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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

Overall network aspects and functions – Performance objectives

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Call processing performance for switched Virtual Channel Connections (VCCs) in a B-ISDN

ITU-T Recommendation I.358

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION I.358

CALL PROCESSING PERFORMANCE FOR SWITCHED VIRTUAL CHANNEL CONNECTIONS (VCCs) IN A B-ISDN

Summary

This new Recommendation defines performance parameters and objectives for call processing in B-ISDNs for switched Virtual Channel Connections (VCCs). The B-ISDN call processing parameters defined in this Recommendation are applicable to point-to-point (Type 1) and point-to-multipoint (Type 2) connection topologies. The QOS relevant network performance objectives provided in this Recommendation are based on the general principles and generic performance parameters of Recommendation I.350. New performance-related aspects, associated with B-ISDN call processing functions providing access or disengagement, include the addition or release of a party to an existing B-ISDN connection. In a B-ISDN, a virtual connection can generally be either a Virtual Channel Connection (VCC) or a Virtual Path Connection (VPC). Since call processing capabilities are currently defined only for VCCs, a virtual connection within the context of this Recommendation is a VCC.

Source

ITU-T Recommendation I.358 was prepared by ITU-T Study Group 13 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 1st of June 1998.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the 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.

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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The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

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 I.358

CALL PROCESSING PERFORMANCE FOR SWITCHED VIRTUAL CHANNEL CONNECTIONS (VCCs) IN A B-ISDN

(Geneva, 1998)

1 Scope

This Recommendation defines performance parameters and objectives for call processing in B-ISDNs. The B-ISDN call processing parameters defined in this Recommendation are applicable to point-to-point (Type 1) and point-to-multipoint (Type 2) connection topologies. Call processing delay parameters for point-to-point, single connection calls on 64 kbit/s channels are defined in Recommendation I.352. These parameters are used where relevant. Additional call processing performance parameters are defined for those call processing aspects that are new with B-ISDN. The parameters include QOS relevant network performance parameters (objectives) and the relationship to GOS parameters relevant to network design (no objectives) in order to provide a consistent approach between service requirements and network design. These parameters are specified in terms of reference events and measurement points defined in Recommendation I.353.

The QOS relevant network performance objectives provided in this Recommendation are based on the general principles and generic performance parameters of Recommendation I.350. According to these principles, performance parameters are established to characterize each call processing aspect that is new for B-ISDN with respect to the three generic performance criteria of speed, accuracy and dependability. The new performance-related aspects, associated with B-ISDN call processing functions providing access or disengagement, are the addition or release of a party to an existing B-ISDN connection. In a B-ISDN, a virtual connection can generally be either a Virtual Channel Connection (VCC) or a Virtual Path Connection (VPC). Since call processing capabilities are currently defined only for VCCs, a virtual connection within the context of this Recommendation is a VCC. Table 1 illustrates the application of the three generic performance criteria to each of the four new call processing functions that can be invoked for a B-ISDN call.

The parameters defined in this Recommendation are applicable only when the network is available. The availability of the network is the subject of another Recommendation.

Table 1/I.358 – Generic performance criteria for B-ISDN call processing functions

Call processing function	Speed	Accuracy	Dependability
1) Connection set-up	Connection set-up delay Connection post selection delay (Note 1) Connection answer signal delay (Note 1)	Connection set-up error probability	Connection set-up failure probability
2) Party set-up	Party set-up delay Party post selection delay (Note 1) Party answer signal delay (Note 1)	Party set-up error probability	Party set-up failure probability
3) Connection disengagement	Connection disconnect delay Connection release delay (Note 2)	Connection premature disconnect probability	Connection clearing failure probability
4) Party disengagement	Party disconnect delay Party release delay (Note 2)	Party premature disconnect probability	Party clearing failure probability
NOTE 1 – These parameters are defined for traffic engineering; objectives are not set for network performance. NOTE 2 – These parameters have local significance only; objectives will not be set.			

1.1 Bearer services

The set of bearer services covered by this Recommendation are those based upon switched virtual connections having:

– Type 1 or Type 2 topologies;

– ATM level traffic descriptors that can be communicated using the established signalling elements of Q.2971; and

– ATM level QOS needs that can be communicated using the established signalling elements.

1.2 Purpose of this Recommendation

The purpose of this Recommendation is to define performance parameters and objectives for call processing in B-ISDNs.

The current issue of this Recommendation is limited to Type 1 (point-to-point) and Type 2 (point-to-multipoint) connection topologies with single party add/drop. Additional capabilities such as multiple connection calls and modification of connection characteristics are for further study.

Quality of Service information should be provided to the users after mapping network performance into user-oriented expressions.

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.

[1] ITU-T Recommendation I.352 (1993), *Network performance objectives for connection processing delays in an ISDN.*

[2] ITU-T Recommendation I.353 (1996), *Reference events for defining ISDN and B-ISDN performance parameters.*

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

[4] ITU-T Recommendation Q.2971 (1995), *Digital Subscriber Signalling System No. 2 – User-Network Interface Layer 3 specification for point-to-multipoint call/connection control.*

[5] ITU-T Recommendation Q.2762 (1995), *General Functions of messages and signals of the B-ISDN User Part (B-ISUP) of Signalling System No. 7.*

[6] ITU-T Recommendation Q.2931 (1995), *Digital Subscriber Signalling No. 2 – User-Network Interface layer 3 specification for basic call/connection control.*

[7] ITU-T Recommendation Q.2761 (1995), *Functional description of the B-ISDN User Part (B-ISUP) of Signalling System No. 7.*

[8] ITU-T Recommendation Q.2650 (1995), *Interworking between Signalling System No. 7 Brandband ISDN User Part (B-ISUP) and Digital Subscriber Signalling No. 2 (DSS 2).*

[9] ITU-T Recommendation Q.2763 (1995), *Signalling System No. 7 B-ISDN User Part (B-ISUP) – Formats and codes.*

[10] ITU-T Recommendation I.356 (1996), *B-ISDN ATM layer cell transfer performance.*

[11] CCITT Recommendation E.721 (1991), *Network grade of service parameters and target values for circuit-switched services in the evolving ISDN.*

[12] ITU-T Recommendation Q.766 (1993), *Performance objectives in the integrated service digital network application.*

[13] ITU-T Recommendation Q.706 (1993), *Message transfer part signalling performance.*

[14] ITU-T Recommendation Q.2110 (1994), *B-ISDN ATM adaptation layer – Service Specific Connection Oriented Protocol (SSCOP).*

3 Abbreviations

This Recommendation uses the following abbreviations:

AAL ATM Adaptation Layer

ACM Address Complete Message

ANM Answer Message

AP Add Party

ATM Asynchronous Transfer Mode

B-ISDN Broadband ISDN

B-ISUP Broadband ISDN Signalling User Part

CASD Connection Answer Signal Delay

CCFP Connection Clearing Failure Probability

CDD Connection Disconnect Delay

CP-AAL	Common Part AAL
CPE	Customer Premises Equipment
CPSD	Connection Post Selection Delay
CRD	Connection Release Delay
CSD	Connection Set-up Delay
CSFP	Connection Set-up Failure Probability
FFS	For Further Study
GOS	Grade of Service
HRX	Hypothetical Reference Connection
IAM	Initial Address Message
IIP	International Interoperator Portion
INI	Inter-Network Interface
ISC	International Switching Center
ISDN	Integrated Service Digital Network
ITP	International Transit Portion
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
MPI	Measurement Point International
MPT	Measurement Point Terminal
MSU	Message Signal Unit
NNI	Network-Node Interface
PASD	Party Answer Signal Delay
PCFP	Party Clearing Failure Probability
PDD	Party Disconnect Delay
PH	PHysical layer
PPSD	Party Post Selection Delay
PRD	Party Release Delay
PSD	Party Set-up Delay
PSFP	Party Set-up Failure Probability
QOS	Quality of Service
RE	Reference Event
REL	Release
SSCF	Service Specific Coordination Function
SSCOP	Service Specific Connection Oriented Protocol
STP	Signalling Transfer Point
TE	Terminal Equipment
UNI	User-Network Interface

VBR	Variable Bit Rate
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VP	Virtual Path
VPC	Virtual Path Connection

4 Reference model

Within the context of this Recommendation, a reference model is intended to establish the context for the definition of performance parameters and the specification of objectives. This reference model provides a baseline reference connection that includes measurement points at which performance-significant reference events are observed and values for B-ISDN call processing performance parameters are determined, and a specification of the traffic loading conditions under which objectives are to be met. This reference model consists of a reference configuration, a set of performance-significant reference events, and time intervals for establishing the conditions under which objectives are to be met.

