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Digital networks – Quality and availability targets

End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections

ITU-T Recommendation G.826

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ITU-T Recommendation G.826

End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections

Summary

This Recommendation defines end-to-end error performance parameters and objectives for international digital paths which operate at or above the primary rate and for international digital connections which operate below the primary rate of the digital hierarchy. The objectives given are independent of the physical network supporting the path or connection.

For digital paths which operate at or above the primary rate, this Recommendation is based upon a block-based measurement concept using error detection codes inherent to the path under test. This supports in-service measurements.

For digital connections which operate below the primary rate of the digital hierarchy, this Recommendation is based upon bit error and bit error ratio measurements. This approach does not support in-service measurements.

Annex A deals with the definition of availability of the path or connection. Annexes B, C and D give specific information concerning PDH, SDH and cell-based transmission paths.

It is not required to apply this Recommendation to connections which operate below the primary rate using equipment designed prior to the adoption of this Recommendation in December 2002.

This Recommendation deals with the performance of PDH paths, and of those SDH paths using equipment designed prior to the adoption of ITU-T Rec. G.828 in March 2000. ITU-T Rec. G.828 deals with the performance of SDH paths using equipment designed as of or after the adoption of ITU-T Rec. G.828 in March 2000. New Recommendation G.8201 deals with performance of ODUk paths of the OTN.

Source

ITU-T Recommendation G.826 was revised by ITU-T Study Group 13 (2001-2004) and approved under the WTSA Resolution 1 procedure on 14 December 2002.

Keywords

Background block error, background block error ratio, bit error, bit error ratio, block-based concept, digital connection, digital path, error detection codes, error performance objectives, error performance parameters, errored second, in-service measurements, severely errored second.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. 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 Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.826

End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections

1 Scope

This Recommendation specifies end-to-end error performance events, parameters and objectives for:

- 1) digital paths operating at bit rates at or above the primary rate; and
- 2) $N \times 64$ kbit/s circuit-switched digital connection ($1 \leq N \leq 24$ or 31 respectively).

This Recommendation also specifies allocations of the end-to-end performance objectives.

1.1 Application of this Recommendation

This Recommendation is applicable to international, constant bit-rate digital paths which operate at or above the primary rate and to international $N \times 64$ kbit/s ($1 \leq N \leq 24$ or 31 respectively) digital connections.

NOTE – It is not required to apply this Recommendation to connections which operate below the primary rate using equipment designed prior to the adoption of this Recommendation in December 2002. Performance events and objectives for connections using equipment designed prior to this date are given in ITU-T Rec. G.821 [14].

The constant bit-rate digital paths may be based on a Plesiochronous Digital Hierarchy, Synchronous Digital Hierarchy or some other transport network such as cell-based. This Recommendation is generic in that it defines the parameters and objectives for the paths and connections independent of the physical transport network. Compliance with the path performance specification of this Recommendation will, in most cases, also ensure that a client 64 kbit/s connection will meet its requirements. Therefore, this Recommendation and ITU-T Rec. G.828 [24] are currently the only Recommendations required for designing the error performance of digital paths at or above the primary rate¹. In accordance with the definition of a digital path, path end points may be located at user's premises.

Paths are used to support services such as circuit switched, packet switched and leased circuit services. The quality of such services, as well as the performance of the network elements belonging to the service layer, is outside of the scope of this Recommendation.

The performance objectives are applicable to a single direction of the path or connection. The values apply end-to-end over a 27 500 km Hypothetical Reference Path or Connection (see Figure 3), which may include optical fibre, digital radio relay, metallic cable and satellite transmission systems. The performance of multiplex and cross-connect functions employing ATM techniques is not included in these values.

The parameter definitions for digital paths which operate at or above the primary rate are block-based, making in-service measurement convenient. In some cases, the network fabric is not able to provide the basic events necessary to directly obtain the performance parameters. In these cases, compliance with this Recommendation can be assessed using out-of-service measurements or estimated by measures compatible with this Recommendation, such as those specified in

¹ This Recommendation deals with the performance of PDH paths, and of those SDH paths using equipment designed prior to the adoption of ITU-T Rec. G.828 in March 2000. ITU-T Rec. G.828 deals with the performance of SDH paths using equipment designed as of or after the adoption of ITU-T Rec. G.828 in March 2000. New ITU-T Rec. G.8201 deals with the performance of ODUk paths of the OTN.

