(ITU-T LS13-35, to TSG-RAN) LS on AAL Type 2 Resource Management

ITU - Telecommunication Standardization Sector

LS13-35

QUESTIONS:　2, 4/13; 3GGP TSG RAN

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TITLE:　　　　Communication on AAL Type 2 Resource Management

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COMMUNICATION

TO:　　　　　3GGP TSG RAN

APPROVAL:　Agreed to at ITU-T SG 13 meeting

FOR:　　　　Information

DEADLINE:　--

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Q4/13 would like to inform you that we are completing a new draft recommendation I.371aal2 with the title "Traffic Control and Congestion Control at the ATM Adaptation Layer Type 2". We expect I.371aal2 to be proposed for Consent at the next SG13 meeting in November 2002. We include I.371aal2 for your information.

Attachments:

Draft new Recommendation I.371aal2: "Traffic Control and Congestion Control at the ATM Adaptation Layer Type 2"

Annex A of draft new Recommendation Y.1221: "Traffic Control and Congestion Control in IP Based Networks"

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ANNEX A: THE TOKEN BUCKET AND THE GENERIC BYTE RATE ALGORITHM (GBRA)

This annex is an integral part of the normative text.

This Annex provides several algorithms, which are used to define packet conformance of an IP flow with respect to a rate R (in byte per second) assuming a bucket size B. The algorithms are considered equivalent in the sense that they will identify the same packets to be conforming.

Traffic metering is a basic component of packet networks that provide various levels of quality of service, such as throughput guarantees and upper bounds on delay and loss. An IP packet stream must conform to a predefined traffic profile in order to assure that the network resources allocated to that stream can provide the expected service level, and to assure that this stream does not cause other network traffic to experience an unacceptable service level.

Starting point is the Token Bucket. This algorithm is considered equivalent to the continuous state token bucket. This algorithm in turn is then shown to be equivalent to the Generic Byte Rate Algorithm (GBRA). The GBRA defines the characteristics that relate an information rate parameter to a burst tolerance parameter. Together, these two traffic parameters and their interrelationship form the basis for a generalized traffic profile conformance test. A secondary goal of GBRA is to avoid referencing one or more implementation options on the basis that it is not central to the conformance concept and that it is a source of unnecessary bias. GBRA specifies the fundamental aspects of a conformance test to a single profile, and as such does not include other related policing functions such as multi-stage metering, packet coloring, packet marking, and packet discard policies.

The token bucket

This algorithm is described as follows (compare also e.g. RFC 2698):

The token bucket has two fixed parameters:

−   The token bucket rate R (in bytes per second)

−   The token bucket size B (in bytes)

The token bucket uses the variable:

−   The token count Tc (in bytes) which is initially (at the arrival at time ta of the first packet of the flow) full, i.e., the token count Tc (ta) = B.

Thereafter, the token count Tc is incremented by one every 1/R seconds up to B.

When a packet of size N bytes arrives at time ta, the following happens:

−   If Tc(ta)-N < 0, the packet is non conforming, else

−   the packet is conforming and Tc is decremented by N.

Note: The arrival time is considered to be when the last bit of the packet arrives.

The continuous state token bucket

To be more precise and unambiguous, a continuous state token bucket is proposed. The continuous state token bucket is considered to be equivalent to the token bucket. The continuous state token bucket has the advantage that it is easily implementable.

The continuous state token bucket has two fixed parameters per IP flow:

−   The token bucket rate R (in bytes per second) for the flow

−   The token bucket size B (in bytes) for the flow

The continuous-state token bucket uses the following variables:

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– The token count Tc (in bytes) of the flow

– LCT is the last conformance time of the flow (in seconds)

Initially (at time ta of the arrival of the first packet of the flow):

– Tc = B

– LCT = ta

At arrival of a packet with size N (bytes) at time ta:

$$Tc' = Tc + R*(ta - LCT)$$

If Tc' < N

      Then   packet is not conforming

      Else   packet is conforming

$$Tc = min(Tc', B) - N$$

For the continuous state token bucket, the variable Tc and LCT are only modified at packet arrival.

