ETSI TECHNICAL REPORT

ETR 155

February 1995

Source: ETSI TC-NA

Reference: DTR/NA-052206

ICS: 33.080

Key words: OAM, performance

Asynchronous Transfer Mode (ATM); Operation Administration and Maintenance (OAM) functions and parameters for assessing performance parameters

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

Contents

Blank page

Foreword

This ETSI Technical Report (ETR) was produced by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

As it is defined in ITU-T Recommendation E.800 [3], the global Quality of Service (QoS) experienced by the user is composed by a number of QoS factors listed in ITU-T Recommendations E.800 [3] and M.21 [9]. As it is indicated in these Recommendations, each factor may be evaluated by considering performance parameters.

This ETR considers the performance parameters which are specific to the Asynchronous Transfer Mode (ATM) technology or whose definition depends on the transfer mode used (asynchronous transfer of cells). Other parameters (e.g. connection set-up or release time) are not considered due to the lack of stable standards.

The various layers in which a network can be partitioned should have independent layer management capabilities. In this ETR, Virtual Path (VP) and Virtual Channel (VC) levels of the ATM layer are considered. In the scope of this ETR, both levels use the same mechanisms and the same parameters are defined for them. Therefore, they are referred in the text within the common indication of "ATM layer".

Clauses 4 to 6 are extracted from ITU-T Recommendation I.356 [6] while clause 7 is the application of ITU-T Recommendation I.356 [6] to the "in service" measurements.

Blank page

1 Scope

This ETSI Technical Report (ETR) considers the performance parameters which are defined in ITU-T Recommendation I.356 [6] and the tools provided by the Asynchronous Transfer Mode (ATM) layer management defined in ITU-T Recommendation I.610 [8], in order to describe measurement mechanisms under "in service" conditions. Limits and requirements of measurements performed using the Operation Administration and Maintenance (OAM) flows are identified.

The technical information contained in this ETR provides guidelines for ETSI Sub Technical Committee (STC) NA 4 activities, and other involved groups.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 464: "Asynchronous Transfer Mode (ATM); Broadband Integrated Services Digital Network (B-ISDN); ATM layer cell transfer performance for B-ISDN connection types".

[2] I-ETS 300 465: "Broadband Integrated Services Digital Network (B-ISDN); Availability and retainability performance for B-ISDN semi-permanent connections".

[3] ITU-T Recommendation E.800: "Terms and definitions related to quality of service and network performance including dependability".

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

[5] ITU-T Recommendation I.353 (1993): "Reference events for defining ISDN performance parameters".

[6] ITU-T Recommendation I.356 (1993): "B-ISDN ATM layer cell transfer performance".

[7] ITU-T Recommendation I.371 (1993): "Traffic control and congestion control in B-ISDN".

[8] ITU-T Recommendation I.610 (1993): "B-ISDN operation and maintenance principles and functions".

[9] ITU-T Recommendation M.21: "Maintenance philosophy for telecommunication services".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the definitions given in ITU-T Recommendation I.356 [6] apply. The definitions of "cell exit event" and "cell entry event" are extended for the purposes of this ETR, as follows.

cell exit event: An event which occurs when the first bit of an ATM cell has completed transmission across a Measurement Point (MP) along a connection.

cell entry event: An event which occurs when the last bit of an ATM cell has completed transmission across a MP along a connection.

With these extended definitions, all of the measurement mechanisms described in this ETR are valid for both Virtual Path Connection (VPC) and Virtual Channel Connection (VCC) segments.

3.2 Abbreviations

For the purposes of this ETR the following abbreviations apply:

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
BER	Bit Error Ratio
BIP-16	Bit Interleaved Parity 16
CDV	Cell Delay Variation
CREn	Cell transfer Reference Event n
MP	Measurement Point
NP	Network Performance
OAM	Operation Administration and Maintenance
PDH	Plesiochronous Digital Hierarchy
QoS	Quality of Service
SDH	Synchronous Digital Hierarchy
VC	Virtual Channel
VCC	Virtual Channel Connection
VP	Virtual Path
VPC	Virtual Path Connection

4 Performance model

ITU-T Recommendation I.353 [5] provides a definition of MPs and associated reference events which provide a basis for an ISDN performance description. Performance of ATM cell transfer is measured by observing the reference events created as ATM cells cross MPs.

Figure 1, derived from ITU-T Recommendation I.356 [6], illustrates the layered nature of Broadband Integrated Services Digital Network (B-ISDN) performance issues. The Network Performance (NP) provided to B-ISDN users depends on the performance of three layers:

a) the physical layer, which may be based on Plesiochronous Digital Hierarchy (PDH), Synchronous Digital Hierarchy (SDH) or cell based transmission systems. This layer is divided at points where a virtual channel or a virtual path is switched by equipment using the ATM technique. It has no end-to-end significance when such switching occurs;

b) the ATM layer, which is cell based. The ATM layer is physical media and application independent and has end-to-end significance;

c) the ATM Adaptation Layer (AAL), which may enhance the performance provided by the ATM layer to meet the needs of higher layers. The AAL supports multiple protocol types, each providing different functions and different performance.

