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INDUSTRY GUIDELINE

INTER-NETWORK ATM SERVICES

ACIF G605:2002

Industry Guideline – ***Inter-network ATM Services***

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1 INTRODUCTION

This document defines guidelines for the implementation of ATM connections between Australian ATM network operators (operators). It defines common traffic parameters and conformance definitions, and makes recommendations on management between ATM networks.

1.1 Background

All operators have the capability to engineer their ATM networks as they best see fit. When purchasing a service from another operator to extend network reach, each operator applies their internal engineering guidelines to the connection, resulting in a potential conflict of settings. This can lead to sub-optimal performance, perhaps culminating in cell discards. This document recommends a consistent approach, which if adopted will help to reduce this inefficiency.

A consideration when using services provided by another operator is service visibility within the other ATM network. It is therefore seen as desirable that a mechanism be developed to detect and report on service availability on such services over the segments carried in other ATM networks.

1.2 Objectives

1.2.1 To develop a voluntary guideline for the connection of networks based on the ATM Forum Asynchronous Transfer Mode (ATM) User-Network Interface (UNI) 3.1 specification.

1.2.2 To recommend the most appropriate use of OAM cells for network management on inter network ATM services.

1.2.3 To define common set(s) of parameters for Permanent Virtual Circuits (PVCs) and for Permanent Virtual Paths (PVPs).

1.2.4 This document does not define the carriage of various services over ATM. However Appendix C provides information on a suggested approach that could assist establishing bilateral agreements for certain services.

1.3 Scope

1.3.1 The scope of this Guideline covers the recommended specification of inter network interfaces based on ATM User-Network Interface Specification V3.1 by the ATM Forum and includes work related to ATM Adaptation Layer (AAL)1, AAL2 and AAL5.

1.3.2 For clarity, the following items are out of the scope of this Guideline:

(a) work related to AAL3 and AAL4;

(b) ITU-T service classes and conformance definitions for ATM (because all operators in the Australian market at the time of publication base their service offering on ATM Forum service classes and conformance definitions);

(c) ABR and UBR service classes (Note: At the time of publication there were no known ABR or UBR implementations between networks. This does not preclude implementation of ABR or UBR service(s) between networks on a bilateral basis.);

(d) signalling between operators to support Private Network-Network Interface (PNNI) via AINI of B-ISUP;

(e) UNI signalling;

(f) Switched Virtual Circuits (SVCs); and

(g) detailed work on specification of the physical layer, although the Guideline does reference international specification(s) for clarity.

2 PARTICIPANTS

The Working Committee (NRP/WC15) that developed this document consisted of the following organisations and their representatives:

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Sam Mangar	Optus / XYZed	Participating
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All enquiries in regard to the document should quote the document reference number and should be directed to ACIF.

3 REFERENCES

The following publications are referenced in this document, and were valid at the time of publication:

Publication and/or Publisher	Title
ATM FORUM SPECIFICATIONS	
af-bici-0013.003	B-ICI 2.0 (integrated specification)
af-ilmi-0065.000	ILMI 4.0
af-pnni-0055.000	P-NNI v1.0
af-vtoa-0078.000	Circuit Emulation Service 2.0
af-sig-0061.000	UNI Signalling 4.0
af-tm-0056.000	Traffic Management 4.0
af-tm-0121.000	Traffic Management 4.1
af-uni-0010.002	ATM User-Network Interface Specification V3.1
FRAME RELAY FORUM IMPLEMENTATION AGREEMENTS	
FRF.5	Frame Relay/ATM PVC Network Interworking Implementation - December 1994
FRF.8.1	Frame Relay / ATM PVC Service Interworking Implementation Agreement - February 2000
ISO STANDARD	
ISO 1000:1992	SI units and recommendations for the use of their multiples and of certain other units
ITU-T RECOMMENDATIONS	
I.371 (03/00)	Traffic control and congestion control in B-ISDN
I.356 (10/96)	B-ISDN ATM layer cell transfer performance
I.361 (02/99)	B-ISDN ATM layer specification
I.363.2 (11/00)	B-ISDN ATM Adaptation Layer specification : Type 2 AAL
I.610 (02/99)	B-ISDN operation and maintenance principles and functions.
G.957 (07/99)	Optical interfaces for equipments and systems relating to the synchronous digital hierarchy
NICC RECOMMENDATIONS	
PNO-IG/ATM/TG/CP(99)89	Interconnect Between UK Licensed Operators Based Upon Permanent ATM Connections

ATM Forum documents can be downloaded from http://www.atmforum.org

Frame Relay Forum documents can be downloaded from http://www.frforum.com

ISO Standards are available from http://www.iso.org

ITU-T Recommendations are available from http://www.itu.int

NICC documents can be downloaded from

http://www.oftel.gov.uk/ind_groups/nicc/index.htm

4 DEFINITIONS AND ABBREVIATIONS

For purposes of convenience and brevity, the following abbreviations and definitions have been adopted within this document.

