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INTERNATIONAL TRANSMISSION SYSTEMS,
TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE
AND LEASED CIRCUITS

International transport network

**Performance limits for bringing-into-service and
maintenance of international multi-operator PDH
paths and connections**

ITU-T Recommendation M.2100

ITU-T M-SERIES RECOMMENDATIONS

TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

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ITU-T Recommendation M.2100

Performance limits for bringing-into-service and maintenance of international multi-operator PDH paths and connections

Summary

This Recommendation provides limits for bringing-into-service and maintenance of international multi-operator PDH paths which operate at or above the primary rate, and connections which operate below the primary rate. Error, timing and availability performance are considered. A method for deriving ES and SES from in-service measurement is given for all hierarchical levels. Sections are not covered by this Recommendation. BIS limits and maintenance procedures for radio sections are described in the relevant ITU-R Recommendations.

Source

ITU-T Recommendation M.2100 (2003) was approved by ITU-T Study Group 4 (2001-2004) under the ITU-T Recommendation A.8 procedure on 13 April 2003.

Keywords

Availability, bringing-into-service (BIS), digital path, digital connection, error performance parameter, errored second (ES), maintenance limit, performance allocation, performance objective (PO), severely errored second (SES), unavailability.

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ITU-T Recommendation M.2100

Performance limits for bringing-into-service and maintenance of international multi-operator PDH paths and connections

1 Scope

The purpose of this Recommendation is to provide limits for bringing-into-service and limits for maintenance of international multi-operator digital PDH paths which operate at or above the primary rate, and connections which operate below the primary rate, in order to achieve the performance objectives given for a multiservice environment. These objectives include error performance (ITU-T Recs G.821 and G.826), timing performance (ITU-T Rec. G.822) and availability. This Recommendation defines the parameters and their associated objectives in order to respect the principles given in ITU-T Recs M.20, M.32 and M.34.

"International multi-operator" in this Recommendation refers to PDH paths and connections which cross international boundaries with a change in jurisdictional responsibility.

The methods and procedures for applying these limits are described in ITU-T Rec. M.2110 for the bringing-into-service procedures and in ITU-T Rec. M.2120 for the maintenance procedures.

This Recommendation uses certain principles which are the basis of the maintenance of a digital network:

- it is desirable to do in-service, continuous measurements. In some cases (e.g., for bringing-into service), out-of-service measurements may be necessary;
- a single set of parameters must be used for maintenance of every level of the hierarchy (this principle does not apply to limits);
- error performance limits of transmission systems are dependent on the medium used; however, due to the many possible network structures, error performance limits on paths are independent of the medium.

Since the performance limits are intended to satisfy the needs of the evolving digital network, it must be recognized that such limits might not be achieved by all of today's digital equipment and systems.

Currently, this Recommendation covers the error performance limits for paths at every level of the PDH hierarchy and in-service parameter evaluation criteria up to the quaternary layer and, for connections below the primary rate, down to 64 kbit/s. Sections are not covered.

By bilateral agreement, ITU-R Rec. F.1330-1 may be used in conjunction with this Recommendation for radio-relay systems where applicable.