Note: A packet can never be conforming if N > B.

The Generic Byte Rate Algorithm

For the generic byte rate algorithm, there are two variants: one is the virtual scheduling byte rate algorithm and one is the continuous state leaky bucket byte rate algorithm.

For both algorithms, the fixed parameters per IP flow are:

– The increment I in units of seconds per byte. I is related to R by I = 1/R

– The Limit L in seconds. L is related to R and B by L = B/R.

The virtual scheduling byte rate algorithm

The virtual scheduling byte rate algorithm uses the following variable:

– TAT in units of seconds is the theoretical arrival time of the next packet

Initially (at time ta of the arrival of the first packet of the flow):

– TAT = ta

The theoretical arrival time (TAT) is updated only after a packet is considered conforming by the algorithm.

At arrival of a packet with size N (bytes) at time ta:

If ta < TAT + N*I - L

      Then   packet is not conforming

      Else   packet is conforming

$$TAT = max(ta, TAT) + N*I$$

The continuous state leaky bucket byte rate algorithm

The continuous state leaky bucket byte rate algorithm uses the following variables:

– LCT is the last conformance time of the flow (in seconds)

– X is the Leaky Bucket counter (in seconds)

Initially (at time ta of the arrival of the first packet of the flow):

– LCT = ta

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−   X = 0

At arrival of a packet with size N (bytes) at time ta:

    X' = X − (ta − LCT)

    If X' + N*I > L

        Then   packet is not conforming

        Else   packet is conforming

             X = max(0, X') + N*I

Note: Equivalence of the algorithms:

−   The continuous state leaky bucket byte rate algorithm is equivalent to the continuous state token bucket: Just set Tc = (L-X)*R, Tc' = (L-X')*R and use B = L*R.

−   The virtual scheduling byte rate algorithm is equivalent to the continuous state leaky bucket byte rate algorithm: Just observe that after the two algorithms have been executed, one has TAT = X+LCT.

Note: Relationship between the GBRA and the GCRA in I.371:

In case of ATM, the cell size is N=53 bytes and N*I becomes equal to T which is the inverse of the cell rate. If one sets L = T + τ where τ is the tolerance of the GCRA, then one sees that the GCRA is a special case of the GBRA (see Annex A of I.371).

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Draft New Recommendation I.371aal2

    Traffic Control and Congestion Control at the ATM Adaptation Layer Type 2

Summary

This Recommendation provides a general description as well as objectives and procedures for AAL type 2 traffic control and congestion control. It introduces the concept of AAL type 2 transfer capability. For each AAL type 2 transfer capability, it specifies AAL type 2 traffic parameters, an AAL type 2 conformance definition and defines AAL type 2 QOS commitments. Additionally, it describes the concepts of the AAL type 2 traffic contract.

1 Scope

This Recommendation describes traffic control and congestion control procedures at the AAL type 2 level as defined in [3]. Such control procedures are necessary in order to support AAL type 2 connections with QOS.

AAL type 2 traffic control refers to all network actions aiming to meet the negotiated performance objectives at the AAL type 2 level and to allow the avoidance of congested conditions.

AAL type 2 congestion control refers to all network actions to minimize the intensity, spread and duration of congestion.

This Recommendation provides a general description as well as objectives and procedures for AAL type 2 traffic control and congestion control. It introduces the concept of AAL type 2 transfer capability. For each AAL type 2 transfer capability, it specifies AAL type 2 traffic parameters, an AAL type 2 conformance definition and defines AAL type 2 QOS commitments. Additionally, it describes the concepts of the AAL type 2 traffic contract.

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; all 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.

