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Quality of service, network management and traffic engineering – Traffic engineering – ISDN traffic engineering

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Network grade of service parameters and target values for B-ISDN

ITU-T Recommendation E.726

(Formerly CCITT Recommendation)

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ITU-T RECOMMENDATION E.726

NETWORK GRADE OF SERVICE PARAMETERS AND TARGET VALUES FOR B-ISDN

Summary

This Recommendation provides reference connections, network Grade of Service (GOS) parameters, and target values at both the call and the cell level for the user-plane for ATM-based B-ISDNs. The first release of E.726 applies to calls that consist of a pair of point-to-point ATM connections providing bidirectional communication between two ATM end-points. This release also assumes that switched ATM connections are established via associated signalling as defined by Recommendations Q.2931 and Q.2761, see also E.728. This Recommendation pertains to both terrestrial and satellite-based systems.

Source

ITU-T Recommendation E.726 was prepared by ITU-T Study Group 2 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 13 March 2000.

FOREWORD

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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.

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, the 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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Recommendation E.726

NETWORK GRADE OF SERVICE PARAMETERS AND TARGET VALUES FOR B-ISDN

(Geneva, 2000)

1 Scope

This Recommendation provides reference connections, network Grade of Service (GOS) parameters, and target values at both the call and the cell level for the user-plane for ATM-based B-ISDNs. The first release of E.726 applies to calls that consist of a pair of point-to-point ATM connections providing bidirectional communication between two ATM end-points. This release also assumes that switched ATM connections are established via associated signalling as defined by Recommendations Q.2931 and Q.2761, see also E.728. This Recommendation pertains to both terrestrial and satellite-based systems. For traffic engineering, the Recommendation assumes that the network is available: that is, it does not consider network equipment in a failure state. Furthermore, outside the scope of this Recommendation are aspects peculiar to mobile and UPT services, or to B-ISDN signalling, as well as to call-level performance parameters for calls established via the management plane.

This Recommendation complements the specifications in E.721, I.356 and I.358.

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; all 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.

– ITU-T Recommendation E.492 (1996), *Traffic reference period*.

– ITU-T Recommendation E.493 (1996), *Grade of service (GOS) monitoring*.

– ITU-T Recommendation E.500 (1998), *Traffic intensity measurement principles*.

– ITU-T Recommendation E.600 (1993), *Terms and definitions of traffic engineering*.

– CCITT Recommendation E.711 (1992), *User demand modelling*.

– CCITT Recommendation E.720 (1988), *ISDN grade of service concept*.

– ITU-T Recommendation E.721 (1999), *Network grade of service parameters and target values for circuit-switched services in the evolving ISDN*.

– ITU-T Recommendation E.724 (1996), *GOS parameters and target GOS objectives for IN services*.

– ITU-T Recommendation E.728 (1998), *Grade-of-service parameters for B-ISDN signalling*.

– ITU-T Recommendation E.735 (1997), *Framework for traffic control and dimensioning in B-ISDN*.

– ITU-T Recommendation E.736 (2000), *Methods for cell level traffic control in B-ISDN*.

– ITU-T Recommendation E.737 (1997), *Dimensioning methods for B-ISDN*.

– ITU-T Recommendation E.745 (2000), *Cell level measurement requirements for the B-ISDN*.

– ITU-T Recommendation E.800 (1994), *Terms and definitions related to quality of service and network performance including dependability*.

– ITU-T Recommendation I.311 (1996), *B-ISDN general network aspects*.

– ITU-T Recommendation I.325 (1993), *Reference configurations for ISDN connection types*.

– ITU-T Recommendation I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDN*.

– ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance*.

– ITU-T Recommendation I.358 (1998), *Call processing performance for switched Virtual Channel Connections (VCCs) in a B-ISDN*.

– ITU-T Recommendation I.361 (1999), *B-ISDN ATM layer specification*.

– ITU-T Recommendation I.371 (2000), *Traffic control and congestion control in B-ISDN*.

– ITU-T Recommendation Q.543 (1993), *Digital exchange performance design objectives*.

– ITU-T Recommendation Q.706 (1993), *Specifications of Signalling System No. 7 – Message transfer part signalling performance*.