NOTE: The ATM layer network may be partitioned into ATM layer sub-networks, where a sub-network performance is measurable. This means that to establish MPs not coincident with endpoints of the ATM connection, no specific parameters for sub-network performance are defined.

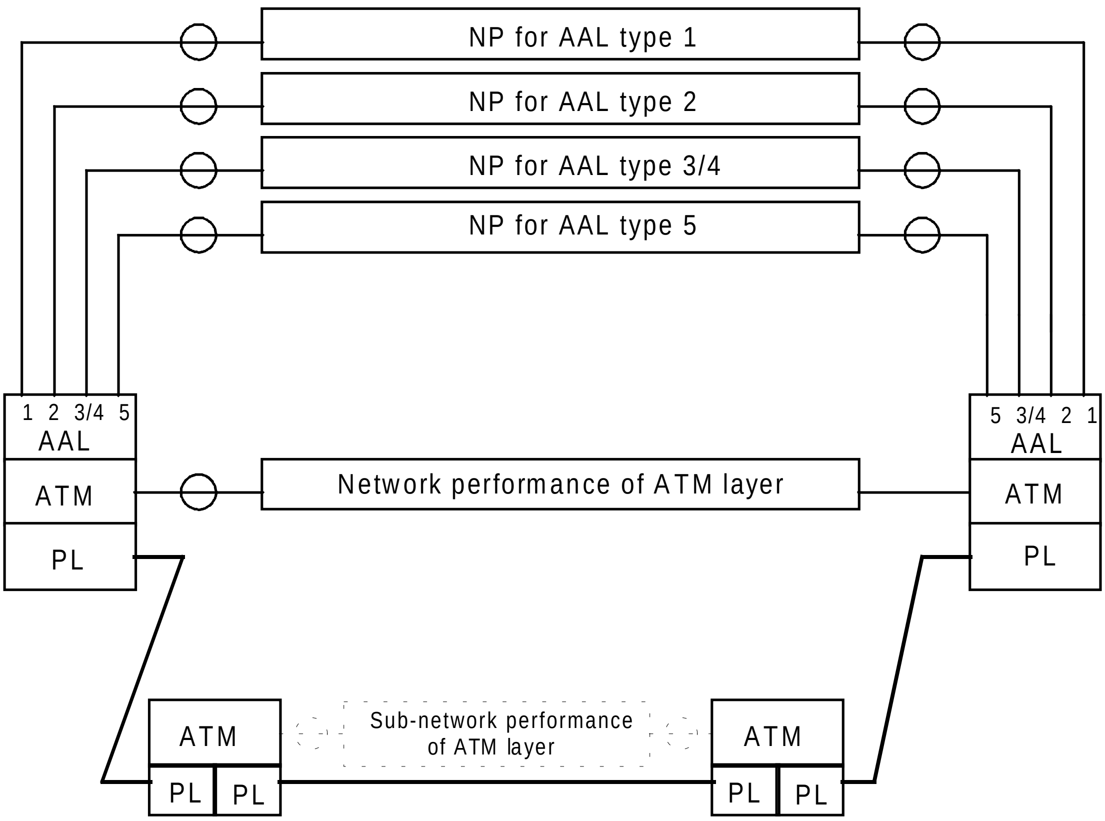


Figure 1: Layered model of performance for B-ISDN

5 General definitions

In this clause, it is assumed that the sequence of ATM cells belonging to the same transport entity (e.g. belonging to a transmission path, to a VPC or to a VCC) is preserved, between the endpoints of the entity. Two events are said to be **corresponding** if they occur on a predefined channel and at a pair of predefined boundaries.

By considering two Cell transfer Reference Events CRE1 and CRE2 at MP1 and MP2 respectively, the following cell transfer outcomes can be defined (figure 2):

a) **successful transfer outcome:** a successful transfer outcome occurs when a CRE2 corresponding to CRE1 happens within a specified time T of CRE1, and:

   1) the binary content of the received cell information field conforms exactly with that of the corresponding transmitted cell; and

   2) the cell is received with a valid header field;

b) **errored cell outcome:** an errored cell outcome occurs when a CRE2 corresponding to CRE1 happens within a specified time T of CRE1, but:

   1) the binary content of the received cell information field differs from that of the corresponding transmitted cell; or

   2) the cell is received with an invalid header field after header error control (HEC) procedures are completed;