2.1 Normative References

[1]   ITU-T Recommendation I.371 (2000), *Traffic Control and Congestion Control in B-ISDN.*

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

[3]   ITU-T Recommendation I.363.2 (2000), *B-ISDN ATM Adaptation Layer (AAL) Type 2 Specification.*

[4]   ITU-T Recommendation Q.2630.1 (2000*), AAL Type 2 Signalling Protocol (Capability Set 1)*

[5]   ITU-T Recommendation Q.2630.2 (2001), *AAL Type 2 Signalling Protocol (Capability Set 2)*

[6]   ITU-T Draft Recommendation Y.*iptc* ??? (2002), *Traffic Control and Congestion Control in IP Based Networks*

2.2 Informative Reference

[7]   3GPP TS 25.415 V3.5.0 (2000-12), *UTRAN Iu Interface User Plane Protocols*

3   Abbreviations

This Recommendation uses the following abbreviations.

AAL type 2	ATM Adaptation Layer Type 2
AMR	Adaptive Multi-Rate
SRcps	Sustainable CPS byte rate
ATC	ATM Transfer Capability
ATM	Asynchronous Transfer Mode
BScps	CPS Token Bucket Size associated with the Sustainable CPS byte rate
BPcps	CPS Token Bucket Size associated with the Peak CPS byte rate
CPS	Common Part Sublayer
DBR	Deterministic Bit Rate
FBW	Fixed Bandwidth
GBRA	Generic Byte Rate Algorithm
IP	Internet Protocol
Mcps	Maximum allowed CPS packet size
PDU	Protocol Data Unit
PRcps	Peak CPS byte rate
QOS	Quality of Service
SBR	Statistical Bit Rate
SCR	Sustainable Cell Rate
SDU	Service Data Unit
TB	Token Bucket
VBW-S	Variable Bandwidth Stringent
VBW-T	Variable Bandwidth Tolerant
VCC	Virtual Channel Connection

4   Introduction

The AAL type 2 was defined in [3]. An AAL type 2 connection uses one or several contiguous ATM VCCs called AAL type 2 paths. An AAL type 2 path can be shared by up to 248 AAL type 2 user connections.

QOS for an AAL type 2 connection is then determined by

- the QOS associated with the AAL type 2 paths (the ATM VCCs) along the connection as defined in [2],
- the QOS supported by AAL type 2 multiplexing where the AAL type 2 connection is put inside an AAL type 2 path.

The primary role of traffic control and congestion control procedures at the AAL type 2 level is to protect the AAL type 2 traffic when it is multiplexed onto an AAL type 2 path. The goal is to achieve the AAL type 2 performance objectives and AAL type 2 QOS commitments. Traffic and congestion control allows the use of AAL type 2 paths to be optimised.

Congestion at the AAL type 2 level is defined as a state of network elements (e.g. AAL type 2 switches) in which the network is not able to meet the AAL type 2 performance objectives and the negotiated AAL type 2 QOS commitments for the established AAL type 2 flows. Congestion is to be distinguished from the state where buffer overflow causes CPS packet loss, but the negotiated quality of service is still met.

This Recommendation defines a set of traffic control and congestion control capabilities at the AAL type 2 level. It may be appropriate to consider additional sets of such capabilities (for which additional traffic control mechanisms will be used) to achieve increased network efficiency.

It should be noted that AAL type 2 traffic control procedures apply to AAL type 2 connections. For AAL type 2 connections, the network commits to meet QOS objectives, assuming the AAL type 2 connection conforms to a traffic contract.

5   AAL type 2 traffic parameters and descriptors

5.1   Definitions

5.1.1   AAL type 2 traffic parameter

An AAL type 2 traffic parameter describes one aspect of an AAL type 2 connection. It may be qualitative or quantitative. An AAL type 2 traffic parameter may for example describe the peak byte rate, the average byte rate, the average or maximum CPS packet size, the burst length of an AAL type 2 connection, etc.