4.1 Abbreviations

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
B_c	Burst Committed
B_e	Burst Excess
B-ISDN	Broadband ISDN
BT	Burst Tolerance
CAC	Connection Admission Control
CBR	Constant Bit Rate
CDV	Cell Delay Variation
CDVT	Cell Delay Variation Tolerance
CIR	Committed Information Rate
CLP	Cell Loss Priority (bit)
CLR	Cell Loss Ratio
CRC	Cyclic Redundancy Check
CS	Convergence Sublayer
CTD	Cell Transfer Delay
ECR	Effective Cell Rate
FPM	Forward Performance Monitoring
GCRA	Generic Cell Rate Algorithm
GFC	Generic Flow Control
ILMI	Integrated Local Management Interface
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunications Union – Telecommunications Sector
MBS	Maximum Burst Size
MIB	Management Information Base
MTU	Maximum Transfer Unit
NICC	Network Interoperability Consultative Committee
NMS	Network Management System
OAM	Operation And Maintenance
PCR	Peak Cell Rate
PDU	Protocol Data Unit
PNNI	Private Network-Network Interface
PTI	Payload Type Indicator

QoS	Quality of Service
SAP	Service Access Point
SAR	Segmentation And Reassembly
SCR	Sustainable Cell Rate
SDU	Service Data Unit
SI	System Internationale
SNMP	Simple Network Management Protocol
UNI	User-Network Interface
UPC	Usage Parameter Control
VBR	Variable Bit Rate
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VPC	Virtual Path Connection
VPI	Virtual Path Identifier

4.2 Definitions

In this document, the following words have the meanings as shown below, unless a contrary intention is stated within the relevant text of this document. Where possible, these definitions are based on and are consistent with definitions in the ATM Forum glossary.

ATM Adaptation Layer: The standards layer that allows multiple applications to have data converted to and from the ATM cell. A protocol used that translates higher layer services into the size and format of an ATM cell.

ATM Adaptation Layer Type 1: AAL functions in support of constant bit rate, time-dependent traffic such as voice and video.

ATM Adaptation Layer Type 2: The AAL type 2 provides for the bandwidth-efficient transmission of low-rate, short, and variable length packets in delay sensitive applications. More than one AAL type 2 user information stream can be supported on a single ATM connection.

ATM Adaptation Layer Type 3/4: AAL functions in support of variable bit rate, delay-tolerant data traffic requiring some sequencing and/or error detection support. Originally two AAL types, i.e. connection-oriented and connectionless, which have been combined.

ATM Adaptation Layer Type 5: AAL functions in support of variable bit rate, delay-tolerant connection-oriented data traffic requiring minimal sequencing or error detection support.

Available Bit Rate is an ATM layer service category for which the limiting ATM layer transfer characteristics provided by the network may change subsequent to connection establishment. A flow control mechanism is specified which supports several types of feedback to control the source rate in response to changing ATM layer transfer characteristics.

Broadband: qualifying a service or system requiring transmission channels capable of supporting rates greater than the primary rate.

Connection Admission Control: Connection Admission Control is defined as the set of actions taken by the network during the call set- up phase (or during call re-negotiation phase) in order to determine whether a connection request can be accepted or should be rejected (or whether a request for re-allocation can be accommodated).

Constant Bit Rate: An ATM service category which supports a constant or guaranteed rate to transport services such as video or voice as well as circuit emulation which requires rigorous timing control and performance parameters.

Cell Delay Variation: CDV is a component of cell transfer delay, induced by buffering and cell scheduling. Peak-to-peak CDV is a QoS delay parameter associated with CBR and VBR services. The peak-to- peak CDV is the ((1-a) quantile of the CTD) minus the fixed CTD that could be experienced by any delivered cell on a connection during the entire connection holding time. The parameter "a" is the probability of a cell arriving late. See CDVT.

Cell Delay Variation Tolerance: ATM layer functions may alter the traffic characteristics of ATM connections by introducing Cell Delay Variation. When cells from two or more ATM connections are multiplexed, cells of a given ATM connection may be delayed while cells of another ATM connection are being inserted at the output of the multiplexer. Similarly, some cells may be delayed while physical layer overhead or OAM cells are inserted. Consequently, some randomness may affect the inter-arrival time between consecutive cells of a connection as monitored at the UNI. The upper bound on the "clumping" measure is the CDVT.

Cell Loss Priority: This bit in the ATM cell header indicates two levels of priority for ATM cells. CLP=0 cells are higher priority than CLP=1 cells. CLP=1 cells may be discarded during periods of congestion to preserve the CLR of CLP=0 cells.

Cell Loss Ratio: CLR is a negotiated QoS parameter and acceptable values are network specific. The objective is to minimize CLR provided the end-system adapts the traffic to the changing ATM layer transfer characteristics. The Cell Loss Ratio is defined for a connection as: Lost Cells/Total Transmitted Cells. The CLR parameter is the value of CLR that the network agrees to offer as an objective over the lifetime of the connection. It is expressed as an order of magnitude, having a range of 10^{-1} to 10^{-15} and unspecified.

Generic Cell Rate Algorithm: The GCRA is used to define conformance with respect to the traffic contract of the connection. For each cell arrival the GCRA determines whether the cell conforms to the traffic contract. The UPC function may implement the GCRA, or one or more equivalent algorithms to enforce conformance. The GCRA is defined with two parameters: the Increment (I) and the Limit (L).

Generic Flow Control: GFC is a field in the ATM header which can be used to provide local functions (e.g., flow control). It has local significance only and the value encoded in the field is not carried end-to-end.

Header Error Control: Using the fifth octet in the ATM cell header, ATM equipment may check for an error and corrects the contents of the header. The check character is calculated using a CRC algorithm allowing a single bit error in the header to be corrected or multiple errors to be detected.

Integrated Local Management Interface: An ATM Forum defined interim specification for network management functions between an end user and a public or private network and between a public network and a private network. This is based on a limited subset of SNMP capabilities.

