the parameters of an alarm message.

Registers shall be readable on demand or periodically. The OS can define the operating mode of the registers as wrapping or stop when full. The OS may also flush the registers or recording stop at any time.

NOTE – Wrapping is the deletion of the earliest record to allow a new record when a register is full. Flushing is the reset to zero of the register.

5.2.3 Testing

For further study.

5.2.4 External events

For further study.

5.3 Performance management

5.3.1 Performance data collection

Performance data collection refers to the event count associated with each of the performance parameters indicated in Recommendation G.826.

The performance events are obtained using the primitives specified in Table A.2.

The performance events are given in Table A.3.

Performance data collection is inhibited during unavailable time, as specified in 5.3.5.

5.3.2 Performance monitoring history

Performance history data are necessary to assess the recent performance of transmission systems. Such information can be used to sectionalise faults and to locate sources of intermittent errors.

Historical data, in the form of performance event counts, shall be stored in registers in the NE. All these registers shall be time stamped.

The following registers will be provided per performance event and per direction of transmission:

- 24-hour registers that accumulate performance events over a fixed 24-hour period;
- 15-minute registers that accumulate performance events over fixed 15-minute periods.

These registers operate as follows:

24-hour registers

Current and recent 24-hour registers accumulate the performance events on a 24-hour basis.

The current 24-hour register shall be reset to zero at the end of each 24-hour period, after the data have been time stamped and transferred to the recent 24-hour register.

15-minute registers

The current 15-minute registers accumulate the performance events count during a 15-minute period.

At the end of the 15-minute period, the content of the current 15-minute registers is transferred to the first of the recent registers, with a time-stamp to identify the particular 15-minute period (including the day). If the content of the current 15-minute register is zero at the end of the 15-minute period, no information is transferred to the recent 15-minute register.

The 15-minute registers form a stack of at least 16 recent registers. When all 15-minute registers are full, a wrapping mechanism is used to discard the oldest information.

NOTE 1 – Wrapping is the deletion of the earliest record to allow a new record when all registers are full.

The above recommended 15-minute register configuration does not preclude an implementation that complies with the 1990 version of this Recommendation.

NOTE 2 – A capability should be provided to insure that, in the absence of reports, the reporting process is functioning properly.

5.3.3 Use of thresholds

The general strategy for the use of performance monitoring information and thresholds is described in Recommendations M.20, M.2100 and M.2120.

5.3.3.1 Threshold setting

The thresholds may be set in the NE, via the OS. The OS shall be able to retrieve and change the settings of the 15-minute and 24-hour thresholds.

The maximum values for the number of events are given in A.12.1 and A.12.2.

5.3.3.2 Threshold crossing notification

As soon as a threshold is reached or crossed for a given performance event, a threshold crossing notification is generated. The detailed functioning of the threshold mechanism is explained in 2.3/M.2120.

5.3.4 Performance data reporting

Performance data stored in the NE may be collected by the OS for analysis.

5.3.4.1 Access by the OS to the performance data

Performance data shall be reportable across the OS/NE interface on demand when requested by the OS.

5.3.4.2 Periodical report of performance data

Data collection may be performed periodically to support trend analysis to predict future failure or degraded conditions. On request of the OS, performance data of specific ports shall be reportable periodically.

5.3.4.3 Autonomous report on reaching or crossing a threshold

Performance data shall be reportable across the NE/OS interface automatically upon reaching or crossing a performance monitoring threshold.

5.3.5 Performance monitoring during unavailable time

Performance event counts shall be inhibited during the unavailable time as defined in G.826.

During changes between available and unavailable states, performance event counts shall be processed in accordance with 5.2/M.2100.

When an unavailable period occurs, the beginning and the ending of this period have to be time stamped and stored in a register in the NE. These two events may generate an event report. The register will be dimensioned to store at least 6 unavailable periods during one day and will be read by OS at least once a day.

5.3.6 Additional monitored events

Additional counts such as OFS, PSC, PSD, UAS, AU PJE, and CSES may be useful. Their implementation is optional (see Table A.4). The OFS, UAS, AU PJE, PSC and PSD event counts may be stored in 15-minute and 24-hour registers, as detailed in 5.3.2.

If AU PJE counters are provided, then positive and negative PJE's shall be counted separately on one selectable AU within an STM-N signal, after the AU has been resynchronized to the local clock.

