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SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

Public data networks – Network aspects

Quality of service metrics for characterizing Frame Relay/ATM service interworking performance

ITU-T Recommendation X.142

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ITU-T Recommendation X.142

Quality of service metrics for characterizing Frame Relay/ATM service interworking performance

Summary

This Recommendation defines quality of service metrics for characterizing performance in the case of FR/ATM service interworking. The specified metrics can be used to quantify the performance of either the FR/ATM interworking function/unit or the quality of the end-to-end data connection. This Recommendation is complementary to ITU-T Rec. X.140 as it is a specific case of the general techniques described therein for assessing performance.

The specified metrics allow users and network operators to assess the performance from a user perspective. The metrics provide a simple manner by which either users or network operators could characterize the end-to-end performance.

The defined metrics are not intended to be a replacement for the frame layer or ATM layer primary performance parameters but can be used to provide a user-oriented perspective of end-to-end performance.

Source

ITU-T Recommendation X.142 was approved by ITU-T Study Group 17 (2001-2004) under the ITU-T Recommendation A.8 procedure on 29 October 2003.

FOREWORD

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ITU-T Recommendation X.142

Quality of service metrics for characterizing Frame Relay/ATM service interworking performance

1 Scope

The purpose of this Recommendation is to define metrics for characterizing frame relay/ATM service interworking performance. This Recommendation is complementary to ITU-T Rec. X.140 as it is a specific case of the general techniques described in ITU-T Rec. X.140 for assessing performance.

Due to the intrinsic differences in the FR and ATM protocols, it is difficult, particularly from a user perspective, to directly map the performance parameters of one technology to the other in order to quantify the end-to-end performance in the case of FR/ATM service interworking. Since FR frames can be of varying length, the loss of one frame may translate into the loss of more than one cell. Also the transit delay of frames across a network will generally be longer than for ATM cells due to increased clocking and switching delays associated with larger frame sizes.

The purpose of defining metrics is to ensure that there is a standard way of characterizing performance in the case where the end-to-end connection cannot be characterized by the usual frame or cell layer performance parameters and objectives. The specified metrics allow users and network operators to readily assess the performance from a user perspective. The metrics provide a simple manner by which either users or network operators may quantify (measure) the performance of either the FR/ATM interworking function/unit or the quality of the end-to-end data connection.

The specified metrics and objectives apply in the case where FR/ATM service interworking is provided. Although FR/ATM service interworking is a network option, there is no reason to prevent the service being provided on an end-to-end basis which may involve an international frame relay or ATM connection and, accordingly, this Recommendation also has applicability on international connections.

This Recommendation applies to those networks supporting the frame relay ATM/service interworking as defined in ITU-T Rec. I.555.

It should be carefully noted that the defined metrics are not intended to be a replacement for the frame layer or ATM layer primary performance parameters but have been defined to provide a user-oriented perspective of end-to-end performance.

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; 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. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance*.

– ITU-T Recommendation I.555 (1997), *Frame Relaying Bearer Service interworking*.

– ITU-T Recommendation X.36 (2003), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for public data networks providing frame relay data transmission service by dedicated circuit*.

– ITU-T Recommendation X.76 (2003), *Network-to-network interface between public networks providing PVC and/or SVC frame relay data transmission service*.

– ITU-T Recommendation X.111 (2003), *Principles for the routing of international frame relay traffic*.

– ITU-T Recommendation X.140 (1992), *General quality of service parameters for communication via public data networks*.

– ITU-T Recommendation X.144 (2003), *User information transfer performance parameters for public frame relay data networks*.

– ITU-T Recommendation X.145 (2003), *Connection establishment and disengagement performance parameters for public Frame Relay data networks providing SVC services*.

– ITU-T Recommendation X.146 (2000), *Performance objectives and quality of service classes applicable to frame relay*.

– ITU-T Recommendation X.148 (2003), *Procedures for the measurement of the performance of public data networks providing the international frame relay service*.

