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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

Overall network aspects and functions – Performance objectives

B-ISDN semi-permanent connection availability

ITU-T Recommendation I.357

(Formerly 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 Annex C.

A two-state availability model is defined along with criteria for entry into and exit from the unavailable state. An estimation procedure is also defined, providing a means of estimating availability performance using sampling techniques.

Source

ITU-T Recommendation I.357 was revised by ITU-T Study Group 13 (2001-2004) and approved under the WTSA Resolution 1 procedure on 24 November 2000.

Keywords

ATM semi-permanent connection portion, availability, availability objectives, availability performance, availability ratio, mean time between outages, severely errored second on the ATM layer, unavailability ratio.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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

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

NOTE

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

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

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ITU-T Recommendation I.357

B-ISDN semi-permanent connection availability

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 ITU-T I.356: 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 will be the subject of a future Recommendation.

This Recommendation defines the availability of a semi-permanent connection in a way that is independent of user behaviour (i.e. a semi-permanent connection can be declared unavailable even if the user is not transmitting ATM cells at a given time). 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 ITU-T I.353 and ITU-T I.356.

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.

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

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

[2] ITU-T I.356 (2000), *B-ISDN ATM layer cell transfer performance*.

[3] ITU-T I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[4] ITU-T I.361 (1999), *B-ISDN ATM layer specification*.

3 Abbreviations

This Recommendation uses the following abbreviations:

AIS	Alarm Indication Signal
AR	Availability Ratio
B-ISDN	Broadband-Integrated Services Digital Network
CC	Continuity Check
CLR	Cell Loss Ratio
CRE	Cell Reference Event
FPM	Forward Performance Monitoring
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
RDI	Remote Defect Indication
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 uses two states corresponding to the ability or inability of the network to sustain a connection in the available state. Transitions between the states of the model are governed by the occurrence of patterns of Severely Errored Seconds in the ATM layer (SES_{ATM}). This Recommendation views availability from the network perspective, where availability performance is characterized independently of 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 – 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 SES_{ATM}.

The methods for estimating the occurrence of an SES_{ATM} are taken from the set of cell transfer parameters defined in ITU-T I.356 and the OAM facilities defined in ITU-T I.610.

The onset of unavailability begins with the occurrence of ten consecutive SES_{ATM}. These ten seconds are part of unavailable time. A period of unavailability ends 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.

It is recognized that in-service measurement of availability as defined above may not be practicable in many cases. A number of estimation methods that can be employed for in-service estimation can be found in Annex A.

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 AR is defined as the proportion of scheduled service time that the connection portion is in the available state. The AR is calculated by dividing the total service available time by the duration of the scheduled service time.

During the scheduled service time 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 MTBO is defined as the average duration of continuous periods of available time. Where scheduled service time is not contiguous they are concatenated in calculating MTBO.

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 ITU-T I.356.

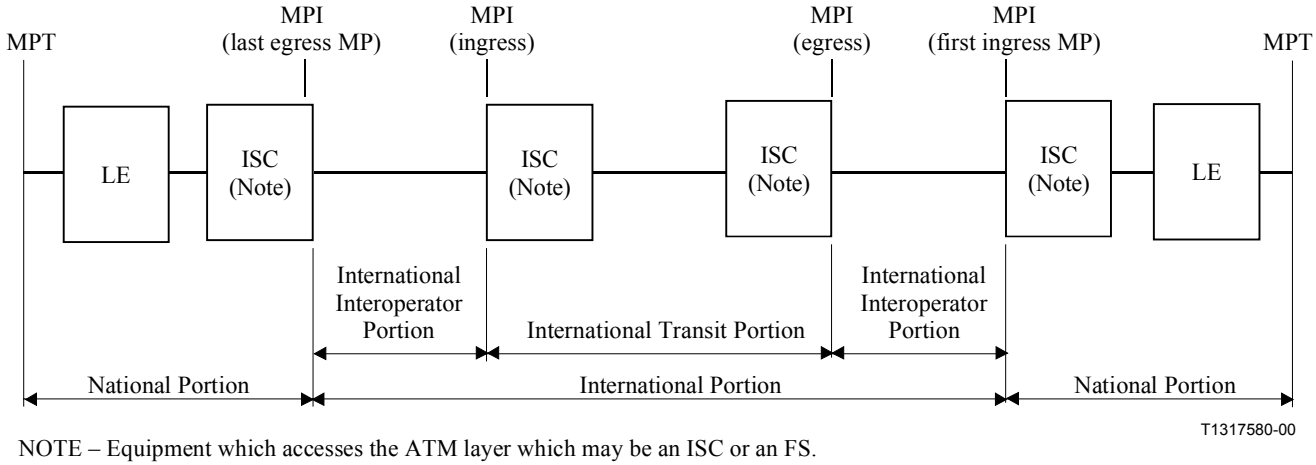
The establishment of a MP on the national side of the ISC (or FS), and its performance allocation in the national portion, are national matters, depending on the network topology of each country.