The CSES event occurs when a sequence that contains X or more consecutive SES is detected. The sequence is terminated by an unavailable period or when a second that is not a SES is encountered. A total of at least 6 time stamped CSES shall be recorded, the time stamp shall indicate the time of the first SES in the sequence. The value of X may be configured by an OS in the range of 2 to 9. When a sequence of consecutive SES is terminated by the entry into an unavailable period the CSES event is not recorded.

5.4 Configuration management

5.4.1 Provisioning

For further study.

5.4.2 Status and control (protection switching)

The general facility of protection switching is defined as the substitution of a standby or back-up facility for a designated facility. The specific functions which allow the user to control the traffic on the protection line are:

- operate/release manual protection switching;
- operate/release force protection switching;
- operate/release lockout;
- request/set automatic protection switching (APS) parameters.

5.4.3 Installation functions

For further study.

5.5 Security management

For further study.

6 Protocol stack

6.1 Description

The protocol stack specified in this clause has been selected to satisfy requirements for the transfer of operations, administration, maintenance and provisioning (OAM&P) messages across the SDH data communications channels (DCC). It is in accordance with the current object oriented approach to the management of open systems.

6.1.1 ECC protocol stack description

The protocols for each layer, as outlined in the following sub-sections, are to be used for management communications over the SDH ECC. The specifications of these protocols are given in 6.2.

6.1.1.1 Physical layer (layer 1)

The SDH data communications channel (DCC) constitutes the physical layer.

6.1.1.2 Data link layer (layer 2)

The data link protocol, LAPD (see Recommendation Q.921 [6]) provides point-to-point connections between nodes of the underlying transmission network.

6.1.1.3 Network layer (layer 3)

The network protocol ISO 8473 [1], provides a datagram service suitable for the higher speed, high quality underlying network. Convergence protocols have been defined in ISO 8473 [1] for the operation of ISO 8473 [1] over both connection-oriented and connectionless data link subnetworks.

6.1.1.4 Transport layer (layer 4)

The transport protocol ensures the accurate end-to-end delivery of information across the network. The protocol creates a transport connection from the underlying connectionless network service (see ISO 8073/AD2 [3]) over both connection-oriented and connectionless data link subnetworks.

6.1.1.5 Session layer (layer 5)

The session protocol ensures that the communications systems are synchronized with respect to the dialogue under way between them and manages, on behalf of the presentation and application layers, the transport connections requires.

6.1.1.6 Presentation layer (layer 6)

The presentation layer and the ASN.1 basic encoding rules act to ensure that application layer information can be understood by both the communicating systems, the context of the information being transferred and the syntax of the encoding of information.

6.1.1.7 Application layer (layer 7)

The following options of the application layer shall be utilized:

i) CMISE

The common management information service element (CMISE) of the ISO common management information protocol (CMIP) ISO 9596 [4] provides services for the manipulation of management information across the ECC.

ii) ROSE

The remote operations service element (ROSE) permits one system to invoke an operation on another system and to be informed of the results of that operation.

iii) ACSE

The association control service element (ACSE) provides services to initiate and terminate a connection (association), between two applications.

6.2 Protocol specifications

This section specifies protocols for the SDH ECC. Where possible, the protocols are specified by reference to Q.811 [7] or Q.812 [8], the lower and upper layer profiles for the Q3 interface. Layer 1, layer 2 and additional parameters for layer 3 are specified here. All other specifications refer to Q.811 [7] or Q.812 [8].

Protocol options, features, parameter values, etc., in addition to those specified in this Recommendation may be included in a conforming system provided they are not explicitly excluded by this Recommendation and they do not prevent interoperability with conforming systems that do not provide them.

A control network topology is outlined in 3.2.2.

6.2.1 Physical layer protocol specification

The regenerator section DCC shall operate as a single 192 kbit/s message channel using the section overhead bytes D1 to D3. The multiplex section DCC shall operate as a single 576 kbit/s message channel using the section overhead bytes D4 to D12.

6.2.2 Data link layer protocol specification

The data link layer shall provide point-to-point transfer, over the SDH DCC, of Network Service Data Units through a single or multiple[1)] logical channel between each pair of adjacent network nodes.

The data link layer shall operate under the rules and procedures specified in Recommendation Q.921 [6] for the Unacknowledged information transfer service specified in 6.2.2.1, and for Acknowledged information transfer service specified in 6.2.2.2. Both services (UITS and AITS) shall be supported. AITS shall be the default mode of operation.