– ITU-T Recommendation Q.709 (1993), *Specifications of Signalling System No. 7 – Hypothetical signalling reference connection*.

– ITU-T Recommendation Q.766 (1993), *Specifications of Signalling System No. 7 – Performance objectives in the integrated services digital network application*.

– ITU-T Recommendation Q.921 (1997), *ISDN user-network interface – Data link layer specification*.

– ITU-T Recommendation Q.2650 (1999), *Interworking between Signalling System No. 7 Broadband ISDN User Part (B-ISUP) and Digital Subscriber Signalling System No. 2 (DSS2)*.

– ITU-T Recommendation Q.2761 (1999), *Functional description of the B-ISDN User Part (B-ISUP) of Signalling System No. 7*.

– ITU-T Recommendation Q.2931 (1995), *Digital subscriber signalling system No. 2 (DSS2) – User-Network Interface (UNI) layer 3 specification for basic call/connection control*.

3 Definitions

For ease of reference, the definitions for Grade of Service given in E.600, and for Network Performance and Quality of Service given in E.800, are repeated herein.

Grade of Service (GOS) is a number of traffic engineering variables used to provide a measure of adequacy of a group of resources under specified conditions. These grade of service variables may be probability of loss, dial tone delay, etc.

NOTE 1 – The parameter values assigned as objectives for grade of service variables are called grade of service standards.

NOTE 2 – The values of grade of service parameters achieved under actual conditions are called grade of service results.

Quality of Service (QOS) is the collective effect of service performance which determines the degree of satisfaction of a *user* of the *service*.

NOTE 3 – The quality of service is characterized by the combined aspects of service support performance, service operability performance, serveability performance, service security performance and other factors specific to each service.

NOTE 4 – The term "quality of service" is not used to express a degree of excellence in a comparative sense nor is it used in a quantitative sense for technical evaluations. In these cases a qualifying adjective (modifier) should be used.

Network Performance is the ability of a network or network portion to provide the functions related to *communications* between *users*.

NOTE 5 – Network performance applies to the network provider's planning, development, operations and maintenance and is the detailed technical part of QOS, excluding service support performance and human factors.

NOTE 6 – Network performance is the main influence on serveability performance.

NOTE 7 – Network performance measures are meaningful to network providers and are quantifiable at the part of the network to which they apply. Quality of service measures are only quantifiable at a service access point.

NOTE 8 – It is up to the network provider to combine the network performance parameters in such a way that the economic requirements of the network provider, as well as the satisfaction of the user, are both fulfilled.

Terminology related to the architectural components and network elements in an ATM transport network follows that defined in Recommendation I.311. The terms VP switch, VC switch, and VP-VC switch defined in I.311 are collectively referred to as ATM switch herein. Similarly, the terms VP cross-connect, VC cross-connect, and VP-VC cross-connect defined in I.311 are collectively referred to as ATM cross-connect herein. Also, as specified in I.311, VC and VP connections are unidirectional. To provide bidirectional communication in a user ATM call between two end-points, two such types of connections are therefore needed, with one in each direction.

4 Abbreviations

This Recommendation uses the following abbreviations:

ABR Available Bit Rate

ABT ATM Block Transfer

ANM Answer Message

ATC ATM Transfer Capability

ATM Asynchronous Transfer Mode

B-ISDN Broadband Integrated Services Digital Network

B-ISUP Broadband ISDN User Part

CAC Connection Admission Control

CPM Call Progress Message

DBR Deterministic Bit Rate

DSS Digital Subscriber Signalling

GOS Grade of Service

IAM Initial Address Message

IIP International Interoperator Portion

INI Inter-Network Interface

ITP International Transit Portion

MP Measurement Point

MPI Measurement Point International

MPT Measurement Point at T_B

PCR Peak Cell Rate

PDU Protocol Data Unit

QOS Quality of Service

SBR Statistical Bit Rate

SECB Severely Errored Cell Block

UBR Unspecified Bit Rate

UNI User-Network Interface

UPT Universal Personal Telecommunication

VCC Virtual Channel Connection

VPC Virtual Path Connection

5 General considerations

ATM-based B-ISDNs are being deployed in public telecommunications networks. They are being used for infrastructure to support multiple telecommunications services, in particular high-bandwidth services. Network operators are using Grade of Service (GOS) parameters and their associated target values:

1) as internal design objectives;

2) to meet Quality of Service (QOS) objectives to customers; and

3) to meet commitments to other network operators.

