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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

Overall network aspects and functions – Performance objectives

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B-ISDN semi-permanent connection availability

ITU-T Recommendation I.357

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION I.357

B-ISDN SEMI-PERMANENT CONNECTION AVAILABILITY

Summary

This Recommendation defines network performance parameters, objectives and measurement methods for describing B-ISDN ATM semi-permanent connection availability. The specified parameters and objectives apply to international ATM semi-permanent connection portions delimited by measurement points: National Portions, International Transit Portions and International Interoperator Portions. The objectives, which are worst-case values, are intended to assist providers in network planning by limiting the aggregate effect of network impairments, including congestion, equipment failures and transmission errors. Guidance on determining expected end-to-end performance is provided in as Annex C.

A four-state availability model is defined corresponding to the combination of the ability of the network to sustain a connection in the available state and the actual usage of the connection. Two perspectives are considered, the "service" perspective and the "network" perspective. Criteria are defined for entry into and exit from the unavailable state which take both perspectives into account. An estimation procedure is also defined, providing a means of estimating availability performance using sampling techniques.

Source

ITU-T Recommendation I.357 was prepared by ITU-T Study Group 13 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 27th of August 1996.

Keywords

ATM semi-permanent connection portion, Availability, Availability objectives, Availability performance, Availability Ratio, Mean Time Between Outages, Severely Errored Second in the ATM layer, Unavailability Ratio.

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 (Helsinki, March 1-12, 1993).

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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Recommendation I.357

B-ISDN SEMI-PERMANENT CONNECTION AVAILABILITY

(Geneva, 1996)

1 Introduction

1.1 Purpose

The purpose of this Recommendation is to define network performance parameters, worst-case objectives and measurement methods for describing B-ISDN ATM semi-permanent connection availability. The specified parameters and objectives apply to ATM semi-permanent connection portions delimited by measurement points (MPT or MPI) as defined in Recommendation I.353: National Portions, International Transit Portions and International Interoperator Portions.

An international B-ISDN ATM semi-permanent connection consists of two national portions, each delimited by a MPT and MPI, and one international portion delimited by two MPIs. The international portion may also be subdivided into a number of connection portions delimited by MPIs. Using this Recommendation, worst-case performance objectives can be derived for the national portions and the international portion of an international B-ISDN ATM semi-permanent connection. Methods for estimating end-to-end availability performance are also provided.

The worst-case objectives specified in this Recommendation are intended to assist providers in network planning by limiting the aggregate effect of network impairments, including congestion, equipment failures and transmission errors, on B-ISDN ATM semi-permanent connection availability. They do not directly correspond to the level of Quality of Service to be expected by customers.

1.2 Scope

This Recommendation currently specifies availability parameters and objectives for B-ISDN ATM semi-permanent connections only. Characterization of the performance of B-ISDN ATM switched connections are for further study and will be included later.

In specifying availability performance, this Recommendation takes into account both the user perspective and the network perspective. An availability model is defined which accommodates both viewpoints. For both perspectives, availability objectives need not be met on any connection that a network provider has determined to be non-compliant.

1.3 Related Recommendations

In characterizing availability performance, this Recommendation applies concepts and definitions provided in related ISDN performance Recommendations. These include Recommendations I.353 and I.356.

Recommendation I.353 defines the following:

- Measurement points (MPs) at which ITU-T recommended ISDN protocols may be observed.
- Particular MPs (designated MPT and MPI) that delimit portions of an end-to-end ISDN connection for which performance objectives may be specified.
- A set of performance-significant Cell Reference Events (CREs), each of which corresponds to the transfer of a cell of control or user information across an MP in accordance with an ITU-T recommended protocol.

- Rules for identifying the time of occurrence of any CRE at any MP.

Recommendation I.356 defines the set of primary performance parameters which will be used as a basis for defining availability criteria.

2 References

The following 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.353 (1996), *Reference events for defining ISDN and B-ISDN performance parameters.*

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

[3] ITU-T Recommendation I.610 (1995), *B-ISDN operation and maintenance principles and functions.*

[4] ITU-T Recommendation I.361 (1995), *B-ISDN ATM layer specification.*

3 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used.

