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Terminology for Call/Cell Benchmarking
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Abstract

This memo discusses and defines terms associated with performance benchmarking tests and the results of these tests in the context of cell-based and call-based switching devices. The terms defined in this memo will be used in addition to terms defined in RFCs 1242, 1944 and 2285. This memo is a product of the Benchmarking Methodology Working Group (BMWG) of the Internet Engineering Task Force (IETF).

1. Introduction.

This document provides terminology for benchmarking cell-based and call-based switching devices. It extends terminology already defined for benchmarking network interconnect devices in RFC's 1242, 1944 and 2285. Although some of the definitions in this memo may be applicable to a broader group of network interconnect devices, the primary focus of the terminology in this memo is on cell-based and call-based switches. Specifically, this includes Asynchronous Transfer Mode (ATM) cell relay and signaling.

This memo contains two major sections: Background and Definitions. Within the definitions section is a formal definitions subsection, provided as a courtesy to the reader, and a measurement definitions subsection, which contains performance metrics with inherent units. The divisions of the measurement sub-section follow the BISDN model.

The BISDN model comprises four layers and two planes. This document addresses the interactions between these layers and how they effect the performance of IP, TCP, etc. A schematic of the model follows:

User Plane		Control Plane	
Services		ILMI	UNI, PNNI
AAL	AAL1, AAL2, AAL3/4, AAL5	AAL5	SAAL
ATM	Cell Relay	OAM, RM	
	Convergence		
Physical	Media		

This document assumes that necessary services are available and active.

For example, IP connectivity requires SSCOP connectivity between signaling entities. Further, it is assumed that the SUT has the ability to configure ATM addresses (via hard coded addresses, ILMI or PNNI neighbor discovery), has the ability to run SSCOP, and has the ability to perform signaled call setups (via UNI or PNNI signaling). Finally, this document presents only the terminology associated with benchmarking IP performance over ATM; therefore, it does not represent a total compilation of ATM test terminology.

The BMWG produces two major classes of documents: Benchmarking Terminology documents and Benchmarking Methodology documents. The Terminology documents present the benchmarks and other related terms. The Methodology documents define the procedures required to collect the benchmarks cited in the corresponding Terminology documents.

2. Existing Definitions

[RFC 1242](#) "Benchmarking Terminology for Network Interconnect Devices" should be consulted before attempting to make use of this document. RFC

1944 "Benchmarking Methodology for Network Interconnect Devices" contains discussions of a number of terms relevant to the benchmarking of switching devices and should also be consulted. [RFC 2285](#) "Benchmarking Terminology for LAN Switching Devices" contains a number of terms pertaining to traffic distributions and datagram interarrival. For the sake of clarity and continuity this RFC adopts the template for definitions set out in [Section 2 of RFC 1242](#). Definitions are indexed and grouped together in sections for ease of reference. The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" go in this document are to be interpreted as described in [RFC 2119](#).

II. Definitions

The definitions presented in this section have been divided into two groups. The first group is formal definitions, which are required in the definitions of the performance metrics but are not themselves strictly metrics. These definitions are subsumed from other work done in other working groups both inside and outside the IETF. They are provided as a courtesy to the reader.

Formal Definitions

1.1. Definition Format (from [RFC 1242](#))

Term to be defined.

Definition: The specific definition for the term.

Discussion: A brief discussion of the term, its application and any restrictions on measurement procedures.

Specification: The working group and document in which the term is specified. Listed in the references.

1.2. Related Definitions.

1.2. 1. Allowed Cell Rate (ACR):

Definition: An ABR service parameter, ACR is the current rate (cells/second) at which a source is allowed to send.

Discussion: For ABR traffic, ACR constitutes the actual data throughput for a particular VC. The time change of this value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.2. ACR Decrease Time Factor (ADTF):

Definition: This is the time permitted between sending RM-cells before the rate is decreased to ICR (Initial Cell Rate). The time units are .01 to 10.23 seconds with a granularity of 10 ms.

Discussion: For ABR traffic, ADTF constitutes the time rate of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.3. Additive Increase Rate (AIR):

Definition: An ABR service parameter, AIR controls the rate at which the cell transmission rate increases. It is signaled as AIRF, where

$$\text{AIRF} = \text{AIR} * \text{Nrm} / \text{PCR}.$$

Discussion: For ABR traffic, AIR effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.4. Additive Increase Rate Factor (AIRF):

Definition: Refer to AIR.

Discussion: Refer to AIR.