The GOS parameters include call-level parameters, such as post-selection delay, as in Recommendation E.721, which concerns circuit-switched services in the evolving ISDN. However, as B-ISDNs based on ATM use a packet technology of fixed-size packets called cells, network operators are also concerned with impairments to the information-transfer stage of a call due to events at the cell level. Thus, this Recommendation also includes GOS parameters at the cell level.

5.1 Call-level GOS

The values of delay-GOS parameters at the call level (see clause 8) are affected by the processing time of signalling messages at ATM switches, propagation delays and traffic load. The value of blocking-GOS parameter at the call level is also affected by ATM switches, in particular the connection admission control (CAC) policy implemented therein, which determines whether there are resources such as bandwidth on transmission paths to support the connections needed for the new call request.

For the establishment of Virtual Channel Connections (VCCs), the use of an infrastructure of network-to-network Virtual Path Connections (VPCs) (see Recommendation E.735) can reduce the number of nodes needed to process the Initial Address Message (IAM), thereby reducing the values of the delay-GOS parameters.

5.2 Cell-level GOS

The values of GOS parameters at the cell level (see clause 9) are affected by queueing disciplines and buffer management policies at ATM nodes, both at ATM switches and cross-connects, as well as propagation delays and traffic load.

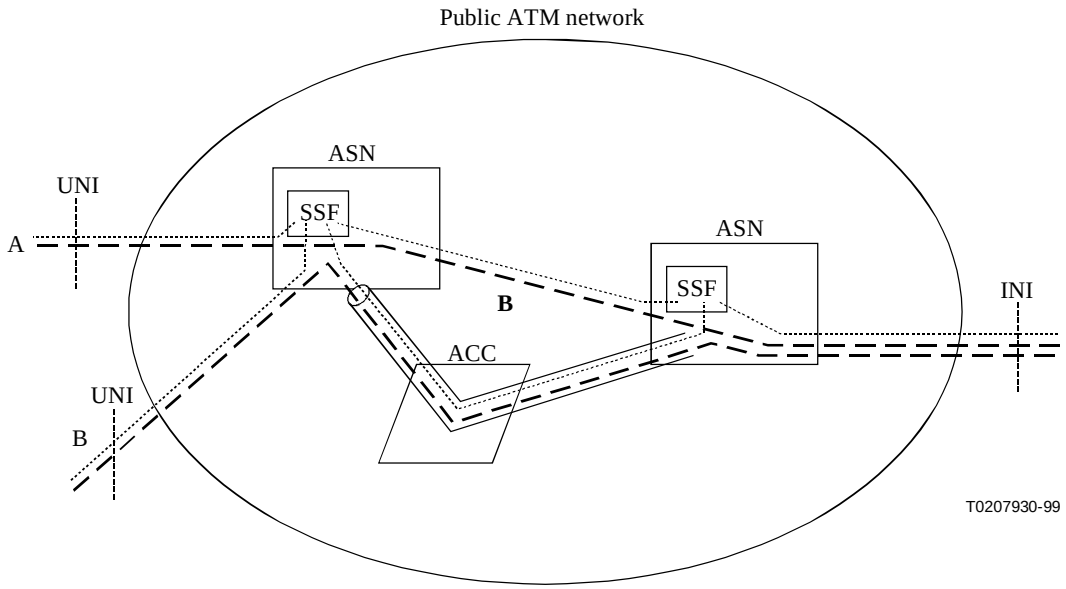
Depending on the design decisions of the network operator, the cell-level performance experienced by a class of connections at ATM switches can be different from that at ATM cross-connects. For example, at ATM switches, the statistical bit rate (SBR) VCCs may experience cell delay variations significantly higher than the deterministic bit rate (DBR) VCCs. However, if the network operator has chosen to use network-to-network DBR VPCs through the ATM cross-connects to support all classes of VCCs, then the SBR VCCs could experience much less cell delay variations at the ATM cross-connects than at the ATM switches. Recommendation E.735 discusses various types of network-to-network VPCs that can be used to support VCCs through ATM cross-connects.