5.1.2   AAL type 2 traffic descriptor

An AAL type 2 traffic descriptor is the set of AAL type 2 traffic parameters that is used to capture the traffic characteristics of an AAL type 2 connection as part of the AAL type 2 traffic contract.

5.1.3   AAL type 2 traffic contract

For a given AAL type 2 connection, the AAL type 2 traffic descriptor, the AAL type 2 conformance definition and the AAL type 2 QOS commitments define the AAL type 2 traffic contract.

5.2   Requirements on AAL type 2 traffic parameters and AAL type 2 traffic descriptors

Any AAL type 2 traffic parameter to be involved in an AAL type 2 traffic descriptor should:

–   have the same interpretation on both sides of an interface or within a network

–   be meaningful in resource allocation schemes to meet network performance requirements,

–   be enforceable by the parameter control.

Whether an AAL type 2 parameter should be enforced is for further study.

5.3   AAL type 2 traffic parameter specifications

5.3.1   AAL type 2 reference configuration

An AAL type 2 connection has a starting point (AAL type 2 source) and an endpoint (AAL type 2 destination). An AAL type 2 connection uses one or several AAL type 2 paths. AAL type 2 traffic parameters are defined at the AAL type 2 source. They are valid along the whole AAL type 2 connection even though the traffic characteristics of the AAL type 2 connection may change due to AAL type 2 packet delay variation after the CPS packets pass through several AAL type 2 paths.
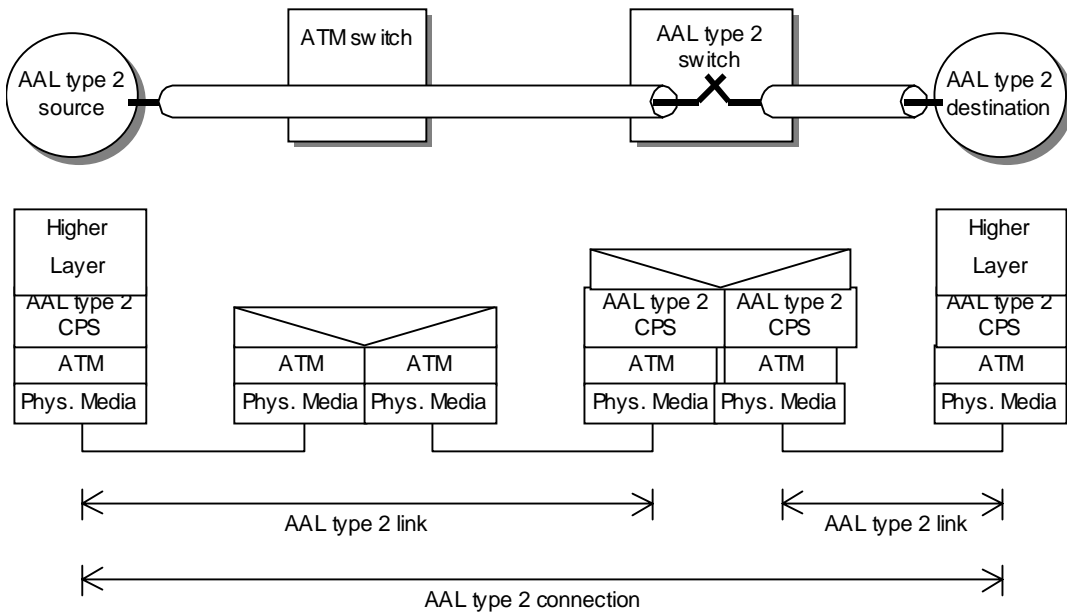
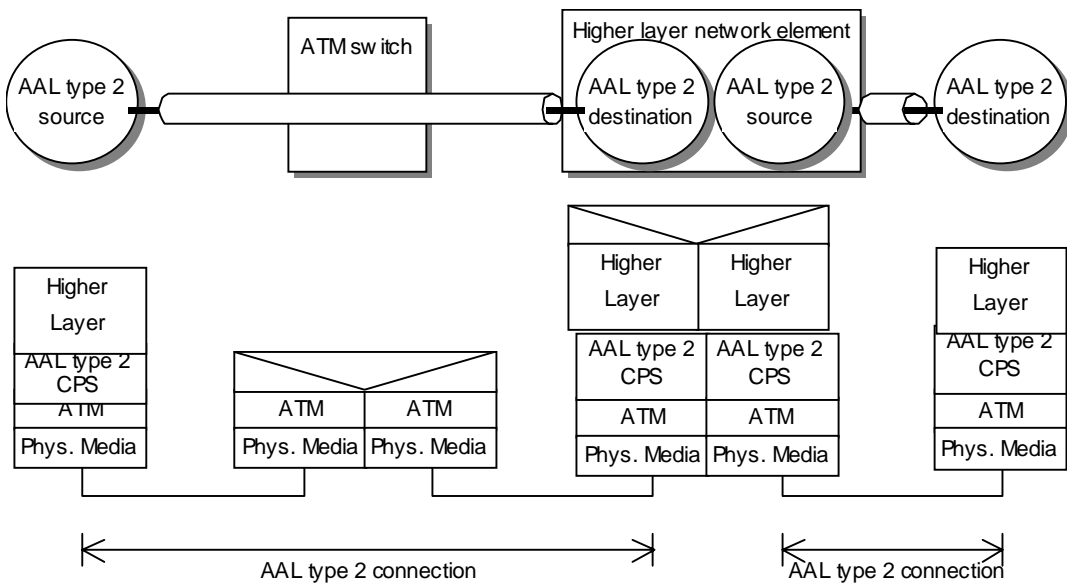**Figure 1: Reference configuration for one AAL type 2 connection**