Specification: AF-TM4.0

1.2.5. ATM Adaptation Layer (AAL):

Definition: The layer in the B-ISDN reference model (see B-ISDN) which adapts higher layer PDU's into the ATM layer.

Discussion: There are 4 types of adaptation layers:

AAL 1: used for circuit emulation, voice over ATM

AAL2: used for sub-rated voice over ATM

AAL3/4: used for data over noisy ATM lines

AAL5: used for data over ATM, most widely used AAL type

These AAL types are not measurements, but it is possible to measure the time required for Segmentation and Reassembly (SAR).

Specification: AF-TM3.1

1.2.6. ATM Adaptation Layer Type 5 (AAL5):

Definition: AAL5 functions in support of variable bit rate, delay-tolerant data traffic requiring minimal sequencing or error detection support.

Discussion: AAL5 is the adaptation layer for UNI signaling, ILMI, PNNI signaling, and for IP PDU'S. It is the most widely used AAL type to date.

Specification: AF-UNI3.1

1.2.7. Available Bit Rate (ABR):

Definition: ABR 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.

Discussion: It is expected that an end-system that adapts its traffic in accordance with the feedback will experience a low cell loss ratio and obtain a fair share of the available bandwidth according to a network specific allocation policy. Cell delay variation is not controlled in this service, although admitted cells are not delayed unnecessarily.

Specification: AF-TM4.0

1.2.8. Asynchronous Transfer Mode (ATM)

Definition: A transfer mode in which the information is organized into 53 octet PDUs called cells. It is asynchronous in the sense that the recurrence of cells containing information from an individual user is not necessarily periodic.

Discussion: ATM is based on the ISDN model.

Specification: AF-UM3.1

1.2.9. ATM Link:

Definition: A virtual path link (VPL) or a virtual channel link (VCL).

Discussion: none.

Specification: AF-UNI3.1

1.2.10. ATM Peer-to-Peer Connection:

Definition: A virtual channel connection (VCC) or a virtual path connection (VPC).

Discussion: none.

Specification: AF-UNI3.1

1.2.11. ATM Traffic Descriptor:

Definition: A generic list of traffic parameters, which specify the intrinsic traffic characteristics of a requested ATM connection. See GCRA and ABR.

Discussion: none.

Specification: AF-UNI3.1

1.2.12. ATM User-User Connection:

Definition: An association established by the ATM Layer to support communication between two or more ATM service users (i.e., between two or more next higher entities or between two or more ATM-entities). The communications over an ATM Layer connection may be either bi-directional or unidirectional. The same Virtual Channel Identifier (VCI) issued for both directions of a connection at an interface.

Discussion: none.

Specification: AF-UNI3.1

1.2.13. Backward Explicit Congestion Notification (BECN):

Definition: A Resource Management (RM) cell type generated by the network or the destination, indicating congestion or approaching congestion for traffic flowing in the direction opposite that of the BECN cell.

Discussion: none.

Specification: AF-TM4.0

1.2.14. BECN Cell (BN):

Definition: A Resource Management (RM) cell type indicator. The network or the destination may generate a Backwards Explicit Congestion Notification (BECN) RM-cell. To do so, BN=1 is set, to indicate the cell is not source-generated, and DIR=1 to indicate the backward flow. Source generated RM-cells are initialized with BN=0.

Discussion: none.

Specification: AF-TM4.0

1.2.15. Broadband ISDN (B-ISDN) Model:

Definition: A layered service model that specifies the mapping of higher layer protocols onto ATM and its underlying physical layer. The model is composed of four layers: Physical, ATM, AAL and Service.

Discussion: none.

Specification: AF-UNI3.1

1.2.16. Burst Tolerance (BT):

Definition: A traffic parameter, which, along with the Sustainable Cell Rate (SCR), specifies the maximum number of cells which will be accepted at the Peak Cell Rate (PCR) on an ATM connection.

Discussion: BT applies to ATM connections supporting VBR services and is the limit parameter of the GCRA.

Specification: AF-TM4.0

1.2.17. Connection Admission Control (CAC):

Definition: 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).

Discussion: none

Specification: AF-UNI3.1

1.2.18. Call:

Definition: A call is an association between two or more users or between a user and a network entity that is established by the use of network capabilities. This association may have zero or more connections.

Discussion: none

Specification: AF-UNI3.1

1.2.19. Call-based:

Definition: A transport requiring call setups- see CALL definition.