5.3 Effect of CAC

There is a relationship between traffic load and the values of GOS parameters at the call and cell levels, as a result of the absence or presence of CAC mechanisms. With the application of CAC for connections such as DBR for voice, call blocking typically increases as offered load increases, while cell blocking (resulting in cell losses) increases with load up to a certain point and then should stay relatively constant, independent of offered load. For connections with no CAC and hence no call blocking, cell blocking (resulting in cell losses) will increase with offered load. This may, for example, be the case for class U traffic as defined in I.356.

6 Reference architecture

The reference architecture in Figure 1 is provided to illustrate concepts pertinent to this Recommendation. Figure 1 shows representative components of a single public network provider, highlighting two user ATM connections labelled "A" and "B", respectively, each of these connections pertains to one direction of the corresponding user ATM call. These connections enter the public network across respective user-network interfaces (UNIs) from customer-premises networks (which are not shown in the figure), and exit the public network across an inter-network interface (INI) and (also not shown) traverse other public networks towards possibly different destinations. Each connection eventually crosses a second UNI and enters a terminating customer-premises network.



ACC	ATM Cross-Connect
ASN	ATM Switching Node
SSF	Signalling System Functions
	Network-to-Network VPC
	User VCC
	Signalling VCC

NOTE 1 – The user-to-user ATM connection "A" could be a VCC or VPC, see Recommendation I.150.

NOTE 2 – Since the user-to-user ATM connection "B" is shown to be supported by a network-to-network VPC within the public network, connection "B" is a VCC, and cannot be a VPC.

NOTE 3 – ATM connections "A" and "B" could each have been established by:
1) the control plane, i.e. signalling, in which case they would be switched ATM connections; or
2) the management plane, in which case they would be semi-permanent ATM connections.

NOTE 4 – The advanced case of *associated* signalling is assumed, see E.728 for details. Thus, when ATM connection "A" or "B" is a switched ATM connection, i.e. established by the control plane, the signalling messages traverse the same path as the to-be-established connection, in assigned signalling VCCs.

NOTE 5 – Between the network nodes or across the network interfaces, the ATM connections could be supported by a satellite-based system.

NOTE 6 – Not shown in the figure are physical-layer components, such as transmission paths, that support the VPCs and VCCs.

Figure 1/E.726 – Reference architecture

7 Reference connections for GOS parameters at the call and cell level

Reference connections for B-ISDNs for setting call-level and cell-level GOS target values are given in Table 1. The reference connections selected for this purpose consider a (near) worst-case scenario in terms of the impact on the call-level and cell-level GOS parameters, so that GOS target values based on the reference connections should be satisfied in almost all practical implementations.

Three categories of reference connections are specified:

- national, local area;
- national, long distance;
- international.

The term "national local area" refers to an ATM connection whose UNI-to-UNI straight-line geographic distance does not exceed 100 kilometres (see Note 4 in Table 1), and thus is of relatively short distance; typically this would be within a greater metropolitan area. The term "national long distance" refers to an ATM connection whose UNI-to-UNI straight-line geographic distance is more than 100 kilometres, and is within a single country. Typically, though not necessarily, a "national local area" connection is supported by a single public network provider, while a "national long distance" connection is supported typically by one to three public network providers. The two categories of national reference connections, "local area" and "long distance," are a revision of the terms "local" and "toll" used in Recommendation E.721 concerning GOS parameters and target values for narrow-band ISDN.

Table 1 specifies the number of ATM switches, the number of ATM cross-connects, and the expected worst-case one-way propagation delay for each of the above three categories of reference connections. Values in this table are pertinent to the extent that they affect the target values in Table 2.

At the call level, the key components of the reference connections affecting delay-GOS are:

1) the number of ATM nodes at which signalling processing is done for the user's ATM connection (i.e. ATM switches); and

2) the length of the connection's route measured in propagation delay.

Therefore, when Table 1 is used for call-level delay-GOS target values, the relevant columns are "Number of ATM switches" and "One-way propagation delay".