Figure 2: Reference configuration for concatenated AAL type 2 connections

Figure 1 above shows one single switched AAL type 2 connection that consists of two concatenated AAL type 2 links.

On the other hand, Figure 2 shows a concatenation of two separate AAL type 2 connections. If the processing of the higher layer in the network element does not take place, i.e. if it is a null function, Figure 2 converts to Figure 1 with respect to AAL type 2 traffic aspects.

AAL type 2 conformance is currently defined only at the AAL type 2 source. AAL type 2 conformance at interfaces along the AAL type 2 connection is not considered in this recommendation.

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If several AAL type 2 connections are concatenated with the same traffic parameters, then a conformance definition may be required only at the AAL type 2 source where the AAL type 2 traffic originates.

5.3.2   AAL type 2 traffic parameter description

The following AAL type 2 traffic parameters are defined which may be used in the AAL type 2 traffic descriptor.

5.3.2.1   Definition of the maximum allowed CPS packet size

The maximum allowed CPS packet size Mcps is expressed in byte. It is a mandatory traffic parameter for each AAL type 2 transfer capability. The 3 byte CPS packet header is to be included in the computation of Mcps.

5.3.2.2   Definition of CPS byte rates

The Generic Byte Rate Algorithm (GBRA) or Token Bucket (TB) as described in Annex A of [6] defines the rate of an IP flow and its associated burstiness. If IP packets are replaced by AAL type 2 CPS packets, then this algorithm can also be used to characterise an AAL type 2 rate and the associated burstiness.

The GBRA and the TB are equivalent. For AAL type 2 traffic descriptions, they use the following set of two parameters:

−   a CPS byte rate expressed in byte/s;

−   a CPS token bucket size expressed in byte.

In case of AAL type 2 traffic parameters, the 3 byte CPS packet headers are to be included in the computation of the CPS byte rates and the CPS token bucket sizes.

For a given AAL type 2 connection, the traffic parameters apply to all CPS packets whether they contain user data or control information (see also Appendix II)

Two rates are defined: the peak CPS byte rate and the sustainable CPS byte rate. The AAL type 2 traffic descriptor contains at least the peak CPS byte rate. If the traffic descriptor contains both the peak and sustainable CPS byte rate, then the sustainable CPS byte rate is less than or equal to the peak CPS byte rate.