4.1 Reference configuration

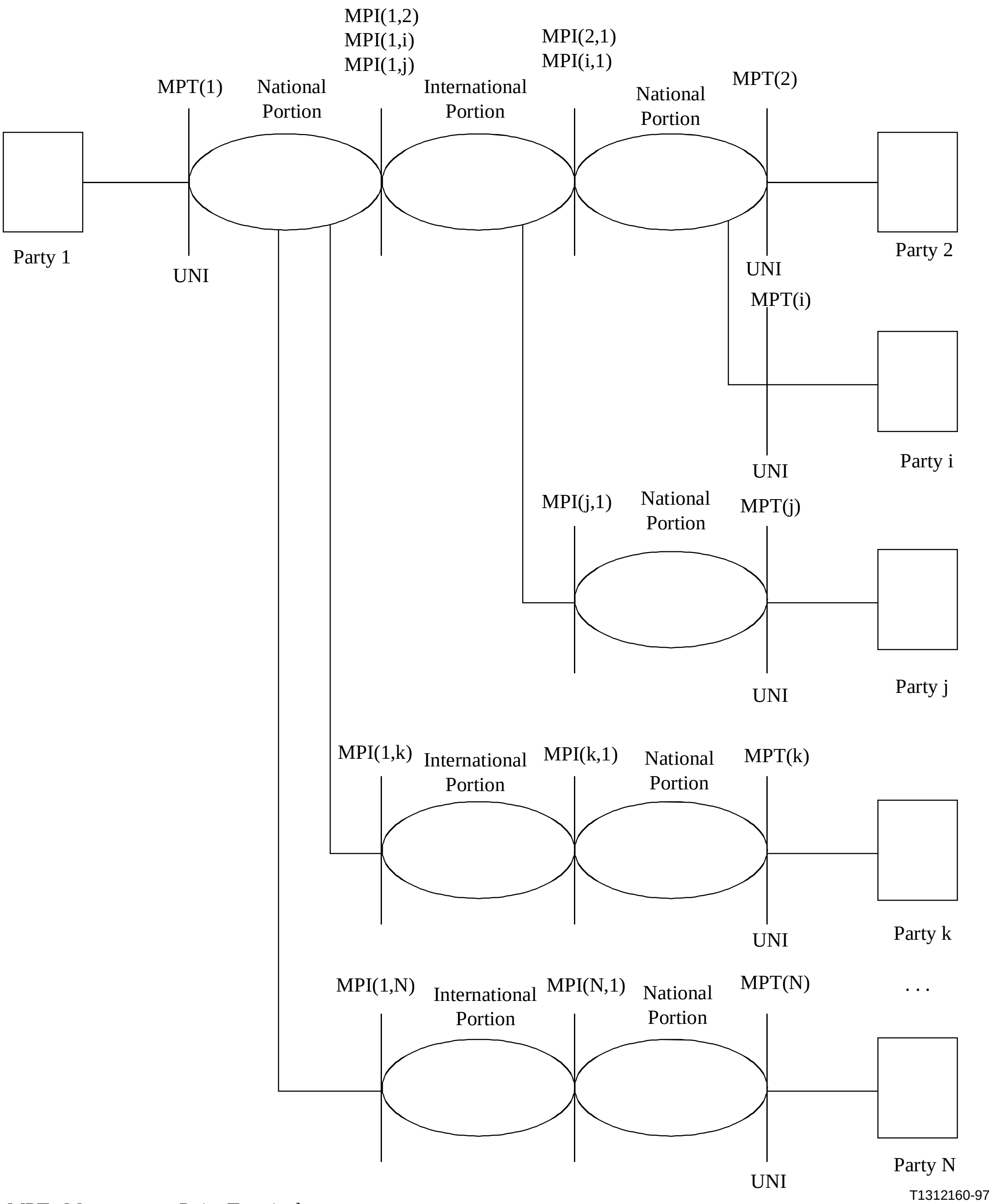
Figure 1 illustrates a reference configuration that is applicable for characterizing call processing performance for point-to-point (Type 1) and point-to-multipoint (Type 2) B-ISDN virtual connection topologies. Figure 1 is equivalent to the reference configuration of I.352 (which is applicable to point-to-point calls in an ISDN based on 64 kbit/s channels) when N = 2, and the capacity of the virtual connection is equivalent to 64 kbit/s.

All B-ISDN call processing performance parameters are specified at measurement points. These measurement points are defined consistent with Recommendation I.353, where a Measurement Point T (MPT) is located at a User-Network Interface (UNI) and a Measurement Point I (MPI) is located at an interface that terminates an ATM transmission system at an international Switching Center (ISC). The measurement points in Figure 1 are identified according to the method established below. In cases where one MPI supports a connection to several topological parties, that MPI is identified by several sets of systematic indices as described below:

- MPT(j) represents the MPT associated with party j.
- MPI(j,k) represents the MPI delimiting the national portion containing party j and carrying the connection from party j to party k.
- MPI(k,j) represents MPI delimiting the national portion containing party k and carrying the connection from party j to party k.

  $k,j \in \{1, ..., N\}$ representing the N parties.

This notation can be used for multipoint-to-multipoint topologies when they are supported. A third index could be added when multi-connection calls are supported.



MPT Measurement Point Terminal
MPI Measurement Point International
UNI User-Network Interface

Figure 1/I.358 – Reference configuration for B-ISDN call processing performance

4.2 Reference events

The reference events used for defining B-ISDN call processing performance parameters are found in Recommendation I.353. Reference events will be defined at MPI type measurement points based on Q.2762 messages, and at MPT type measurement point based on Q.2931 and Q.2971 messages.

For each B-ISDN call processing function identified in Table 1, Table 2 will list the performance-significant reference events associated with the Q.2931 or Q.2972 protocol.

For each B-ISDN call processing function identified in Table 1, Table 3 will list the performance-significant reference events associated with the Q.2761 protocol and its signalling messages. Interworking between the Q.2931 and Q.2971 protocols and their messages is described in Recommendation Q.2650.

Table 2/I.358 – Performance-significant reference events based on Q.2931 and Q.2971 layer 3 message transfer

Call processing function	Signalling message	Purpose	Code
1) Connection set-up			
Set-up at MPT(1)	SETUP	Request call establishment	T1a
Set-up at MPT(2)	SETUP	Call arrival notification	T1b
Set-up at MPT(2)	CONNECT	Accept arrived call	T2a
Set-up at MPT(1)	CONNECT	Acknowledge call establishment	T2b
Alerting at MPT(2)	ALERTING	Acknowledge called party alerted	T9a
Alerting at MPT(1)	ALERTING	Called party alerted	T9b
2) Party set-up			
Add at MPT(1)	ADD PARTY	Request party establishment	T5a
Add at MPT(i) i=3,N	ADD PARTY	Call arrival notification	T5b
Add at MPT(i) i=3,N	ADD PARTY ACK	Accept party acknowledgment	T6a
Add at MPT(1)	ADD PARTY ACK	Acknowledge party establishment	T6b
Party Alerting at MPT(i) i=3,N	PARTY ALERTING	Acknowledge add party alerted	T10a
Party Alerting at MPT(1)	PARTY ALERTING	Add party alerted	T10b
3) Connection disengagement			
Disconnect at MPT(1)	RELEASE	Request connection release	T3a
Disconnect at MPT(i) i=2,N	RELEASE	Party release notification	T3b
Connection Release at MPT(1)	RELease COMplete	Confirm release (local)	T4b
4) Party disengagement			
Drop Party at MPT(1)	DROP PARTY	Request party drop	T7a
Drop Party at MPT(i) i=2,N	DROP PARTY	Party drop notification	T7b
Disconnect Party by MPT(i) i=2,N	RELEASE	Request party disconnect	T3a
Disconnect Party at MPT(1)	RELEASE	Receive party disconnect	T3b
Drop Party at MPT(1)	DROP PARTY ACK	Confirm drop (local)	T8b
Drop Party at MPT(i) i=2,N	RELease COMplete	Confirm party release (local)	T4b

Table 3/I.358 – Performance-significant reference events based on Q.2761 layer 3 message transfer

Call processing function	Signalling message	Purpose	Code
1) Connection Set-up			
Set-up at MPI(1,2)	Initial Address (IAM)	Initiate connection establishment	U1a
Set-up at MPI(2,1)	Initial Address (IAM)	Call arrival notification	U1b
Set-up at MPI(2,1)	Answer (ANM)	Return answer indication	U2a
Set-up at MPI(1,2)	Answer (ANM)	Acknowledge connection establishment	U2b
Alerting at MPI(2,1)	Address Complete (ACM)	Return alerting	U9a
Alerting at MPI(1,2)	Address Complete (ACM)	Acknowledge alerting	U9b
2) Party set-up			
Add Party at MPI(1,i) i=3,N	Initial Address (IAM)	Initiate party establishment	U5a
Add Party at MPI(i,1) i=3,N	Initial Address (IAM)	Call arrival notification	U5b
Add Party at MPI(i,1) i=3,N	Answer (ANM)	Return answer indication	U6a
Add Party at MPI(1,i) i=3,N	Answer (ANM)	Acknowledge party establishment	U6b
3) Connection disengagement			
at MPI(1,i) i=2,N	Release (REL)	Initiate disconnect	U3a
at MPI(i,1) i=2,N	Release (REL)	Disconnect	U3b
4) Party disengagement			
Drop by MPI(1,i) i=2,N	Release (REL)	Initiate party disconnect	U7a
Drop at MPI(i,1) i=2,N	Release (REL)	Party disconnect	U7b
Drop by MPI(i,1) i=2,N	Release (REL)	Initiate party disconnect	U7a
Drop at MPI(1,i) i=2,N	Release (REL)	Party disconnect	U7b

4.3 Future reference events

B-ISDN call processing supports sequential modes for adding/dropping parties to existing B-ISDN calls. Currently, B-ISDN call processing does not support a request to establish, modify or terminate a call involving more than two parties with multiple virtual connections for each party. Reference events for future modes of B-ISDN call processing will be determined as it becomes clear that they will be supported.

For this initial issue of this Recommendation, a look ahead feature for multi-party and multi-connection calls will not be treated.

4.4 Assumptions for establishing objectives

1) User's terminals do not make new calls in any time interval between a connection/add party request and its complete/incomplete response.

2) For a given call, no add party request is made until the CONNECT message is received by the initiating terminal.

3) Time intervals between calls which any user's terminal makes, are more than a time interval value T1.

4) If a call requested by a user's terminal is incomplete because SETUP parameters of this call cannot be negotiated due to impossible or invalid parameter values, the retrying call request should change the SETUP parameters' value.

5) Time intervals between an incomplete answer and the next call requests, are more than a time interval value T2.

6) Calls considered in this Recommendation are initiated during times when the network is available.

7) Frequency of add party requests are less than a value A1. The unit of value A1 is parties/time.

4.5 Performance objective for delay parameters

End-to-end delay parameters are defined using reference events occurring at MPTs, therefore, performance objectives applied to this set of parameters reflect the Quality of Service provided by a provider's network.

The performance objectives for the set of delay parameters can be expressed in terms of:

– mean delay; and

– 95%-tile delay.