3 Definitions

The terms and definitions used in this Recommendation are consistent with those used in ITU-T Recs I.356, I.555, X.36, X.76, X.111, X.140, X.144, X.145, X.146 and X.148.

4 Abbreviations

This Recommendation uses the following abbreviations:

ATM Asynchronous Transfer Mode

CLR Cell Loss Ratio

DBDJ Data Block Delay Jitter

DBDR Data Block Delivered Ratio

DBLR Data Block Loss Ratio

DBTD Data Block Transfer Delay

FCS Frame Check Sequence

FLR Frame Loss Ratio

FR Frame Relay

FTD Frame Transfer Delay

IWF InterWorking Function

MP Measurement Point

PVC Permanent Virtual Circuit

SVC Switched Virtual Circuit

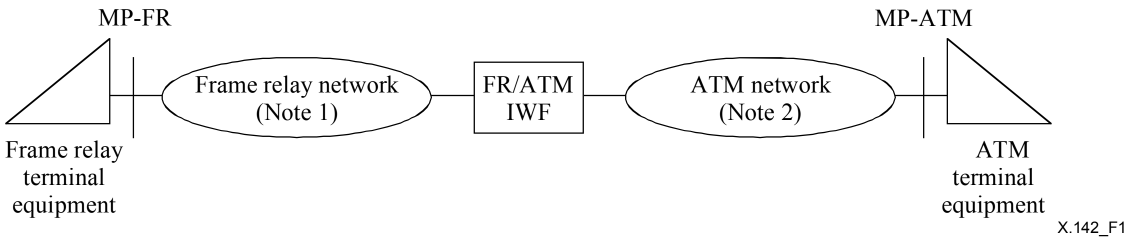
5 Conventions

No specific conventions apply.

6 General reference model for FR/ATM service interworking

A general reference model in the case where a frame relay service user interworks with an ATM service user is shown in Figure 1. The ATM service user performs no frame relay service specific functions, and the frame relay service user performs no ATM service specific functions. The ATM terminal has no knowledge that the distant terminal is connected to a frame relay network and likewise, the frame relay terminal has no knowledge that the distant terminal is connected to an ATM network. This is known as service interworking. All interworking is performed by the FR/ATM interworking function. The functionality provided by the FR/ATM interworking function can be located in either the frame relay network, or the ATM network, or may be a separate entity.

ITU-T Rec. X.111 provides guidance and principles for the routing of traffic between frame relay and ATM networks. In the case where FR/ATM service interworking is provided on an international connection, the network operators will route traffic to the FR/ATM IWF in accordance with network capabilities and bilateral arrangements.



NOTE 1 – The FR connection between the originating FR terminal equipment and the FR/ATM IWF may involve one or more transit networks.

NOTE 2 – The ATM connection between the FR/ATM IWF and the destination ATM terminal equipment may involve one or more transit networks.

NOTE 3 – The IWF may be functionally located in either the frame relay network or the ATM network or may be a separate entity as shown.