5.3.2.2.1   Definition of the peak CPS byte rate and associated token bucket size

The peak CPS byte rate is defined by two parameters:

−   a CPS byte rate PRcps expressed in byte/s;

−   a CPS token bucket size BPcps associated with PRcps; BPcps is expressed in byte. A traffic flow is within the peak CPS byte rate PRcps if it passes a token bucket or GBRA with rate PRcps and bucket size BPcps.

5.3.2.2.2   Definition of the sustainable CPS byte rate and associated token bucket size

The sustainable CPS byte rate is defined by two parameters:

−   a CPS byte rate SRcps expressed in byte/s;

−   a CPS token bucket size BScps associated with SRcps; BScps is expressed in byte.

A traffic flow is within the sustainable CPS byte rate SRcps if it passes a token bucket or GBRA with rate SRcps and bucket size BScps.

5.3.2.3   Definition of Source Traffic Type

Some connections may find it difficult to submit traffic at a specified sustainable CPS byte rate even though they do not always send at the peak CPS byte rate. Such connections may use a source traffic type to characterise the traffic. Source traffic type for an AAL type 2 connection is an information that indicates that the source usually does not always send with its peak CPS byte rate. The source traffic type also gives details as to what extend the connections sustainable CPS byte rate lies below the peak byte rate when sustained over many such connections with the same source traffic type (see also appendix III).

6   AAL type 2 transfer capabilities

An AAL type 2 transfer capability is a set of network capabilities provided for an AAL type 2 connection. For an AAL type 2 transfer capability, the AAL type 2 service model, the AAL type 2 traffic descriptor, the AAL type 2 conformance definition and the AAL type 2 QOS commitments are defined. An AAL type 2 transfer capability is supported by a set of AAL type 2 traffic control and AAL type 2 congestion control functions.

The set of AAL type 2 transfer capabilities may be extended in the future.

For AAL type 2 transfer capabilities, the QOS requirements may be stringent which implies low CPS packet delay and low CPS packet delay variation and that they are suitable for voice traffic transport

They also may be tolerant which means that the CPS packet delay and CPS packet delay variation may be higher than in the stringent case. Tolerant QOS requirements are suitable for data packet transport.

The CPS packet loss is expected to be low in all cases.

6.1   Fixed Bandwidth (FBW) AAL type 2 transfer capability

6.1.1   Description

The Fixed Bandwidth (FBW) transfer capability is intended to support applications which require a fixed AAL type 2 bandwidth and fixed burstiness as well as stringent QOS requirements. Examples are circuit switched data traffic and constant bit rate speech.

6.1.2   Service model

The FBW transfer capability can be used by applications that characterize the traffic at the AAL type 2 layer with a single rate and a burst size by way of a Token Bucket or GBRA. The commitment made by the network is that stringent QOS commitments are assured to all CPS packets when all CPS packets are conforming.

6.1.3   Traffic descriptor

The AAL type 2 traffic descriptor consists in the following parameters:

−   The peak CPS byte rate PRcps and CPS token bucket size BPcps as specified for the GBRA and TB in 5.3.2.2.1.

−   The maximum allowed CPS packet size Mcps as specified in 5.3.2.1.

6.1.4   Conformance definition

A CPS packet for which the rate PRcps is applicable is conforming if it fulfills both of the following two conditions:

−   the CPS packet passes the TB or GBRA with parameters PRcps and BPcps;

−   the actual CPS packet length does not exceed the maximum allowed CPS packet size Mcps.

The GBRA is updated only for conforming CPS packets.

6.1.5 QOS commitments

If all CPS packets are conforming, the stringent QOS commitments apply to all CPS packets. If not all CPS packets are conforming, the network may choose to commit QOS to some of the CPS packets, for example to a volume of CPS packets that is conforming.