Discussion: none

Specification: AF-UNI3.1

1.2.20. Constant Bit Rate (CBR):

Definition: 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.

Discussion: CBR reduces problems associated with TCP performance and throughput. **

Specification: AF-UNI3.1

1.2.21. Cell:

Definition: A unit of transmission in ATM. A fixed-size frame consisting of a 5-octet header and a 48-octet payload.

Discussion: none.

Specification: AF-UNI3.1

1.2.22. Cell Header:

Definition: ATM Layer protocol control information.

Discussion: The ATM cell header is a 5-byte header that contains the following fields:

Generic Flow Control (GFC): 4 bits

Virtual Path Identifier (VPI): 8 bits

Virtual Channel Identifier (VCI): 16 bits

Payload Type (PT): 3 bits

Cell Loss Priority (CLP): 1 bit

Header Error Check (HEC): 8 bit CRC computed over the previous 4 octets

Each field is discussed in this document.

Specification: AF-UNI3.1

1.2.23. Congestion Indicator (CI):

Definition: This is a field in a RM-cell, and is used to cause the source to decrease its ACR. The source sets CI=0 when it sends a RM-cell. Setting CI=1 is typically how destinations indicate that Explicit Forward Congestion Indication (EFCI) has been received on a previous data cell.

Discussion: none.

Specification: AF-TM4.0

1.2.24. Cell Loss Priority (CLP):

Definition: 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.

Discussion: The CLP bit is used to determine GCRA contract compliance.

Specification: AF-UNI3.1

1.2.25. Connection:

Definition: An ATM connection consists of concatenation of ATM Layer links in order to provide an end-to-end information transfer capability to access points.

Discussion: none.

Specification: AF-UNI3.1

1.2.26. Cutoff Decrease Factor (CDF):

Definition: CDF controls the decrease in ACR (Allowed Cell Rate) associated with CRM (missing RM cell count).

Discussion: For ABR traffic, CDF effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.27. Current Cell Rate (CCR):

Definition: The Current Cell Rate is an RM-cell field set by the source to its current ACR when it generates a forward RM-cell. This field may be used to facilitate the calculation of ER, and may not be changed by network elements. CCR is formatted as a rate.

Discussion: See actual cell rate.

Specification: AF-TM4.0

1.2.28. Cyclic Redundancy Check (CRC):

Definition: A mathematical algorithm that computes a numerical value based on the bits in a block of data. This number is transmitted with the data and the receiver uses this information and the same algorithm to insure the accurate delivery of data by comparing the results of algorithm and the number received. If a mismatch occurs, an error in transmission is presumed.

Discussion: CRC is not a measurement, but it is possible to measure the amount of time to perform a CRC on a string of bits. This measurement will not be addressed in this document.

Specification: AF-UNI3.1

1.2.29. DIR:

Definition: This is a field in a RM-cell, which indicates the direction of the RM-cell with respect to the data flow with which it is associated. The source sets DIR=0 and the destination sets DIR=1.

Discussion: none

Specification: AF-TM4.0

1.2.30. Explicit Forward Congestion Indication (EFCI):

Definition: EFCI is an indication in the PTI field of the ATM cell header. A network element in an impending-congested state or a congested state may set EFCI so that this indication may be examined by the destination end-system. For example, the end-system may use this indication to implement a protocol that adoptively lowers the cell rate of the connection during congestion or impending congestion. A network element that is not in a congestion state or an impending congestion state will not modify the value of this indication. Impending congestion is the state when network equipment is operating around its engineered capacity level.

Discussion: none.

Specification: AF-TM4.0

1.2.3 1. Explicit Rate (ER):

Definition: The Explicit Rate is a RM-cell field used to limit the source

ACR to a specific value. It is initially set by the source to a requested rate (such as PCR). It may be subsequently reduced by any network element in the path to a value that the element can sustain. ER is formatted as a rate.

Discussion: For ABR traffic, ER effects the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.32. End System (ES):

Definition: A system where an ATM connection is terminated or initiated. An originating end system initiates the ATM connection, and terminating end system terminates the ATM connection. OAM cells may be generated and received.

Discussion: An ES can be the user side of a UNI signaling interface.

Specification: AF-TEST-0022

1.2.33. Generic Cell Rate Algorithm (GCRA):

Definition: 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).

Discussion: GCRA is not a measurement, but there are a number of measurements that can be obtained using the GCRA and other parameters.

Specification: AF-TM4.0

1.2.34. Generic Flow Control (GFC):

Definition: 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.