AR	Availability Ratio
B-ISDN	Broadband ISDN
CLR	Cell Loss Ratio
CRE	Cell Reference Event
FS	Frontier Station
ISC	International Switching Centre
ISDN	Integrated Services Digital Network
LE	Local Exchange
MP	Measurement Point
MPI	Measurement Point I
MPT	Measurement Point T
MTBO	Mean Time Between Outages
SECBR	Severely Errored Cell Block Ratio
SES_{ATM}	Severely Errored Second in the ATM layer
UR	Unavailability Ratio

4 Method for availability specification

4.1 Definition of Availability

From a dependability point of view, a portion of an international B-ISDN ATM semi-permanent connection should have the following properties:

- The fraction of time during which it is in a down state (i.e. unable to support a transaction) should be as low as possible.
- Once a transaction has been established, it should have low probability of being either terminated (because of insufficient data transfer performance) or prematurely released (due to the failure of a network component) before the intended end of transaction.

Availability of a B-ISDN ATM semi-permanent connection portion is defined as the fraction of time during which the portion is able to support a transaction. Conversely, unavailability of a portion is the fraction of time during which the portion is unable to support a transaction (i.e. it is in the down state). Annex B specifies other commonly used availability definitions and their relationships.

4.2 Availability model

A common availability model is used within this Recommendation which applies to any semi-permanent connection type. The model is depicted in Figure 1.

The model uses four states corresponding to the combination of the ability of the network to sustain a connection in the available state and the actual usage of the connection. Transitions between the states of the model are governed by the occurrence of patterns of Severely Errored Seconds in the ATM layer (SES_{ATM}).

Two independent perspectives are evident from the model:

1) The service perspective, where availability performance is directly associated with the performance perceived by the user. This is represented in Figure 1 by States 1 and 2, even in the case of an on/off source, since the user is only concerned with the connection availability performance whilst attempting to transmit cells.
2) The network perspective, where availability performance is characterized independently of user behaviour. All four states in Figure 1 are appropriate.

Both perspectives are considered in this Recommendation.

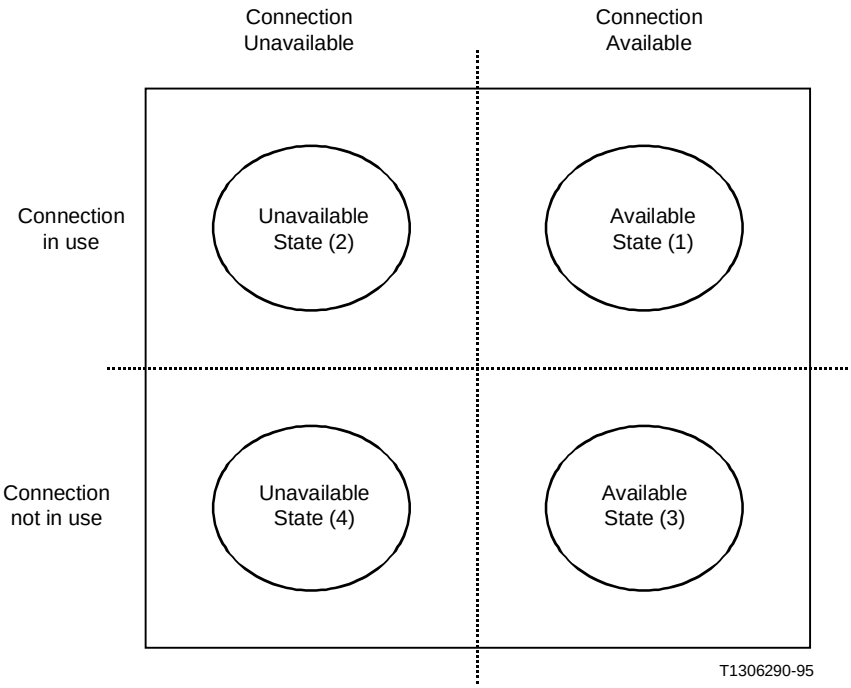


FIGURE 1/I.357

Availability model

An assumption is made at the start of any measurement period that the network is in available States 1 or 3, depending on user behaviour.