6.2 Variable Bandwidth Stringent (VBW-S) AAL type 2 transfer capability

6.2.1 Description

The Variable Bandwidth Stringent (VBW-S) transfer capability is intended to support applications which submit their traffic to the AAL type 2 with the following characteristics:

- a variable rate

- stringent QoS requirements

Examples are variable bit rate voice and some multimedia applications.

6.2.2 Service model

The VBW-S transfer capability can be used by applications that characterize the traffic at the AAL type 2 level with a peak CPS byte rate PRcps together with a token bucket size BPcps and a source traffic type.

For traffic matching the source traffic type, the commitment made by the network is that stringent QOS commitments are assured to all CPS packets when all CPS packets are conforming.

6.2.3 VBW-S traffic descriptor

The VBW-S traffic descriptor consists of the following parameters:

− The peak CPS byte rate PRcps and CPS token bucket size BPcps as specified for the GBRA and TB in 5.3.2.2.1

− A source traffic type (like AMR coded speech or video, see Appendix III)

− The maximum allowed CPS packet size Mcps as specified in 5.3.2.1.

6.2.4 VBW-S conformance definition

For a VBW-S connection, conformance is defined at the CPS packet level and at the connection level.

A CPS packet is conforming at the CPS packet level if it fulfills the following two conditions:

− the CPS packet passes the TB or GBRA with parameters PRcps and BPcps

− the actual CPS packet length does not exceed the maximum allowed CPS packet size Mcps.

The GBRA is updated only for CPS packets which are conforming at the CPS packet level.

If the traffic does not match the source traffic type, the connection is non-conforming at the connection level.

The source traffic type may be used for AAL type 2 connection admission control.

6.2.5 QOS commitments

If all CPS packets are conforming at the CPS packet level and if the connection is conforming to the source traffic type, the stringent QOS commitments apply to all CPS packets. If the connection is conforming to the source traffic type, but if not all CPS packets are conforming at the CPS packet

level, the network may choose to commit QOS to some of the CPS packets, for example to a volume of CPS packets that is conforming at the CPS packet level.

There is no QOS commitment if the connection is non-conforming to the source traffic type.

6.3 Variable Bandwidth Tolerant (VBW-T) AAL type 2 transfer capability

6.3.1 Description

The Variable Bandwidth Tolerant (VBW-T) transfer capability is intended to support applications which submit their traffic to the AAL type 2 with the following characteristics :

- a variable rate

- bursty traffic

- tolerant QoS requirements

An example is IP traffic.

6.3.2 Service model

The VBW-T transfer capability can be used by applications that characterize the traffic at the AAL type 2 with two rates: a peak CPS byte rate PRcps together with an associated token bucket size BPcps and an sustainable CPS byte rate SRcps together with an associated token bucket size BScps.

The commitment made by the network is that tolerant QOS commitments are assured to all CPS packets when all CPS packets are conforming.

6.3.3 VBW-T traffic descriptor

The VBW-T traffic descriptor consists in the following parameters:

– The peak CPS byte rate PRcps and CPS token bucket size BPcps as specified for the GBRA and TB in 5.3.2.2.1

– The sustainable CPS byte rate SRcps and CPS token bucket size BScps as specified for the GBRA and TB in 5.3.2.2.2

– The maximum allowed CPS packet size Mcps as specified in 5.3.2.1.

It is assumed that the sustainable CPS byte rate is less than or equal to the peak CPS byte rate for a given connection.

6.3.4 VBW-T conformance definition

A CPS packet is conforming if it fulfills the following three conditions:

– the CPS packet passes the TB or GBRA with parameters PRcps and BPcps

– the CPS packet passes the TB or GBRA with parameters SRcps and BScps

– the actual CPS packet length does not exceed the maximum allowed CPS packet size Mcps.

Both GBRAs are updated only for conforming CPS packets (i.e., conforming to all three conformance tests).

The sustainable CPS byte rate may be used for AAL type 2 connection admission control.