Discussion: none

Specification: AF-UNI3.1

1.2.35. Header Error Control (HEC):

Definition: A check character calculated using an 8 bit CRC computed over

the first 4 octets of the ATM cell header. This allows for single bit error correction or multiple bit error detection.

Discussion: none

Specification: AF-UNI3.1

1.2.36. Initial Cell Rate (ICR):

Definition: An ABR service parameter, in cells/sec, that is the rate at which a source should send initially and after an idle period.

Discussion: none

Specification: AF-TM4.0

1.2.37. Integrated Local Management Interface

Definition: A management protocol which uses SNMPv1 carried on AAL5 to provide ATM network devices with status and configuration information concerning VPC's, VCC's, registered ATM addresses and the capabilities of ATM interfaces.

Discussion: ILMI is a conditionally required portion of UNI3.1; however, ILMI 4.0 has been issued as a separate specification. This document will refer to ILMI 4.0.

Specification: AF-ILMI4.0

1.2.38. Intermediate System (IS):

Definition: A system that provides forwarding functions or relaying functions or both for a specific ATM connection. OAM cells may be generated and received.

Discussion: An IS can be either the user or network side of a UNI signaling interface, or the network side of a PNNI signaling interface.

Specification: AF-TEST-0022

1.2.39. Leaky Bucket (LB):

Definition: Leaky Bucket is the term used as an analogous description of the algorithm used for conformance checking of cell flows from a user or network. See GCRA and UPC. The "leaking hole in the bucket" applies to the sustained rate at which cells can be accommodated, while the "bucket depth" applies to the tolerance to cell bursting over a given time period.

Discussion: There are two types of LB algorithms- single and dual. Single LB defines a PCR; dual LB defines a PCR and SCR.

Specification: AF-TM4.0

1.2.40. Maximum Cell Rate (MCR):

Definition: This is the maximum capacity usable by connections belonging to the specified service category.

Discussion: none

Specification: AF-TM4.0

1.2.41. Maximum Burst Size (MBS):

Definition: In the signaling message, the Burst Tolerance (BT) is conveyed through the MBS that 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 is in conformance with the GCRA.

Discussion: none

Specification: AF-TM4.0

1.2.42. Minimum Cell Rate (MCR):

Definition: An ABR service traffic descriptor, in cells/sec, that is the rate at which the source is always allowed to send.

Discussion: none

Specification: AF-TM4.0

1.2.43. Missing RM-Cell Count (CRM):

Definition: CRM limits the number of forward RM-cells that may be sent in the absence of received backward RM-cells.

Discussion: none.

Specification: AF-TM4.0

1.2.44. Mrm:

Definition: An ABR service parameter that controls allocation of bandwidth between forward W-cells, backward RM-cells, and data cells.

Discussion: none

Specification: AF-TM4.0

1.2.45. Nrm:

Definition: An ABR service parameter, Nrm is the maximum number of cells a source may send for each forward RM-cell.

Discussion: none.

Specification: AF-TM4.0

1.2.46. Operations, Administration, and Maintenance (OAM):

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

Discussion: There are four types of ATM OAM flows: segment or end-to-end VP termination management (i.e. F4 segment, F4 E2E) and segment or end-to-end VC termination management (i.e. F5 segment, F5 E2E). These OAM cells can be used to identify fault management, connection verification, and loopback measurements.

Specification: AF-UNI3.1

1.2.47. Protocol Data Unit (PDU):

Definition: A PDU is a message of a given protocol comprising payload and protocol-specific control information, typically contained in a header. PDU's pass over the protocol interfaces that exist between the layers of protocols (per OSI model).

Discussion: In ATM networks, a PDU can refer to an ATM cell, multiple ATM cells, an AAL segment, an IP datagram and others.

Specification: -

1.2.48. Private Network-Network Interface (PNNI):

Definition: A routing information protocol that enables extremely, scalable, full function, dynamic multi-vendor ATM switches to be integrated in the same network.

Discussion: PNNI consists of signaling and routing between ATM network devices. PNNI signaling is based on UNI 4.0 signaling between two network side interfaces, while PNNI routing provides a mechanism to route ATM

cells between two separate, autonomous ATM networks.

Specification: AF-PNNI1.0

1.2.49. Payload Type Indicator (PTI):

Definition: Payload Type Indicator is the Payload Type field value distinguishing the various management cells and user cells.

Example:

Resource Management cell is indicated as PTI=110,
end-to-end OAM F5 Flow cell is indicated as PTI=101.