A mapping between the connection-mode Data Link service primitives defined in ISO 8886 [9] (Recommendation X.212 [10]) and Recommendations Q.920 [5] and Q.921 [6] primitives is defined in Table 6-1.

6.2.2.1 Unacknowledged information transfer service

UITS shall follow the rules and procedures specified in Recommendation Q.921 [6]. For the UITS, the sub-network dependent convergence function provides a direct mapping onto the data link layer as specified in 8.4.4.1/ISO 8473/Add.3 [2]. For this application, mandatory and optional service and protocol parameters shall have the values specified in Table 6-2.

6.2.2.2 Acknowledged information transfer services (AITS)

AITS shall follow the rules and procedures specified in Recommendation Q.921 [6]. For AITS, the sub-network dependent convergence function provides a mapping onto the data link layer as specified in 8.4.4.2/ISO 8473/Add.3 [2]. For this application, mandatory and optional service and protocol parameters shall have the values specified in Table 6-3. In addition, the requirements specified in c) to f) of Table 6-2 shall also be followed. The default values defined in Table 6-3 may not be suitable for high delay (satellite) applications.

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1) The use of multiple logical channels is recommended for circuits with a high propagation delay.

TABLE 6-1/G.784

Mapping of Data Link service and Q.920 [5] primitives

Data Link Service Primitive	Q.920 Primitive
DL-CONNECT request DL-CONNECT indication DL-CONNECT response DL-CONNECT confirm DL-DATA request DL-DATA indication DL-DISCONNECT request DL-DISCONNECT indication (Note 3)	DL-ESTABLISH request DL-ESTABLISH indication (Notes 1 and 2) DL-ESTABLISH confirm DL-DATA request DL-DATA indication DL-RELEASE request DL-RELEASE indication DL-RELEASE confirm

NOTES

1 This primitive indicates that the data link connection is open.

2 Recommendation Q.921 will ignore this response.

3 Network layer will ignore this confirmation.

TABLE 6-2/G.784

UITS specification

a)	The unnumbered information (UI) frames shall be used for data transfer as specified in Recommendation Q.921 [6].
b)	As specified in Recommendation Q.921 [6], UI frames shall always be commands. The assignment of user-side/network-side roles (and hence the C/R bit value) shall be made prior to initialization.
c)	Access point identifier (SAPI) Value: 62[a)]
d)	Terminal end-point identifier (TEI) Value: 0 (Note)
e)	Frame size shall be capable of supporting an Information Field of 512 octets as specified in 8.4.2/ISO 8473 [1].
f)	Management procedure, as specified in Recommendation Q.921 [6], shall *not* be supported.
g)	Poll/Final Bit shall always be set to 0, as specified in Recommendation Q.921 [6].

[a)] The need for additional SAPIs is for further study, e.g. to support SDH DCC.

NOTE – Q.921 [6] and Q.922 [11] specify that implementations must route on the two octet address field. Currently two applications use SAPI = 62, SDH ECC (TEI = 0) and frame relay maintenance (TEI = 127).

TABLE 6-3/G.784

AITS specifications

a)	Assignment of user-side/network-side roles, and hence the C/R bit value, shall be made prior to initialization.
b)	The default value for (k): 7
c)	The default value for T200: 1 second
d)	The default value for T203: 10 seconds (Note)
e)	The default value for N200: 3
f)	Data link monitor functions as specified in Recommendation Q.921 [6] are optional.
g)	Negotiation as described in Appendix IV/Q.921 [6] may be used to select alternative parameter values.
NOTE – This parameter is used with the optional procedures listed as item f).	

6.2.3 Network layer protocol specification

The network layer protocol shall be ISO 8473 [1] as specified in 5.3.3/Q.811 [7]. In addition the Quality of service maintenance function shall be used for the selection of AITS or UITS service at layer 2. The QOS parameter shall be used as specified in 6.16/, 7.5.6/ and 7.5.6.3/ISO 8473 [1]. The coding of the QOS parameter for the selection of UITS/AITS is shown below:

1) The absence of a QOS parameter shall select AITS in the data link.

2) In the QOS parameter, bits 7 and 8 set to 1 (globally unique QOS) and bit 1 set to 1 shall select AITS.

3) In the QOS parameter, bits 7 and 8 set to 1 (globally unique QOS) and bit 1 set to 0 shall select UITS.

