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X.144

Amendment 1
(08/97)

SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATION

Public data networks – Network aspects

User information transfer performance parameters for data networks providing international frame relay PVC service

Amendment 1: Annex C – Some relations between frame-level and ATM-level performance parameters

ITU-T Recommendation X.144 – Amendment 1

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION X.144

USER INFORMATION TRANSFER PERFORMANCE PARAMETERS FOR DATA NETWORKS PROVIDING INTERNATIONAL FRAME RELAY PVC SERVICE

AMENDMENT 1

Annex C

Some relations between frame-level and ATM-level performance parameters

Summary

This amendment provides a new Annex C to Recommendation X.144: Annex C – Some relations between Frame-level and ATM-level performance parameters.

Source

Amendment 1 to ITU-T Recommendation X.144, was prepared by ITU-T Study Group 7 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 9th of August 1997.

FOREWORD

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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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USER INFORMATION TRANSFER PERFORMANCE PARAMETERS FOR DATA NETWORKS PROVIDING INTERNATIONAL FRAME RELAY PVC SERVICE

AMENDMENT 1

Annex C

Some relations between frame-level and ATM-level performance parameters

(Geneva, 1997)

C.1 Scope

This annex develops some relations between the frame-level performance parameters defined in the body of this Recommendation and the ATM-level performance parameters defined in the latest version of Recommendation I.356[1]. These performance relationships are based on the Frame Relay and ATM (FR-ATM) network interworking scenario [see Figure C.1a)] and the FR-ATM service interworking scenario [see Figure C.1b)] identified in Recommendation I.555[2] and more fully developed in Recommendations I.365.1[3] and clause 6/I.363[4]. The relationships developed in this annex between the ATM-level and frame-level performance parameters may be used as a basis for establishing performance objectives for frame relay when supported over, or interworked with, ATM.

C.2 Motivation for relating frame-level and ATM-level and performance parameters

A suitable relation between the network performance parameters for frame transfer and cell transfer should allow determination of end-to-end performance for the two interworking scenarios identified in Figure C.1/X.144. Furthermore, for a connection segment that supports frame relay service over ATM technology, such a relation should also allow the estimation of a connection segment's frame-level performance from a measurement of the connection segment's ATM-level performance.

Referring to Figure C.1/X.144, an end-to-end (or CPE-to-CPE) virtual connection could be partitioned into two or more "connection segments" by using a Measurement Point (MP) near each IWF. The end-to-end performance of such a virtual connection could be estimated by measuring the performance of each connection segment and then suitably combining the performance impairments measured on each connection segment. Since some of these connection segments use frame-oriented technology and others use ATM-oriented technology, the determination of end-to-end network performance by this approach requires a suitable means for relating the performance parameters based on these two technologies.

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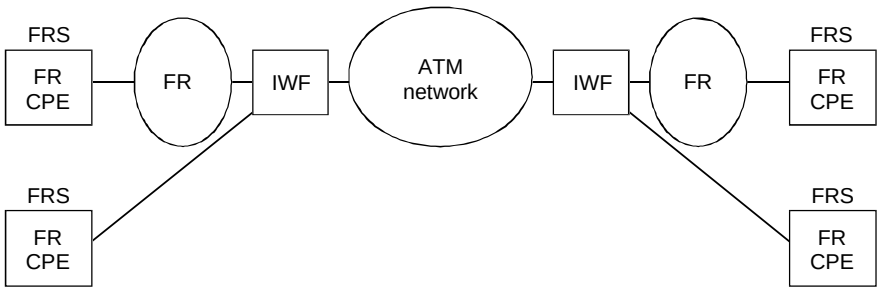
1 ITU-T Recommendation I.356: *B-ISDN ATM layer cell transfer performance*, Study Group 13 Draft 4, February, 1996.

2 ITU-T Recommendation I.555: *Frame relaying bearer service interworking*, Study Group 13, Geneva, 1993.

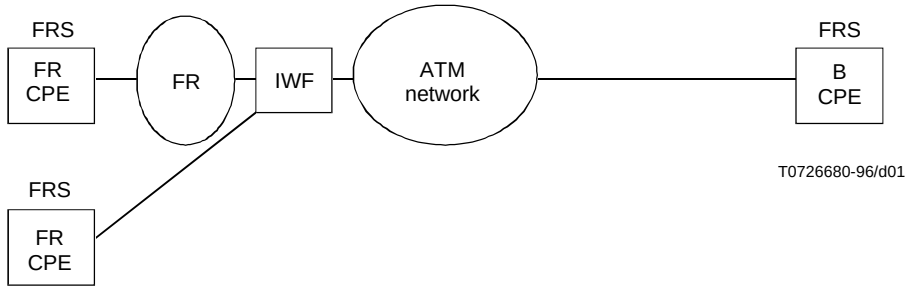
3 ITU-T Recommendation I.365.1: *B-ISDN ATM adaptation layer sublayers: Frame Relaying Service Specific Convergence Sublayer (FR-SSCS)*, Study Group 13, Geneva, 1993.