Discussion: none.

Specification: AF-UNI3.1

1.2-50. Peak Cell Rate (PCR):

Definition: A traffic parameter, which specifies the upper bound on the rate at which ATM cells can be submitted to an ATM connection. This parameter is used by the GCRA.

Discussion: none.

Specification: AF-TM4.0

1.2.5 1. Permanent Virtual Circuit (PVC):

Definition: This is a link with static route(s) defined in advance, usually by manual setup.

Discussion: none.

Specification: AF-UNI3.1

1.2.52. Permanent Virtual Channel Connection (PVCC):

Definition: A Virtual Channel Connection (VCC) is an ATM connection where switching is performed on the VPI/VCI fields of each cell. A permanent VCC is one that is provisioned through some network management function and left up indefinitely.

Discussion: none.

Specification: AF-UNI3.1

1.2.53. Permanent Virtual Path Connection: (PVPC):

Definition: A Virtual Path Connection (VPC) is an ATM connection where switching is performed on the VPI field only of each cell. A permanent VPC is one that is provisioned through some network management function and left up indefinitely.

Discussion: none.

Specification: AF-UNI3.1

1.2.54. Rate Decrease Factor (RDF):

Definition: An ABR service parameter, RDF controls the decrease in the cell transmission rate. RDF is a power of 2 from $1/32,768$ to 1.

Discussion: For ABR traffic, RDF effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.55. Rate Increase Factor (RIF):

Definition: This controls the amount by which the cell transmission rate may increase upon receipt of a RM-cell. The additive increase rate $AIR=PCR \cdot RIF$. RIF is a power of 2, ranging from $1/32,768$ to 1.

Discussion: For ABR traffic, RIF effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.56. Resource Management (RM):

Definition: Resource Management is the management of critical resources in an ATM network. Two critical resources are buffer space and trunk bandwidth. Provisioning may be used to allocate network resources in order to separate traffic flows according to service characteristics. VPC's play a key role in resource management. By reserving capacity on VPCs, the processing required to establish individual VCC's is reduced. Refer to RM-cell.

Discussion: none.

Specification: AF-TM4.0

1.2.57. Resource Management Cell (RM-Cell):

Definition: Information about the state of the network like bandwidth availability, state of congestion, and impending congestion, is conveyed to the source through special control cells called Resource Management Cells (RM-cells).

Discussion: none.

Specification: AF-TM4.0

1.2-58. Segmentation and Reassembly (SAR):

Definition: The process used by the AAL in the B-ISDN reference model (see B-ISDN) which fragments higher layer PDU's into ATM cells.

Discussion: SAR is not a measurement, but the speed in which SAR can be completed on a bit stream can be measured. This measurement will not be discussed in this document.

Specification: AF-UNI3.1

1.2.59. Sustainable Cell Rate (SCR):

Definition: 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.

Discussion: none.

Specification: AF-TM4.0

1.2.60. Switched Virtual Circuit (SVC):

Definition: A connection established via signaling. The user defines the endpoints when the call is initiated.

Discussion: SVC's are established using either UNI signaling or PNNI signaling. The signaling state machine implements several timers, which can effect the time required for call establishment. This will, in turn, effect TCP round trip time calculation, effecting TCP throughput.

Specification: AF-UNI3.1, AF-UNI4.0, AF-PNNI1.0

1.2.61. Switched Virtual Channel Connection (SVCC):

Definition: A Switched VCC is one that is established and taken down

dynamically through control signaling. A Virtual Channel Connection (VCC) is an ATM connection where switching is performed on the VPI/VCI fields of each cell.

Discussion: none.

Specification: AF-UNI3.1

1.2.62. Switched Virtual Path Connection (SVPC):

Definition: A Switched Virtual Path Connection is one that is established and taken down dynamically through control signaling. A Virtual Path Connection (VPC) is an ATM connection where switching is performed on the VPI field only of each cell.

Discussion: none.

Specification: AF-UNI3.1

1.2.63. Switched Connection:

Definition: A connection established via signaling.

Discussion: none.

Specification: AF-UNI3.1

1.2.64. Tagged Cell Rate (TCR):

Definition: An ABR service parameter, TCR limits the rate at which a source may send out-of-rate forward RM-cells. TCR is a constant fixed at 10 cells/second.

Discussion: none.

Specification: AF-TM4.0

1.2.65. Traffic Contract

Definition: A specification of the negotiated traffic characteristics of an ATM connection.