4.3 Definition of Unavailability Entry/Exit Criteria

In order to define the availability of an ATM semi-permanent connection portion, a criterion is defined for entry into the unavailable state. This criterion is applicable to any ATM semi-permanent connection portion, whether the user continuously transmits cells or not. This is achieved by defining a cell transfer outcome, the Severely Errored Second in the ATM Layer (SES_{ATM}).

A given second is considered to be an SES_{ATM} if:

a) user information cells are presented during this period of time to the connection portion and either the Cell Loss Ratio (CLR) > 1/1024 or the Severely Errored Cell Block Ratio (SECBR) > 1/32, where CLR and SECBR are computed over the considered period of time;

NOTE 1 – The above CLR threshold is intended to support QOS classes in which the CLR objective is $\leq 10^{-5}$. Appropriate CLR thresholds for other QOS classes are for further study.

b) user information cells are not presented during this period of time to the connection portion, but the ATM connection is considered to be unable to provide acceptable cell transfer performance, because an interruption has occurred within the connection portion. This interruption prevents cells from being transmitted on the connection portion during the considered one-second period of time, should the user attempt to transmit cells. An interruption corresponds to a failure occurring within the connection portion, either of the physical layer or of the ATM layer. Annex A provides means of estimating the occurrence of an interruption.

The decision parameters to be evaluated for the purpose of estimating the occurrence of an SES_{ATM} are taken from the set of cell transfer parameters defined in Recommendation I.356 and the OAM facilities defined in Recommendation I.610.

NOTE 2 – The mechanism for determining if a user is, or is not, attempting to transmit cells is for further study.

Case a) applies to both service and network perspectives of availability. Case b) applies only to the network perspective of availability.

The onset of unavailability shall begin with the occurrence of ten consecutive SES_{ATM}. These ten seconds are part of unavailable time. A period of unavailability shall end with the occurrence of ten consecutive seconds, none of which are SES_{ATM}. These ten seconds are part of available time. The ten-second criteria are supported using a sliding window with one-second granularity.

A portion of a bidirectional B-ISDN connection is available if, and only if, both directions are available.

In practice, it will not be necessary to constantly monitor an ATM connection in order to assess availability performance according to the above definition. A sampling estimation procedure is defined in Annex A which enables the availability performance of an ATM connection over an observation period to be determined from a series of intermittent measurements.

4.4 Availability parameters

Performance objectives are defined in this Recommendation for two availability performance parameters, Availability Ratio (AR) and Mean Time Between Outages (MTBO).

4.4.1 Availability Ratio

Availability Ratio (AR) applies to ATM semi-permanent connection portions.

The service AR is defined as the proportion of time that the connection portion is in the available state over an observation period. This is characterized in Figure 1 by the proportion of time in State 1 compared to the overall time in States 1 and 2. The service AR is calculated by dividing the total service available time during the observation period by the duration of the observation period.

The network AR is defined as the proportion of time that the connection portion is in the available state over an observation period. This is characterized in Figure 1 by the proportion of time in States 1 and 3 compared to the overall time in States 1 to 4. The network AR is calculated by dividing the total service available time during the observation period by the duration of the observation period.

From the service perspective, the observation period may consist of non-overlapping intervals during which the user transmits cells on the connection portion.

From the network perspective, the observation period is a continuous period of time during which the user may or may not transmit cells.

4.4.2 Mean Time Between Outages

The Mean Time Between Outages (MTBO) applies to ATM semi-permanent connection portions.

The service MTBO is defined as the average duration of a time interval during which the portion is available from the service perspective. Consecutive intervals of available time during which the user attempts to transmit cells are concatenated.

The network MTBO is defined as the average duration of a continuous time interval during which the portion is available from the network perspective.

5 B-ISDN ATM semi-permanent connection portions

An international B-ISDN ATM connection consists of a number of connection portions, each delimited by MPs. The MPs are located at interfaces where the ATM layer is accessible.