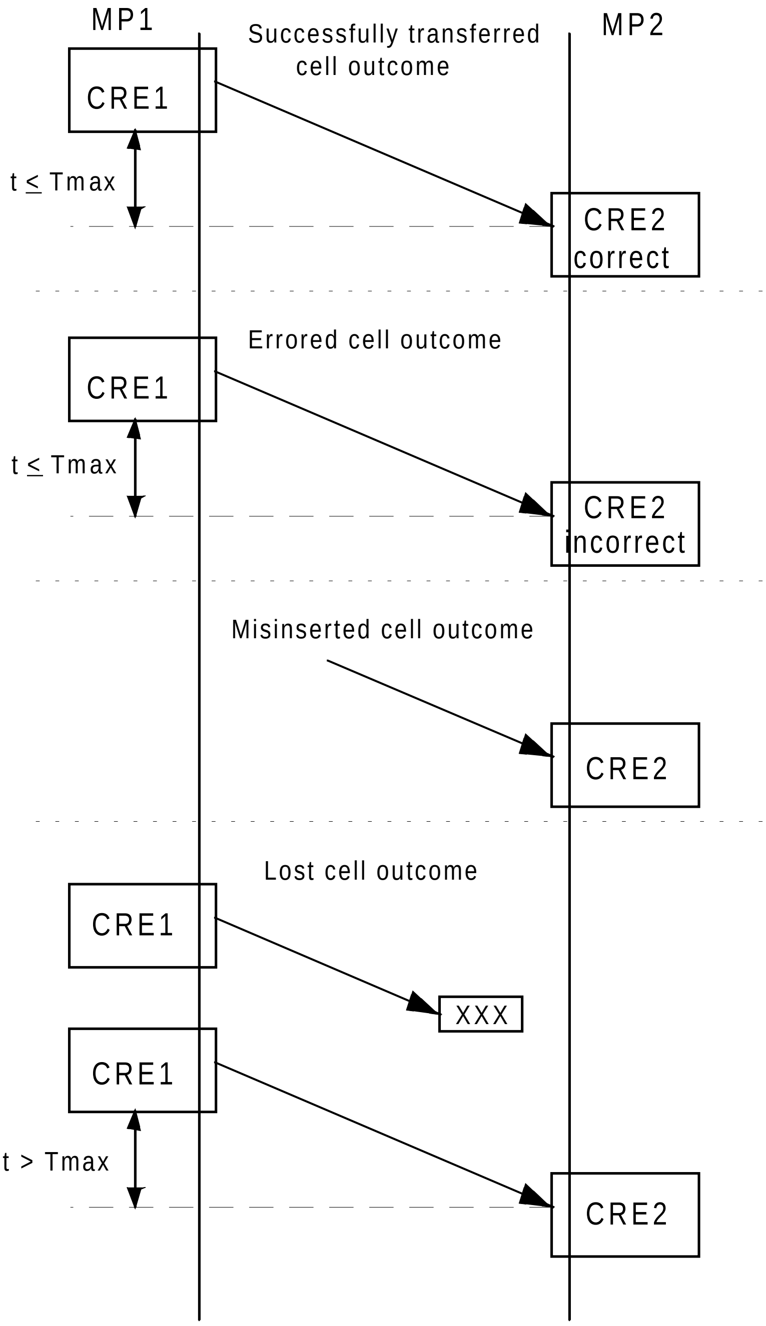
   NOTE 1: Errors on header, when not correctable, generates with very high probability loss of the cell. Only errors of this type occurring on the last ATM level link can be observed.

c) **lost cell outcome:** a lost cell outcome occurs when a CRE2 fails to happen within time Tmax of the corresponding CRE1;

   NOTE 2: Cell losses attributable to customer equipment shall be excluded in assessing the performance of the network. Estimation of cell losses occurring in customer equipment due to network causes is for further study.

d) **misinserted cell outcome:** a misinserted cell outcome occurs when a CRE2 happens without a corresponding CRE1;

e) **severely errored cell block outcome:** a cell block is a sequence of N cells transmitted consecutively on a given connection. A severely errored cell block outcome occurs when more than M errored cells, lost cells, or misinserted cells are observed in a received block.



NOTE: Outcome occurs independent of cell content.

Figure 2: Cell transfer outcomes

6 ATM layer performance parameters

This clause defines a set of ATM cell transfer performance parameters using the cell transfer outcomes defined in clause 6. It is based on the content of ITU-T Recommendation I.356 [6]. All parameters may be estimated, at least theoretically, on the basis of observations at the MPs. These parameters apply to any entity, at ATM level, transporting cells. In particular they apply to VPCs, VCCs and to related Segments. Methods for measurement of cell transfer performance are described in clause 7, where what is actually measurable under in-service and out-of-service conditions will be discussed.

6.1 Cell error parameters

Two cell error parameters are defined:

- cell error ratio; and
- severely errored cell block ratio.

6.1.1 Cell error ratio

Cell error ratio is the ratio of total errored cells to total successfully transferred cells plus errored cells in a population of interest. Successfully transferred cells and errored cells contained in cell blocks counted as severely errored cell blocks should be excluded from the population used in calculating cell error ratio[1)].

6.1.2 Severely errored cell block ratio

Severely errored cell block ratio is the ratio of total severely errored cell blocks to total cell blocks in a population of interest.

6.2 Cells variation parameters

These parameters are related to variation of the number of cells that are transferred between two MPs. Two parameters are defined.