Maximum Burst Size: In the signalling message, the Burst Tolerance (BT) is conveyed through the MBS, which is coded as a number of cells. The BT together with the SCR and the GCRA determine the MBS that may be transmitted at the peak rate and still be in conformance with the GCRA.

Narrowband: qualifying a service or system requiring transmission channels capable of supporting rates up to and including the primary rate (i.e. 2Mbit/s).

Network Parameter Control: Network Parameter Control is defined as the set of actions taken by the network to monitor and control traffic from the NNI. Its main purpose is to protect network resources from malicious as well as unintentional misbehavior which can affect the QoS of other already established connections by detecting violations of negotiated parameters and taking appropriate actions. Refer to UPC.

Non-real-time VBR traffic is VBR traffic that does not guarantee any delay bounds.

Operations Administration and Maintenance: A group of network management functions that provide network fault indication, performance information, and data and diagnosis functions.

Protocol Data Unit: A PDU is a message of a given protocol comprising payload and protocol-specific control information, typically contained in a header. PDUs pass over the protocol interfaces which exist between the layers of protocols (per OSI model).

Peak Cell Rate: The Peak Cell Rate, in cells/sec, is the cell rate which the source may never exceed.

Payload Type: Payload Type is a 3-bit field in the ATM cell header that discriminates between a cell carrying management information or one which is carrying user information.

Payload Type Indicator: Payload Type Indicator is the Payload Type field value distinguishing the various management cells and user cells. Example: Resource Management cell has PTI=110, end-to-end OAM F5 Flow cell has PTI=101.

Permanent Virtual Circuit: A VC with static route defined in advance, usually by manual setup.

Permanent Virtual Path: A VP with static route defined in advance, usually by manual setup.

Real-time VBR traffic is VBR traffic that has strict end-to-end delay requirements.

Sustainable Cell Rate: The SCR is an upper bound on the conforming average rate of an ATM connection over time scales which are long relative to those for which the PCR is defined. Enforcement of this bound by the UPC could allow the network to allocate sufficient resources, but less than those based on the PCR, and still ensure that the performance objectives (e.g., for Cell Loss Ratio) can be achieved.

Switched Virtual Circuit: A VC connection established via signalling between the two end devices.

Soft Permanent Virtual Circuit: A VC with static route established via PNNI signalling.

Soft Permanent Virtual Path: A VP with static route established via PNNI signalling.

Usage Parameter Control: Usage Parameter Control is defined as the set of actions taken by the network to monitor and control traffic, in terms of traffic offered and validity of the ATM connection, at the end-system access. Its main purpose is to protect network resources from malicious as well as unintentional misbehavior, which can affect the QoS of other already established connections, by detecting violations of negotiated parameters and taking appropriate actions.

Variable Bit Rate: An ATM Forum defined service category which supports variable bit rate data traffic with average and peak traffic parameters.

Virtual channel: A communication channel that provides for the sequential unidirectional transport of ATM cells.

Virtual channel connection: A concatenation of VCLs that extends between the points where the ATM service users access the ATM Layer. The points at which the ATM cell payload is passed to, or received from, the users of the ATM Layer (i.e., a higher layer or ATMM-entity) for processing signify the endpoints of a VCC. VCCs are unidirectional.

Virtual channel link: A means of unidirectional transport of ATM cells between the point where a VCI value is assigned and the point where that value is translated or removed.

Virtual path: A unidirectional logical association or bundle of VCs.

Virtual path connection: A concatenation of VPLs between virtual path Terminators (VPTs). VPCs are unidirectional.

Virtual path link: A means of unidirectional transport of ATM cells between the point where a VPI value is assigned and the point where that value is translated or removed.

Virtual path terminator: A system that unbundles the VCs of a VP for independent processing of each VC.

5 THE ATM LAYER[1]

5.1 ATM Cell Structure at the UNI

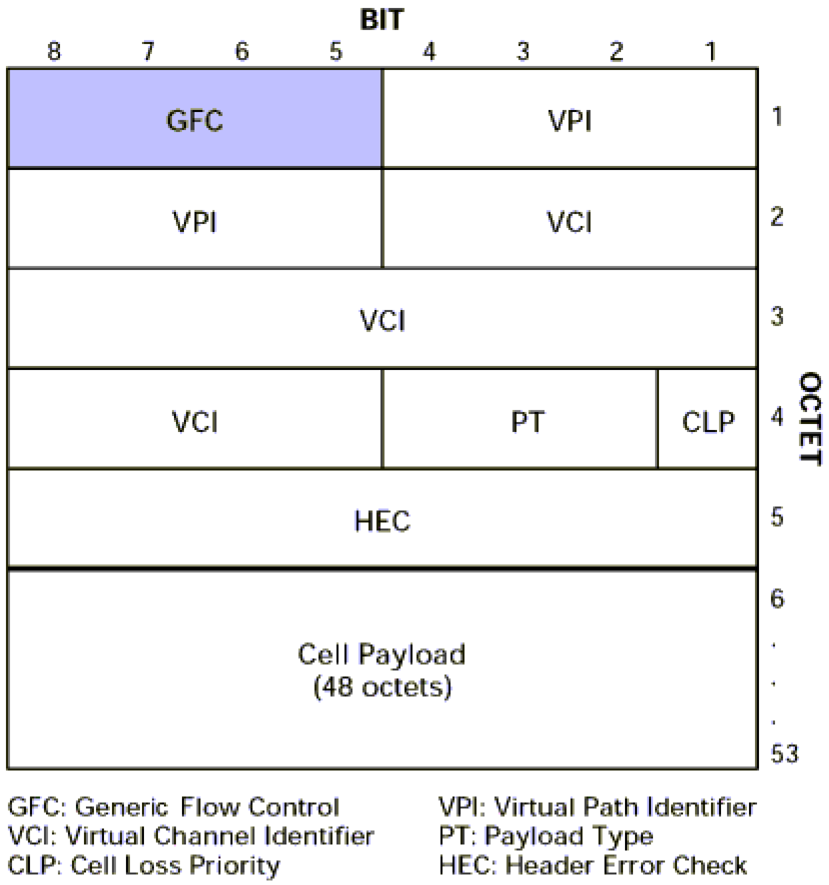


Figure 5-1
ATM UNI Cell Structure

The structure of the ATM cell at the UNI is shown in Figure 5-1. The cell contains several fields, which are discussed in the following sections.