4) The use of QOS parameter bits 2, 3, 4, 5 and 6 are not the subject of, or specified in, this Recommendation.

The criteria for selecting AITS or UITS is the network provider's responsibility.

6.2.4 Transport layer protocol specification

The required transport layer protocol shall be class 4 operation as specified in 3.2/Q.812 [8].

6.2.5 Session layer

The session layer shall be as specified in 3.3/Q.812 [8].

6.2.6 Presentation layer

The presentation layer shall be as specified in 3.4/Q.812 [8].

6.2.7 Application layer

The application layer shall be as specified in 3.5/Q.812 [8]. Support of the file transfer, access and management (FTAM) protocol is not required.

7 EEC interworking

7.1 Introduction

Within the TMN architecture (see Recommendation M.30), the SMS is a type of local communication network (LCN). Communications between an SMS and OS will take place (optionally) over one or more intervening wide-area data communications networks (DCN) and LCNs. Therefore, interworking is necessary between the SMS and either a DCN or another LCN. Interworking may also be necessary between a DCN and an LCN. This clause will only specify the interworking between a SMS and DCN.

The regenerator section and multiplex section DCCs will use the seven layer, OSI protocol stack specified in clause 6 and includes the connectionless-mode network protocol (CLNP) that is specified in ISO 8473 [1]. For the purpose of this Recommendation, the communications on the DCN between the OS and entry point(s) to the SMS will use an OSI protocol stack that includes the X.25 connection-mode network protocol (CONP) specified in ISO 8208 with ISO IP (ISO 8473 [1]) as an option in the OS.

The OSI architecture describes the view that interworking between sub-networks, such as the SMS and DCN, should take place within the network layer, with the transport and higher layers operating strictly on a peer-to-peer basis between end systems (SNE and OS). ISO 7498 specifies that the network layer will provide the transparent data transfer between transport-entities, i.e. end systems, that is independent of the characteristics, other than quality of service, of different sub-networks. This is identified as the routing and relaying function in the network layer. ISO 8648 specifies the OSI principles of interworking within sublayers of the network layer.

7.2 Interworking between the SMS and DCN

Interworking between the SMS's CLNP and the DCN's CONP OSI protocol stacks shall be required. Interworking, at the lower layers, between the SMS's and the DCN's OSI protocol stacks shall be based upon ISO DTR 10172. The ISO interworking PDTR defines an interworking functional unit (IFU) that will perform relaying and/or conversion of PDUs between networks.

7.3 Network layer relay overview

The IFU, operating in the NLR mode, would function as a regular intermediate system and is the only OSI compliant method of interworking between end systems with different OSI network protocols. As specified in ISO 7498 and ISO 8648, interworking is a network layer function. ISO 8473 [1] specifies the CLNP and describes an SNDCF that specifies the rules for operating the CLNP over a X.25 packet switched network (PSN).

The NLR could provide interworking between the SMN and the DCN if both the SMN and DCN operated the ISO 8473 [1] CLNP and utilized TP class 4 (TP4) connections. The top-level SMS SNE – DCN OS network service would then be connectionless, with the X.25 PSN providing an underlying CONP from the IFU to the OS via the DCN. The IFU would examine the destination address of network PDUs (NPDU) received from the SMN and then transfer those CLNP NPDUs (from the SMS) to an appropriate X.25 switched virtual circuit (SVC) on the DCN.

8 Operations interfaces

8.1 Q-interface

For interconnection with the TMN, the SMS will communicate through a Q-interface having a protocol suite, B1, B2 or B3 as defined in Recommendation G.773. The selection of which of the three protocol suites to adopt is a network provider's decision.

8.2 F-interface

For further study.

Annex A

Support object, attributes and messages

(This annex forms an integral part of this Recommendation)

A.1 ECC

For further study.

A.2 Alarms

A.2.1 SDH alarm indications

Table A.1 contains a summary of alarm indications required to be available for reporting, if enabled. This information is derived from the anomalies and defects tables in Recommendation G.783 [12].

A.3 Performance monitoring

A.3.1 SDH data collection

Required (R) primitives and performance events are given in Tables A.2 and A.3 respectively. Other monitored events are indicated as optional (O) in Table A.4.

A.3.2 SDH thresholding

SDH thresholding requirements are given in Table A.12.

A.4 Protection switching control

For further study

A.5 Configuration

For further study.

A.6 Security

For further study.