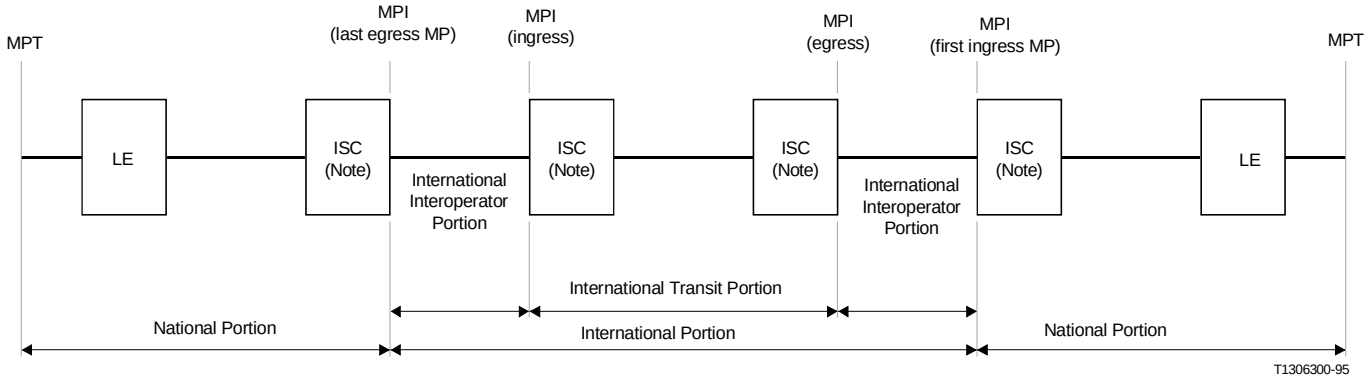
For B-ISDN, two types of MP are defined, the ingress MP and the egress MP. For definitions of these MPs, including their locations, refer to Recommendation I.353.

The establishment of a MP on the national side of the ISC (or FS), and its performance allocation in the national portion, are national matters, depending on the network topology of each country.

For the purpose of availability performance management, ATM connections are divided into three types of connection portions:

- *National Portions*
  - for a National Portion of type MPT-MPI, the MPI is an egress MPI;
  - for a National Portion of type MPI-MPT, the MPI is an ingress MPI.
- *International Transit Portions*
  - an International Transit Portion is delimited by a pair of MPIs, the first of which is an ingress MPI, and the second is an egress MPI, both located in the same transit country.
- *International Interoperator Portions*
  - an International Interoperator Portion is delimited by a pair of MPIs, the first of which is an egress MPI, and the second is an ingress MPI, located in adjacent countries. Such a portion links:
    i) a National Portion to an International Transit Portion; or
    ii) two adjacent International Transit Portions; or
    iii) two adjacent National Portions.

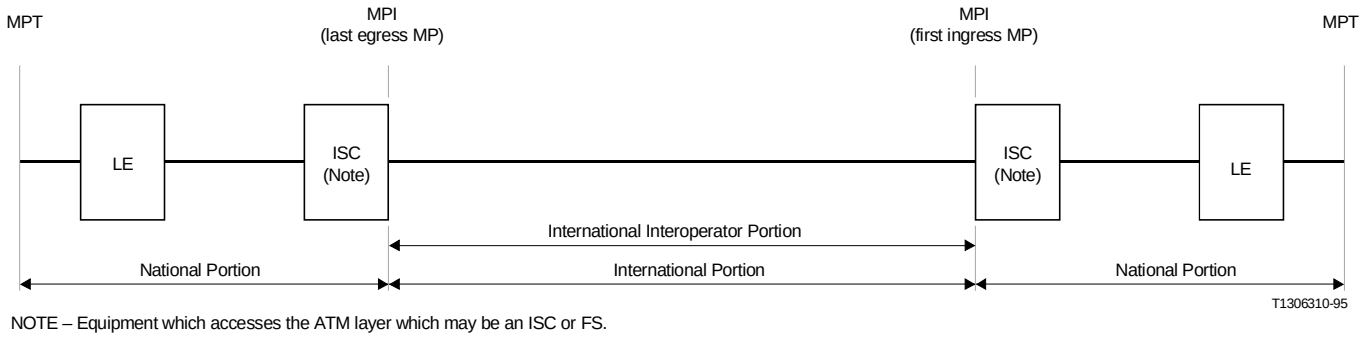
The set of International Transit Portions and International Interoperator Portions constitutes the International Portion of the connection. Figures 2 and 3 illustrate these concepts for connections with one International Transit Portion and no International Transit Portions respectively.