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.

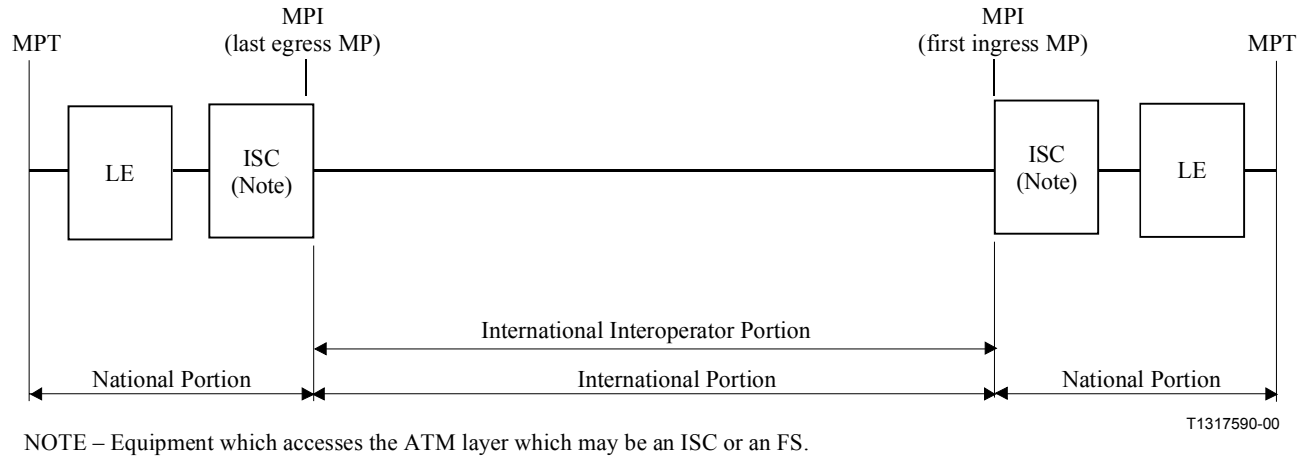
- *International Interoperator Portions*
  - An International Interoperator Portion is delimited by a pair of MPIs, the first of which is an egress MPI, and the second is an ingress MPI, located in adjacent countries. Such a portion links:
    i) a National Portion to an International Transit Portion; 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 1 and 2 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 an FS.

Figure 1/I.357 – Connection with one international transit operator



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

Figure 2/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 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.

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

In-service 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 ITU-T I.610. In this clause, the availability of one direction of a connection portion is estimated at the sink of this connection portion while some OAM flows are generated at the source of the 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 ITU-T 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 means by which this event is estimated in-service depends on which OAM flows are activated on the connection. That is:

1) FPM and CC flows;

2) FPM flow only;

3) CC flow only;

4) no CC or FPM flows.

The four cases listed above provide varying accuracies of availability estimation. The accuracy of each of the above cases is remarked on in Table A.1.

Note that only option 2 of the CC cell (i.e. a CC cell is sent with a periodicity of nominally 1 cell per second independently of user cells) is used for in-service estimation of availability.

Each case has an associated level of accuracy in the estimation of the SES_{ATM} event. It should be noted that out-of-service measurement provides a potentially greater accuracy, but this is not considered here.