5.2 Generic Flow Control

This field has local significance only and can be use to provide standardised local functions (e.g. flow control) on the customer site. The value encoded in the GFC is not carried end-to-end and will be overwritten by the ATM switches. Public network equipment at the public UNI shall encode the GFC value to all zeros (0000).

5.3 Virtual Path/Virtual Channel Identifier

The actual number of routing bits in the VPI and VCI subfields use for routing is negotiated between the user and the network, e.g. on a subscription basis. This number is determined on the basis of the lower requirement of the user or the network.

[1] Based on the ATM-Forum Recommendation "ATM User-Network Interface Specification V3.1", af-uni-0010.002.

The reserved VPI/VCI values for control and management plane information should be in accordance with ITU-T Recommendation I.361. The remaining VPI and VCI values for user plane information should be bilaterally agreed by the connecting operators.

5.4 Payload Type

This is a 3-bit field used to indicate whether the cell contains user information or Connection Associated Layer Management information (F5 flow). It is also used to indicate a network congestion state or for network resource management.

5.5 Cell Loss Priority

This is a 1-bit field which allows the user or the network to optionally indicate the explicit loss priority of the cell.

5.6 Header Error Control

The HEC field is used by the physical layer for detection/ correction of bit errors in the cell header. It may also be used for cell delineation.

6 ATM TRAFFIC PARAMETER ENGINEERING

An ATM connection requires a traffic contract. This traffic contract consists of a number of parameters used to define the characteristics and behaviour of the ATM connection.

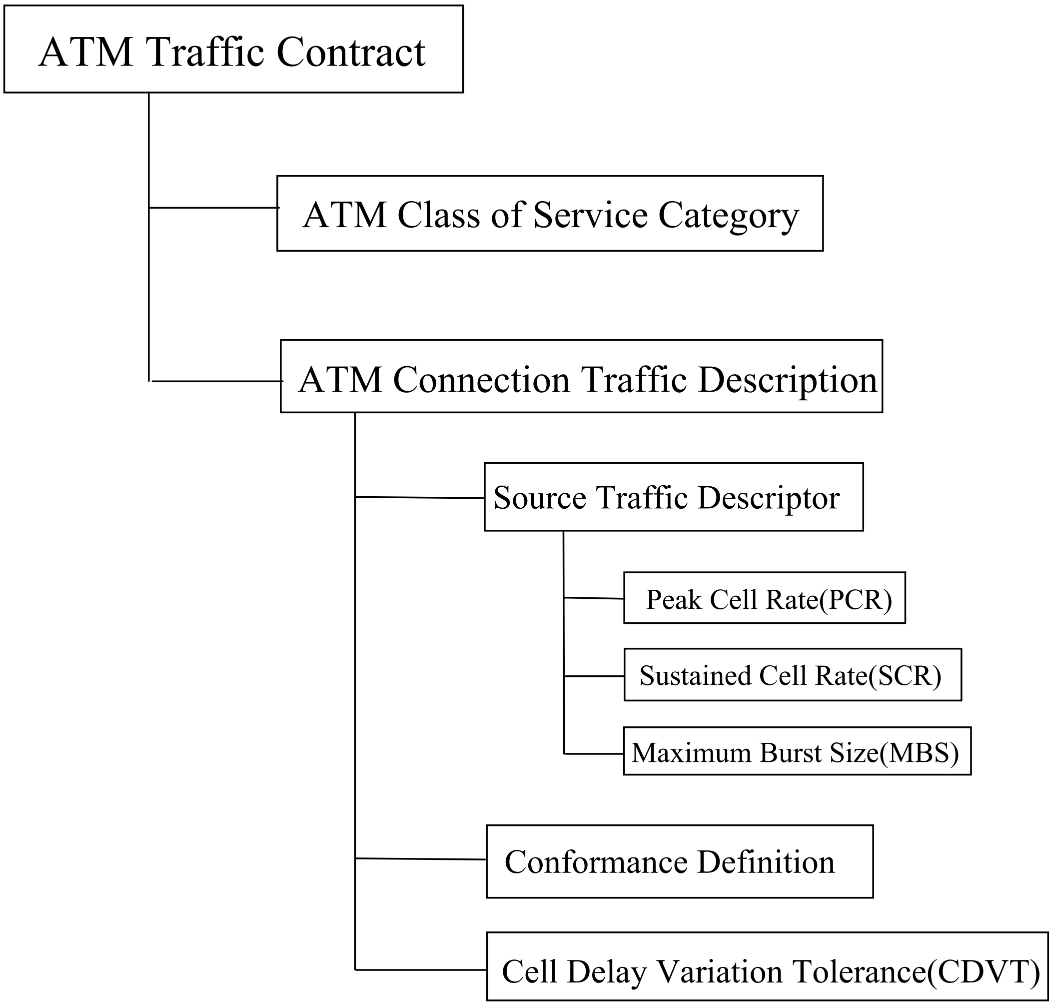


Figure 6-1
Parameters used in Traffic Contracts

The Traffic Contract consists of the following parameters:

(a) ATM Class of Service category

(b) Connection Traffic Description

(i) Source Traffic Descriptor Types

- PCR (Peak Cell Rate)
- SCR (Sustained Cell Rate)
- MBS (Maximum Burst Size)

(ii) Cell Delay Variation Tolerance (CDVT)

(iii) Conformance Definition.