For the cell-level GOS parameters, the signal processing function is not pertinent. Rather, the key components are:

1) the number of ATM network nodes, including both ATM switches and cross-connects; and

2) the length of the connection's route measured in propagation delay.

Therefore, when Table 1 is used for cell-level GOS target values, all three columns are relevant.

Table 1/E.726 – UNI-to-UNI reference connections: number of network nodes and propagation delay

	Number of ATM switches	**Number of ATM cross-connects**	**One-way propagation delay**
National, local area connection	3	1	1 ms
National, long distance connection	6	4	50 ms
International connection	9	10	300 ms

NOTE 1 – For the international reference connection, it is assumed that there is one transit network and that there are three ATM switches in the originating and terminating national portions.

NOTE 2 – The international connection assumes one satellite link.

NOTE 3 – The values in the columns "Number of ATM switches" and "One-way propagation delay" are consistent with the corresponding values specified in E.728.

NOTE 4 – The near worst-case one-way propagation delay of 1 ms for a local area connection assumes the following:

a) the UNI-to-UNI straight-line geographic distance for the connection is 100 km;

b) signal speed is two-thirds the speed of light, resulting in a delay of 0.5 ms in 100 km;

c) the ratio of a connection's route-length to geographic straight-line distance is 2, thereby giving a delay of 1 ms.

8 GOS parameters at the call level

In this clause network performance parameters for call setup and release phases are considered.

This Recommendation assumes that call establishment and release use the associated signalling defined by Recommendations Q.2931 and Q.2761, see also E.728.

8.1 Definition of grade of service parameters

The following traffic GOS parameters are recommended:

1) Post-selection delay.
2) Answer-signal delay.
3) Connection-release delay.
4) Probability of end-to-end blocking.

The definitions of these GOS parameters are given in Recommendation E.721 and are adapted herein by changing the location of the reference events from the calling or called terminal to the UNI of the calling or called terminal. Also herein, the term "party" is used instead of "terminal." Consistent definitions are given in Recommendation I.358, which integrates these parameters with others that are not of particular relevance to traffic engineering.

The delay-GOS parameters are based on the message flows in Recommendations Q.2931 and Q.2761.

This Recommendation considers only the most significant case of the *en bloc* address sending procedures. In the case of overlap sending procedures, which may be used when the call originates in the N-ISDN, the pre-selection delay must be added to the preceding list of GOS parameters. The definition and the target values for this parameter included in Recommendation E.721 can be adopted.

Delays or blocking within the customer-premises equipment or subscriber terminal are not part of the following definitions. (Note that the customer-premises network wherein such equipment is located can by itself be a network of global reach. Hence, the delay or blocking component within such a network may be a significant part of the end-to-end values.)

8.1.1 Post-selection delay

Post-selection delay is defined as the time interval from the instant the last bit of the initial SETUP message containing the called party's address crosses the calling party's UNI, until the first bit of the first message indicating call disposition to the calling party (ALERTING message in the case of successful call) crosses the calling party's UNI.

NOTE – In the case of automatic answering terminals, the ALERTING message is replaced by the CONNECT message.

8.1.2 Answer-signal delay

Answer-signal delay is defined as the time interval from the instant that the last bit of the CONNECT message from the called party crosses the called party's UNI, until the first bit of the CONNECT message crosses the calling party's UNI.

8.1.3 Connection-release delay

Connection-release delay is defined as the time interval from the instant the last bit of the RELEASE message from the party that terminates the connection crosses that party's UNI, until the first bit of the RELEASE COMPLETE message destined for that party crosses that party's UNI.

8.1.4 Probability of end-to-end blocking

Probability of end-to-end blocking is the probability that any call attempts will be unsuccessful due to a lack of public network resources during a reference period, see clause 10.

NOTE 1 – As defined in E.600, "probability of end-to-end blocking" considers blocking only due to a lack of resources. When the network-performance parameter for blocking is not conditioned on the cause for the blocking (which, besides lack of resources, could be for example network failures or corruption of signalling messages from physical layer impairments), Recommendation I.358 uses the term "connection/party setup failure".

NOTE 2 – Blocking because of the lack of resources at the access links to the public network or within the customer-premises network is excluded from this definition.