6.2.1 Cell loss ratio

Cell loss ratio is the ratio of total lost cells to the total transmitted cells in a population of interest. Lost cells and transmitted cells in cell blocks counted as severely errored cell blocks should be excluded from the population used in calculating cell loss ratio[1)].

6.2.2 Cell misinsertion rate

Cell misinsertion rate is the total number of misinserted cells observed during a specified time interval divided by the time interval duration (or equivalently, the number of misinserted cells per connection second)[2)]. Misinserted cells and time intervals associated with cell blocks counted as severely errored cell blocks should be excluded from the population used in calculating cell misinsertion rate.

6.3 Cell transfer time parameters

Cell transfer delay is the time (t2 - t1) between the occurrence of two corresponding successful cell transfer events, CRE1 at time t1 and CRE2 at time t2, where $t2 > t1$ and $(t2 - t1) \leq Tmax$. The value of Tmax is for further study.

6.3.1 Mean cell transfer delay

Mean cell transfer delay is the arithmetic average of a specified number of cell transfer delays.

---

1) The severely errored cell block outcome and parameter provide a means of preventing bursts of cell transfer failures from inappropriately influencing the observed values for cell error ratio, cell misinsertion rate and the associated availability parameters.

2) By definition, a misinserted cell is a received cell that has no corresponding transmitted cell for the considered connection. Cell misinsertion on a particular connection is caused by impairments on cells being transmitted on a different connection or physical layer cells. Since the mechanisms that cause misinserted cells have nothing to do with the number of cells transmitted on the observed connection, this performance parameter cannot be expressed as a ratio, only as a rate.

6.3.2 Cell Delay Variation (CDV)

Two cell transfer performance parameters are defined, that are associated with CDV.

The first parameter, 1-point CDV, is defined on the basis of observation of a sequence of consecutive cell arrivals at a single MP. The second parameter, 2-point CDV, is defined on the basis of observations of corresponding cell arrivals at two MPs that delimit a virtual connection portion. The 1-point CDV parameter describes variability in the pattern of cell arrival (entry or exit events) at a MP with reference to the negotiated peak cell rate 1 / T (see ITU-T Recommendation I.371 [7]). It includes variability present at the cell source (customer equipment) and the cumulative effects of variability introduced (or removed) in all connection portions between the cell source and the specified MP.

The 2-point CDV parameter describes variability in the pattern of cell arrival events at the output of a connection portion (i.e. MP2) with reference to the pattern of corresponding events at the input to the portion (i.e. MP1). It includes only variability introduced within the connection portion. It provides a direct measure of portion performance and an indication of the maximum (aggregate) length of cell queues that may exist within the portion.

6.3.2.1 1-point CDV at a MP

The 1-point CDV (y_k) for cell k at a MP is the difference between the cell's reference arrival time (c_k) and the actual arrival time (a_k) at the MP (as indicated in figure 3); $y_k = c_k - a_k$. The reference arrival time pattern $\{c_k\}$ is defined as follows:

$c_0 = a_0 = 0$

$c_{k+1} = c_k + T$ when $c_k \geq a_k$,

$c_{k+1} = a_k + T$ otherwise.

Positive values of 1-point CDV ("early" cell arrivals) correspond to **cell clumping**; negative values of 1-point CDV ("late" cell arrivals) correspond to **gaps** in the cell stream. The reference pattern defined above eliminates the effect of gaps in the specification and measurement of cell clumping[3)]. The reference instant c_0 is defined as the arrival time of the first cell recognized by the 1-point CDV mechanism.

6.3.2.2 2-points CDV between two MPs

The 2-point CDV (v_k) for cell k between MP1 and MP2 is the difference between the absolute cell transfer delay (x_k) of the cell k between the two MPs and a defined cell transfer delay ($d_{1,2}$) between the same two MPs (figure 4); $v_k = x_k - d_{1,2}$

The absolute cell transfer delay (x_k) of cell k between MP1 and MP2 is the difference between the cell's actual arrival time at MP2 ($a2_k$) and cell's actual arrival time at MP1 ($a1_k$): $x_k = a2_k - a1_k$[4)]. The reference cell transfer delay ($d_{1,2}$) between MP1 and MP2 is the absolute cell transfer delay experienced by cell 0 between the two MPs.