The subsequent sections articulate these parameters in more detail.

6.1 ATM Class Of Service Category

6.1.1 CBR

The constant bit rate (CBR) service category is designed to support real-time applications. CBR traffic is characterised by:

(a) dedicated bandwidth

(b) extremely low probability of cell loss

(c) low and predictable delay.

(d) constant inter-arrival time between cells

(e) the inter-arrival time can characterised as a minimum cell inter-arrival, which corresponds to a known peak emission rate, referred to as the peak cell rate (PCR).

6.1.2 VBR

The VBR service category is mainly intended for more efficient support of applications that have known or predictable bursty traffic characteristics. VBR traffic is characterised by:

(a) a sustained cell rate (SCR). The SCR is measured over a defined period and represents the average transmission rate.

(b) a peak cell rate (PCR). The PCR represents the minimum spacing of the cells, which represents the peak bandwidth required.

The VBR service is further divided into two subcategories based on the delay requirements of the applications.

6.1.2.1 rt-VBR

Real-time VBR (rt-VBR) traffic has strict end-to-end delay requirements and therefore cannot be extensively buffered in the network.

6.1.2.2 nrt-VBR

Non-real-time VBR (nrt-VBR) traffic does not guarantee any delay bounds and therefore can be buffered more extensively.

6.1.3 Typical Mapping of Adaptation Layers to Class of Service Categories (Informative)

See Table 6-1 for an example of typical mappings of Adaptation Layers to Class of Service categories.

Adaptation Layer	ATM Cos Category
AAL1	CBR
AAL2	CBR, rt-VBR
AAL5	VBR

Table 6-1
Typical Mapping of Adaptation Layers to Class of Service Categories

6.2 ATM Connection Traffic Description

The ATM connection traffic description is the generic list of parameters and service conformance definitions that are used to capture the traffic characteristics of an ATM connection.

6.2.1 Source Traffic Descriptor

The source traffic descriptor type is defined as a set of traffic parameters that specify the traffic characteristics and the quantitative bandwidth requirements requested by a source.

These include:

(a) Peak Cell Rate (PCR)

(b) Sustained Cell Rate (SCR)

(c) Maximum Burst Size (MBS)

The following section defines these traffic parameters.

6.2.1.1 Cell Rate and Bandwidths

Different operators utilise different conversion factors between cell rates and bandwidths (refer to Appendix A for further information on data rate to cell rate conversion). For consistency across networks, the only universal figure of relevance is the cell rate. In any communication between operators about provisioning parameters, it is the cell rate that should be quoted in each direction of transmission.

6.2.1.2 Peak Cell Rate (PCR)

The PCR used should be specified in cells per second. For VBR traffic, the PCR is equal to or greater than the SCR. The upper bound on the PCR is the line rate.

6.2.1.3 Sustained Cell Rate (SCR)

The SCR is relevant only for VBR traffic, and should be specified in cells per second.

6.2.1.4 Maximum Burst Size (MBS)

The MBS parameter is relevant only for VBR traffic, and directly reflects the number of cells that can be sent at PCR without violating the SCR.

Different operators utilise different MBS settings in their networks. It is noted that traffic descriptors such as MBS are often viewed as a related set by network operators (i.e. MBS against PCR/SCR ratios, MBS against Effective Cell Rate etc) to assist in achieving efficient network resource allocation and SLA targets.

ATM Forum Recommendation af-tm-0056.000 Traffic Management 4.0, Annexure C.4 sets out one way of relating MBS against other traffic descriptors via the following formula:

$$MBS = \left\lfloor 1 + \frac{BT}{\frac{1}{SCR} - \frac{1}{PCR}} \right\rfloor$$

Variations in MBS may involve trade-offs in other parameters and can be negotiated on a bilateral basis.

It is recommended that the MBS be set to accept 32 cells or more for all network connections. The value of 32 cells is sufficient to support 1 x MTU sized Ethernet frame. A higher MBS value may be agreed bilaterally.

6.2.2 *Conformance Definition*

The conformance definition describes the method used to determine conformant cells, against the connection traffic descriptor, and how cells judged to be non-conformant are handled. The conformance definition determines the types of cells for which the CLR and the traffic descriptors are defined.

Where a definition applies only to cells with the CLP bit set to 0, this is indicated by CLP = 0. Where a definition applies jointly to cells with the CLP bit set to 0, and cells with the CLP set to 1, this is indicated by CLP = 0 + 1. There is no conformance definition that applies only to cells with the CLP bit set to 1.

The conformance definition is said to be CLP transparent when the CLR guarantee applies to the aggregate traffic (CLP = 0 +1) without differentiating priority between the CLP = 0 and CLP = 1 cells.