NOTE 3 – A call attempt is any first attempt or reattempt initiated by the calling party or the calling party's terminal.

NOTE 4 – The "network resources" include the control plane as well as the user plane.

9 GOS parameters at the cell level

GOS parameters at the cell level pertain to the performance during the information-transfer phase of an ATM call. Of relevance to E.726 are parameters whose values are influenced by traffic engineering decisions, such as network topology, link and node sizing, and ATM-layer controls. The following subclauses provide an initial list of these GOS parameters. Other parameters are for further study.

9.1 Cell-based GOS parameters

The following cell-level performance parameters defined in Recommendation I.356 are relevant to E.726:

1) Cell transfer delay.
2) Cell delay variation.
3) Severely errored cell block ratio.
4) Cell loss ratio.

NOTE 1 – Definitions of the above GOS parameters for traffic engineering purposes are for further study. Specifically, the definition of cell loss ratio in I.356 needs to be adapted. E.726 is particularly concerned with cell losses due to buffer congestion where either an arriving cell is not stored in memory or an already-stored cell is discarded from memory.

NOTE 2 – I.356 excludes severely errored cell blocks from the cell loss ratio. Whether E.726 should do so is for further study; see clause 11 for a more detailed discussion. In any case, for aggregate traffic sharing a buffer, when cell losses occur, they tend to occur in bursts, and this should likely be taken into account.

NOTE 3 – The concept of a "loss-free interval" may be relevant.

9.2 Frame-based GOS parameters

For applications transferring information over an ATM network, in some cases, if a single cell is lost, then an entire higher-layer protocol data unit (PDU) becomes useless, and may need to be retransmitted. Taking this into account, ATM equipment is being deployed with controls whereby if a cell needs to be discarded, then an entire set of cells corresponding to a higher-layer PDU is discarded. This concentration of discards does not adversely affect the application and can significantly reduce the number of connections affected. Given such ATM equipment, the GOS parameters discussed in this subclause can be used to assess this aggregated per-connection cell loss.

A "frame" is defined as a contiguous set of cells within the same ATM connection whose boundary is detectable at the ATM layer and for which a network node could implement a congestion control that discards cells in units thereof.

NOTE – On a transmission path, cells of a given frame can be interspersed with cells from other ATM connections.

Examples of a frame are:

1) A block of cells in the ATM Block Transfer (ABT) capability, where the boundary is determined by the presence of specific ABT resource management cells; see Recommendation I.371.

2) A sequence of cells carrying an ATM-Adaptation-Layer 5 PDU, where the boundary is determined by the "ATM-user-to-ATM-user indication" in the payload type field of the ATM cell header; see Recommendation I.361.

The following frame-based GOS parameters are recommended:

1) Frame transmission delay.

2) Frame discard ratio.

9.2.1 Frame transmission delay

The definition of this parameter for traffic engineering purposes is for further study.

9.2.2 Frame discard ratio

For ABT, a "frame discard outcome" occurs when a network node discards all of the cells of a frame.

NOTE 1 – The leading cell of a frame may also be the trailing cell of the previous frame; conversely, the trailing cell may also be the leading cell of the subsequent frame; see, for example, 5.5.5.2.1/I.371 (August 1996) in the discussion of ABT with immediate transmission. Such a cell may not be discarded in a frame discard outcome.

NOTE 2 – The definition of frame discard outcome for guaranteed frame rate ATC is for further study. In this case, it is possible for the network to deliver only part of a frame, especially when the frame is non-conforming. Such a partially-discarded frame may also be counted as a frame discard outcome.

Frame discard ratio is defined as the ratio of the number of frame discard outcomes to the total number of transmitted frames in a population of interest.

Example populations of interest are:

1) all of the frames emitted on a given ATM connection;

2) all of the frames to arrive a given network node on connections of a given ATM transfer capability.

9.3 Throughput GOS parameters

For the ABR transfer capability, an allowed throughput (or provided throughput) is informally defined as the time average of the allowed cell rate of a given ABR connection. This allowed (provided) throughput could be compared with the minimum cell rate of the ABR connection. Further study is required for this parameter.