Throughout this Recommendation the terms "path" and "connections" should be understood as digital.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-R Recommendation F.1330-1 (1999), *Performance limits for bringing-into-service of the parts of international plesiochronous digital hierarchy and synchronous digital hierarchy paths and sections implemented by digital radio-relay systems.*
- ITU-T Recommendation G.703 (2001), *Physical/electrical characteristics of hierarchical digital interfaces.*
- ITU-T Recommendation G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels.*
- ITU-T Recommendation G.706 (1991), *Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704.*
- ITU-T Recommendation G.724 (1988), *Characteristics of a 48-channel low bit rate encoding primary multiplex operating at 1544 kbit/s.*
- ITU-T Recommendation G.732 (1988), *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s.*
- ITU-T Recommendation G.733 (1988), *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s.*
- ITU-T Recommendation G.734 (1988), *Characteristics of synchronous digital multiplex equipment operating at 1544 kbit/s.*
- ITU-T Recommendation G.735 (1988), *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s and offering synchronous digital access at 384 kbit/s and/or 64 kbit/s.*
- ITU-T Recommendation G.736 (1993), *Characteristics of a synchronous digital multiplex equipment operating at 2048 kbit/s.*
- ITU-T Recommendation G.737 (1988), *Characteristics of an external access equipment operating at 2048 kbit/s offering synchronous digital access at 384 kbit/s and/or 64 kbit/s.*
- ITU-T Recommendation G.738 (1988), *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s and offering synchronous digital access at 320 kbit/s and/or 64 kbit/s.*
- ITU-T Recommendation G.739 (1988), *Characteristics of an external access equipment operating at 2048 kbit/s offering synchronous digital access at 320 kbit/s and/or 64 kbit/s.*
- ITU-T Recommendation G.742 (1988), *Second order digital multiplex equipment operating at 8448 kbit/s and using positive justification.*
- ITU-T Recommendation G.743 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and using positive justification.*
- ITU-T Recommendation G.745 (1988), *Second order digital multiplex equipment operating at 8448 kbit/s and using positive/zero/negative justification.*
- ITU-T Recommendation G.747 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and multiplexing three tributaries at 2048 kbit/s.*
- ITU-T Recommendation G.751 (1988), *Digital multiplex equipments operating at the third order bit rate of 34 368 kbit/s and the fourth order bit rate of 139 264 kbit/s and using positive justification.*
- ITU-T Recommendation G.752 (1988), *Characteristics of digital multiplex equipments based on a second order bit rate of 6312 kbit/s and using positive justification.*
- ITU-T Recommendation G.753 (1988), *Third order digital multiplex equipment operating at 34 368 kbit/s and using positive/zero/negative justification.*

- ITU-T Recommendation G.754 (1988), *Fourth order digital multiplex equipment operating at 139 264 kbit/s and using positive/zero/negative justification.*
- ITU-T Recommendation G.755 (1988), *Digital multiplex equipment operating at 139 264 kbit/s and multiplexing three tributaries at 44 736 kbit/s.*
- ITU-T Recommendation G.761 (1988), *General characteristics of a 60-channel transcoder equipment.*
- ITU-T Recommendation G.762 (1988), *General characteristics of a 48-channel transcoder equipment.*
- ITU-T Recommendation G.775 (1998), *Loss of Signal (LOS) and Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) defect detection and clearance criteria for PDH signals.*
- ITU-T Recommendation G.793 (1988), *Characteristics of 60-channel transmultiplexing equipments.*
- ITU-T Recommendation G.794 (1988), *Characteristics of a 24-channel transmultiplexing equipment.*
- ITU-T Recommendation G.821 (2002), *Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an Integrated Services Digital Network.*
- ITU-T Recommendation G.822 (1988), *Controlled slip rate objectives on an international digital connection.*
- ITU-T Recommendation G.823 (2000), *The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy.*
- ITU-T Recommendation G.824 (2000), *The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy.*
- ITU-T Recommendation G.826 (2002), *End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections.*
- ITU-T Recommendation H.221 (1999), *Frame structure for a 64 kbit/s to 1920 kbit/s channel in audiovisual teleservices.*
- ITU-T Recommendation M.20 (1992), *Maintenance philosophy for telecommunication networks.*
- ITU-T Recommendation M.32 (1988), *Principles for using alarm information for maintenance of international transmission systems and equipment.*
- ITU-T Recommendation M.34 (1988), *Performance monitoring on international transmission systems and equipment.*
- ITU-T Recommendation M.35 (1988), *Principles concerning line-up and maintenance limits.*
- ITU-T Recommendation M.60 (1993), *Maintenance terminology and definitions.*
- ITU-T Recommendation M.2110 (2002), *Bringing into service international multi-operator paths, sections and transmission systems.*
- ITU-T Recommendation M.2120 (2002), *International multi-operator paths, sections and transmission systems fault detection and localization procedures.*

3 Terms and definitions

General terms and definitions related to this Recommendation are provided in ITU-T Rec. M.60. In addition, this Recommendation defines the following terms:

3.1 Performance Objective (PO): Performance objective for the international portion of the hypothetical reference path (see Figure 3/G.826) and the hypothetical reference connection (see Figure 1/G.821).

3.2 Allocated Performance Objective (APO): Performance objective for a real path or connection calculated according to the allocation rules.

3.3 Bringing-Into-Service Performance Objective (BISPO): Bringing-into-service performance objective for a real path or connection calculated from its APO.

3.4 international portion: An international digital path can be subdivided into two national portions and one international portion. The boundary between these portions is defined to be at an International Gateway (IG), which corresponds to:

- an International Switching Centre (ISC), on the international side, for 64 kbit/s paths between switches (IG = ISC = Path End Point (PEP));
- an International Digital Transmission Centre (IDTC) for paths at 2 Mbit/s and above (IG = IDTC = PEP), carrying lower order paths providing paths between ISCs or leased lines.