Annexes B, C and D. The parameter definitions for digital connections which operate below the primary rate of the digital hierarchy are not block-based; rather, they are based upon bit error and bit-error ratio measurements.

1.2 Transport network layers

For paths, this Recommendation specifies the error performance in a given transport network layer. Two cases have to be considered:

1.2.1 PDH and SDH transport networks

Figure 1 gives the intended scope where ATM does not form part of the end-to-end path. It should be noted that end-to-end performance monitoring is only possible if the monitored blocks together with the accompanying overhead are transmitted transparently to the path end points.

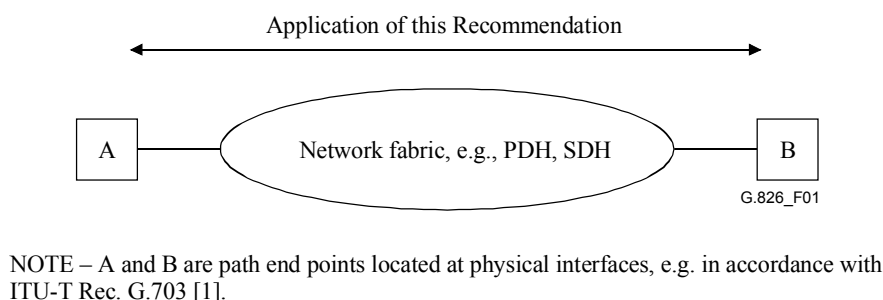


Figure 1/G.826 – Application of this Recommendation for a non-ATM end-to-end transmission path

1.2.2 ATM connections

Where the path forms the physical part of an ATM connection (see Figure 2), the overall end-to-end performance of the ATM connection is defined by ITU-T Rec. I.356 [16]. In this case, this Recommendation can be applied with an appropriate allocation to the performance between the path end points where the physical layer of the ATM protocol reference model (see ITU-T Rec. I.321 [15]) is terminated by ATM cross-connects or switches. ATM transmission paths in the physical layer correspond to a stream of cells mapped either into a cell-based format or into SDH or PDH-based frame structures.

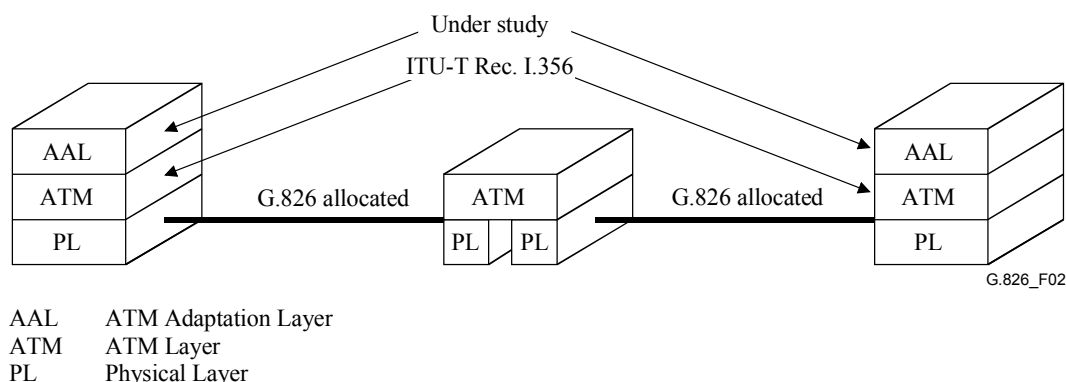


Figure 2/G.826 – Architectural relationship between this Recommendation G.826 and ITU-T Rec. I.356 [16]

1.3 Allocation of end-to-end performance

Allocations of end-to-end performance of CBR paths and connections are derived using the rules laid out in 7.2 which are length- and complexity-based. Detailed allocations of G.826 performance to the individual components (lines, sections, multiplexers and cross-connects, etc.) are outside the scope of this Recommendation, but when such allocations are performed, the national and international allocations as given in 7.2 shall be achieved.