10 Target values for GOS parameters at the call level

10.1 Considerations for target values

To assign target values to the GOS parameters, many factors and conditions should be considered. In this release of E.726, two main considerations are:

- loading condition (normal or high load, as in Recommendation E.500);
- geographical relation (local area, long distance, or international connection).

As stated in clause 1, network failure conditions are outside the scope of this Recommendation.

Other factors and conditions are:

- time relation of the service (permanent, on demand, on reservation);
- connection topology (point-to-point, point-to-multipoint, multipoint-to-point, multipoint-to-multipoint);
- number of parties and connections (see Recommendation E.716);
- required bit rates and their variability;
- holding times of the connections and their relations with the busy period;
- service type (priorities, service quality);
- possibility of parameter negotiation at call setup or parameter renegotiation during the call.

The influence of each of these factors and conditions on the target values is for further study.

10.2 Specification of target values

Target values for the delay-GOS parameters are specified in terms of the mean and the 95th percentile level.

The GOS target values are to be interpreted as design objectives, to be met for each traffic relation. Even the worst treated traffic relations should satisfy the end-to-end blocking-GOS target values. In the case of single node connections, the GOS is taken to be internal to the node.

Table 2 provides the target values for the GOS parameters in the case of a bidirectional call composed of two unidirectional connections.

In addition to the considerations discussed in 10.1, the target values presented in Table 2 take account of the evolving nature of the B-ISDN and Signalling System No. 7 capabilities, user expectation of service quality, technology and network constraints, and existing Recommendations. Specifically:

1) The target values assume that call establishment and release will use the associated signalling defined by Recommendations Q.2931 and Q.2761, see also E.728.

2) The target values for the delay-GOS parameters apply to calls with connections that may be of any ATM transfer capability and any QOS class.

3) For calls requiring database lookup, an additional delay needs to be added to the post-selection delay for each database lookup.

4) The target values for the blocking-GOS parameter apply to a DBR connection with peak cell rate (PCR) not exceeding 5320 cells/second (which corresponds to an information transfer rate of 2 Mbit/s above the ATM Adaptation Layer (AAL) assuming AAL1), and with QOS class 1, "stringent class", see Recommendation I.356. A DBR connection of any rate (not exceeding 5320 cells/second) should have a blocking probability within the target value. In other words, to meet the objective of the blocking-GOS standard, connections with PCRs in any sub-range, say e.g. 4000 to 5320 cells/second, must have a blocking probability not higher than the target value, even though the blocking probability for the set of all connections (with rate not exceeding 5320 cells/second) is less than the target value.

5) The target values for the blocking-GOS parameter apply to an SBR connection with QOS class 1 and with a PCR not exceeding 5320 cells/second.

6) The target values for the blocking-GOS parameter apply to an SBR connection with QOS class 2 "tolerant class" or QOS class 3 "bi-level class" and with a sustainable cell rate not exceeding 5320 cells/second.

7) The target values for the blocking-GOS parameter apply to an ABR connection with a minimum cell rate not exceeding 5320 cells/second.

8) The target values for the blocking-GOS parameter apply to an ABT connection with a PCR not exceeding 5320 cells/second.

9) Target values for rates greater than 5320 cells/second are for further study.

10) A target value for an ATC/QOS-class pertains for a network only if the network provider offers the given ATC/QOS-class.

Table 2/E.726 – Target values for call-level GOS parameters in B-ISDN

GOS parameter	Normal load		High load	
	Mean	**95%**	**Mean**	**95%**
Post-selection delay				
National local area connection	0.5 s	1.0 s	FS	FS
National long-distance connection	1.0 s	2.0 s	FS	FS
International connection	2.0 s	4.0 s	FS	FS
Answer-signal delay				
National local area connection	0.2 s	0.4 s	FS	FS
National long-distance connection	0.4 s	0.8 s	FS	FS
International connection	0.8 s	1.5 s	FS	FS
Connection-release delay	0.1 s	0.2 s	FS	FS
Probability of end-to-end blocking				
National local area connection	0.5%	NA	FS	NA
National long-distance connection	1.0%	NA	FS	NA
International connection	5.0%	NA	FS	NA

FS Further study

NA Not applicable

NOTE 1 – The target values in Table 2 are for both directions of a call combined.