4 ITU-T Recommendation I.363: *B-ISDN ATM Adaptation Layer (AAL) specification*, (Addendum 1 – April 1994), Study Group 13, Geneva, 1993.

On a given connection segment where ATM technology is used to support frame relay service, it can be operationally useful to establish the relation between that segment's ATM-oriented delay, loss and error performance characteristics and their impact on the analogous frame-oriented performance characteristics.



a) Network Interworking Scenario 1



b) Network Interworking Scenario 2

ATM	Asynchronous Transfer Mode
B	Broadband
CPE	Customer Premises Equipment
FR	Frame Relay
FRS	Frame Relay Service
IWF	Interworking Function

Figure C.1/X.144 – Some FR-ATM interworking

C.3 Frame relay parameters considered

The relevant frame-level parameters[5] include:

- user information Frame Transfer Delay (FTD);
- user information Frame Loss Ratio (FLR);
- Residual Frame Error Ratio (RFER);
- Extra Frame Rate (EFR).

5 The frame-based conformant traffic distortion ratio and potential frame flow related parameters are not considered in this annex.

At least two factors influence correlation of FTD with Cell Transfer Delay (CTD). First, the FR-ATM interworking scenarios provide for the mapping (also called multiplexing) of FR-level Data Link Channel Identifiers (DLCIs) to ATM-level Virtual Channel Identifiers (VCIs). Two types of mapping schemes have been discussed, those which map one DLCI to one VCI (called 1-to-1 multiplexing) and those which map a number of DLCIs to one VCI (called N-to-1 multiplexing).

The type of mapping scheme can influence the relation between CTD and FTD because the N-to-1 mapping scheme could include the buffering of information from several DLCIs before an opportunity exists for their transmission over the one designated VCI. Furthermore, some of a VCI's information transfer capacity can be used to transfer OAM cells in addition to user information cells. If a VCI is transferring both OAM cells and user information cells that bear frame relay service information, some consideration must be given to identifying the capacity that is available for these user information cells even though the impact on FTD of OAM cell transfer is likely to be quite small.

The FLR can be related to the Cell Loss Ratio (CLR) and other performance parameters when either the frame size is known or a nominal frame size is assumed. This is discussed further in C.4/X.144.

The RFER can be related to the Cell Error Ratio (CER) when either the frame size is known or a nominal frame size is assumed. However, development of this relation involves consideration of the frame-level CRC's breakdown during its error detection task. This relationship is for further study.

The EFR is conceptually analogous to the Cell Misinsertion Rate (CMR). The reference events for each of these parameters can be caused by either an undetected/miscorrected error in the channel identifier field (i.e. DLCI or VPI-VCI) or an incorrectly programmed translation of channel identifier labels.

C.4 Relation between FR and ATM user information loss parameters

Consider now the relation between the user information Frame Loss Ratio (FLR), the Cell Loss Ratio (CLR) and other relevant performance parameters. A frame length of F_{cells} or an equivalent F_{bits} is assumed[6].

The FLR is defined over a connection segment delimited by two MPs as the ratio of the number of lost frame outcomes to the number of lost, successfully transferred and residually errored frame outcomes. The denominator of this ratio can be viewed as representing the total number of frames transmitted onto a given connection segment during a time period of interest. Our approach is to first estimate the probability of frame loss under each of several identified mechanisms, next equate each such probability to the ratio of the number of frames lost under a specific mechanism to the total number of frames transmitted onto the connection segment during a common period of interest, and finally sum the probabilities over all identified mechanisms.

A lost frame outcome occurs on a connection segment either when a frame entry event fails to happen within a specified time interval T_{max} after the corresponding frame exit event or when the CRC of the received frame corresponding to the frame entry event is invalid. Consistent with this definition, five mechanisms that result in frame loss can be identified:

1) frame loss due to burst impairment events involving multiple bit errors, cell losses and/or misinserted cells;
2) frame loss due to (background) random, single-bit errors;
3) frame loss due to (background) loss of a constituent cell or cells, e.g. cell-level buffer overflow;

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6 Since one cell requires 53 octets, $F_{bits} = 424 \times F_{cells}$, where F_{bits} represents the total number of bits needed to transport the frame at the ATM level. F_{cells} is determined from the frame length and the fact that AAL 5 is used to transport FR frames. Up to 48 octets of FR information would be contained in each cell used to transport a given frame, and the last cell used for that frame would contain 8 octets of AAL 5-specific information.

4) frame loss due to (background) misinsertion of a cell;

5) frame loss due to frame-level processing failure, e.g. frame-level buffer overflow or frame-level processor saturation.

Mechanism 1) accounts for the impact of all burst impairments that are visible at the ATM level, while mechanisms 2), 3) and 4) account for the independent impacts of the background impairment types that are visible at the ATM level and that remain after burst impairments are counted and removed. Mechanism 5) accounts for impairments (of both burst and background types) that are caused strictly at the frame level, and hence not visible at the cell level. Take these five mechanisms to be independent. Then applying the approach just cited, the FLR on a particular connection segment during a specific time period is represented as:

$$FLR = FLR_{burst} + FLR_{error} + FLR_{CLR} + FLR_{CMR} + FLR_{frame} \quad \text{(C-1)}$$

where FLR_{burst} is the FLR due to burst impairment events, FLR_{error} is the FLR due to random, single-bit errors, FLR_{CLR} is the FLR due to loss of constituent cells, FLR_{CMR} is the FLR due to misinserted cells and FLR_{frame} is the FLR due to frame-level processing failure. The remainder of this subclause considers the FLR component due to each of these mechanisms.