However, this approach does not take into account the impact of traffic load on call processing performance parameters (i.e. speed, dependability, and accuracy). An alternative worst-case objective is addressed in the next subclause.

4.6 Alternate specification of objectives

In general, while the value taken by a particular call processing performance parameter is sensitive to the traffic load that exists on each portion of the network through which a call is being processed, the worst-case objectives specified in this Recommendation are meant to apply to any one-hour of time.

NOTE – To allow for the impacts of random, short-term traffic load fluctuations during any hour, the probability that a particular call processing performance parameter value, V, fails to meet its objective, O, may be specified. That is:

$$Prob.\ \{V > O\} \leq X$$

where

V = actual parameter value;

O = objective.

The exact conditions or assumptions under which these worst-case objectives may apply are for further study. Use of an hour or possibly 15-minute interval of time would facilitate support by existing operations systems. It is recognized that the objective would be developed taking into consideration peak traffic factors such as "busy hour".

5 Call processing delays for a Type 2 B-ISDN call

Call processing delays in this Recommendation are for Type 1 and Type 2 B-ISDN call processing modes. Call processing delay parameters for a point-to-point, single connection (Type 1) call are a special case of Type 2 using only the connection establishment parameters (i.e. no party establishment). Additional performance parameters that treat call processing delay for those call processing aspects that are new with B-ISDN are defined in the following subclauses.

To define the call processing delays when establishing a call involving more than two parties (Type 2), the following conditions are assumed:

– A Type 2 B-ISDN call is requested by the party whose UNI coincides with MPT(1), and who will be the transmitter over the point-to-multipoint connection (i.e. the "root").

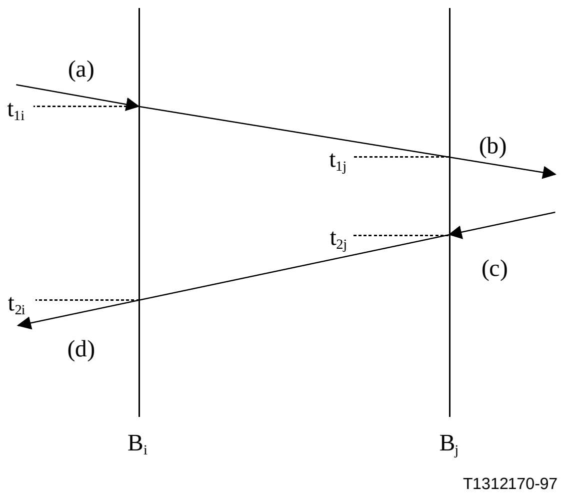
– Parties 2, ..., i,j, ... N whose UNIs coincide with MPT(2, ..., i,j, ... N), respectively, are receivers over the point-to-multipoint connection (i.e. "leaves").

– The call will be initiated with a connection established to party 2 whose UNI coincides with MPT(2).

– Parties 3, ..., i,j, ... N whose UNIs coincide with MPT(3, ..., i,j, ... N), respectively, are added sequentially.

The model for determining call processing delays (see Figure 2) allows for single portion and between portion definitions using the reference events from Tables 3 and 4. Parameters involving round trip delays (e.g. connection/party establishment) are defined by portion boundaries (i.e. B_i and B_j below). Unidirectional delay parameters (e.g. connection/party disconnect delay) are defined only between two portion boundaries. This approach ensures that performance is attributable to specific portions.

For each parameter, performance-significant Reference Event (RE) tables are provided containing those REs used in the parameter's definition. These REs are listed by relevant boundary. The boundaries are described according to Figure 1.



B_i and B_j represent pairs of boundaries from Figure 1.

Figure 2/I.358 – General nomenclature for parameter measurement

Processing delay at a single boundary is the difference in time between the starting RE and the ending RE for that particular boundary. Thus the delay at portion boundary B_i, is $d(B_i) = t_{2i} - t_{1i}$, where t_{1i} is the time of occurrence of the starting RE at B_i and t_{2i} is the time of occurrence of the ending RE at B_i. The delay between two boundaries, B_i and B_j, is $d_{i,j} = d(B_i) - d(B_j)$, where B_i is a boundary further downstream from the starting RE at boundary B_i, $d(B_j) = t_{2j} - t_{1j}$.

5.1 Call establishment delays

The boundaries (B_i and B_j) from Figure 2 for call establishment delays are MPT(1), MPI(1,2), MPI(2,1) and MPT(2) (from Figure 1). Figure 3 illustrates aspects of call establishment processing that are observable at measurement points. This figure is based on all parties being added successfully and the assumptions in 4.4 being met.

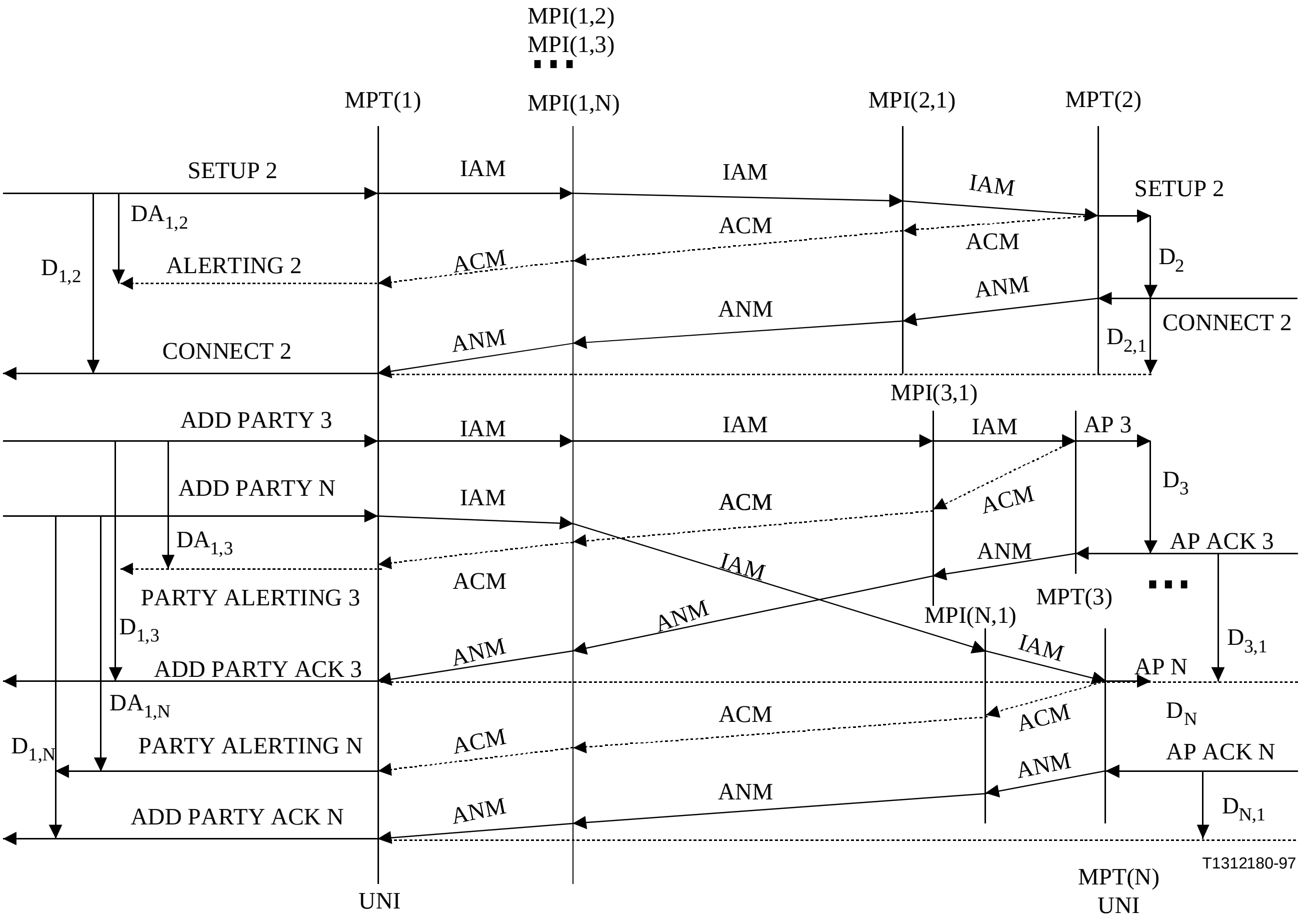


Figure 3/I.358 – Call establishment processing delays for a Type 2 B-ISDN call

5.1.1 Connection delays

5.1.1.1 Connection Set-up Delay (CSD)

The performance significant reference events for CSD are listed in Table 4.

Table 4/I.358 – Starting and Ending REs for connection set-up delay at a single boundary

Boundary, B_i	Starting RE	Ending RE
MPT(1)	T1a (SETUP exit)	T2b (CONNECT entry)
MPI(1,2)	U1a (IAM exit)	U2b (ANM entry)
MPI(2,1)	U1b (IAM entry)	U2a (ANM exit)
MPT(2)	T1b (SETUP entry)	T2a (CONNECT exit)

End-to-end connection set-up delay is the time from the transmission of the SETUP message from the calling party until a CONNECT message is received by the calling party minus the response time of the terminal (called user response time). Using the general model of Figure 2, with B_i = MPT(1) and B_j = MPT(2), end-to-end connection set-up delay is determined as $d_{i,j} = d_{12}$ = d(MPT(1)) – d(MPT(2)). The reference events identified by codes T1a and T2b in Table 2 are used to measure the time d(MPT(1)); the reference events identified by codes T1b and T2a in Table 2 are used to measure d(MPT(2)). These time differences correspond to delays labelled $D_{1,2}$ and D_2 respectively, in Figure 3. Using the notation in Figure 3, the following difference is formed for end-to-end connection set-up delay (to MPT(2)):

$$CSD = D_{1,2} - D_2$$

$$(= d[MPT(1)] - d[MPT(2)])$$

The worst-case delay objective for the call processing performance parameter, applying to any one-hour period, may be specified as:

Table 5/I.358 – Provisional delay objectives in ms for Connection Set-up Delay

Portions	Mean of CSD (ms)	95%-tile of CSD (ms)
National	FFS	FFS
International Transit	FFS	FFS
International Interoperator	FFS	FFS
End-to-end	FFS	FFS

5.1.1.2 Connection Post Selection Delay (CPSD)

The performance significant reference events for CPSD are listed in Table 6.