NOTE 2 – The target values for the delay-GOS parameters under normal load in Table 2 are derived in Annex A using the per-node assumptions therein and using the reference connections in Table 1.

NOTE 3 – For further study is the concept of "normal load" and "high load" in a network that may be geographically distributed with non-coincident busy hours. This may require an adaptation of the definitions of normal and high load in E.500, and of the definition of reference period in E.492.

11 Target values for GOS parameters at the cell level

Target values for cell-level GOS parameters are for further study. In assigning target values for cell-level GOS parameters, consideration should be given to the per QOS-class objectives for cell-level performance parameters as specified in Recommendation I.356. As described therein, these objectives are also supposed to hold on a per-connection basis, conditioned on the QOS class. However, there are certain statistical estimation issues to be considered. For example, what if the lifetime of a given ATM connection is too short to determine with acceptable statistical accuracy whether a given QOS commitment was satisfied; see 8.2.2/I.356.

These issues may be compounded when viewed from the traffic engineering perspective. For example, for traffic engineering purposes, measurements could be made at a given buffer of cell losses that occur for the class of connections that share the buffer. When cell losses occur, they often occur in batches. Thus, if the I.356 definitions of cell loss ratio and severely errored cell block (SECB) ratio are applied to the aggregate of the connections sharing the buffer, then a SECB outcome will likely be observed, but the cell loss ratio could be zero, as the I.356 definition of cell loss ratio excludes the cell blocks that are severely errored. However, if there are many connections sharing the buffer, any given connection may only experience isolated cell losses and thus not experience a SECB outcome. On the other hand, a possible scenario is that cell losses are occurring because a given connection is blasting away and this connection's cell losses are approximately the same as the aggregate cell losses.

The relationship between the performance experienced by the aggregate and that by individual flows is complicated, and may depend on network dimensioning as well as the type of controls being applied. The determination of the aggregated set of connections for which target values of the GOS parameters should be specified is left for further study.

12 History

This is the first issue of Recommendation E.726.

ANNEX A

Explanation of basis for target values for post-selection delay, answer-signal delay, and connection-release delay

This annex presents the rationale used to derive the call-level delay-GOS target values in this Recommendation. The material in this annex is not intended to provide a means of deriving other target values using different reference connections or partitioning the target values in Table 2.

The target values for post-selection delay and answer-signal delay were calculated for the reference connections using the following assumptions:

1) Initial Address Message (IAM) cross-switch mean delay is 100 ms.

2) Call Progress Message (CPM) cross-switch mean delay is 50 ms.

3) Answer Message (ANM) cross-switch mean delay is 50 ms.

NOTE 1 – The above values of cross-switch mean delays for IAM, CPM, and ANM are half the corresponding values used in Annex A/E.728. This assumes that as B-ISDN matures, the cross-office delays will decrease.

The one-way UNI-to-UNI propagation delay for the local-area reference connection is 1 ms, for the long-distance reference connection is 50 ms, and for the international reference connection is 300 ms, as specified in Table 1.

Mean post-selection delay =

(number of ATM switches in reference connection) × (IAM cross-switch delay) +

(number of ATM switches in reference connection) × (CPM cross-switch delay) +

2 × (one-way UNI-to-UNI propagation delay)

Mean answer-signal delay =

(number of ATM switches in reference connection) × (ANM cross-switch delay) +

(one-way UNI-to-UNI propagation delay)

Each of the delay values so computed is then rounded up to the nearest 100 ms.

NOTE 2 – The SETUP message in DSS corresponds to the IAM in B-ISUP. The ALERTING message in DSS corresponds to the CPM in B-ISUP. The CONNECT message in DSS corresponds to the ANM in B-ISUP. See Recommendation Q.2650.

Connection-release delay is assumed to be the processing time of a RELEASE message at the first ATM switch at the network side of the UNI, rounded up to the nearest 100 ms. This processing delay is assumed to be less than 100 ms, independent of the type of reference connection.

The target values for the 95th percentile delay-GOS parameters under normal load in Table 2 are obtained by doubling the corresponding target values associated with the mean. This follows the heuristic adopted in E.728, which is based on the observation of a relatively slight variation in call establishment and release delays under various traffic loads.

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