Discussion: none.

Specification: AF-TM4.0

1.2.66. Transmission Convergence (TC):

Definition: A sub-layer of the physical layer of the B-ISDN model transforms the flow of cells into a steady flow of bits and bytes for transmission over the physical medium. On transmit the TC sublayer maps the cells to the frame format, generates the Header Error Check (HEC), and sends idle cells when the ATM layer has none to send. On reception, the TC sublayer delineates individual cells in the received bit stream, and uses the HEC to detect and correct received errors.

Discussion: TC is not a measurement, but the speed in which TC can occur on a bit stream can be measured. This measurement will not be discussed in this document.

Specification: AF-UNI3.1

1.2.67. TDF:

Definition: An ABR service parameter, TDF controls the decrease in ACR associated with TOF. TDF is signaled as TDFF, where $TDF = TDFF / RDF$ times the smallest power of 2 greater or equal to PCR. TDF is in units of 1/seconds.

Discussion: For ABR traffic, TDF effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.68. TDFF.

Definition: Refer to TDF. TDFF is either zero or a power of two in the range 1/64 to 1 in units of 1 /cells.

Discussion: Refer to TDF.

Specification: AF-TM4.0

1.2.69. Traffic Management (TM):

Definition: Traffic Management is the aspect of the traffic control and congestion control procedures for ATM. ATM layer traffic control refers to the set of actions taken by the network to avoid congestion conditions. ATM layer congestion control refers to the set of actions taken by the network to minimize the intensity, spread and duration of congestion. The following functions form a framework for managing and controlling traffic and congestion in ATM networks and may be used in appropriate combinations.

Connection Admission Control

Feedback Control

Usage Parameter Control

Priority Control
Traffic Shaping
Network Resource Management
Frame Discard
ABR Flow Control

Discussion: none.

Specification: AF-TM4.0

1.2.70. Time Out Factor (TOF):

Definition: An ABR service parameter, TOF controls the maximum time permitted between sending forward RM-cells before a rate decrease is required. It is signaled as TOFF where $TOF = TOFF + 1$. TOFF is a power of 2 in the range: 1/8 to 4,096.

Discussion: For ABR traffic, TOF effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.7 1. Time Out Factor (TOFF):

Definition: Refer to TOF.

Discussion: none

Specification: AF-TM4.0

1.2.72. Trm.

Definition: An ABR service parameter that provides an upper bound on the time between forward RM-cells for an active source. It is 100 times a power of two with a range of $100 \cdot 2^{-7}$ to $100 \cdot 2^0$

Discussion: For ABR traffic, Trm effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.73. Traffic Shaping (TS):

Definition: Traffic Shaping is a mechanism that alters the traffic characteristics of a stream of cells on a connection to achieve better network efficiency, while meeting the QoS objectives, or to ensure

conformance at a subsequent interface. Traffic shaping must maintain cell sequence integrity on a connection. Shaping modifies traffic characteristics of a cell flow with the consequence of increasing the mean Cell Transfer Delay.

Discussion: TS should improve TCP throughput by reducing round trip time variations.

Specification: AF-UNI3.1

1.2.74. Unspecified Bit Rate (UBR):

Definition: UBR is an ATM service category, which does not specify traffic related service guarantees. Specifically, UBR does not include the notion of a per-connection-negotiated bandwidth. No commitments are made with respect to the cell loss ratio experienced by a UBR connection, or as to the cell transfer delay experienced by cells on the connection.

Discussion: [RFC 2331](#) specifies UBR service class for IP over ATM. UBR service models the best effort service type specified in [RFC 791](#); however, UBR has specific drawbacks with respect to TCP service. Since UBR makes no guarantee with respect to cell loss, cell delay variation or cell mis-insertion, TCP round trip time estimates may not be accurate.

Specification: AF-TM4.0

1.2.75. User-Network Interface (UNI):

Definition: An interface point between ATM end users and a private ATM switch, or between a private ATM switch and the public carrier ATM network; defined by physical and protocol specifications per ATM Forum UNI documents. The standard adopted by the ATM Forum to define connections between users or end stations and a local switch.

Discussion: none.

Specification: AF-UNI3.1

1.2.76. Usage Parameter Control (UPC):

Definition: 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.

Discussion: none.

Specification: AF-TM4.0

1.2.77. Variable Bit Rate (VBR):

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

Discussion: VBR may potentially adversely effect TCP throughput due to large round trip time variations.