A.7 Testing

For further study.

A.8 External events

For further study.

A.9 Software download

For further study.

A.10 Remote log in

For further study.

A.11 Detailed network model

For further study.

TABLE A.1/G.784

Required defect indications

Defect	SPI	RS	MS	Path HOVC	Path LOVC	PPI/LPA	SETS
TF	R					R	
LOS	R					R	
LOF		R				R+	
LOP				R	R		
FERF			R	R	R		
TIM				R	R#		
SLM				R	R		
LOM				R*			
AIS			R	R	R		
Exc			O				
LTI							R
SD			O				

O Optional

R Required

TF	Transmit Fail	SPI	Synchronous Physical Interface
LOS	Loss of Signal	RS	Regenerator Section
LOF	Loss of Frame	MS	Multiplex Section
LOP	Loss of Pointer	HOVC	Higher Order Virtual Container
FERF	Far-End Receive Failure	LOVC	Lower Order Virtual Container
TIM	Trace Identifier Mismatch	PPI/LPA	Plesiochronous Physical Interface/ Lower order Path Adaptation
SLM	Signal Lable Mismatch		
LOM	Loss of Multiframe	SETS	Synchronous Equipment Timing Source
AIS Exc	Alarm Indication Signal Excessive errors	*	Only for payloads that require the multiframe indication
LTI	Loss of Timing Inputs	+	For byte synchronous mappings only
SD	Signal Degrade	#	Provided that use of the J2 byte in the VC-11, 12 and 2 is confirmed

NOTE – The term “defect” is defined in Recommendation M.20.

TABLE A.2/G.784

SDH performance primitives

Impairment type	Performance primitives	RS	MS	Path HOVC	Path LOVC
Parity violation	EB (Notes 1 and 2)	A	R	R	R
	Defect	R	R	R	R

A Application specific (i.e. not required in the case of no intermediate regenerators)

R Required

EB Errored Block

NOTES

1 As indicated in Annex C/G.826, an estimate of EBs can be derived from an appropriate translation from BIP error count to Errored Block count.

2 For some applications, FEBE is also required.

TABLE A.3/G.784

SDH performance events

Performance primitives	Performance events	RS	MS	Path HOVC	Path LOVC
EB (Note 1)	BBE	A	R	A	A
EB (Note 1), Defect (Note 2)	ES	A	R	A	A
	SES	O	R	A	A

R Required

O Optional

A Application specific (e.g. not required in the case of no intermediate regenerators)

BBE Background Block Error

NOTES

1 As indicated in Annex C/G.826, an estimate of EBs can be derived from an appropriate translation from BIP error count to Errored Block count.

2 The defects included in the calculation of ES and SES events are defined in Tables 4-1/G.783 to 4-15/G.783 [12].

TABLE A.4/G.784

SDH additional monitored events

Monitored events	RS	MS	Path HOVC	Path LOVC
OFS	O			
PSC		O		
PSD		O		
UAS	O	O	O	O
CSES	O	O	O	O
AU PJE			O	

O Optional
PSC Protection Switching Count
UAS Unavailable Second
AU PJE Administrative Unit Pointer Justification Event
OFS Out of Frame Second
PSD Protection Switching Duration
CSES Consecutive SES counts configurable in the range of 2 to 9 SES

A.12 Threshold values

A.12.1 15-minute window

The threshold values for events evaluated over the 15-minute period should be programmable.

The maximum values for the number of events are:

- 900 for the ES and SES events;
- $2^{16} – 1$ for the BBE event in the case of VC-11 up to VC-4 paths;
- $2^{24} – 1$ for the BBE event in the case of VC-4 nc paths and STM-N ($n \leq 16$ and $N \leq 16$);

  $2^{16} – 1$ for each positive and negative counts of AU PJE.

A.12.2 24-hour window

For further study.

Annex B

Network layer protocol procedures

(This annex forms an integral part of this Recommendation)

If it is felt that the administrative procedures for manually inputting routing information is burdensome or no routing information is available, another procedure may be used. This procedure, called broadcast routing, consists of the forwarding of the network protocol data units to all underlying services except the service from which it may have been received.

The ISO IP protocol (ISO 8473) [1], requires an error message be created when an NPDU is received with an unknown address. The error reporting flag may be set to inhibit error messages. However, this procedure inhibits all error messages and not just routing error messages. It may be utilized, with the loss of some maintenance functionality, at the discretion of the user.