When the 2 Mbit/s paths are terminated inside an ISC (ISC = PEP), IG is located at the IDTC associated with the ISC. No national portion has to be considered since IDTC and ISC are situated in the same geographical area.

The national portion is outside the scope of this Recommendation.

3.5 international boundary and border crossing points: The International Boundary, the point at which control transfers from one international operator to the next international operator, normally exists within the Inter Country Path Core Element (ICPCE). Generally, this would be half-way along a submarine cable or terrestrial border crossing ICPCE. The Border Crossing Point may coincide with the International Boundary (for example, for a terrestrial border crossing ICPCE) or, in the case of a submarine cable (for example), there would be two border crossings, corresponding to the coastline of the operator's country, which would not coincide with the International Boundary.

3.6 Path Core Element (PCE): An international digital path has been partitioned in geographical terms for the purpose of allocating the PO. These partitions have been titled Path Core Elements.

Two types of PCEs are used:

- an International Path Core Element (IPCE) is between an IG and a frontier station (FS) in a terminating country, or between frontier stations in a transit country;
- an ICPCE is between the adjacent frontier stations of the two countries involved. The ICPCE corresponds to the highest order digital path carried on a digital transmission system linking the two countries. An ICPCE may be transported on a terrestrial, satellite or undersea cable transmission system.

There are two cases where a country may not contain an IPCE:

- depending on the geographical situation and network topology, the IG may coincide with the FS in a terminating country;
- the path uses only one FS in a transit country.

4 Abbreviations

This Recommendation uses the following abbreviations:

AIS	Alarm Indication Signal
APO	Allocated Performance Objective
BER	Bit Error Ratio
BIS	Bringing-Into-Service
BISPO	Bringing-Into-Service Performance Objective
CRC	Cyclic Redundancy Check
DPL	Degraded Performance Level
ES	Errored Second
FAS	Frame Alignment Signal
FS	Frontier Station
IB	International Boundary
ICPCE	Inter-Country Path Core Element
IDTC	International Digital Transmission Centre
IG	International Gateway
IPCE	International Path Core Element
ISC	International Switching Centre
ISDN	Integrated Services Digital Network
LOF	Loss Of Frame
LOS	Loss Of Signal
PCE	Path Core Element
PDH	Plesiochronous Digital Hierarchy
PEP	Path End Point
PO	Performance Objective
PRBS	Pseudo-Random Binary Sequence
RDI	Remote Defect Indication
SES	Severely Errored Second
TMN	Telecommunications Management Network
TP	Test Period
UPL	Unacceptable Performance Level

5 Reference models

5.1 Hypothetical reference performance models for international 64 kbit/s connections

Two ITU-T Recommendations deal with performance of international digital connections operating below the primary rate:

- ITU-T Rec. G.821 for connections using equipment designed before the adoption of ITU-T Rec. G.826 in November 2002;
- ITU-T Rec. G.826 for the other connections.

So, two reference models are defined, one for connections designed to ITU-T Rec. G.821 and another one for connections designed to ITU-T Rec. G.826 (2002).



5.1.1 Connections using equipment designed before the adoption of ITU-T Rec. G.826 (2002)

The physical relationship between international paths of the primary rate network layer and connections in the 64 kbit/s network layer is illustrated in Figure 1.

Key points to note in Figure 1 are:

- a) Paths of the primary rate network layer can serve either:
 - peer-layer clients, e.g., an H12 channel in the case of 2048 kbit/s paths; or
 - lower order clients, e.g., 64 kbit/s section of a path in the 64 kbit/s network layer.
- b) The international portion of the 64 kbit/s connection is given 40% of the end-to-end error PO.
- c) Some examples of international primary rate paths are given in Annex A. These examples also illustrate the breakdown of the international primary rate path into PCEs; the PCE APOs are given in Table 2b.
- d) Simple addition of the PCE APOs is assumed when determining the end-to-end APO (i.e., between primary rate – PEPs). Moreover, simple addition of tandemed international primary rate path APOs is assumed when considering the APO offered to the section of the 64 kbit/s network layer.
- e) Sensible engineering planning is required to ensure that tandemed international primary rate paths respect the 40% allocation to 64 kbit/s connections.

5.1.2 Connections using equipment designed after the adoption of ITU-T Rec. G.826 (2002)

The physical relationship between connections and higher order paths is illustrated in Figure 2a.