6.2.2.1 CBR Service Category

For PVC Links and PVP Links carrying a CBR service category, the conformance definition for CBR.1 shall be used as the default as defined in the ATM-F Traffic Management Specification v4.0, Ref [1]. Conformance definitions for CBR traffic assumes the use of the GCRA for assessing cell conformance. Cells judged to be non conformant shall be discarded under the ATM-F Traffic Management Specification v4.0, Ref [1] default conformance definition.

6.2.2.2 VBR Service Category

For PVC Links and PVP Links carrying a VBR service category, three conformance definition options are available. These three conformance definitions are known as VBR.1, VBR.2 and VBR.3. The support of each conformance definition, VBR.1, VBR.2 and VBR.3 shall be by bilateral agreement between the connecting operators. The conformance definitions for VBR.1, VBR.2 and VBR.3 as described in the ATM-F Traffic Management Specification v4.0, Ref. [1] shall be used as the default. Conformance definitions for VBR traffic assumes the use of the GCRA for assessing cell conformance.

6.2.2.3 Summary

The conformance definitions relevant for CBR and VBR services are outlined in Table 6-2 below. Cells with CLP = 0 + 1 (CLP transparent) are indicated by “0 + 1”. Cells with CLP = 0 are indicated by “0”.

The cell loss ratio (CLR) is a measure of the quality of service (QoS) for a given connection. Operators can commit to a pre-determined CLR. Whether this CLR applies to CLP = 0, or CLP = 0 + 1 is indicated in Table 6-2 below.

Name	Service Category	PCR flow	SCR flow	Non-conforming action	CLR
CBR.1	CBR	0 + 1	N/A	Discard	0 + 1
VBR.1	rt-VBR, nrt-VBR	0 + 1	0 + 1	Discard	0 + 1
VBR.2	rt-VBR, nrt-VBR	0 + 1	0	Discard	0
VBR.3	rt-VBR, nrt-VBR	0 + 1	0	Tag	0

Table 6-2
Conformance definitions for CBR and VBR service categories

6.2.2.4 Implementation Mechanism

Two methods of approach can be used by the connecting operators to guarantee successful carriage of data across the UNI connection. They were to either police the end user’s UNI 3.1 connection the same as the UNI 3.1 network connection, therefore eliminating policing issues at the point of connection. The other alternative is to enable traffic shaping on the UNI 3.1 connection, which in turn will adequately shape the ATM traffic to the connecting ATM network, minimising the potential discard of cells.

6.2.3 *Cell Delay Variation Tolerance(CDVT)*

The CDVT value used is usually given in µsec. Because each operator has engineered their CDVT network settings differently, CDVT settings for network connection should adhere to the ITU-T Recommendation I.371 for B-ISDN rates. The CDVT value derived from the formula below will ensure the most stringent setting for connecting networks. For narrowband rates the minimum CDVT is 250 µsec. A higher CDVT value may be agreed bilaterally.

ITU-T Recommendation I.371 (03/00)

5.4.1.3 Cell delay variation tolerance specification for peak cell rate

$$\frac{\tau_{PCR}}{\Delta} = \max\left[\frac{T_{PCR}}{\Delta}, \alpha\left(1 - \frac{\Delta}{T_{PCR}}\right)\right]$$

where:

τ_{PCR} is the peak emission interval of the connection (expressed in seconds).

Δ is the cell transmission time (in seconds) at the interface link speed.

α is a dimensionless coefficient; the suggested value is $\alpha = 80$.

7 CONNECTION GUIDELINES

7.1 UNI

UNI 3.1 should be used to connect networks in all instances.

7.2 Signalling

No signalling (or addressing) requirements have been defined as part of this Guideline apart from network management (refer to Section 8).

7.3 Physical

The only physical connection supported by this Guideline is an ITU-T Recommendation G.957-compliant optical STM-1 (single-mode).

7.4 Connection Admission Control and Overbooking

The Connection Admission Control (CAC) should be supported to ensure that the ATM switches at either side of the connection shall have sufficient resources to support the traffic and QoS parameter values that have been agreed for the PVC link(s) or PVP link(s). The CAC algorithm is network specific but may require negotiation so that given the amount of free resources over the connection, both switches can accept the establishment of a new PVC link or PVP link request. Both operators should bilaterally agree a common booking policy for the connection which may be different from that used in their own networks.

8 NETWORK MANAGEMENT

8.1 Introduction

It is recommended that OAM cells be used for network management in preference to other NMSs. Additional choices for implementation of network management between operators include, in no particular order:

(a) ILMI (refer to Appendix B) or

(b) No network management system or

(c) A proprietary network management system.

8.2 OAM Cell Types and Use[2]

8.2.1 Introduction

The ATM layer contains the two highest OAM levels; the allocation of OAM flows is as follows:

– F4: virtual path level;

– F5: virtual channel level.

OAM flows are related to bidirectional Maintenance Entities (MEs) corresponding to either the entire ATM VPC/VCC, referred to as the VPC/VCC ME, or to a portion of this connection referred to as a VPC/VCC segment ME.

ITU-T Recommendation I.610 defines the following cell types and uses (see Table 8-1).