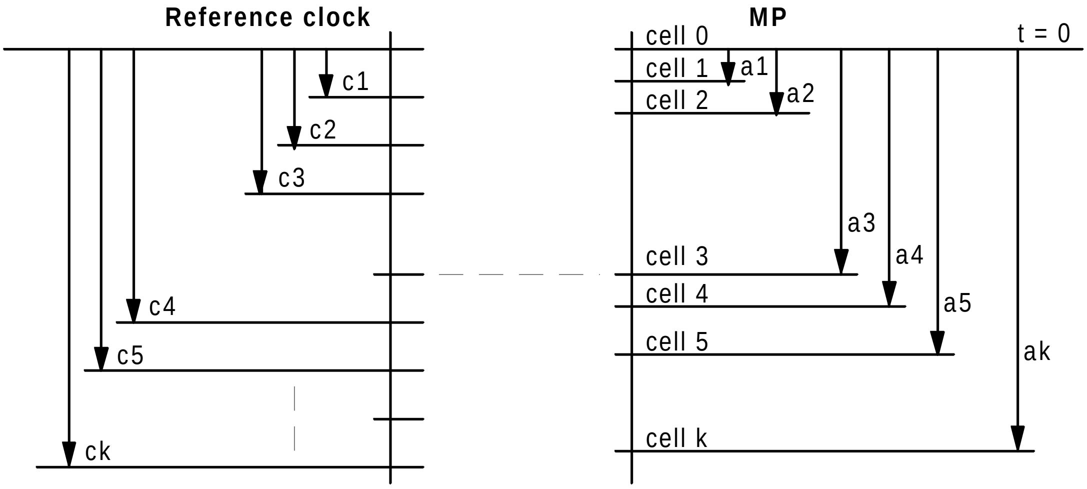
Positive values of 2-points CDV correspond to cell transfer delays greater than that experienced by the reference cell; negative values of 2-points CDV correspond to cell transfer delays less than that experienced by the reference cell. The distribution of 2-point CDV is identical to the distribution of absolute cell transfer delay for any specified population of transferred cells.

NOTE: The specification of cell 0 is for further study.

---

3) The reference clock "skips" by an amount equal to the difference between the expected and actual arrival times immediately after each "late" cell arrival.

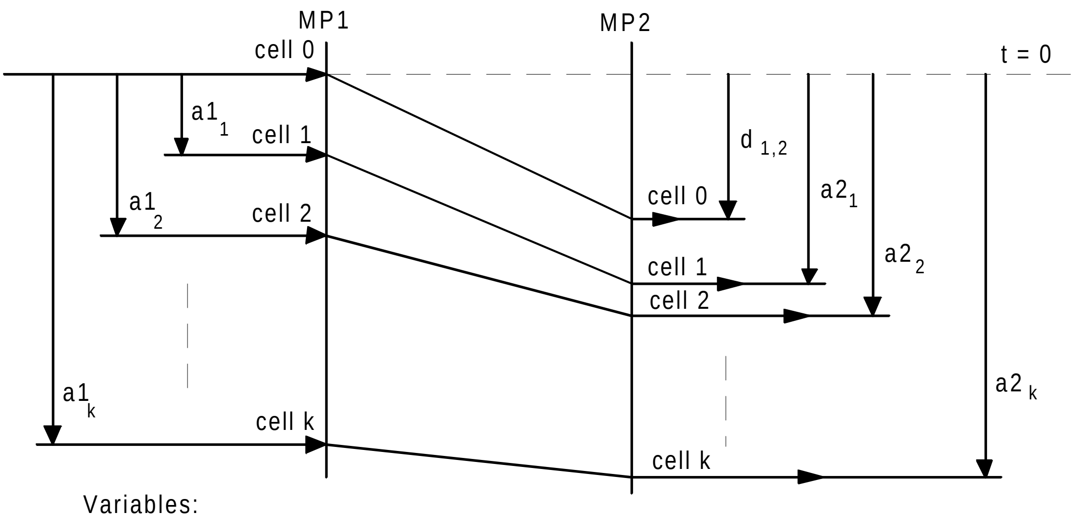
4) It is defined for all corresponding cell transfer event pairs (CRE1, CRE2); cell transfer delay as it is defined in subclause 7.3 applies only to successful cell transfer outcomes. Variables $a2_k$ and $a1_k$ are measured with reference to the same reference time in calculating absolute cell transfer delay.



Variables:
ak = cell k actual arrival time at MP
ck = cell k reference arrival time at MP
yk = 1-point CDV

yk = ck - ak

Figure 3: CDV: 1-point definition



Variables:

$a1_k$ = cell k actual arrival time at MP1

$a2_k$ = cell k actual arrival time at MP2

$d_{1,2}$ = absolute cell 0 transfer delay betweenMP1 and MP2

x_k = absolute cell k transfer delay between MP1 and MP2

v_k = 2-point CDV value between MP1 and MP2

$x_k = a2_k - a1_k$

$v_k = x_k - d_{1,2}$

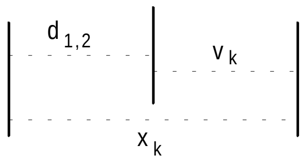


Figure 4: CDV: 2-point definition

7 Measurement of ATM layer performance parameters.

Definitions of parameters given in clause 6 are not always directly applicable to actual measurement. This clause describes measurement methods and identifies what is actually measurable for in-service and out-of-service conditions[5)].

NOTE: For "in service" measurements, using OAM flows, the accuracy of the results depends on the actual distribution of the impairments.