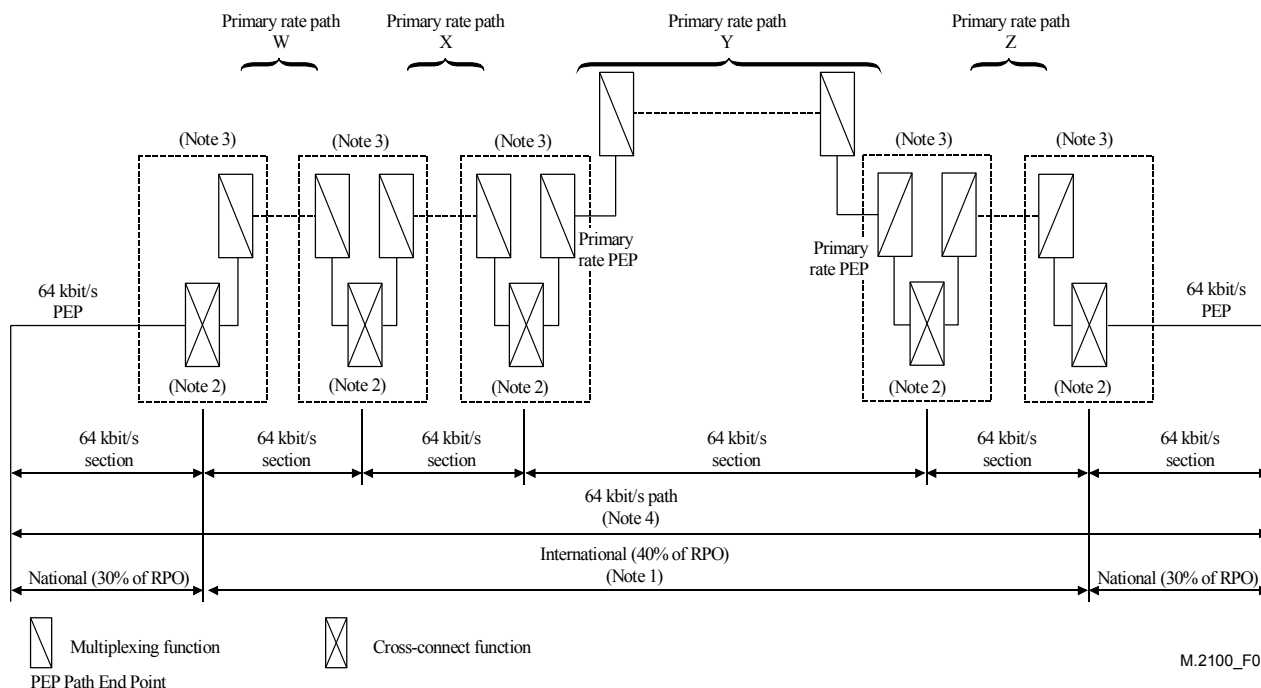
Key points to note in Figure 2a:

- a) Allocation of the end-to-end connection is specified in ITU-T Rec. G.826.
- b) The international portion of connections is given a maximum of 63% of the end-to-end PO.

5.2 Hypothetical reference performance model for international primary and higher order paths

The physical relationship between international primary and higher order paths is illustrated in Figure 2b. Key points to note in Figure 2b are:

- a) Allocation of the end-to-end path is specified in ITU-T Rec. G.826.
- b) According to ITU-T Rec. G.826, the international portion of primary and higher order paths are given a maximum 63% of the end-to-end error PO.
- c) Sensible engineering planning is required to ensure that international "n" Mbit/s paths in tandem, above or equal to the primary rate respect the 63% allocation.
- d) Some examples of primary and higher order international paths are provided in Annex A.



NOTE 1 – The international portion of 64 kbit/s path may be made up of up to 4 tandem primary rate paths W, X, Y and Z, where $W + X + Y + Z \leq 40\%$ of the total RPO.