Specification: AF-TM4.0

1.2.78. VC:

Definition: A communications channel that provides for the sequential unidirectional transport of ATM cells.

Discussion: none.

Specification: AF-TM3.1

1.2.79. Virtual Channel Connection (VCC):

Definition: A concatenation of VCI's 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 ATM-entity) for processing signify the endpoints of a VCC. VCC's are unidirectional.

Discussion: none.

Specification: AF-TM3.1

1.2.80. Virtual Channel Identifier (VCI):

Definition: A unique numerical tag as defined by a 16 bit field in the ATM cell header that identifies a virtual channel, over which the cell is to travel.

Discussion: none.

Specification: AF-UNI3.1

1.2.8 1. Virtual Path (VP):

Definition: A unidirectional logical association or bundle of VCs.

Discussion: none.

Specification: AF-UNI3.1

1.2.82. Virtual Path Connection (VPC):

Definition: A concatenation of VPIs between Virtual Path Terminators (VPT's). VPC's are unidirectional

Discussion: none.

Specification: AF-TM3.1

1.2.83. Virtual Path Identifier (VPI):

Definition: An eight-bit field in the ATM cell header that indicates the virtual path over which the cell should be routed.

Discussion: none.

Specification: AF-UNI3.1

1.2.84. Virtual Source/Virtual Destination (VSND):

Definition: An ABR connection may be divided into two or more separately controlled ABR segments. Each ABR control segment, except the first, is sourced by a virtual source. A virtual source implements the behavior of an ABR source endpoint. Backward RM-cells received by a virtual source are removed from the connection. Each ABR control segment, except the last, is terminated by a virtual destination. A virtual destination assumes the behavior of an ABR destination endpoint. Forward RM-cells received by a virtual destination are turned around and not forwarded to the next segment of the connection.

Discussion: none.

Specification: AF-TM4.0

1.2.85. Xrm Decrease Factor (XDM):

Definition: An ABR service parameter, XDF controls the decrease in ACR associated with Xrm. It is a power of two in range: [0, 1].

Discussion: For ABR traffic, XDM effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

1.2.86. Xrm:

Definition: An ABR service parameter, Xrm limits the number of forward RM-cells which may be sent in the absence of received backward PM-cells. The range is 0-255.

Discussion: For ABR traffic, Xrm effects the time rate of change of the ACR. This value effects TCP round trip time calculations, which in turn effects TCP throughput.

Specification: AF-TM4.0

2. Performance Metrics

2. 1. Definition Format (from [RFC 1242](#))

Metric to be defined.

Definition: The specific definition for the metric.

Discussion: A brief discussion of the metric, its application and any restrictions on measurement procedures.

Measurement units: Intrinsic units used to quantify this metric. This includes subsidiary units; e.g., microseconds are acceptable if the intrinsic unit is seconds.

2.2. Definitions

2.2.1. Physical Layer- SONET

2.2.1.1. Pointer Movements

Definition: Pointer Movements is the number of changes in a SONET pointer due to clock synchronization slips.

Discussion: SONET Pointer Movements can cause loss of information in the SONET payload envelop (SPE) which contains IP datagrams, either in the form of cells or as PPP delimited PDUs.

Measurement Units: Per second.

2.2.1.2. Transport Overhead Error Count

Definition: SONET Transport Overhead Error Count is the number of SONET transport overhead errors detected.

Discussion: SONET Transport Overhead Errors SONET Transport Overhead Errors cause SONET frames to be lost. These frames may contain IP datagrams, either in the form of cells or as PPP delimited PDUs.

Measurement Units: Positive integer

2.2.1.3. Path Overhead Error Count

Definition: SONET Path Overhead Error Count is the number of SONET path overhead errors detected.

Discussion: SONET Path Overhead Errors cause SONET frames to be lost. These frames may contain IP datagrams, either in the form of cells or as PPP delimited PDUs.

Measurement Units: Positive integer

2.2.2. ATM Layer

2.2.2.1. Cell Delay Variation (CDV):

Definition: The variation in cell transfer delay associated with a given traffic load, orientation and distribution, as well as an integration period. $CDV = \max(CTD) - \min(CTD)$ where max and min indicate the maximum and minimum over the integration period, respectively.

Discussion:

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.

CDV effects TCP round trip time calculations. Large values of CDV will adversely effect TCP throughput.

Measurement Units: seconds

2.2.2.2. Cell Delay Variation Tolerance (CDVT):

Definition: 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.