Table 6/I.358 – Starting and Ending REs for connection post selection delay at a single boundary

Boundary, B_i	Starting RE	Ending RE
MPT(1)	T1a (SETUP exit)	T9b (ALERTING entry)
MPI(1,2)	U1a (IAM exit)	U9b (ACM entry)
MPI(2,1)	U1b (IAM entry)	U9a (ACM exit)
MPT(2)	Not applicable	Not applicable

Connection post selection delay is the time from the transmission of the SETUP message from the calling party until an ALERTING message (when present) is received by the calling party. For end-to-end PSD, the reference events at MPT(1) defined by codes T1a and T9b in Table 2 are used to define the time difference d(MPT(1)) in Figure 2. $DA_{1,2}$ in Figure 3 = d(MPT(1)) for these reference events. The ALERTING message is optional and is typically used when delay D_2 is due to human response, e.g. a voice call. Otherwise the "CONNECT" message will be immediate and PSD will be equal to CSD. Objectives for CPSD are for future study.

5.1.1.3 Connection Answer Signal Delay (CASD)

The performance significant reference events for CASD are listed in Table 7.

Table 7/I.358 – Starting and Ending REs for connection answer signal delay between portion boundaries

Boundary, B_i	**RE at (d)**	**Boundary, B_i**	**RE at (b)**
MPT(1)	T2b (CONNECT entry)	MPT(2)	T2a (CONNECT exit)
MPI(1,2)	U2b (ANM entry)	MPI(2,1)	U2a (ANM exit)

End-to-end connection answer signal delay is the time from transmission of a CONNECT message from the called party until it is received by the calling party. The reference events defined by codes T2b and T2a in Table 2 are used to define the time difference ($d_{2,1}$) formed by t_{2i} at MPT(1) – t_{2j} at MPT(2), in Figure 2. This difference, $D_{2,1}$ in Figure 3 = CASD. This double ended measure is optional. Objectives for CASD are for future study.

5.1.2 Party delays

5.1.2.1 Party Set-up Delay (PSD)

The performance significant reference events for PSD are listed in Table 8.

Table 8/I.358 – Starting and Ending REs for party set-up delay at a single boundary

Boundary, B_i	**Starting RE**	**Ending RE**
MPT(1)	T1a (ADD PARTY exit)	T2b (ADD PARTY ACK entry)
MPI(1,2)	U1a (IAM exit)	U2b (ANM entry)
MPI(2,1)	U1b (IAM entry)	U2a (ANM exit)
MPT(2)	T1b (ADD PARTY entry)	T2a (ADD PARTY ACK exit)

End-to-end party set-up delay is the time from the transmission of the ADD PARTY message from the calling party until an ADD PARTY ACK message is received by the calling party minus the response time of the terminal (called user response time). Using the general model of Figure 2, with B_i = MPT(1) and B_j = MPT(k) k = 3,N; end-to-end Party Set-up Delay (PSD) is determined as d(MPT(1)) – d(MPT(3) through MPT(N)). The reference events identified by codes T5a and T6b in Table 2 are used to measure the time d(MPT(1)); the reference events identified by codes T5b and T6a in Table 2 are used to measure d(MPT(3)) through d(MPT(N)). These time differences correspond to delays labelled $D_{1,3}$ through $D_{1,N}$ and D_3 through D_N in Figure 3. Using the notation of Figure 3, the following differences are formed for end-to-end party set-up delay (to MPT(i), i=3,N).

$$PSD_i = D_{1,i} - D_i$$

$$= d[MPT(1)] - d[MPT(3) \text{ through } MPT(N)]$$

The worst-case delay objectives for the add party call processing performance parameter (for party i), applying to any one-hour period, may be specified as:

Table 9/I.358 – Provisional delay objectives in ms for Party Set-up Delay

Portion	Mean of PSD	95%-tile of PSD
National	FFS	FFS
International Transit	FFS	FFS
International Interoperator	FFS	FFS
End-to-end	FFS	FFS

5.1.2.2 Party Post Selection Delay (PPSD)

The performance significant reference events for PPSD are listed in Table 10.

Table 10/I.358 – Starting and Ending REs for party post selection delay at a single boundary

Boundary, B_i	Starting RE	Ending RE
MPT(1)	T5a (ADD PARTY exit)	T10b (PARTY ALERTING entry)
MPI(1,2)	U1a (IAM exit)	U9b (ACM entry)
MPI(2,1)	U1b (IAM entry)	U9a (ACM exit)
MPT(2)	Not applicable	Not applicable

Party post selection delay is the time from the transmission of the ADD PARTY message from the calling party until a PARTY ALERTING message (when present) is received by the calling party. For end-to-end PPSD, the reference events at MPT(1) defined by codes T5a and T10b in Table 2 are used to define the time differences d(MPT(1)) in Figure 2. $DA_{1,i}$ i=3,N in Figure 3 = d(MPT(1)) for these reference events. The PARTY ALERTING message is optional; the need for PPSD is for further study.

5.1.2.3 Party Answer Signal Delay (PASD)

The performance significant reference events for PASD are listed in Table 11.

Table 11/I.358 – Starting and Ending REs for party answer signal delay between portion boundaries

Boundary, B_i	RE at (d)	Boundary, B_i	RE at (b)
MPT(1)	T6b (ADD PARTY ACK entry)	MPT(i) i=3,N	T6a (ADD PARTY ACK exit)
MPI(1,i) i=3,N	U2b (ANM entry)	MPI(i,1) i=3,N	U2a (ANM exit)

Party answer signal delay is the time from transmission of ADD PARTY ACK from the called party until it is received by the calling party. The reference events defined by codes T6a and T6b in Table 2 are used to define the time differences ($d_{k,1}$) formed by t_{2i} at MPT(1) – t_{2j} at MPT(k) k=3,N in Figure 2. This difference, $D_{k,i}$ k=3,N in Figure 3, defines PASD. The need for PASD is for further study.

5.1.3 Overall multi-party call establishment delay for N-1 added parties

This parameter is for further study. The following issues are under study:

- When should party set-up attempts be called successful?
- When should the call (connection + party set-up attempts) be called successful? Two possible methods are:
  - a) Call party call set-up attempts successful only if they are associated with a successful call setup.
  - b) Evaluate call and party set-up performance separately, so that party set-up attempts that were successful and are associated with an unsuccessful call set-up still have to meet the party establishment delay objective.
- Are there any limits on the amount of additional party set-up attempts that can be associated with a call, beyond which the individual party set-up delay requirements would not apply and beyond which the call processing objectives would also not apply? That is would we consider the party set-up delay objective to apply when 10 000 additional parties are requested?
- What are the limits, if any, on the rate at which either add party requests or connection set-up requests can be made in order for the delay objectives to apply?
- What percentage, or number, of party set-up attempts need to be successful for the call to be deemed successful?
- How are delays evaluated when some of the add parties are not successful?

5.2 Call disengagement delays

The boundaries (B_i and B_j) from Figure 2 for call disengagement delays are MPT(1), MPI(1,2), MPI(2,1) and MPT(2) (from Figure 1). Figure 4 illustrates aspects of call disconnect processing that are observable at the measurement points. This figure is based on all parties being released.

In a Type 2 B-ISDN call, only the root (calling party) can release the call (connection). Individual parties can be released by either the root (DROP PARTY) or the called party (leaf) requesting the party drop (RELEASE). Figure 4 depicts these actions based on the general model in Figure 1 and Table 2.