NOTE – Equipment which accesses the ATM layer which may be an ISC or FS.

FIGURE 2/I.357

Connection with one international transit operator



NOTE – Equipment which accesses the ATM layer which may be an ISC or FS.

FIGURE 3/I.357

Connection with no international transit operators

6 Availability performance objectives

Performance objectives are specified for the AR and MTBO parameters for the following connection portion types:

- National Portion;
- International Transit Portion;
- International Interoperator Portion.

A single set of objectives is specified which is applicable to both the service and network perspectives. The objectives are worst-case and are applicable to each individual connection portion. The end-to-end performance of an international B-ISDN connection can be calculated using the guidance given in Annex C.

NOTE – The recommended observation period is for further study.

6.1 Availability Ratio

The AR objective for each connection portion type is specified in Table 1.

TABLE 1/I.357

Objectives for Availability Ratio

Connection Portion	AR objective
National Portion	For further study
International Transit Portion	For further study
International Interoperator Portion	For further study

6.2 Mean Time Between Outages

The MTBO objective for each connection portion type is specified in Table 2.

TABLE 2/I.357

Objectives for Mean Time Between Outages

Connection Portion	MTBO objective
National Portion	For further study
International Transit Portion	For further study
International Interoperator Portion	For further study

Annex A

Sampling estimation of B-ISDN ATM semi-permanent availability parameters

A.1 In-service estimation of SES_{ATM}

If network availability parameters are estimated using in-service techniques, it is possible to use OAM facilities defined in Recommendation I.610. In this subclause, the availability of one direction of a connection portion is estimated at the sink of this connection portion. Assessing the availability of both directions of the connection portion is under study. It should be noted that this Annex may be revised and enhanced in the future to reflect further developments in Recommendation I.610.

Let A and B delimit the span of the connection portion whose availability performance is to be estimated. It is proposed to activate simultaneously a forward PM and a CC OAM flow between A and B. If the connection portion is the end-to-end connection, the OAM flows are end-to-end OAM flows. Otherwise, the OAM flows are segment flows.

The use of other types of OAM cells (e.g. segment AIS cells), or of OAM defect indications (e.g. the LOC defect) is under study.

A.1.1 Network perspective of SES_{ATM}

The occurrence of SES_{ATM} during a one-second period of time is estimated as follows:

- If a sufficient number of user information cells are received at B, it is possible to estimate the value of the CLR and SECBR during this period of time on the basis of the forward PM cells that are received. The SES_{ATM} decision is then taken on the basis of this estimation. A default decision should be taken for the case when an insufficient number of user information cells are transmitted during the one-second period of time. This default decision is under study.
- If no user information cells are received at B, the second is characterized as follows:
  - if a CC cell is received at B, whether or not an AIS cell is received during the same period of time, the second is not considered to be an SES_{ATM};
  - if no CC cell is received during the one-second period of time, the second is considered to be an SES_{ATM} due to an interruption within the connection portion.

A.1.2 Service perspective of SES_{ATM}

The occurrence of SES_{ATM} during a one-second period of time is estimated as follows:

- If a sufficient number of user information cells are received at B, it is possible to estimate the value of the CLR and SECBR during this period of time on the basis of the forward PM cells that are received. The SES_{ATM} decision is then taken on the basis of this estimation. A default decision should be taken for the case when an insufficient number of user

information cells are transmitted during the one-second period of time. This default decision is under study.

- If no user information cells are received at B, the second may be characterized as follows:
  - if a CC cell is received at B, whether or not an AIS cell is received during the same period of time, the second is not taken into account from the service perspective of availability performance;
  - if no CC cell is received during the one-second period of time, the second is taken into account from the service perspective of availability performance, and is considered to be an SES_{ATM} due to an interruption within the connection portion.