OAM Cell Type	Function Type	Main application	Coding
Fault Management	AIS	For reporting defect indications in the forward direction	0001 0000
	RDI	For reporting remote defect indications in the backward direction	0001 0001
	CC	For continuously monitoring continuity	0001 0100
	LB	For on-demand connectivity monitoring For fault localization For pre-service connectivity verification	0001 1000
Performance Management	FPM	For estimating performance in the forward direction	0010 0000
	BR	For reporting performance estimations in the backward direction	0010 0001
Automatic Protection Switching	Group Protection	For carrying protection switching protocol information	0101 0000
	Individual Protection	For carrying protection switching protocol information	0101 0001
Activation and deactivation	FPM with BR	For activating/deactivating FPM with BR	1000 0000
	CC	For activating/deactivating CC	1000 0001
	FPM	For activating/deactivating FPM	1000 0010

Table 8-1
OAM cell types and uses

[2] Please refer to ITU-T Recommendation I.610 “B-ISDN operation and maintenance principles and functions” (02/99)

8.2.2 F4 Flow

There are two kinds of F4 flows, which can simultaneously exist in a VPC. These are:

(a) End-to-end F4 flow: This flow, identified by VCI=4, is used for end-to-end VPC operations communications.

(b) Segment F4 flow: This flow, identified by VCI=3, is used for communicating operations information within the boundaries of the VPC segment.

One or more VPC segments may be defined along a VPC. Neither overlapped nor embedded VPC segments can be defined. For that purpose, it must be ensured that none of the CPs between the source and sink CP of a VPC segment shall be a source or sink CP of another VPC segment of the same connection.

The definition of the span of a VPC segment is not necessarily fixed for the duration of a connection, i.e. the VPC segment may be re-configured as required.

Before any type of VPC segment OAM cells can be used, the endpoints of a VPC segment shall be established.

8.2.3 F5 Flow

OAM cells of the F5 flow have the same VPI/VCI values as the user cells of the VCC thus constituting an in-band flow. OAM cells of the F5 flow are identified by pre-assigned PTI values. The same PTI value shall be used for both directions of the F5 flow. The PTI value shall not be modified along the whole connection.

There are two kinds of F5 flows, which can simultaneously exist in a VCC. These are:

(a) End-to-end F5 flow: This flow, identified by PTI = 101, is used for end-to-end VCC operations communications.

(b) Segment F5 flow: This flow, identified by PTI = 100, is used for communicating operations information within the boundaries of the VCC segment.

One or more VCC segments may be defined along a VCC. Neither overlapped nor embedded VCC segments can be defined. For that purpose, it must be ensured that none of the CPs between the source and sink CP of a VCC segment shall be a source or sink CP of another VCC segment of the same connection.

The definition of the span of a VCC segment is not necessarily fixed for the duration of a connection, i.e. the VCC segment may be re-configured as required.

Before any type of VCC segment OAM cells can be used, the endpoints of a VCC segment shall be established.

8.2.4 Common Requirements

If using OAM cells for fault management then it is recommended that:

(a) monitoring of potential fault conditions within another ATM network should be achieved through F4 and F5 end-to-end fault management OAM cells, particularly AIS and RDI cells; and

(b) externally generated end-to-end OAM cells should be passed transparently.

No recommendation is made on:

(a) the generation and use of OAM cells other than for fault management; or

(b) the use of segment end-points for network connections, or OAM segment flows; or

(c) whether an operator is expected to provide support for performance management, automatic protection switching or activation/deactivation cells.

APPENDIX A: DATA RATE TO CELL RATE CONVERSION

A.1 ATM Adaptation Layer Considerations

Each ATM Adaptation Layer (AAL) service class maps an AAL Service Data Unit (SDU) into a 48-byte ATM cell payload at the ATM-SAP. The four AAL service classes, namely:

(a) AAL1

(b) AAL2

(c) AAL3/4 and

(d) AAL5

make use of one or more AAL sublayers, such as the Service Specific Convergence Sublayer (SSCS), Common Part Convergence Sublayer (CPCS), and Segmentation and Reassembly (SAR) sublayers.

Each sublayer has an associated header (or trailer), specific to the AAL service class and/or higher layer protocol. For example, AAL1, commonly used for voice over ATM or circuit emulation, makes use of 1 octet AAL1 SAR-PDU header, leaving a SAR-PDU of 47 octets.

A.2 Cell Rate

The cell rate is the rate in cell/s associated with a given PVC or PVP.

A.3 Cell Data Rate

The cell data rate is defined as the rate (in bit/s) associated with transporting an entire 53-octet (payload + overhead) ATM cell at a specified PCR or SCR. Working backwards, a 1Mbit/s cell data rate then equates to a cell rate of 2358.5 cells/s:

Note that 1Mbit/s has been defined as 1,000,000 bit/s in line with SI unit definitions (refer to ISO 1000). See http://physics.nist.gov/cuu/Units/binary.html for further information.

1 Mbit/s = 1,000,000 bit/s

= 1,000,000/8 bytes/s = 125,000 bytes/s

= 125,000/53 cells/s = 2358.5 cells/s

A.4 Effective Data Rate

The effective data rate is the data rate available to an upper layer protocol defined by the user. Thus the effective data rate for an AAL PDU is 48/53 times the cell data rate. The effective data rate for an upper layer protocol at the AAL-SAP depends on the AAL service class used.

For example:

(a) if AAL1 is used, then the effective data rate is 47/53 times the cell data rate (1 octet AAL1 SAR-PDU overhead per cell).

(b) AAL5 overhead is 8 octet per AAL5 CPCS-PDU. The effective data rate depends on AAL5 CPCS-PDU size.

A.5 Miscellaneous

In many cases, the operator does not have control over what AAL service class a user adopts. In the case of a PVP, the operator may not even be aware what ATM Forum service class has been assigned to an individual PVC.

Some operators have anticipated a certain AAL service class being used for PVCs of a given ATM Forum service class, and have based their commercial offering on an effective data rate (rather than cell data rate). Other operators have used different numbers in converting data rates (cell or effective) back into cell rates.