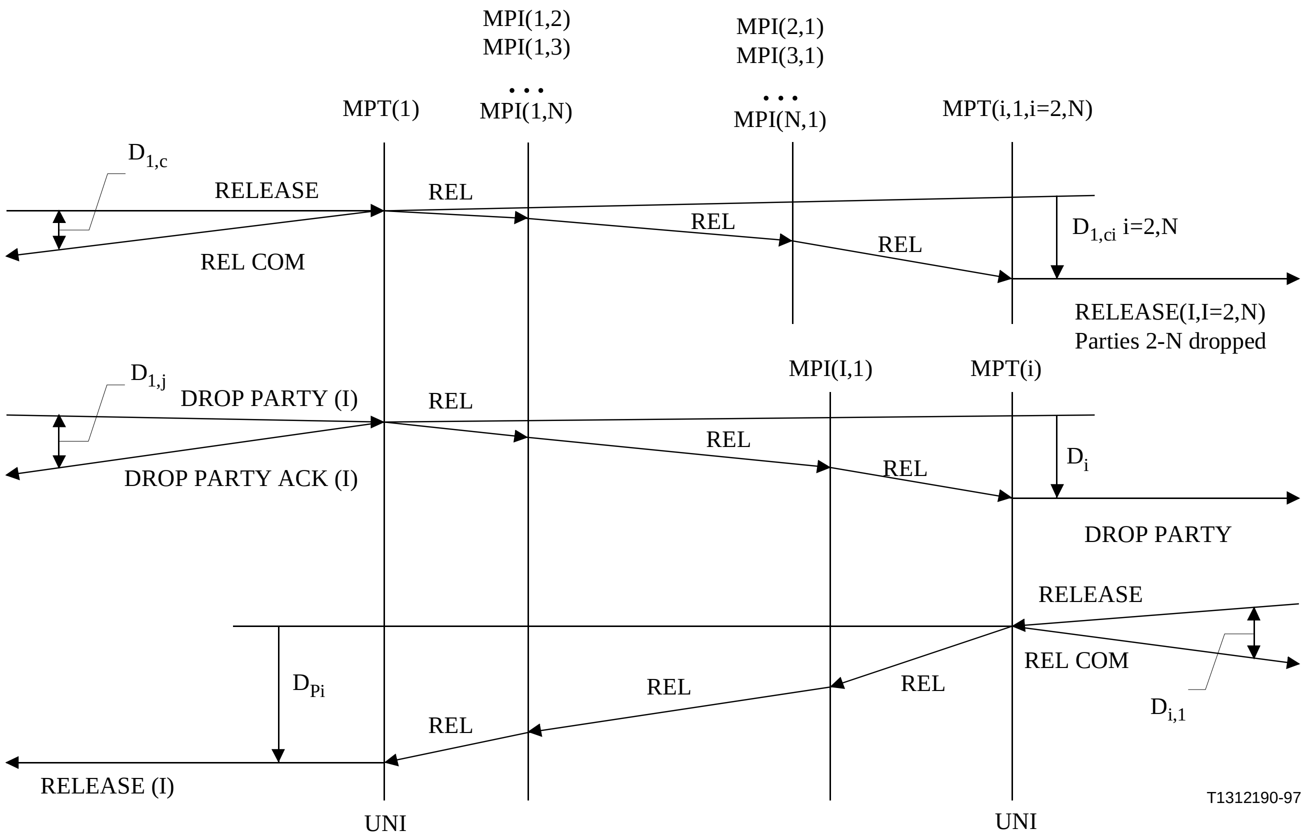


Figure 4/I.358 – Call disconnect processing delays for a Type 2 B-ISDN call

5.2.1 Connection Disconnect Delay (CDD)

The performance significant reference events for CDD are listed in Table 12.

Table 12/I.358 – Starting and Ending REs for connection disconnect delay between portion boundaries

Boundary, B_i	RE at (d)	Boundary, B_i	RE at (b)
MPT(1)	T3a (RELEASE exit)	MPT(i) i=2,N	T3b (RELEASE entry)
MPI(1,i) i=2,N	U3a (REL exit)	MPI(i,1) i=2,N	U3b (REL entry)

Connection disconnect delay is the time from transmission of a RELEASE from the root until the network resources are available to the root. CDD is determined using the reference events defined by codes T3a and T3b in Table 2 to define the time differences ($d_{1,k}$) formed by t_{1i} at MPT(1) − $t_{1,j}$ at MPT(k) k=2,N in Figure 2. This difference is indicated by $D_{1,ci}$ i=2,N in Figure 4. Disconnect delay is defined as the length of time that begins when the reference event identified by the code T3a occurs at MPT(1) and ends when the reference event identified by code T3b occurs at the last party released. Using the notation of Figure 4:

$$CDD = Max(D_{1,ci}, i=2,N)$$

The worst-case delay objective for the connection disconnect delay parameter may be specified as:

Table 13/I.358 – Delay objectives in ms for Connection Disconnect Delay

Portion	Mean of CDD (ms)	95%-tile of CDD (ms)
National	FFS	FFS
International Transit	FFS	FFS
International Interoperator	FFS	FFS
End-to-end	FFS	FFS

5.2.2 Connection Release Delay (CRD)

The performance significant reference events for CRD are listed in Table 14.

Table 14/I.358 – Starting and Ending REs for connection release delay at a single boundary

Boundary, B_i	Starting RE	Ending RE
MPT(1)	T3a (RELEASE exit)	T4b (REL COM entry)
MPI(1,2)	Not applicable	Not applicable
MPI(2,1)	Not applicable	Not applicable
MPT(2)	Not applicable	Not applicable

Connection release delay is the time from the transmission of a RELEASE message from the clearing party until a RELease COMplete is received by the clearing party (this is a local signal). Using the general model in Figure 2, CRD is determined using the reference events identified in Table 2 by codes T3a and T4b defined at MPT(1) to determine the time difference d[MPT(1)]. This difference is indicated by $D_{1,c}$ in Figure 4. Connection release delay is identified only at MPT(1). As this parameter does not have end-to-end significance, no objectives will be established.

5.2.3 Party Disconnect Delay (PDD)

The performance significant reference events for PDD are listed in Table 15.

Table 15/I.358 – Starting and Ending REs for party disconnect delay between portion boundaries

Boundary, B_i	RE at (d)	Boundary, B_i	RE at (b)
MPT(1)	T7a (DROP PARTY exit)	MPT(i) i=2,N	T7b (DROP PARTY entry)
MPI(1,i) i=2,N	U3a (REL exit)	MPI(i,1) i=2,N	U3b (REL entry)
MPT(i) I=2,N	T3a (RELEASE exit)	MPT(1)	T3b (RELEASE entry)
MPI(i,1) i=2,N	U3a (REL exit)	MPI(1,i) i=2,N	U3b (REL entry)

5.2.3.1 Party Disconnect Delay (Root)

Party Disconnect Delay (root) [PDD(root)] is the time from transmission of a DROP PARTY from the Root until the network resources associated with the dropped party are available to the Root. PDD(root) is determined using the reference events defined by codes T7a and T7b in Table 2 to define the time differences ($d_{1,k}$) formed by t_{1i} at MPT(1) − $t_{1,j}$ at MPT(k) k=2,N in Figure 2. This difference is indicated by D_i i=2,N in Figure 4. PDD(root), when the party is disconnected by the Root is:

$$PDD(root)_i = D_i \quad i=2,N$$

The worst-case delay objective for the party disconnect (from the root) delay parameter may be specified as:

Table 16/I.358 – Delay objectives in ms for Party Disconnect Delay (Root)

Portion	mean of PDD(root) (ms)	95%-tile of PDD(root) (ms)
National	FFS	FFS
International Transit	FFS	FFS
International Interoperator	FFS	FFS
End-to-end	FFS	FFS

5.2.3.2 Party Disconnect Delay (Leaf)

Party Disconnect Delay (leaf) [PDD(leaf)] is the time from transmission of a RELEASE from the Leaf until the network resources are available to the Leaf. PDD(leaf) is determined using the reference events defined by codes T3a and T3b in Table 2 to define the time differences ($D_{1,k}$) formed by t_{1i} at MPT(k) k=2,N – $t_{1,j}$ at MPT(1) in Figure 2. This difference is indicated by D_{pi} i=2,N in Figure 4. PDD(leaf), when the party is disconnected by the Leaf is:

$$PDD(leaf)_i = D_{pi} \quad i=2,N$$

The worst-case delay objective for the party disconnect from leaf delay parameter, applying to any one-hour period, may be specified as:

Table 17/I.358 – Delay Objectives in ms for Party Disconnect Delay (Leaf)

Portion	Mean of PDD(leaf) (ms)	95%-tile of PDD(leaf) (ms)
National	FFS	FFS
International Transit	FFS	FFS
International Interoperator	FFS	FFS
End-to-end	FFS	FFS

5.2.4 Party Release Delay (PRD)

The performance significant reference events for PRD are listed in Table 18.

Table 18/I.358 – Starting and Ending REs for party release delay at a single boundary

Boundary, B_i	Starting RE	Ending RE
MPT(1)	T7a (DROP PARTY exit)	T8b (DROP PARTY ACK entry)
MPI(1,2)	Not applicable	Not applicable
MPI(2,1)	Not applicable	Not applicable
MPT(i) i=2,N	T3a (RELEASE exit)	T4b (REL COM entry)

5.2.4.1 Party Release Delay (Root)

Party release delay (root) originating from the Root is the time from the transmission of a DROP PARTY message from the root until a DROP PARTY ACK is received by the Root (these are local signals). Using the general model in Figure 2, PRD is determined using the reference events identified in Table 2 by codes T7a and T8b defined at MPT(1) to determine the time difference d_1. This difference is indicated by $D_{1,i}$ i=2,N in Figure 4. As this parameter does not have end-to-end significance, no objectives will be established.

5.2.4.2 Party Release Delay (Leaf)

Party release delay (leaf) is the time from the transmission of a RELEASE message from the leaf until a RELease COMplete is received by the leaf (these are local signals). Using the general model in Figure 2, PRD is determined using the reference events identified in Table 2 by codes T3a and T4b defined at MPT(i) i=2,N to determine the time difference d_1. This difference is indicated by $D_{i,1}$ i=2,N in Figure 4. As this parameter does not have end-to-end significance, no objectives will be established.

6 Incorrect processing parameters

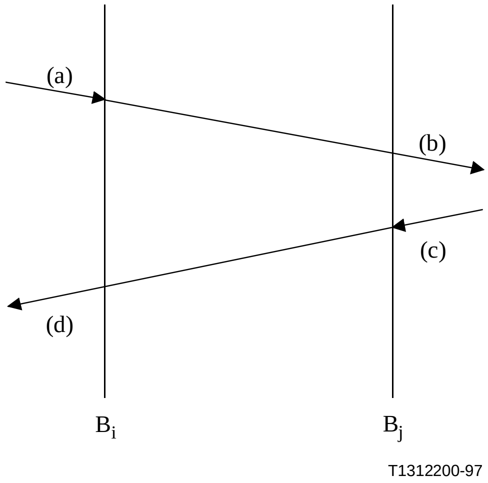
6.1 Connection, party and multi-party call set-up error probabilities

The incorrect processing parameters addressed in this clause are connection, party, and multi-party call set-up error probabilities. Connection and party set-up error probability are defined in 6.1.1 and 6.1.2 respectively. The definition of the multi-party call set-up error probability in 6.1.3 is for further study.

The connection and party setup error probabilities are defined between pairs of portion boundaries (B_i, B_j), where B_j is one of the set of portion boundaries to which the connection or party set-up attempt can properly be routed. Figure 5 identifies the sequence of four classes of events that occur in a successful connection or party setup. All of the specific instances of these four classes applicable to connection or party establishment must occur in their proper sequence (a, b, c, d) prior to expiration of timer T_{Max1}[1] for a successful connection or party set-up to have occurred.