7.1 In-service conditions

Performance measurements in this case are mainly based on OAM performance monitoring flows whose definition and use are given in ITU-T Recommendation I.610 [8]. In some cases they can also be performed on the overall cell flow (e.g. for 1-point CDV measurement). If the MPs are coincident with the endpoints the related OAM flow is the **end-to-end** one, if the MPs are located in other connecting points the related OAM flow is a **segment** one. The defined parameters apply to both VPCs and VCCs. The measurements of performance parameters are supposed to be performed on traffic conditions involving cells which conform to the negotiated traffic contract. The measurements of performance parameters taking into account traffic conditions involving cells which do not conform to the negotiated traffic contract is a matter under study.

At the present state of standardization, OAM flows are not able to distinguish cells discarded by UPC/NPC functions from cells that are lost due to other reasons. The measurement that can be performed is related to the actual performance of the monitored connection or segment including any UPC/NPC actions. Further processes may be needed in order to distinguish cells discarded by UPC/NPC functions.

OAM F4 and F5 performance monitoring cells do not directly measure the parameters defined in clause 6 but OAM parameters which are related to blocks of N cells, as described below. Measurements are obtained according to the rules given in ITU-T Recommendation I.610 [8].

7.1.1 Parity violation of Bit Interleaved Parity 16 (BIP-16) in a block

What is actually measured by OAM performance monitoring cells is the number of parity bits that are errored, calculated on the information field of a block of N cells. The measurement is obtained by comparison between the BIP-16 field of the OAM received cell and the local corresponding calculation. Errors on the header may generate loss of the cell (and possible misinsertion of the cell itself on another connection), and, with very low probability, undue changes in type of cell or congestion status, undue changes in priority. This indication is relevant only if the block has not experienced cell loss or misinsertion.

---

5) Out-of-service condition is referred to a connection not carrying user traffic, that is accessed by one MP or two MPs. On the connection it is possible to inject artificial traffic having given characteristics. The connection is embedded in a working network, and its performance parameters (as in the in-service case) are influenced by the overall traffic supported by the network.

7.1.2 Evaluation of errored cells

The method suggested in ITU-T Recommendation I.356 [6] to evaluate errored cells by means of BIP-16 indicator uses the following algorithm:

- if i parity violations are observed ($0 \leq i \leq 2$) without any loss of cells, estimate the number of errored cells by i;

- if more than 2 parity violations are observed without any loss of cells, the estimated number of errored cells is N.

This method assumes that the number of cells within a block is not too large (e.g. less than 200 cells) and the transmission medium is such that either very few errors are experienced, or large bursts of errors occur. The feasibility and accuracy of this and other in-service methods are for further study. Evaluation of the number of errored cells allows the calculation of the **cell error ratio** given in clause 6.

NOTE: In case of frequent occurrence of "> 2" parity violations, the cell error ratio will be overestimated.

The BIP-16 mechanism is mainly a maintenance tool and not an accurate measurement method. It is adapted for detecting errored blocks and is suggested to be used for estimating the number of errored cells.

Annex A deals with the behaviour of BIP-16 mechanism in the presence of binary errors.

7.1.3 Variation in number of cells in a block

Another measurement which is performed by the OAM cells is the comparison between the number n1 of transmitted cells in the block (number of CRE1 events) and the number n2 of received ones (CRE2s). A positive value of (n1 - n2) is assumed to indicate loss of cells, a negative value is assumed to indicate misinsertion of cells, a zero value is assumed to indicate a correct transfer of the block[6)].

The total number of transmitted user cells (modulo 65 536) is counted at MP1 and carried by OAM performance monitoring cells. The count of the received user cells is performed at MP2. The comparison of these two numbers allows the calculation of the number of lost cells or misinserted cells in the block, according to the sign of the difference. The parameter always gives an under-evaluated absolute value if the two outcomes co-exist (see note).

NOTE: In this case a reference to a Tmax is not possible in evaluating "cell loss".

7.1.4 Errored cell block

Two types of errored blocks may be detected: Blocks containing errored cells without any lost or misinserted cell, and blocks which have experienced loss or misinsertion. As defined in ITU-T Recommendation I.356 [6], according to the level of impairment, the errored block should be considered as severely errored or not. At present, the exact definition of a severely errored outcome is unclear as far as the limit of the number of errored cells is concerned. From an impact of Quality of Service (QoS) perspective, it is expected that severely errored blocks due only to errored cells will have a different impact compared to severely errored blocks due to lost/misinserted cells.

---

6) What is possible to measure is actually the difference between the number of lost cells and the number of inserted cells. The estimation of the performance parameters is correct if the probability to experience both misinserted and lost cells outcomes within the same OAM block is very low.

7.1.5 Severely errored cell block ratio

The severely errored cell block ratio can be estimated by counting the severely errored blocks over a number of blocks and dividing the number by the total number of blocks.

7.1.6 Errored OAM cells

F4 and F5 OAM cells have a means for detecting errors in their information field (CRC 10 as indicated in ITU-T Recommendation I.610 [8]) and, therefore, errored OAM cells are directly detected.

Blocks related to an errored OAM cell should be excluded from the evaluation of all the performance parameters of clause 6. Nevertheless, this event should be taken into account for maintenance purposes.