Annex C

A mechanism to eliminate routing control administration in the SMS

(This annex forms an integral part of this Recommendation)

A layer 2 multicast function and a media access (MA) sublayer are introduced to eliminate the need for intermediate system functionality at branch points in the SMS. Thus, any SMS, no matter how complex the topology, will consist of one intermediate system (the GNE) and a number of end systems.

C.1 Data link layer protocol description

The main purpose of the data link layer is to provide a broadcast service with address filtering, to the network layer. It must achieve this using the underlying SDH DCC network, which is made up from a series of physical point-to-point links. The data link layer is made up from two sublayers, one controlling logical links and one dealing with media access (see Figure C.1).

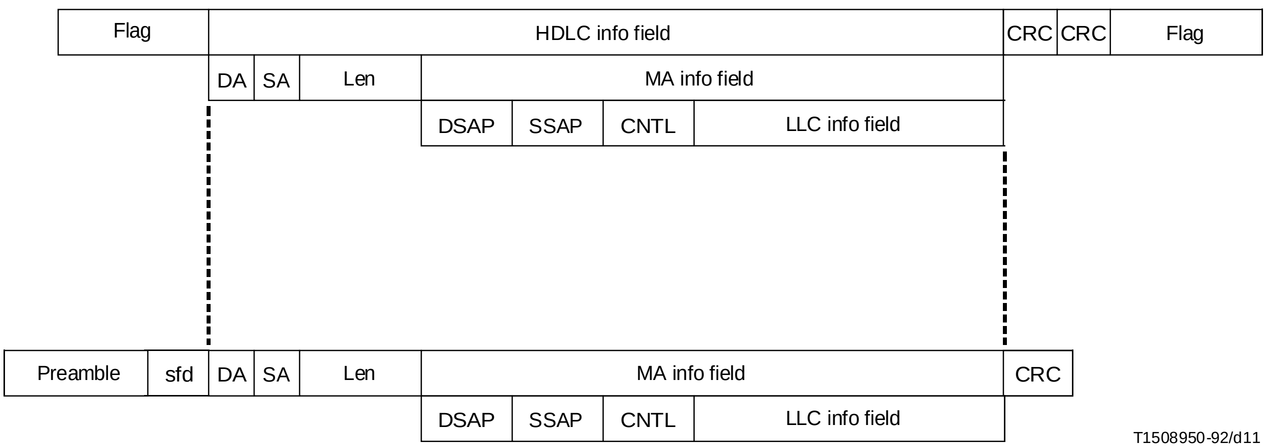

FIGURE C.1/G.784

Comparison of ISO 8023 frame (lower) and the proposed HDLC frame with an embedded MA frame (upper)

C.1.1 Logical link control (LLC) sublayer description

Since the network layer assumes an underlying connectionless mode sub-network, ISO 8802 class 1 logical link control shall be used. This protocol needs 3 octets at the start of the LLC PDU (see Table C.1).

These octets are carried in the media access sublayer information field.

TABLE C.1/G.784

Octet	Field
1	Destination service Access Point (DSAP)
2	Source Service Access Point (SSAP)
3	Control (CNTL) field
4 to N	LLC information field

C.1.2 Media access sublayer description

The description of the media access (MA) sublayer covers three areas, the general operation, the format of various fields and the bit oriented frame structure. The sublayer is based on a combination of the IEEE 802.3 MAC services plus part of the frame structure and the Q.921 HDLC frame structure.

The service this sublayer provides is to transfer LLC PDUs from one LLC sublayer entity to a peer LLC sublayer entity, by transporting the LLC PDUs across a physical sub-network, which is made up from SDH NEs connected by point to point SDH DCCs.

The sublayer uses HDLC framing and the octets shown in Table C.2 are carried in the HDLC frame information field.

TABLE C.2/G.784

Octet	Field
1-6	Destination address (DA)
7-12	Source address (SA)
13-14	Length (Len)
15-N	MA information field
DA	MA address of the NE for which the PDU is intended
SA	MA address of the NE that originated the PDU
Len	Length in octets of LLC PDU, which is carried in the MA information field

The provision of the NE address is a local matter, but it shall be assigned to a NE prior to initialization.