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

- [1] ITU-T Recommendation G.703 (2001), *Physical/electrical characteristics of hierarchical digital interfaces*.
- [2] ITU-T Recommendation G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels*.
- [3] ITU-T Recommendation G.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy (SDH)*, plus Corrigendum 1 (2001), Corrigendum 2 (2001), and Amendment 1 (2001).
- [4] ITU-T Recommendation G.732 (1988), *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*.
- [5] ITU-T Recommendation G.733 (1988), *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*.
- [6] ITU-T Recommendation G.734 (1988), *Characteristics of synchronous digital multiplex equipment operating at 1544 kbit/s*.
- [7] ITU-T Recommendation G.742 (1988), *Second order digital multiplex equipment operating at 8448 kbit/s and using positive justification*.
- [8] ITU-T Recommendation G.743 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and using positive justification*.
- [9] 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*.
- [10] 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*.
- [11] ITU-T Recommendation G.755 (1988), *Digital multiplex equipment operating at 139 264 kbit/s and multiplexing three tributaries at 44 736 kbit/s*.
- [12] ITU-T Recommendation G.775 (1998), *Loss of Signal (LOS), Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) defect detection and clearance criteria for PDH signals*.
- [13] ITU-T Recommendation G.783 (2000), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*, plus Corrigendum 1 (2001).

- [14] 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*.
- [15] ITU-T Recommendation I.321 (1991), *B-ISDN protocol reference model and its application*.
- [16] ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance*.
- [17] ITU-T Recommendation I.362², *B-ISDN ATM adaptation layer (AAL) functional description*.
- [18] ITU-T Recommendations I.432.x series, *B-ISDN user-network interface – Physical layer specification*.
- [19] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*, plus Corrigendum 1 (2000).
- [20] ITU-T Recommendation M.60 (1993), *Maintenance terminology and definitions*.
- [21] ITU-T Recommendation M.2100 (1995), *Performance limits for bringing-into-service and maintenance of international PDH paths, sections and transmission systems*.
- [22] ITU-T Recommendation M.2101 (2000), *Performance limits and objectives for bringing-into-service and maintenance of international SDH paths and multiplex sections*.
- [23] ITU-T Recommendation M.2101.1 (1997), *Performance limits for bringing-into-service and maintenance of international SDH paths and multiplex sections*.
- [24] ITU-T Recommendation G.828 (2000), *Error performance parameters and objectives for international, constant bit-rate synchronous digital paths*.
- [25] ITU-T Recommendation I.325 (1993), *Reference configurations for ISDN connection types*.
- [26] ITU-T Recommendation I.340 (1988), *ISDN connection types*.
- [27] ITU-T Recommendation G.801 (1988), *Digital transmission models*.

3 Abbreviations

This Recommendation uses the following abbreviations:

AAL	ATM Adaptation Layer
AIS	Alarm Indication Signal
ATM	Asynchronous Transfer Mode
AU	Administrative Unit
BBE	Background Block Error
BBER	Background Block Error Ratio
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network
CBR	Constant Bit Rate
CEC	Cell Error Control
CRC	Cyclic Redundancy Check

² Withdrawn in June 1997.

EB	Errored Block
EDC	Error Detection Code
ES	Errored Second
ESR	Errored Second Ratio
FAS	Frame Alignment Signal
HEC	Header Error Check
HP	Higher order Path
HRP	Hypothetical Reference Path
HRX	Hypothetical Reference Connection
IG	International Gateway
ISDN	Integrated Services Digital Network
ISM	In-Service Monitoring
LOF	Loss of Frame Alignment
LOM	Loss of Multiframe Alignment
LOP	Loss Of Pointer
LOS	Loss Of Signal
LP	Lower order Path
MS	Multiplex Section
N-ISDN	Narrow-band Integrated Services Digital Network
NTE	Network Terminal Equipment
OAM	Operation and Maintenance
ODUk	Optical Channel Data Unit-k
OOS	Out-of-Service
OTN	Optical Transport Network
PDH	Plesiochronous Digital Hierarchy
PEP	Path End Point
PL	Physical Layer
RDI	Remote Defect Indication
REI	Remote Error Indication
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Second
SESR	Severely Errored Second Ratio
STM	Synchronous Transport Module
TE	Terminal Equipment
TIM	Trace Identifier Mismatch
TP	Transmission Path
TU	Tributary Unit