NOTE – Any other unsuccessful set-up attempt (apart from the parameters defined in clauses 6 and 7) are caused by problems outside the portion.

[1] The value of T_{Max1} is for further study.



B_i and B_j represent pairs of boundaries from Figure 1.

Figure 5/I.358 – Classes of reference events occurring during successful connection or party set-up

6.1.1 Connection set-up error probability

Connection set-up error probability describes the accuracy of the function of connection establishment.

Connection set-up error probability is the ratio of total connection set-up attempts that result in connection set-up error to the total connection set-up attempts in a population of interest.

With reference to Figure 5, a connection set-up error is defined to occur on any connection set-up attempt in which the appropriate reference event from class (d) occurs, but the appropriate reference event from class (c) does not occur prior to expiration of timer T_{Max1}.

Connection set-up error is essentially the case of a network-caused "wrong number" at the connection level. It occurs when the network responds to a valid connection request by erroneously establishing a connection to a destination TE other than the one designated in the connection request, and does not correct the error prior to entry to the user information transfer state. It may be caused, for example, by network operator administrative or maintenance actions.

Connection set-up error is distinguished for successful connection set-up by the fact that the intended called party is not contacted and not committed to the user information transfer session during the connection set-up attempt.

The specific Reference Events (REs) used in defining successful connection set-up at each portion boundary are identified in Tables 19 and 20.

Table 19/I.358 – REs at B_i occurring during a successful connection set-up

Boundary, B_i	**RE**	
	(a)	**(d)**
MPT(1)	T1a (SETUP exit)	T2b (CONNECT entry)
MPI(1,2)	U1a (IAM exit)	U2b (ANM entry)
MPI(2,1)	U1b (IAM entry)	U2a (ANM exit)
MPT(2)	Not applicable	Not applicable

Table 20/I.358 – REs at B_j occurring during a successful connection set-up

Boundary, B_j	RE	
	(b)	**(c)**
MPT(1)	Not applicable	Not applicable
MPI(1,2)	U2a (IAM exit)	U1b (IAM entry)
MPI(2,1)	U1b (IAM entry)	U2a (ANM exit)
MPT(2)	T1b (SETUP entry)	T2a (CONNECT exit)

NOTE – A time interval over which connection set-up error probability is to be evaluated needs to be defined before worst-case objectives can be established.

6.1.2 Party set-up error probability

Party set-up error probability describes the accuracy of the function of party establishment.

Party set-up error probability is the ratio of total party set-up attempts that result in party set-up error to the total party set-up attempts in a population of interest.

With reference to Figure 5, a party set-up error is defined to occur on any party set-up attempt in which the appropriate reference event from class (d) occurs, but the appropriate reference event from class (c) does not occur prior to expiration of timer T_{Max1}.

Party set-up error is essentially the case of a network-caused "wrong number" at the party-level. It occurs when the network responds to a valid party request by erroneously establishing a party to a destination TE other than the one designated in the party request, and does not correct the error prior to entry to the user information transfer state. It may be caused, for example, by network operator administrative or maintenance actions.

Party set-up error is distinguished from successful party set-up by the fact that the intended called party is not contacted and not committed to the user information transfer session during the party set-up attempt.

The specific Reference Events (REs) used in defining successful party set-up at each portion boundary are identified in Tables 21 and 22.

Table 21/I.358 – REs at B_i occurring during a successful party set-up

Boundary, B_i	RE	
	(a)	**(d)**
MPT(1)	T1a (PARTY ADD exit)	T2b (ADD PARTY ACK entry)
MPI(1,k) k=3,N	U1a (IAM exit)	U2b (ANM entry)
MPI(k,1) k=3,N	U1b (IAM entry)	U2a (ANM exit)
MPT(k) k=3,N	Not applicable	Not applicable

Table 22/I.358 – REs at B_j occurring during a successful party set-up

Boundary, B_j	RE	
	(b)	**(c)**
MPT(1)	Not applicable	Not applicable
MPI(1,2)	U1a (IAM exit)	U2b (ANM entry)
MPI(2,1)	U1b (IAM entry)	U2a (ANM exit)
MPT(2)	T1b (ADD PARTY entry)	T2a (ADD PARTY ACK exit)

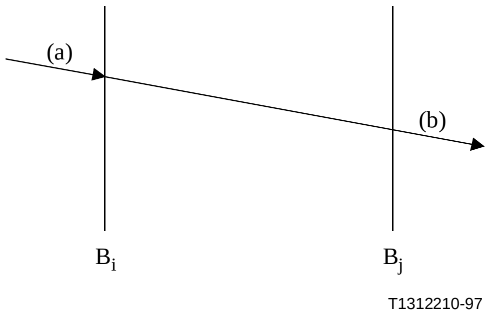
NOTE – A time interval over which party set-up error probability is to be evaluated needs to be defined before worst-case objectives can be established.

6.1.3 Multi-party call set-up error probability

For further study.

6.2 Connection and party premature disconnect

The connection and party premature disconnect are defined between pairs of portion boundaries (B_i, B_j), where B_j is one of the set of portion boundaries within the connection or party VCC. Figure 6 identifies the sequence of events that occur in a successful user requested connection or party disconnect.



B_i and B_j represent pairs of boundaries from Figure 1.

Figure 6/I.358 – Classes of reference events occurring during successful connection or party disconnect

A premature disconnect corresponds to the unexpected disconnect of an already established connection or party. Premature disconnect events are defined between pairs of portion boundaries (B_i,B_j) where B_i and B_j can be an MPT or an MPI.

A premature disconnect event is defined to occur on any connection or party already established in which either one of the following outcomes is observed:

– the appropriate reference events from class (a) do not occur, but those from (b) do, excluding those cases which are caused by an external premature disconnect stimulus event;

– an internally-generated premature disconnect stimulus event is transferred across a boundary of the portion.

A premature disconnect stimulus event is any event or combination of events generated within a portion that, according to the protocol, should result in a connection being disconnected by another portion. The definition of a premature disconnect stimulus event is for further study.

6.2.1 Connection premature disconnect probability

Connection premature disconnect probability is the probability per connection-second of the occurrence of a connection premature disconnect event.

The specific Reference Events (REs) used in defining successful connection disconnect at each portion boundary are identified in Table 23.

Table 23/I.358 – REs at B_i occurring during a successful connection disconnect

Boundary, B_i	RE at (a)	Boundary, B_i	RE at (b)
MPT(1)	T3a (RELEASE exit)	MPT(i) i=2,N	T3b (RELEASE entry)
MPI(1,2)	U3a (REL exit)	MPI(i) i=2,N,1	U3b (REL entry)

6.2.2 Party premature disconnect probability

Party premature disconnect probability is the probability per connection-second of the occurrence of a party premature disconnect event.

The specific Reference Events (REs) used in defining successful party disconnect at each portion boundary are identified in Table 24.

Table 24/I.358 – REs at B_i occurring during a successful party disconnect

Boundary, B_i	RE at (a)	Boundary, B_i	RE at (b)
MPT(1)	T7a (DROP PARTY exit)	MPT(i) i=2,N	T7b (DROP PARTY exit)
MPI(i,1) i=2,N	U3a (REL exit)	MPI(i,1) i=2,N	U3b (REL entry)
MPT(i) i=2,N	T3a (RELEASE exit)	MPT(1)	T3b (RELEASE entry)
MPI(i) i=2,N,1	U3a (REL exit)	MPI(1,i) i=2,N	U3b (REL entry)

7 Denial parameters

7.1 Connection/party set-up denial parameters

The denial parameters addressed in this clause are connection, party, and multi-party call set-up failure probabilities. Connection and party set-up failure probability are defined in 7.1.1 and 7.1.2 respectively. The definition of the multi-party call set-up failure probability in 7.1.3 is for further study.

NOTE – End-to-end connection, party, and multi-party set-up failure, which applies between boundaries MPT(1) and MPT(2) in Figure 1, can occur from a lack of resources due to insufficient dimensioning or failure or from other errors. End-to-end failure from a lack of resources due to insufficient dimensioning can be considered as a special case of the set-up failure probability. This source, which is used for network dimensioning, is referred to as "probability of end-to-end blocking" in Recommendation E.721. The connection and party set-up failure probabilities are defined between pairs of portion boundaries (B_i, B_j), where B_j is one of the set of portion boundaries to which the connection or party set-up attempt can properly be routed.

Figure 5 identifies the sequence of four classes of events that occur in a successful connection or party set-up. All of the specific instances of these four classes applicable to connection or party establishment must occur in their proper sequence for a successful connection or party set-up to have occurred. Probability of connection and party blocking are special cases of connection and party set-up failure probability.

Tables 19 and 20 are used to determine the reference events for connection set-up failure probability. Tables 21 and 22 are used to determine the reference events for party set-up failure probability.

The multi-party call failure probability and its special case of probability of multi-party blocking are for further study.

7.1.1 Connection Set-up Failure Probability (CSFP)

Connection set-up failure probability describes the dependability of the function of connection establishment.

Connection set-up failure probability is the ratio of total connection set-up attempts that result in connection set-up failure to the total connection set-up attempts in a population of interest.

With reference to Figure 5, connection set-up failure is defined to occur on any connection set-up attempt in which either one of the following outcomes is observed prior to expiration of timer T_{Max2}[2]:

– the appropriate reference events from both classes (b) and (d) do not occur;

– the appropriate reference events from classes (b) and (c) occur, but those from (d) do not.

Connection set-up attempts that are cleared by the portion as a result of incorrect performance or non-performance on the part of an entity outside the portion are excluded. In particular, instances of user non-performance or incorrect performance include:

– the called user issues a message to reject the connection set-up attempt;

– the appropriate reference event from class (c) fails to occur due to the lack of a corresponding reference event from class (c) at the terminating MPT boundary;

– the called user delays excessively in generating the appropriate reference event from class (c), resulting in a time-out;

– there is no capability in the called TE to accept additional connection establishments.