The operation of the sublayer is a combination of address filtering and frame relay. When an MA frame is received at an SDH NE, the following basic algorithm is applied. If the MA destination address (DA) of the received frame matches the MA address of the NE or it is a group address, the HDLC information field is passed to the logical link sublayer. If the MA destination address (DA) of the received frame does not match the MA address of the NE or it is a group address, the frame is sent out on all DCC physical ports, except the one it was received on.

C.1.3 HDLC description

The purpose of the HDLC frame is to provide a bit structure that can be transmitted to and received from the SDH DCC physical line. It also provides for the removal of corrupted frames using the cyclic redundancy check. Since the frequency of errors on an optical line is so low, it is not efficient to perform retransmission of lost frames at this layer.

The HDLC frame described in clause 2/Q.921 shall be used. However, the address (see 2.3/Q.921) and control (see 2.4/Q.921) fields shall not be used, because they are redundant. Present hardware will be able to operate with this partial use of HDLC.

The fields shall be defined as in Table C.3.

TABLE C.3/G.784

Octet	Field
1	Flag
2-(N-3)	HDLC information field
(N-2)	CRC
(N-1)	CRC
N	Flag

The HDLC information field length must be at least 529 octets (512 + 3 + 14); 512 octets for the NPDU, 3 octets for LLC 1 and 14 octets for the MA address.

Two further options in the use of HDLC are outlined in the section entitled "HDLC options".

C.2 Physical layer description

The physical layer consists of a point-to-point connection, between SDH network elements, where it is terminated. The data link PDUs are carried in the octets (D1 to D3 or D4 to D12) of the SDH DCC, which form two clear channels. There is no physical layer signalling protocol associated with this layer.

Annex D

Object model overview

(This annex forms an integral part of this Recommendation)

An information model provides a structured means of describing a portion of the real world that is of interest. Information models use a formal notation and vocabulary for organizing, classifying, and abstracting items. Information is identified in terms of objects. Detailed characteristics of each object are described in terms of attributes and behaviour. Objects with similar properties may be grouped into object classes. Additionally, associations between object instances may be described by relationships.

A telecommunications information model provides a means of describing those items used to provide telecommunications services. Such an information model, applicable to all telecommunications networks, is essential for the consistent management of different types of telecommunications networks. The SDH information model is a subset of the telecommunications network information model.

The SDH information model will allow a manager to obtain the following from an agent regarding those entities for which it is responsible:

a) object classes and instances (what the entities are);

b) attributes and methods (what they know and how they behave);

c) relationships (what they are related to and how they relate).

Criteria for evaluating the SDH information model include:

1) Satisfactory management of the transport reference configurations, a subset of which is given in Figure D.1. Test cases are for further study. These test cases should minimally address the network-wide management of paths, as well as the management of equipment.

2) Unambiguous inter-vendor communications, when the reference configurations are provided by equipment from different vendors.

3) Unambiguous inter-operator communications when the reference configurations cross one or more inter-operator boundaries.

4) Ability to generate a unique mapping of the information model to the functional reference model described in Recommendations G.782 and G.783.

5) Ability to manage the reference configurations in the context of a large network which has many network elements and crosses multi-operator boundaries.

6) Controlled mechanism for extending the information model within the procedures of ITU-T.