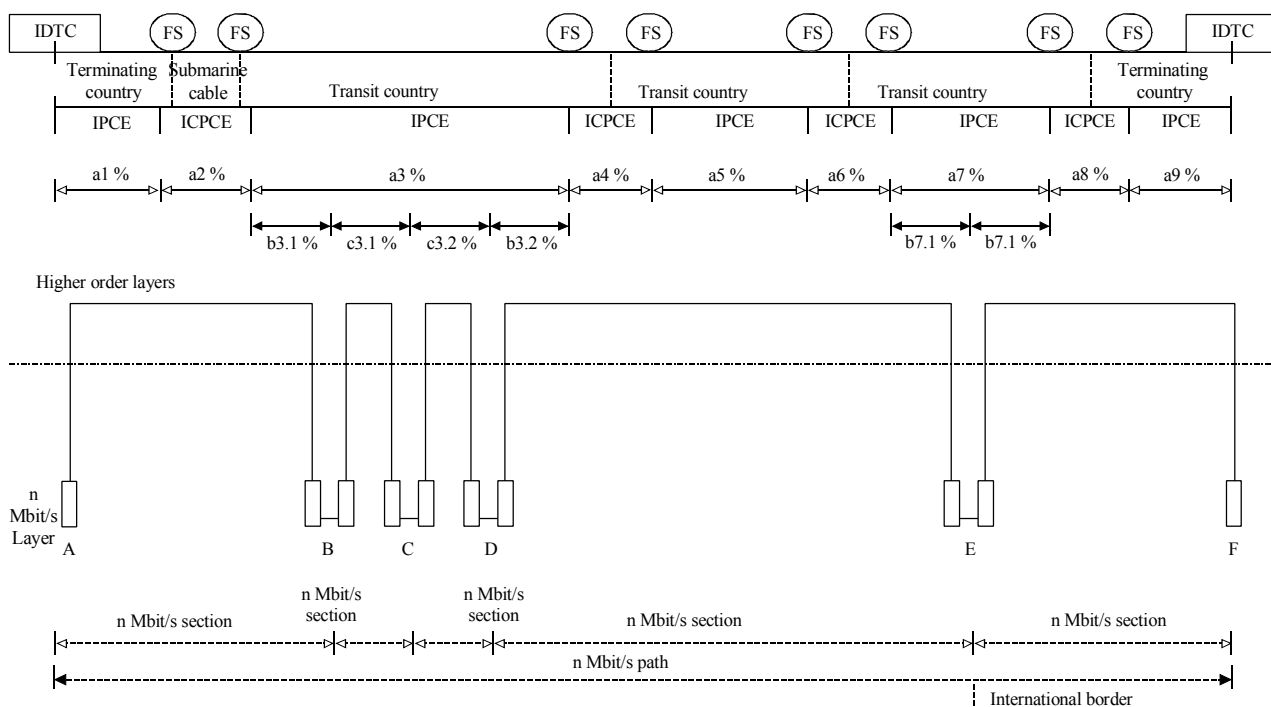
NOTE 2 – For a 64 kbit/s switched connection, this point has historically been referred to as an (International Switching Centre).

For other network layers, the node of the network (e.g., digital distribution frames) is defined to exist at the International Digital Transmission Centre (IDTC).

NOTE 3 – The primary rate PEPs logically terminate the primary rate transmission network layer. Physically, however, it might reside in a 64 kbit/s node, e.g., an International Switching Centre for International 64 kbit/s switched ISDN path.

NOTE 4 – In the case of a 64 kbit/s ISDN path, further information on the partitioning of quality classes (e.g., high grade, medium grade and low grade) is given in Figure 1/G.821 [1].

Figure 1/M.2100 – HRP model for international primary rate path and 64 kbit/s path