7.1.7 Loss/misinsertion of OAM cells

The sequence number of OAM monitoring cells allows for lost or misinserted OAM monitoring cells. The block of cells terminated by an out-of-sequence OAM cell should not be considered in evaluating all the performance parameters of clause 6. Criteria for detecting unavailability are for further study.

7.1.8 Cell transfer delay

There is no way of measuring the transfer delay of individual user cells. The only direct measurement that is possible in service is the transfer delay of OAM cells. OAM cells contain information and can be monitored along the connection. Measuring the transfer delay of two consecutive OAM cells can be used to provide an estimation for the transfer delay of the user cells included between the two OAM cells. A way to measure cell transfer delay is to transmit time stamped OAM cells. The transmitted OAM cell payload contains the time t_1 at which the cell was transmitted. The receiver subtracts t_1 from the time t_2 at which the cell is received to determine the cell transfer delay for that cell. The method requires the same reference for the "time of the day" at the two MPs. The arithmetic average of the transfer delays of a given number of OAM cells allows the calculation of the **mean cell transfer delay**, considered valid for all the cells.

NOTE: As the measurement is processed only on OAM cells, some inaccuracy results for the evaluation of the transfer delay of user cells.

Another method, which does not require the same reference for the time of the day at the two MPs, is based on the evaluation of one half of the round trip delay (see subclause 7.1.8). This method can provide an estimation of the transfer delay, if processing delays are similar in both directions.

7.1.9 CDV

The CDV can be measured in service using either 1-point CDV or 2-point CDV methods.

1-point CDV is measurable over all the user cells while 2-point CDV makes use of OAM cells only, carrying time stamps. For both methods, synchronized time reference is not required. The necessity of measuring the 2-point CDV is under study. A detailed description of the method will be included when this point is clarified.

Clause C.7 of ETS 300 464 [1] illustrates a measurement method that calculates, for a cell stream received at a MP, the number of cells that do not conform with a specified peak cell rate at a specified CDV tolerance.

7.1.10 Round trip delay

A possibility exists of measuring this parameter by means of performance monitoring OAM cells. Considering that in this case the time between the reception of the OAM cell and its re-transmission is not significant and introduces an error on the measurement, it is necessary to evaluate it. It is also assumed that synchronization between clocks of the transmitting/receiving and looping points can be unreliable.

MP1 sends the OAM cell at time t_0 towards MP2, which receives it at its time θ_0.

MP2 reflects back the cell at time θ_1. The cell is received by MP1 at its time t_1.

The round trip delay is (r) = $t_1 - (\theta_1 - \theta_0) - t_0$.

The value ($\theta_1 - \theta_0$) or the values θ_1 and θ_0 should be carried inside the cell. The measured time is the sum of the transfer delays in the two directions experienced by the OAM cell.

7.2 Out-of-service conditions

The parameters of clause 6 are easier to measure under out-of-service conditions. It is supposed that MP1 is able to insert cells having a predefined content (referred to as test cells) and MP2 is able to compare the actual content of the received cells with the known expected one. In this way the received cells may be checked to state whether the cell is errored or not. The content of this clause will be aligned in the future with the new draft ITU-T Recommendation *"O.ATM"*.

The measurements given in subclauses 7.2.1 to 7.2.7 can be made in these conditions.

7.2.1 Cell error ratio

The definition of this parameter is given in clause 6. It is measured by transmission of N1 test cells from MP1, having known information field, and by counting, at MP2 the total number N1 of successfully transferred and errored cells which are received, and the number n of errored cells. How to take into account the severely errored cell blocks is for further study.

cell error ratio = n / N2.

7.2.2 Cell loss ratio

The definition of this parameter is given in clause 6. It is measured by transmission of N1 test cells from MP1, having known information field, and by counting at MP2 the total number N2 of successfully transferred and errored cells which are received How to take into account the severely errored cell blocks is for further study.

cell loss ratio = (N1 - N2) / N1.

In this case a Tmax can be defined and used in evaluating "cell loss".

7.2.3 Cell misinsertion rate

Without inserting artificial traffic at MP1, the count n_i of all the cells received by MP2 in a given time T is the number of inserted cells.

cell misinsertion rate = n_i / T.

The method supposes that inserted cells on a connection are independent from the traffic on the connection itself.

7.2.4 Cell transfer delay

The parameter is defined and measured as in-service conditions.

7.2.5 CDV

The parameter is defined and measured as in-service conditions. In this case it is easier to match the condition of Transmitting cells from MP1 at fixed T intervals.

7.2.6 Round trip delay

The parameter is defined and measured as in-service conditions.

7.2.7 Mis-sequenced cell ratio

Cells of artificial traffic may carry a sequence number for detecting possible mis-sequenced cells due to operations inside some network element. Definition and evaluation methods of this parameter are for further study[7)].

---

7) Considering in-service conditions, this parameter is only observable at AAL level. At the same level it is also possible detect and discard misinserted cells. This is an example of possible mis-behaviour of the ATM layer only measurable at AAL level. In general, performance parameters defined and measured at AAL level should be investigated.