A.1.1 Near-end estimation of SES_{ATM}

Table A.1 provides guidance on how to estimate near-end SES_{ATM} whilst the connection is in-service. In the case of segment-level availability estimation, references to FPM, CC and AIS cells in the table should be interpreted as segment OAM cells. End-to-end AIS cells should not be considered when estimating the availability performance of a segment. Similarly, for end-to-end availability estimation, the same references should be interpreted as end-to-end OAM cells.

Case 1: FPM and CC are activated on a connection. A given second is declared an SES_{ATM} if, during the one-second interval:

– at least one FPM cell is detected and the CLR is greater than 1/1024; or

– at least one FPM cell is detected and the SECBR is greater than 1/32; or

– no CC cell is received and/or at least one AIS cell is received.

Case 2: FPM is activated without CC on a connection. A given second is declared an SES_{ATM} if, during the one-second interval:

– at least one FPM cell is detected and the CLR is greater than 1/1024; or

– at least one FPM cell is detected and the SECBR is greater than 1/32; or

– at least one AIS cell is received.

Case 3: CC is activated without FPM on a connection. A given second is declared an SES_{ATM} if, during the one-second interval:

– no CC cell is received; or

– at least one AIS cell is received.

Case 4: No OAM call flows activated on a connection. A given second is declared an SES_{ATM} if, during the one-second interval:

– at least one AIS cell is received.

These possible conditions and outcomes are summarized in Table A.1. It appears that in cases 2 to 4 there is a significant risk of not detecting unavailability periods due to performance degradations of ATM layer functions.

Table A.1/I.357 – Near-end SES_{ATM} estimation rules for various OAM-flow options

FPM	CC	Near-end SES_{ATM}	Remark concerning accuracy
Yes	Yes	If at least one FPM cell received and CLR > 1/1024 (Note) or If at least one FPM cell received and SECBR > 1/32 (Note) or No CC cell received or ≥ 1 AIS cell	If neither FPM nor CC is received during the second, a SES_{ATM} may be declared wrongly, due to jitter, but it is unlikely that unavailability is wrongly declared.
Yes	No	If at least one FPM cell received and CLR > 1/1024 (Note) or If at least one FPM cell received and SECBR > 1/32 (Note) or ≥ 1 AIS cell	If neither FPM nor AIS are received, a second may be considered as non-SES_{ATM}, which may eventually lead to not detecting unavailability conditions due to the ATM layer (not detected by AIS procedures).
No	Yes	No CC cell received or ≥ 1 AIS cell	Unavailability due to congestion conditions within the ATM layer may not be detected with this method.
No	No	≥ 1 AIS cell	This method detects only unavailability due to physical layer impairments.
NOTE – CLR/SECBR estimation is obtained from the FPM cell.			

A.1.2 Bidirectional availability estimation of an ATM connection

When the in-service measurement of availability as defined in 4.3 is not practicable, the estimation method for bidirectional connection availability described in this clause can be used. This estimation is based on the fault management defined in ITU-T I.610. The criterion is based on the outage of a connection. When a connection experiences an outage, it is estimated as unavailable, while the connection exits outage, the connection is estimated as available.

This estimation method is not tied to the 10-second entry and exit criteria for unavailability and does not capture all periods of unavailability. It is expected that most events causing the transmission of AIS and RDI will result in greater than 10 seconds of interruption to the service but some shorter interruptions which are not strictly unavailable time will be captured. This estimation method may cause problems with reaching the long-term performance objectives of ITU-T I.356 and it should be noted that care must be taken when measuring availability this way in conjunction with a service level agreement.

Consider a connection or portion of a connection delimited by measurement points X and Y, as shown in Figure A.1. If and only if both connection X $\rightarrow$ Y and Y $\rightarrow$ X are available, the connection (X, Y) is said to be available; otherwise the connection (X, Y) is said to be unavailable.