Figure 1/X.142 – Frame relay/ATM service interworking

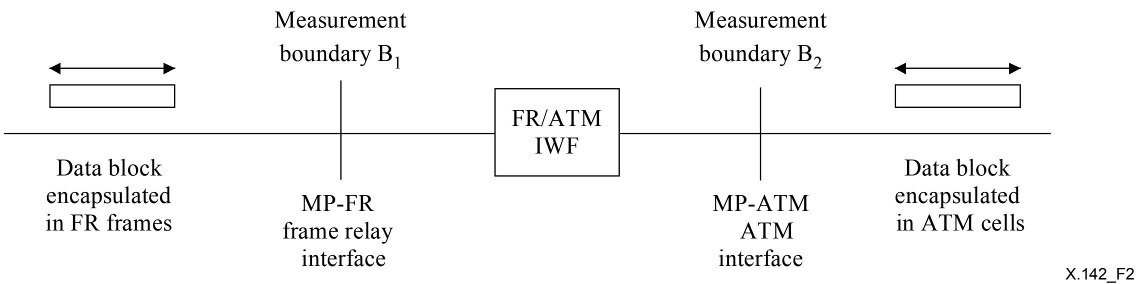


Figure 2/X.142 – General location of measurement points

Whilst frame relay (or ATM) layer performance can be measured/monitored at any network boundary where a frame relay (or ATM) layer reference event can be monitored, the metrics defined in this Recommendation strictly apply in the case where one measurement point has access to the frame layer reference events and the other measurement point has access to ATM layer reference events. That is, the measurement is assessed across two boundaries B_1 and B_2, where B_1 is a measurement point on the frame relay side of the interworking function and B_2 is a measurement point on the ATM side of the interworking function (or vice versa) as shown in Figure 2.

7 Metrics for characterizing FR/ATM service interworking performance

This clause defines a number of metrics which can be used to characterize the transmission performance of the end-to-end connection in the case of FR/ATM service interworking. Three parameters are defined: Data Block Delivered Ratio, Data Block Transfer Delay and Data Block Delay Jitter. The measured/achieved value for each of these parameters will depend on the frame and ATM cell loss ratios, frame transfer delay and frame delay jitter, cell transfer delay and cell delay variation performance.

The FR/ATM service interworking performance metrics are independent of the frame relay or ATM service classes or traffic contracts which may be used to establish the end-to-end connection. The metrics are applicable to both SVCs and PVCs.

7.1 Data block delivered ratio/loss ratio

The effects of frame or cell loss on the end-to-end performance is characterized by the metric of Data Block Delivered Ratio (DBDR). This parameter characterizes the user data transfer performance of the end-to-end connection.

$$DBDR = \frac{DataDelivered}{DataOffered}$$

For the case where the transfer is from the frame relay terminal to the ATM terminal

$$DBDR = \frac{DataDelivered\_to\_ATM\ interface}{DataOffered\_by\_FR\ interface}$$

For the case where the transfer is from the ATM terminal to the frame relay terminal

$$DBDR = \frac{DataDelivered\_to\_the\_FR\ interface}{DataOffered\_by\_ATM\ interface}$$

The data block loss ratio is then (1–*DBDR*).

7.2 Data block transfer delay

The Data Block Transfer Delay (DBTD) is defined as:

$$DBTD = t_2 - t_1$$

where, in a specified population:

- for the case where the transfer is from the frame relay terminal to the ATM terminal:
  - t_1 is the time of occurrence for the first bit of the first FR frame encapsulating the data block to be transmitted across the measurement boundary;
  - t_2 is the time of occurrence for the last bit of the last ATM cell encapsulating the data block to be transmitted across the measurement boundary;
- for the case where the transfer is from the ATM terminal to the frame relay terminal:
  - t_1 is the time of occurrence for the first bit of the first ATM cell encapsulating the data block to be transmitted across the measurement boundary;
  - t_2 is the time of occurrence for the last bit of the last FR frame encapsulating the data block to be transmitted across the measurement boundary.

NOTE – In general $t_2 - t_1 \leq T_{max}$

where:

T_{max} = $T_{FR} + T_{ATM} + T_{IWF}$ and

T_{FR} = Frame relay network frame transit delay objective

T_{ATM} = ATM network cell transit delay objective

T_{IWF} = the transit delay through the IWF

The end-to-end user information transfer delay is the one-way delay between DTE boundaries; (for example, the delay between MP_{FR} and MP_{ATM} as shown in Figure 1.

7.3 Data block delay jitter

The Data Block Delay Jitter (DBDJ) is defined as the maximum Data Block Transfer Delay ($DBTD_{max}$) minus the minimum Data Block Transfer Delay ($DBTD_{min}$) during a given measurement interval, consisting of a statistically significant number of delay measurements (N).

$$DBDJ = DBTD_{max} - DBTD_{min}$$

where:

$DBTD_{max}$ is the maximum DBTD recorded during a measurement interval of N delay measurements

$DBTD_{min}$ is the minimum DBTD recorded during a measurement interval of N delay measurements

N is the number of DBTD measurements made to give a statistically significant representation of the DBTD performance. N must be chosen to be at least 1000 (see Note).