NOTE – This is a worst-case default decision, based on information available only at the sink. Such a default decision need not be taken if information is also available from the source, indicating whether or not user information cells were presented to the connection portion during the second.

A.2 In-service estimation of availability parameters

Once the occurrence of the SES_{ATM} outcome is estimated for a connection portion, it is possible to estimate the onset of availability/unavailability periods (under the assumption that the direction of the connection portion is available at the start of the observation period) and the value of the availability parameters for the considered direction of the connection portion during the observation period:

- the Availability Ratio is estimated as the ratio of the accumulated durations of the availability periods to the duration of the observation period;
- the MTBO is estimated as the mean time between successive unavailability periods.

The estimation process is straightforward for the network perspective. It is more complex for the service perspective, and uses a sampling method as described below.

A.2.1 Service availability sampling

When attempting to determine the service availability of a semi-permanent connection portion, it is possible that there may never be ten consecutive seconds in which user information cells are presented to the connection portion. In this case, no transition, either into the unavailable state or into the available state, can be captured. An appropriate method of handling estimation of service availability for semi-permanent connection types, based on categorization of non-overlapping ten-second intervals as available or unavailable, is given below.

Eight or more of ten consecutive seconds being SES_{ATM} shall cause these ten seconds to be deemed a period of unavailable time. Three or more of ten consecutive seconds, none of which are SES_{ATM}, shall cause these ten seconds to be deemed a period of available time.

In this method, the user need not be sending cells in each of the ten consecutive seconds. For a determination of service unavailability, the user must send cells in at least eight of the ten consecutive seconds. For a determination of service availability, the user must send cells in at least three of the ten consecutive seconds.

The potential bias of the above estimation procedure, which is believed to be small, is for further study.

NOTES

1 The values of eight and ten given above are provisional.

2 An estimation procedure for services which do not satisfy the above minimal criteria is for further study.

Annex B

Related availability parameters

Two parameters have been defined in 4.4, Availability Ratio (AR) and Mean Time Between Outages (MTBO). Two related parameters are defined below.

B.1 Unavailability Ratio

The service Unavailability Ratio (UR) is defined as the proportion of time that the connection portion is in the unavailable state over an observation period. This is characterized in Figure 1 by the proportion of time in State 2 compared to the overall time in States 1 and 2. The service UR is calculated by dividing the total service unavailable time during the observation period by the duration of the observation period.

The network UR is defined as the proportion of time that the connection portion is in the unavailable state over an observation period. This is characterized in Figure 1 by the proportion of time in States 2 and 4 compared to the overall time in States 1 to 4. The network UR is calculated by dividing the total network unavailable time during the observation period by the duration of the observation period.

From the service perspective, the observation period may consist of non-overlapping intervals during which the user transmits cells on the connection portion.

From the network perspective, the observation period is a continuous period of time during which the user may or may not transmit cells.

The AR and UR parameters are related by the following equation:

$$AR + UR = 1 \qquad \text{(B-1)}$$

Either ratio can be used for design, measurement and maintenance applications.

B.2 Outage Intensity

The Outage Intensity (OI) for a B-ISDN semi-permanent connection portion is defined as the number of unavailable periods in this portion, during an observation period, divided by the concatenated duration of available time during the observation period.

From the service perspective, the observation period may consist of non-overlapping intervals during which the user transmits cells on the connection portion.

From the network perspective, the observation period is a continuous period of time during which the user may or may not transmit cells.

The MTBO and OI parameters are related by the following equation:

$$MTBO = 1/OI \qquad \text{(B-2)}$$

Either MTBO or OI can be used for design, measurement and maintenance applications.

Annex C

Calculation of end-to-end availability performance

C.1 Purpose

The purpose of this Annex is to provide guidance for the calculation of the end-to-end performance of a connection from the performances of subportions, using examples of basic topologies (linear and redundant).

In some cases, more complex topologies will result from negotiations between operators, but the principles of calculation given here will still apply.

Currently, there are no objectives specified for end-to-end performance. This is under study and will be included in a later revision.

C.2 End-to-end availability calculations

The process for estimating end-to-end availability performance from the connection topology is under study.

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