C.4.1 Burst-type impairments

Consider first the probability of frame loss due to burst-type impairments. The Severely Errored Cell Block Ratio (SECBR), as measured on a given connection segment over a time period of interest, can be used to bound the probability of occurrence during that period of burst-type impairments involving bit errors, cell losses and/or misinserted cells. It remains to relate the length of a frame, F_{cells}, to the length of a cell block, B_{cells}[7]. Three cases will be considered here:

- $F_{cells} << B_{cells}$;
- $F_{cells} >> B_{cells}$;
- $F_{cells} \approx B_{cells}$.

NOTE – If only frames of size 512 or less are supported, then only the first case is applicable.

If F_{cells} is significantly smaller than B_{cells}, then the fraction of frames that are impacted by burst-type impairments is approximated by the fraction of cell blocks that are severely errored, i.e. the SECBR. Hence

$$FLR_{burst} = SECBR \quad \text{(C-2a)}$$

However, if F_{cells} is significantly larger than B_{cells}, then any one of (F_{cells}/B_{cells}) cell blocks[8] would, if severely errored, impact a given frame. The probability that a frame of such length is not so impacted is:

$$(1 - SECBR)^{F_{cells}/B_{cells}}$$

The FLR due to this mechanism is the logical complement of this, namely the probability that a frame of such length does experience one or more SECBs, which is:

$$FLR_{burst} = 1 - (1 - SECBR)^{F_{cells}/B_{cells}} \quad \text{(C-2b)}$$

If F_{cells} and B_{cells} are about equal, then a single SECB would generally impact two frames, and so:

$$FLR_{burst} = 2\ SECBR \quad \text{(C-2c)}$$

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7 The length of the cell block identified in Recommendation I.356 is related to the Peak Cell Rate (PCR). The minimum length is 128 cells and the maximum length is 32 768 cells. Assuming a maximum frame length of 512 octets, 5 octets of overhead, and AAL 5, the number of frames contained in one cell block of 128 cells is $(128 \times 48 - 8)/(512 + 5) = 12$ frames, and the number of frames contained in one cell block of 32 768 cells is 3014 frames.

8 Or more precisely, $[F_{cells}/B_{cells}]$ where [x] denotes the smallest integer which is greater than or equal to x.

We observe that an alternative approach for estimating the impact at frame level of burst-type impairments would be to use a physical level parameter such as the number of severely errored seconds per day or the time spent per day executing protection switches. The appropriateness of this alternative is for further study.

C.4.2 Single-bit errors

Consider next the probability of frame loss due to independently occurring, single-bit errors. Take the probability of a single-bit error to be as given by the Bit Error Ratio (BER). The probability that a frame F_{bits} bits in length does not experience a random, single-bit error is:

$$(1 - BER)^{F_{bits}}$$

The FLR due to this mechanism is the logical complement of this, namely the probability that such a frame does experience one or more random, single-bit errors, which is:

$$FLR_{error} = 1 - (1 - BER)^{F_{bits}} \quad \text{(C-3)}$$

We observe that relations could in principle be established first between physical level bit error parameters and CER, and then between the CER and this FLR_{error}.

C.4.3 Cell losses

Consider next the probability of frame loss due to independently occurring cell losses. Take the probability of a single cell's loss to be as given by the CLR. The probability that a frame F_{cells} in length does not experience a lost cell is:

$$(1 - CLR)^{F_{cells}}$$

The FLR due to this mechanism is the logical complement of this, namely the probability that such a frame does experience one or more cell losses, which is:

$$FLR_{CLR} = 1 - (1 - CLR)^{F_{cells}} \quad \text{(C-4)}$$

C.4.4 Misinserted cells

Consider the probability of frame loss due to a randomly occurring misinserted cell. If the Cell Misinsertion Rate (CMR) and the Peak Cell Rate (PCR) applicable to the ATM connection are known, then the fraction of received cells that are misinserted is CMR/PCR. Take this fraction to be the probability that a single cell is misinserted. The probability that a frame F_{cells} in length does not experience a misinserted cell is:

$$(1 - CMR/PCR)^{F_{cells}}$$

The FLR due to this mechanism is the logical complement of this, namely the probability that such a frame does experience one or more cell losses, which is:

$$FLR_{CMR} = 1 - (1 - CMR/PCR)^{F}$$

(C-5)

C.4.5 Frame-level processing failures

Finally consider the probability of frame loss due to frame-level processing failure. This is dependent upon processes above the physical and ATM levels, and hence is beyond the scope of this contribution. The resulting FLR_{frame} would be estimated by frame-based methods and substituted into equation C-1, together with the results of equations C-2, C-3, C-4 and C-5.

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