Annex A: Analysis of BIP-16 errors

The BIP-16 mechanism subdivides the information fields of the cells contained in the block into 16 code words and calculates a parity bit on each of them. The code is able to detect an odd number of errors on each word. The interleaved system allows to have blocks of variable length and to better distribute burst errors on the words. On the other hand each parity bit is derived from bits of every cells in the block. Under these conditions it is a good approximation to consider errors uniformly distributed on the code words.

Considering a given Bit Error Ratio (BER) along the connection and a given block length L, it is possible to calculate the probability of blocks affected by *n* errors and, for each *n*, the probability of error configuration on the 16 words.

If *a* is the number of words without errors, *b* is the number of words having detectable errors and *c* is the number of words having undetectable errors, $(a + b + c = 16)$ for each given BER and L it is possible to calculate the probability $p(a, b, c)$ of a given error configuration. The number *b* is the number of errored parity bits.

The graphics in figure A.1 summarizes the above described calculations, for $p(a, b, c)$ values.

From the results it is possible to deduce that the probability of three errored parity bits corresponding to three errored words and thirteen correct words is less than the probability of undetected errors (it is more likely to have a double error on a word than three errors on three different words). Furthermore, the probability that the two detected errors are on the same cell is very small. This is a reason which can justify the assertion (see subclause 7.1.2) that a block having more than 2 errors indicated by BIP-16 code has to be considered as a block having N errored cells.

This situation is independent from the block length, and that means that the longer the blocks are, the less accurate the method is.

This procedure is also in accordance with the hypothesis of an error model which considers single errors with low probability and possible long bursts. The probability of three single errors on a block should be significantly lower than the probability of a burst of errors.

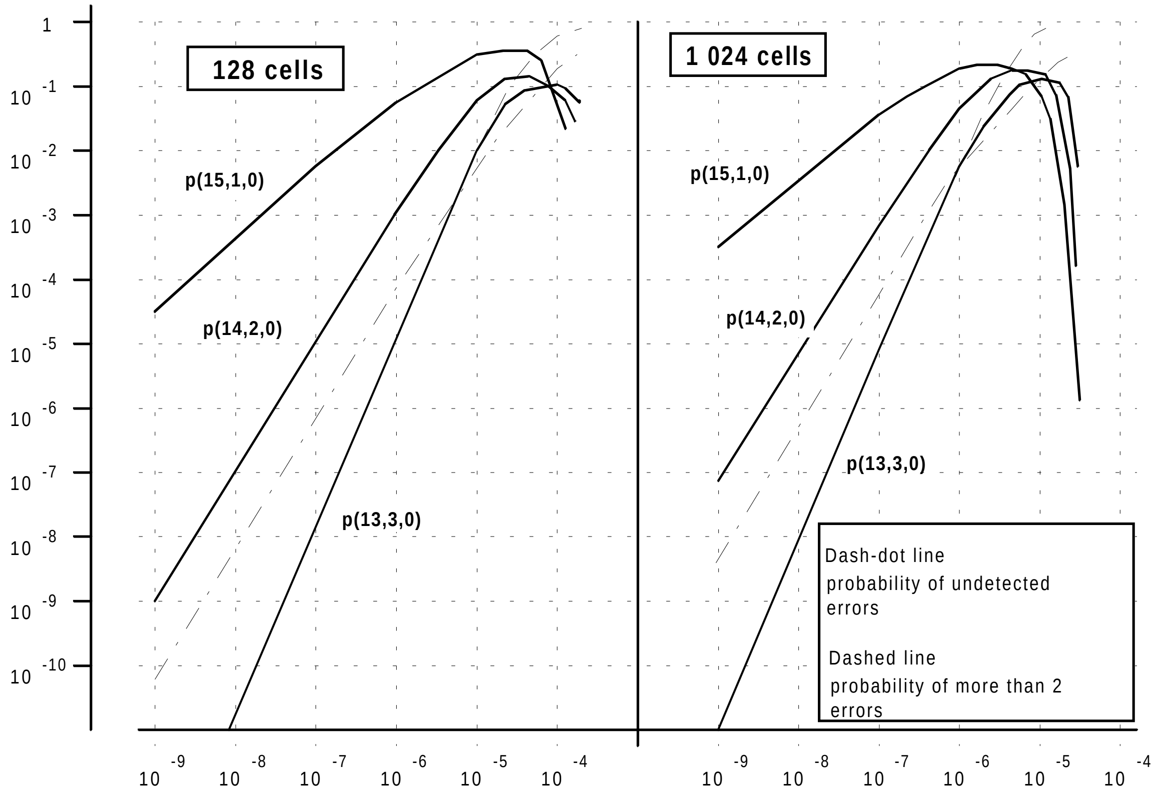


Figure A.1: BIP-16 errors probability versus total BER

History

Document history	
February 1995	First Edition
February 1996	Converted into Adobe Acrobat Portable Document Format (PDF)

ISBN 2-7437-0083-1
Dépôt légal : Février 1995