NOTE – A time interval over which connection set-up failure probability is to be evaluated needs to be defined before worst-case objectives can be established.

7.1.2 Party Set-up Failure Probability (PSFP)

Party set-up failure probability describes the dependability of the function of party establishment.

Party set-up failure probability is the ratio of total party set-up attempts that result in party set-up failure to the total party set-up attempts in a population of interest.

With reference to Figure 1, party set-up failure is defined to occur on any party set-up attempt in which either one of the following outcomes is observed prior to expiration of timer T_{Max2}:

– the appropriate reference events from both classes (b) and (d) do not occur;

– the appropriate reference events from classes (b) and (c) occur, but those from (d) do not.

Party set-up attempts that are cleared by the portion as a result of incorrect performance or non-performance on the part of an entity outside the portion are excluded. In particular, instances of user non-performance or incorrect performance include:

– the called user issues a message to reject the party set-up attempt;

---

[2] The value of T_{Max2} is for further study.

– the appropriate reference event from class (c) fails to occur due to the lack of a corresponding reference event from class (c) at the terminating MPT boundary;

– the called user delays excessively in generating the appropriate reference event from class (c), resulting in a time-out;

– there is no capability in the called TE to accept additional party establishments.

NOTE – A time interval over which party set-up failure probability is to be evaluated needs to be defined before worst-case objectives can be established.

7.1.3 Multi-party call set-up failure probability

For further study.

7.2 Connection/party clearing failure probability

A clearing failure occurs either due to a network equipment fault or when a RELEASE/DROP PARTY message is lost. The Connection/Party Clearing failure probability describes the dependability of the function of disengagement (see Recommendation I.350).

The connection and party clearing failure probability are defined between pairs of portion boundaries (B_i,B_j) where B_i and B_j can be an MPT or an MPI. Figure 7 identifies the sequence of reference events (a, b) corresponding to the Clearing message that should occur in a requested (expected by user) connection or party clearing.

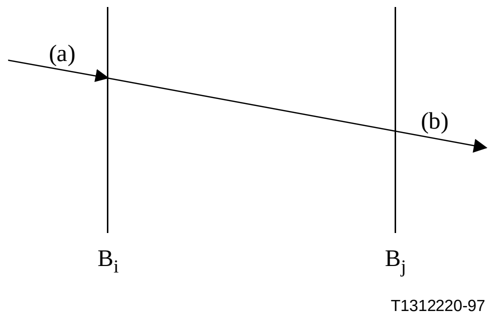


Figure 7/I.358 – Reference events

7.2.1 Connection Clearing Failure Probability (CCFP)

A connection clearing failure is defined to occur on any connection already established in which the following outcome is observed prior to the expiration of timer T_{Max2}.

• The appropriate reference events from class (a) occur but those from class (b) do not.

Connection clearing failure probability is measured as the ratio of total clearing attempts that result in clearing failure to the total clearing attempts in a population of interest.

7.2.2 Party Clearing Failure Probability (PCFP)

A party clearing failure is defined to occur on any connection already established in which the following outcome is observed prior to the expiration of timer T_{Max2}.

– The appropriate reference events from class (a) occur but those from class (b) do not.

Party clearing failure probability is measured as the ratio of total clearing attempts that result in clearing failure to the total clearing attempts in a population of interest (i.e. established parties ending in an unsuccessful clearing to the total number of established parties successfully cleared and unsuccessfully cleared).

ANNEX A

Call set-up timers

While B-ISDN call processing performance parameters in this Recommendation I.358 are the same as N-ISDN parameters in Recommendation I.352, call attempts for B-ISDNs may be different from call attempts for N-ISDNs. User's terminals for N-ISDNs make point-to-point 64 kbit/s calls, and overloads of call processing equipment are infrequent. On the other hand, user's intelligent terminals for B-ISDNs can make many call attempts at a high rate. Considering that point-to-multipoint calls can have many parties as shown in Figure 1, these call attempts may degrade call processing performance because call processing equipment becomes overloaded.

Call processing performance such as connection establishment delay is determined using measurements defined at UNI (MPT(1)) and UNI (MPT(2)). If TEs make call attempts at a high rate, the rate of call attempts on the UNI would strongly depend on the rate of call attempts from TE. Thus, specifying conditions for call attempt rate of the TE would minimize the impact on call processing performance.

Development of call processing parameters assumes the following conditions regarding call attempts to remove the effect user actions and network unavailability:

1) User's terminals do not make new calls in any time interval between a connection/add party request and its complete/incomplete response.
2) For a given call, no add party request is made until the CONNECT message is received by the initiating terminal.
3) Time intervals between calls which any user's terminal makes are more than a time interval value T1.
4) If a call requested by a user's terminal is incomplete because SETUP parameters of this call cannot be negotiated due to impossible or invalid parameter values, the retrying call request should change the SETUP parameters' value.
5) Calls considered in this Recommendation are initiated during times when the network is available.
6) Time intervals between an incomplete answer and the next call requests are more than a time interval value T2.
7) Frequency of add party requests are less than a value A1. The unit of value A1 is parties/time.

These assumptions are pictured in Figure A.1.

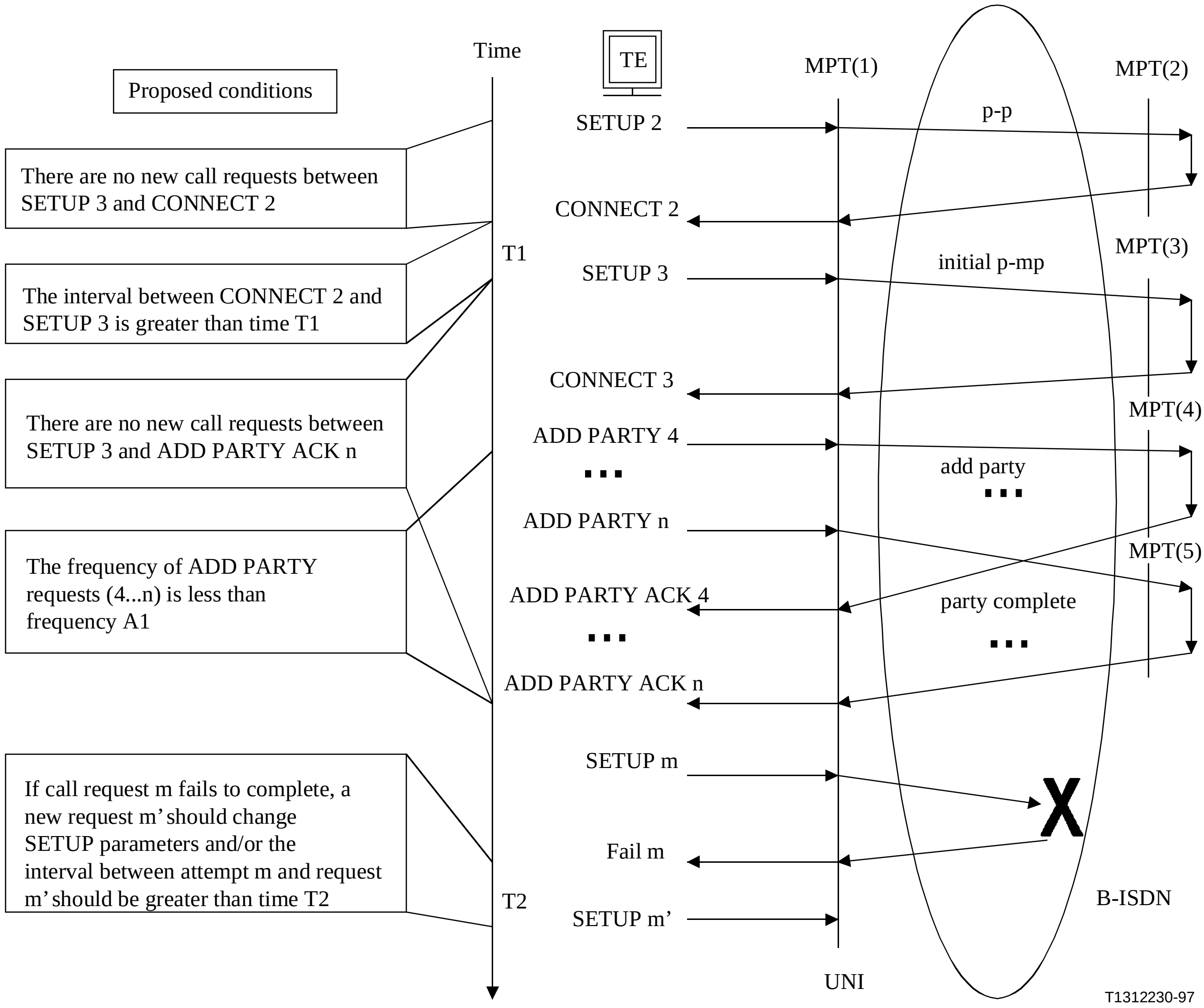


Figure A.1/I.358 – Conditions for call attempts at the UNI

APPENDIX I

Hypothetical reference connection

Derivation of I.358 performance objectives from the worst-case I.356 HRX

The 27 500 km hypothetical reference connections (HRXs) described in Recommendation I.356 allow the verification of realistic performance objectives. The connection processing performance for a VCC depends on the number of VP and VC switches in a given connection. For the purpose of the calculation of worst case VCC connection processing performance objectives, it must be assumed that all of the switches in a connection are VC switches. This worst case HRX is illustrated in Figure I.1 and consists of two national portions (each of eight VC switches) and an International Portion of four IIP(0)s and three ITPs (each of three VC switches).