Discussion:

CDVT effects TCP round trip time calculations. Large values of CDVT will adversely effect TCP throughput.

Measurement units: seconds

2.2.2.3. Cell Error Ratio (CER):

Definition: The ratio of errored cells in a transmission in relation to the total cells sent in a transmission associated with a given traffic load, orientation and distribution, as well as an integration period.

$$\text{CER} = \text{Errored Cells} / \text{Total Cells Transmitted.}$$

Discussion: The measurement is taken over a time interval and is desirable to be measured on an in-service circuit.

CER causes ATM cells to be lost. These cells may contain AAL5 segments of IP datagrams.

Measurement Units: dimensionless.

2.2.2.4. Cell Loss Ratio (CLR):

Definition: The ratio of lost cells in a transmission in relation to the total cells sent in a transmission associated with a given traffic load, orientation and distribution, as well as an integration period. CLR

$$\text{Lost Cells} / \text{Total Cells Transmitted.}$$

Discussion:

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 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.

CLR measures the number of ATM cells lost. These cells may contain AAL5 segments of IP datagrams.

Measurement Units: dimensionless.

2.2.2.5. Cell Misinsertion Rate (CMR):

Definition: The ratio of cells received at an endpoint that were not originally transmitted by the source end in relation to the total number

of cells properly transmitted associated with a given traffic load, orientation and distribution, as well as an integration period. $CMR = \text{Mis-inserted Cells} / \text{Total Cells Transmitted}$.

Discussion:

CMR causes ATM streams to be corrupted. These streams may contain AAL5 segments of IP datagrams.

Measurement Units: dimensionless.

2.2.2.6. Cell Rate Margin (CRM):

Definition: This is a measure of the difference between the effective bandwidth allocation and the allocation for sustainable rate in cells per second.

Discussion: none.

Measurement units: Cells per second

2.2.2.7. CRC Error Ratio:

Definition: The ratio of PDUs received at an endpoint that which contain an invalid CRC in relation to the total number of cells properly transmitted associated with a given traffic load, orientation and distribution, as well as an integration period.

Discussion:

CRC errors cause ATM cells to be lost. These cells may contain AAL5 segments of IP datagrams.

Measurement Units: dimensionless

2.2.2.8. Cell Transfer Delay (CTD):

Definition: The elapsed time between a cell exit event at the measurement point 1 (e.g., at the source UNI) and the corresponding cell entry event at a measurement point 2 (e.g., the destination UNI) for a particular connection.

Discussion:

The cell transfer delay between two measurement points is the sum of the total inter-ATM node transmission delay and the total ATM node processing delay.

Measurement units: seconds

2.2.3. ATM Adaptation Layer (AAL) Type 5 (AAL5)

2.2.3.1. AAL5 Reassembly Errors

Definition: AAL5 Reassembly Errors constitute any error which causes the AAL5 PDU to be corrupted.

Discussion:

AAL5 Reassembly errors cause AAL5 PDUs to be lost. These PDUs may contain IP datagrams.

Measurement Units: Positive Integer

2.2.3.2. AAL5 Reassembly Time

Definition: AAL5 Reassembly Time constitutes the time between the arrival of the final cell in the AAL5 PDU and the AAL5 PDU being made available to the service layer.

Discussion:

AAL5 Reassembly time directly effects TCP round trip time calculations.

Measurement Units: seconds

2.2.3.3. AAL5 CRC Error Ratio:

Definition: The ratio of PDUs received at an endpoint that which contain an invalid CRC in relation to the total number of cells properly transmitted associated with a given traffic load, orientation and distribution, as well as an integration period.

Discussion:

AAL5 CRC errors causes AAL5 PDUs to be dropped. These PDUs may contain IP datagrams.

Measurement Units: dimensionless

3. Security Considerations.

As this document is solely for the purpose of providing terminology and describes neither a protocol nor an implementation, there are no security considerations associated with this document.

4. References

[AF-ILMI4.0] ATM Forum Integrated Local Management Interface Version 4.0, af-ilmi-0065.000, September 1996.

[AF-TEST-0022] Introduction to ATM Forum Test Specifications, af-test-0022.00, December 1994.

[AF-TM4.0] ATM Forum, Traffic Management Specification Version 4.0, af-tm-0056.00, April 1996.

[AF-UNI3.1] ATM Forum, User Network Interface Specification Version 3.1, September 1994.

[AF-UNI4.0] ATM Forum, User Network Interface Specification Version 4.0, July 1996.

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