NOTE – This number of 1000 observations will ensure that the 99.5 percentile of delay is observed at least 99% of the time. The suggested measurement interval is five (5) minutes. It is desirable that the observations be distributed uniformly across the measurement interval.

8 Formal relationships between frame level and ATM level performance and traffic parameters

It should be noted that information on performance parameter relationships and traffic parameter mappings is specified in Annex C/X.144 and Annex D/I.555 as follows:

Annex C/X.144 provides information on the relationship between frame level and ATM level performance parameters in the case of FR/ATM interworking.

Annex D/I.555 defines a conservative mapping between the frame relay traffic parameters and the ATM transfer capability for statistical bit rate configuration 1.

The relationships and mappings can be used to estimate performance as shown in Appendix I.

9 Performance objectives

This Recommendation does not specify end-to-end performance objectives for frame relay/ATM service interworking. The specification of end-to-end performance objectives for frame relay/ATM service interworking is for further study in accordance with industry needs.

Appendix I

Estimation of loss and transit delay in the case of FR/ATM service interworking

I.1 Introduction

This appendix provides a worst-case estimate for loss ratio and transit delay in the case of FR/ATM service interworking across an international virtual connection

Table 1/X.146 specifies performance objectives for a number of frame relay service classes. In the case of frame relay, the transit delay objective is generally specified with respect to a 256-octet user data field. Table 2/I.356 specifies performance objectives for a number of ATM service classes.

I.2 Estimation of end-to-end transit delay

Assume that the frame relay connection is provided by a FR (class 1) service and that the ATM connection is provided by an ATM (class 1) service.

Frame relay (class 1) and ATM (class 1) both specify 400 ms as the end-to-end transit delay objective.

With modern switching equipment it is reasonable to assume that the FR/ATM IWF would not insert significant additional delay. It should be noted that, on a long international connection, the propagation delay is most likely to be the dominant contribution.

Hence, it is expected that the end-to-end data block transfer delay (for data blocks up to 256 bytes) across an international connection is expected to be within the 400 ms objective.

I.3 Estimation of data block loss ratio

Assume that the frame relay connection is provided by a FR (class 1) service and that the ATM connection is provided by an ATM (class 2) service.

The FLR objective for FR (class 1) is 1×10^{-3}. The CLR objective for ATM (class 2) is 1×10^{-5}.

I.3.1 Impact of FLR and CLR on DBLR

In the frame relay environment, data blocks of 256 bytes or less will be encapsulated inside a single FR frame. Thus the DBLR will be approximately equal to the FLR. Thus for a FLR of 1×10^{-3} the DBLR will be approximately 1×10^{-3}.

As defined in ITU-T Rec. I.555, in general:

$$\text{FLR} = \text{CLR} \times (M/Y), \text{ approximately}$$

$$\text{CLR} = \text{FLR} \times (Y/M), \text{ approximately}$$

where:

Y = Number of cells required to carry one frame of user information (cells/frame)

= Round up$\{ (N + 8 + K) / 48 \}$, where 8 bytes of AAL5 overhead are included

M = Number of bytes required to carry one frame of user information (bytes/frame)

= $N + 5$, where 5 bytes include the FR flag, header, and FCS.

N = Number of user information bytes carried in a FR frame (bytes)

For example, in the ATM environment a data block of 256 bytes will be encapsulated into up to six ATM cells. The loss of one cell will corrupt the entire data block. Assuming that the cell loss is uniformly spread (non bursty); the DBLR is potentially 6 times the CLR. Thus for a CLR of 1×10^{-5} the worst-case DBLR will be 6×10^{-5}.

On the end-to-end connection, the data block loss ratio is dominated by the loss in the frame relay network. With modern switching equipment it is also reasonable to assume that the FR/ATM IWF would not significantly increase frame or cell loss.

Hence, it is expected that the end-to-end data block loss ratio (for data blocks up to 256 bytes) across an international connection is expected to be approximately $< 1 \times 10^{-3}$.

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