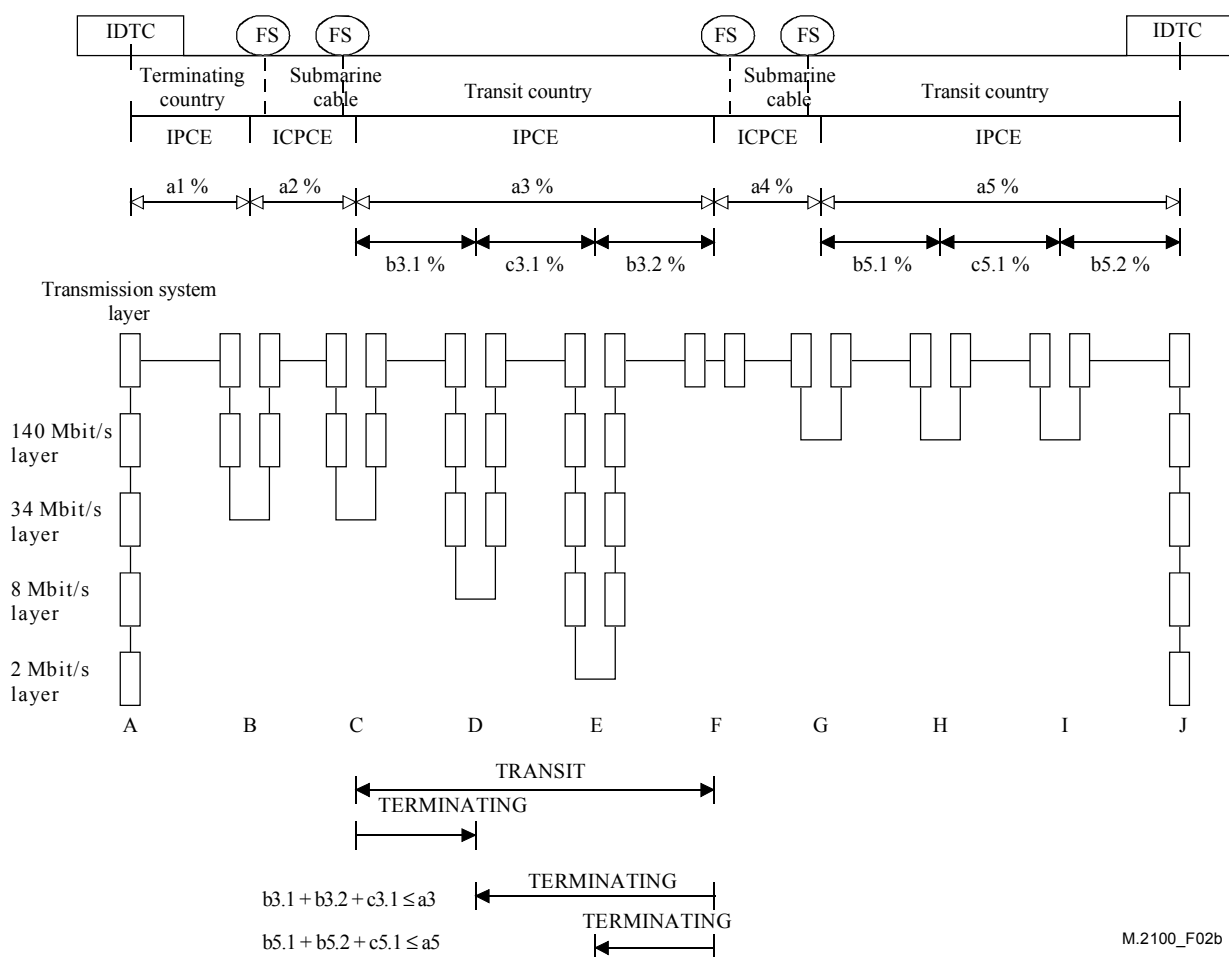
a_i are given in Table 2b. Path allocation = $a_1 + a_2 + \dots + a_9 = \sum_{i=1}^n a_i$ (%)

M.2100_F02a

b_i and c_i values are the responsibility of the national network operators for country i with the following constraints: $b_i \times n + c_i \times m \leq a_i$ for each PCE; where $n = 1, 2, \dots$, and $m = 1, 2, \dots$, etc.

c_i values must be communicated to each control station.

Figure 2a/M.2100 – Example of apportionment for an international n Mbit/s path, where $n = 1.5, 2, 6, 8, \dots, 140$



M.2100_F02b

Figure 2b/M.2100 – Example of apportionment for a primary rate path showing the relationship with the higher bit rate paths which support it

6 Performance objectives

In this Recommendation, ES and SES events are dealt with. Both performance events are considered essential for BIS and maintenance.

6.1 Connections operating below the primary rate

There are two types of connections, those using equipment designed before the approval of revised ITU-T Rec. G.826 (2002) and those using equipments designed according to ITU-T Rec. G.826 (2002).

6.1.1 Connections using equipment designed before the adoption of revised ITU-T Rec. G.826

The ES performance objective (PO) will support the 8% end-to-end objective for services based on ITU-T Rec. G.821. The PO is based on empirical evidence of readily achievable primary rate path performance. It is 50% of the objective values for ES per ITU-T Rec. G.821 and the adopted value is 4%.

The SES performance objective is based on 0.1% end-to-end PO taken directly from ITU-T Rec. G.821. However, since the periods used for BIS/maintenance are short compared to the one month evaluation period suggested in ITU-T Rec. G.821, the additional allowance for radio/satellite systems (per ITU-T Rec. G.821) has not been included. See Table 1a.