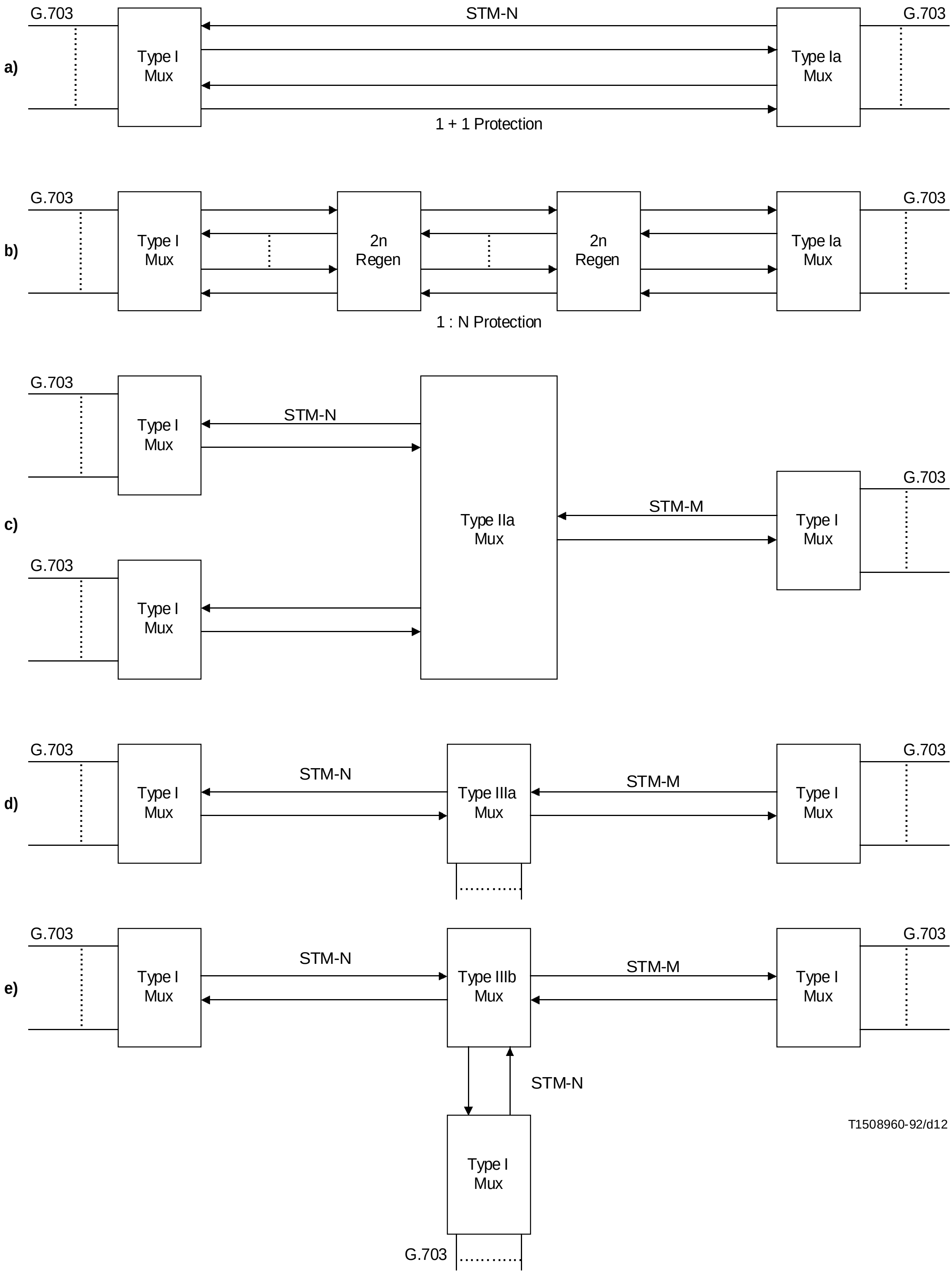

FIGURE D.1/G.784

Transport reference configurations

References

[1] ISO 8473:1988 – *Information processing systems – Data communications – Protocol for providing the connectionless-mode network service*.

[2] ISO 8473:1989/Add.3 – *Information processing systems – Data communications – Protocol for providing the connectionless-mode network service – Addendum 3: Provision of the underlying service assumed by ISO 8473 over point-to-point subnetworks which provide the OSI data link service*.

[3] ISO/IEC 8073:1989/Add.2 – *Information processing systems – Open Systems interconnection – Connection oriented transport protocol specification – Addendum 2: Class 4 operation over connectionless network service*.

[4] ISO/IEC 9596:1991 – *Information processing systems – Open systems interconnection – Common management information protocol specification (CMIP)*.

[5] ITU-T Recommendation Q.920 – *ISDN User-network interface – Data link layer – General aspects*.

[6] ITU-T Recommendation Q.921 – *ISDN User-network interface – Data link layer specification*.

[7] ITU-T Recommendation Q.811 – *Lower layer profiles for the Q3 interface*.

[8] ITU-T Recommendation Q.812 – *Upper layer profiles for the Q3 interface*.

[9] ISO/IEC 8886:1992 – *Information processing systems – Data communications - Data link service definitions for open systems interconnection*.

[10] ITU-T Recommendation X.212 – *Data link service definitions for open systems interconnection for ITU-T applications*.

[11] ITU-T Recommendation Q.922 (1992) – *ISDN data link layer specification for frame relay mode bearer services*.

[12] ITU-T Recommendation G.783 (1993) – *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks*.

[13] ITU-T Recommendation G.774 – *Synchronous Digital Hierarchy (SDH) Management Information Model for the Network Element View*.