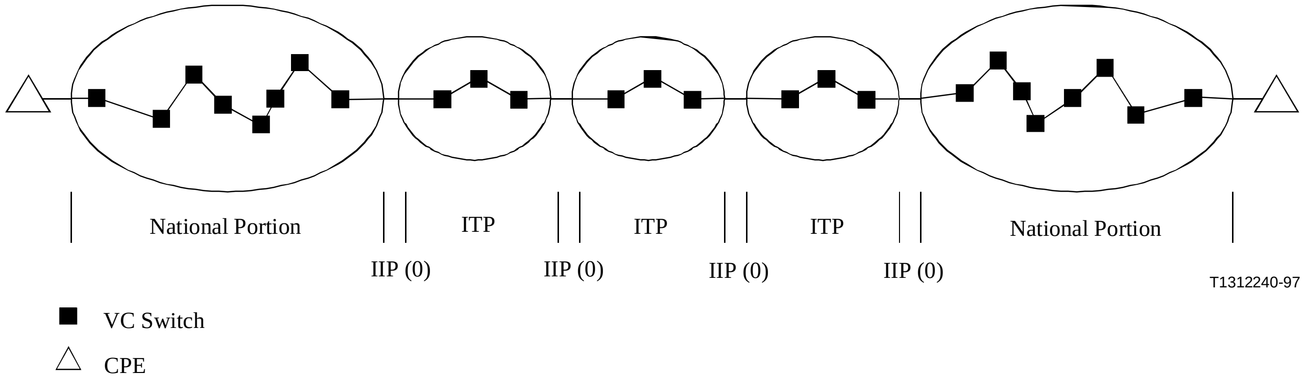


Figure I.1/I.358 – Worst-case Hypothetical Reference Connection

The mean connection establishment delay for such an HRX can be calculated from Table II.1 and Figure I.1 that the connection set-up messages are transported by I.356 QOS Class 1 and, therefore, experience a one-way transmission delay of no more than 400 ms.

For the National Portion, the processing delay is as follows.

Table I.1/I.358 – Processing delay in the national portion

Message	First Switch	Other Switches
IAM	2×160 ms	7×160 ms
ANM	2×80 ms	7×80 ms
	Total rounded to 2200 ms	

For the International Portion, the processing delay is as follows.

Table I.2/I.358 – Processing delay in the international portion

Message	Total for Nine Switches
IAM	9×160 ms
ANM	9×80 ms
	Total rounded to 2200 ms

The total establishment delay is equal to:

- the delay for two national portions
  - **plus** the delay for the international portion
  - **plus** the maximum two-way transmission delay = $[(3 \times 2200) + 800]$ ms = 7400 ms.

This is rounded up to give an objective of 7500 ms as the mean connection establishment delay for a B-ISDN. The allocation of this overall objective between national and international portions requires further discussion as, while the processing time is easily allocated, the transfer delay depends very much on the portion size and the presence of satellites. See 9.3/I.356.

NOTE 1 – This objective is the same as that given in Recommendation I.352 for 64 kbit/s ISDN connections. However, the worst-case HRX illustrated here is not representative of the majority of B-ISDN connections. In reality, a considerable amount of the switching is likely to be at the VP level and the amount of processing time will be substantially reduced. For network operation purposes it may be necessary to derive allocations of the overall objective for the various types of IIPs illustrated in Recommendation I.356 and for national portions with a large degree of VP switching. For each Type of IIP [except IIP(0)] there is a fixed processing delay due to the first VP switch and a transfer delay dependent on the portion size. The fixed processing delay is due to the switching of the VCC into a VPC and is carried out by the first VP switch only.

NOTE 2 – Changes to the above HRX may be needed to accommodate out-of-band signalling. Such changes could result in fewer switching nodes and greater per-node processing times, but the end-to-end delay objectives should remain unchanged.

APPENDIX II

Delay of elements

Some first proposals for signalling delay are given, regarding the transit exchange cross-office handling time of a broadband exchange. Functional reference points and transfer time components are used as defined in Recommendations Q.2766.1 and Q.766.

II.1 Proposal

It is proposed to organize the transfer time components in a similar way as already introduced into Recommendation Q.706 (1993) and most probably to be used in Recommendation Q.2706[3], the relevant B-ISDN recommendation.

II.2 Outgoing link delay T_{od}

The outgoing link delay T_{od} is defined in 4.3.2.5/Q.706 in the following way:

> "T_{od} is the period which starts when the last bit of the message signal unit enters the level 2 transmission buffer and ends when the last bit of the message signal unit enters the outgoing signalling data link. It includes the level 2 queuing delay in the absence of disturbances and the emission time. The emission time starts when the first bit of the message signal unit enters the outgoing signalling data link and ends when the last bit of the message signal unit enters the outgoing signalling data link."

For Q.2766.1 and Q.2706[3] T_{od} could be defined as follows:

> "T_{od} is the period which starts when the Service Specific Connection Oriented Protocol (SSCOP) has placed the last bit of the Message Signal Unit (MSU) into the conceptual transmission queue (see Figure 20/Q.2110) at the interface to the Common Part AAL functions (CP-AAL) and ends when the ATM cell containing the last bit of the MSU has entered the outgoing Point-to-Point Signalling Virtual Channel completely. It includes besides the delay in the conceptual transmission queue also the Common Part AAL- and ATM-Layer queuing delays and the emission time. The emission time starts when the ATM cell containing the first bit of the MSU enters the outgoing Point-to-Point Signalling Virtual Channel and ends when the ATM cell containing the last bit of the MSU has entered the outgoing Point-to-Point Signalling Virtual Channel completely."

Values for T_{od} may be given in Recommendation Q.2706[3].

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[3] Presently at the stage of draft.

II.3 Cross-office handling time T_{ch}

This new defined cross-office handling time T_{ch} would have some logical similarity to the STP processor handling time T_{ph} of Recommendation Q.706. Its analogous definition in Recommendation Q.2766.1 could read:

> "T_{ch} is the period which starts when the ATM cell containing the last bit of the message signal unit leaves the incoming Point-to-Point Signalling Virtual Channel and ends when the last bit of the message unit enters the conceptual transmission queue SSCOP/CP-AAL. It does not include the outgoing link delay T_{od}."

II.4 Functional reference points

The reference model could be written as follows.

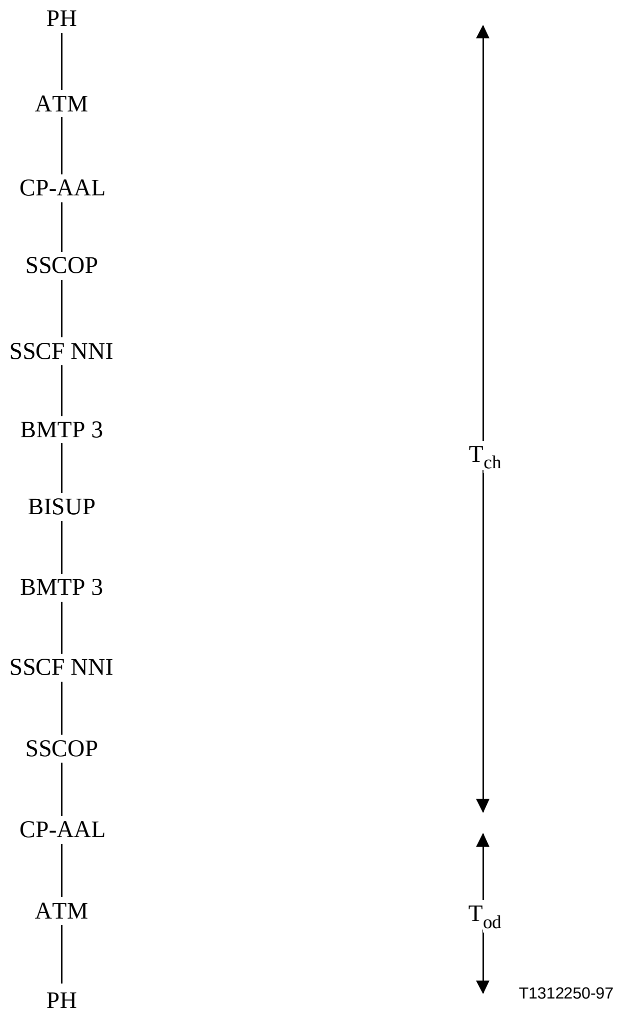

Figure II.1/I.358 – Reference model for the cross-office handling time T_{ch}

II.5 Reasons for the above proposal

T_{od} + T_{ch} will give the connection set-up delay of a broadband exchange.

The component T_{od} will be determined via the queuing delay, merely by the network and the load, i.e. by the bit rate of the outgoing link, and by the traffic loading (Erl) and by the – increased – MSU length.

Against that the component T_{ch} will depend on the implementation of the B-ISDN exchange.

II.6 Objectives for cross-office handling time T_{ch}

II.6.1 Considerations

The call set-up within a broadband exchange includes essentially the same tasks as call set-up within a narrow-band exchange, or even more, e.g.:

- handling of longer messages;
- handling of policing parameters for connection admission control;
- calculation of required bandwidth for Variable Bit Rate (VBR) connections, enabling statistical multiplexing:
- Virtual Path (VP) selection considering bandwidth and quality of service of VP and active connections in VP (outgoing and under certain conditions incoming);
- selection of Virtual Channel Identifier (VCI) (outgoing and under certain conditions incoming).

On the other hand, general progress in technology will result in shorter processing times.

Therefore it is proposed to reduce the delay times for broadband exchanges against those which are given in Table 1/Q.766 for narrow-band exchanges.

The proposed values for T_{ch} are those given in the following subclause. (The separation of T_{od} is included within this reduction.)

II.6.2 Proposal for T_{ch}

The values for higher loading than normal and for 95% are calculated in the same way as in Recommendation Q.766.

Table II.1/I.358 – Transit exchange cross-office handling time

Message type	Exchange call attempt loading[a)]	T_{ch} [ms]	
		Mean	95%
Simple (e.g. answer)	Normal	80	160
	+ 15%	120	240
	+ 30%	200	400
Processing intensive (e.g. IAM)	Normal	160	320
	+ 15%	240	480
	+ 30%	400	800

a) Exchange call attempt loading "normal" is that load in busy hour, where the transit exchange is planned for (=load A).

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