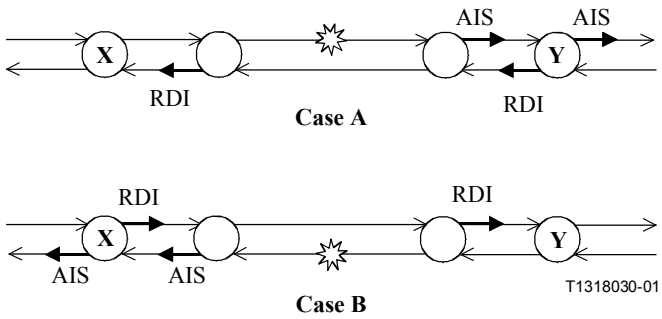


Figure A.1/I.357 – A bidirectional connection delimited by MP X and Y

For a connection (X, Y), the measurement point, in which the observer or measuring device is located, is called the *Near-end*, and the other measurement point is named the *Far-end*. From the observer's point of view, i.e. the near-end point of view, the outgoing connection is the connection from near-end to far-end, while the incoming connection is the connection from far-end to near-end. For example, for the observer in measurement point X, X is the near-end and Y is the far-end; the connection from X to Y is the outgoing connection, the connection from Y to X is the incoming connection. Conversely, for the observer in measurement point Y, X is the far-end and Y is the near-end; the connection from X to Y is the incoming connection and the connection Y to X is the outgoing connection. Generally, the observer on a measurement point judges whether the incoming connection is available based on the incoming data stream, and we call this judgement as near-end estimation.

From the point of view of the measurement made at either X or Y, the outgoing connection is called forward direction, while the incoming connection is called the backwards direction. In either case, as evident from Figure A.1, it is clear the measurement is symmetrical with respect to the estimation method defined below. Consequently, it is immaterial whether the measurement point is taken as either X or Y in what follows.

One advantage of the estimation method described in this clause is that it can provide the bidirectional availability estimation at one measurement point. In other words, this method can give both near-end and far-end availability estimations of the connection from one measurement point.

For the following estimation method, the bidirectional continuity check function option 2 of ITU-T I.610 (i.e. sending nominally one CC cell per second regardless of the presence of user cells) must be activated on the connection which is undergoing the availability estimation.

A.1.2.1 The declaration from connection available to connection unavailable

When the connection is in the available state:

a) If there is a physical layer failure between the MPs:

The far-end node will receive AIS cells and will enter the AIS state. At that point the far-end node will send RDI cells towards the node at which the estimation is made, causing it to enter the RDI state. At that time the bidirectional connection will be unavailable.

If the near-end node detects AIS cells, it will enter AIS state and it will declare the connection is unavailable.

b) If there is a LOC defect between the MPs:

The far-end node will stop receiving CC cells and also user cells, entering the AIS state after 3.5 ± 0.5 seconds of not receiving CC or user cells. The far-end node will start sending RDI cells towards the node at which the estimation is made, causing it to enter the RDI state. At that point in time the bidirectional connection will be unavailable. The 3.5 ± 0.5 seconds are part of the unavailable time and will have to be considered by the NMS.

If the near-end node stops receiving CC cells, it will enter AIS state in 3.5 ± 0.5 seconds and will declare the connection is unavailable.

A.1.2.2 The declaration from connection unavailable to connection available

When the connection is in the unavailable state:

– As soon as the far-end node receives CC or user cells, it will exit the AIS state. However, the node at which the estimation is made will only get out of the RDI state after 2.5 ± 0.5 seconds without receiving RDI cells. At that time, the bidirectional connection will become available. The 2.5 ± 0.5 seconds are part of the available time and have to be considered by the NMS.

If the near-end node was in the AIS state and starts receiving CC or user cells, it will exit the AIS state and it will stop sending RDI cells towards the far-end node immediately. However, the far-end node will exit the RDI state only 2.5 ± 0.5 seconds after not receiving RDI cells. At that point, the bidirectional connection is considered available. The 2.5 ± 0.5 seconds are part of the available time and have to be considered by the NMS.

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.

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 UR is defined as the proportion of time that the connection portion is in the unavailable state over an observation period. The UR is calculated by dividing the total network unavailable time during the observation period by the duration of the observation period.

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.

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:

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

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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Geneva, 2001