APPENDIX B: SUPPLEMENTARY ILMI INFORMATION

B.1 Introduction

The ILMI (Integrated Local Management Interface) protocol uses SNMP (Simple Network Management Protocol) format packets across the ATM UNI to access Management Information Base (MIB) associated with the link. It is encapsulated in AAL5. The ILMI allows adjacent ATM nodes to determine various characteristics of each other. The two most useful features of the ILMI are address registration, which facilitates the administration of ATM addresses and its support for the exchange of UNI management information between UNI management Entities.

This Appendix describes ILMI support for the exchange of management information only. It does not discuss the use of address registration function of the ILMI protocol on ATM links between different ATM service providers.

B.2 Suggested Settings

The ATM UNI MIB for the ILMI service interface includes information on:

(a) Physical Layer

(b) ATM Layer

(c) Virtual Path Connections

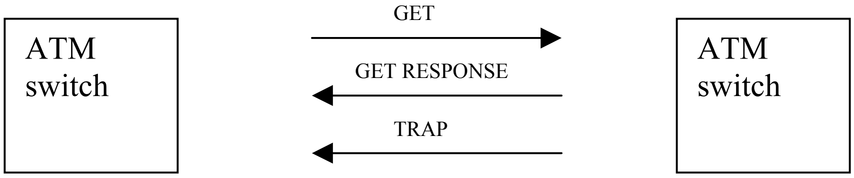
(d) Virtual Circuit Connections

This information should be accessible from either device across a UNI that has ILMI implemented.

The ATM switches should be configured to send periodic polls across the ATM link. A poll usually consists of a Get Request, and a Get Response is expected from the attached ATM device before the next poll is sent.

A polling timer (T491) is defined as the time period between Get Requests. If a number of Responses (N491) are not received out of a number of Requests (N492), the protocol will fail.

Traps may also be enabled for the ATM interface. This will result in an SNMP message to be sent to the attached device in an event or status change.



APPENDIX C: ATM SERVICES INTERWORKING

C.1 Introduction

With the demand to carry traffic types from various technologies over ATM networks, the following information provides a suggested approach that could assist establishing bilateral agreements.

C.2 Circuit Emulation Services

Reliable implementation of CBR traffic for structured E1 Nx64kbit/s and unstructured E1 2.048Mbit/s services over ATM networks are obtainable from the ATM Forum Circuit Emulation Service interoperability specification (af-vtoa-0078.000).

C.3 Frame Relay Services

The use of Frame Relay technology over ATM networks is defined by two implementation agreements developed by the Frame Relay Forum - network interworking (FRF.5) and service interworking (FRF.8).

Section 5.1 of FRF.5 and FRF.8 describes traffic management procedures for converting between Frame Relay traffic conformance parameters like CIR, B_c, and B_e into equivalent traffic conformance values in an ATM network.

The FRF.5 and FRF.8 guideline on traffic mapping defers to existing guidelines on such mappings:

(a) Appendix A of the ATM forum B-ICI specification “af-bici-0013.003”

(b) Appendix B, examples 2a and 2b of the ATM forum’s UNI 3.1 specification.

APPENDIX D: EXAMPLE OF CONNECTION ADMISSION CONTROL

D.1 Effective Cell Rate

An example of a Call Admission Control (CAC) algorithm is Effective Cell Rate (ECR), which is not a provisionable parameter, but a derived one. Effective Cell Rate (ECR) is calculated by ATM switches Call Admission Control (CAC) on entry of the following parameters – Peak Cell Rate (PCR), Sustained Cell Rate (SCR), Maximum Burst Size (MBS), ATM QoS, Cell Loss Ratio (CLR), Conformance traffic descriptor and CDVT as part of establishing a new ATM PVC/PVP connection. As ATM switches are shared resources, a method of allocating a certain quantity of resources to a particular ATM PVC/PVP connection must be used to ensure that a minimum level of service quality is maintained on all services using that switch.

An ATM Access has a finite bandwidth pool of available Effective Cell Rate (ECR) that may be used by ATM connections.

Once a new ATM PVC/PVP connection is established the ECR calculated for the new connection is subtracted from the available bandwidth pool. The total sum of the Effective Cell Rates (ECR) of each individual ATM PVC or PVP connection cannot exceed the available bandwidth pool on a particular ATM Access.

This available bandwidth pool is also subject to oversubscription, which allows customers to establish a higher quantity of PVC and PVP bandwidth than is physically possible on an ATM UNI Access. This is done by increasing the pool available by multiples (n x) of 100%. For instance, an STM-1 ATM UNI usually has a pool available bandwidth of 353,207 cells/s (149,759,768 bits/s) available for PVC/P connections. This is also equivalent to its physical throughput capability.

Now, if an STM-1 ATM UNI access were to be overbooked by a factor of 200%, then the pool available bandwidth would be 706,414 cells/s (299,519,536 bits/s). This would empower the CAC to allow twice as much bandwidth to be configured in the form of ATM PVC/P connections, although these virtual connections would still be subject to the maximum physical throughput of the STM-1 ATM UNI which is 353,207 cells/s (149,759,768 bits/s).

Currently, most carriers do not allow customer ATM UNI accesses to be subject to any form of oversubscription, although this can be negotiated between carriers in a bilateral agreement. If oversubscription is applied, then Cell Loss Ratio (CLR) service level agreement targets must be waived since the guarantee of 100% throughput on all connections simultaneously is now negated in favour of more connection bandwidth.

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