Note: In order to submit conforming traffic, a VBW-T connection has to shape the traffic not only according to the peak CPS byte rate but also according to the sustainable CPS byte rate.

6.3.5 QOS commitments

If all CPS packets are conforming, the tolerant QOS commitments apply to all CPS packets. If not all CPS packets are conforming, the network may choose to commit QOS to some of the CPS packets, for example to a volume of CPS packets that is conforming.

7 Functions for AAL type 2 traffic control and AAL type 2 congestion control

AAL type 2 traffic control is a set of functions that control the flow of CPS packets via a series of functions such as AAL type 2 connection admission control or AAL type 2 network resource management. The main objective of AAL type 2 traffic control is to satisfy user requirements such as QOS while still supporting efficient AAL type 2 path utilisation.

As opposed to traffic engineering, AAL type 2 traffic control is accomplished in a short time scale. Therefore, a well-established and automated mechanism is to be provided to control the flow of AAL type 2 traffic into the AAL type 2 path.

7.1 Introduction to AAL type 2 traffic control and AAL type 2 congestion control functions

7.1.1 AAL type 2 traffic control functions

The following functions are identified for traffic control functions:

i)   AAL type 2 path resource management

ii)   AAL type 2 connection admission control

iii)   CPS packet discard control

iv)   AAL type 2 traffic shaping

v)   AAL type 2 scheduling control

7.1.2 AAL type 2 congestion control functions

The following functions are identified for congestion control functions:

i)   CPS packet discard control

ii)   AAL type 2 scheduling control

7.2 AAL type 2 traffic control functions

7.2.1 AAL type 2 path resource management

AAL type 2 path resource management refers to a set of policies and rules for allocating the AAL type 2 path resources. These resources include the bandwidth for the AAL type 2 path and the buffer for multiplexing AAL type 2 connections onto an AAL type 2 path.

7.2.2 AAL type 2 connection admission control

AAL type 2 connection admission control refers to the policies of the network to admit commitments to a new AAL type 2 connection onto an AAL type 2 path or to refuse the commitments when adding the new connection would result in unacceptable QOS for the existing AAL type 2 connections and/or the new AAL type 2 connection.

7.2.3 CPS packet discard control

When CPS packets are put onto an AAL type 2 path, congestion may occur. In this case it may be preferable to discard CPS packets of some connections and not of other connections.

7.2.4   AAL type 2 traffic shaping

AAL type 2 traffic shaping is an action by the network to modify the AAL type 2 traffic characteristics of the AAL type 2 flow such that the flow becomes more suitable for the network. One example is shaping of the flow at the AAL type 2 source so it becomes conforming to the traffic contract.

7.2.5   AAL type 2 packet scheduling

AAL type 2 packet scheduling can bound the queuing delay for an AAL type 2 connection which has stringent delay requirements. E.g. one can introduce delay priorities among the connections to be multiplexed onto an AAL type 2 path. The CPS packets of one connection would wait less time in the CPS multiplexing buffer than the CPS packets of another connection.

7.3   AAL type 2 congestion control functions

For all presently known services that use AAL type 2, CPS packet discard in the network should happen only with low probability. Congestion should therefore be avoided by proper resource dimensioning. However, if congestion occurs, there are functions that can reduce the negative effects of congestion.

7.3.1   CPS Packet discard control

If congestion occurs when CPS packets are put onto an AAL type 2 path, it may be preferable to discard CPS packets of some connections and not of other connections.

7.3.2   AAL type 2 scheduling control

In case of congestion, the scheduling methods or parameters can be adapted to limit the congestion situation.

8   Methods and tools for AAL type 2 path resource management

An AAL type 2 path may be an ATM DBR VCC. In this case, there is a PCR associated with each direction of the AAL type 2 path. When AAL type 2 connections are multiplexed onto such an AAL type 2 path, this AAL type 2 path has to be shaped according to the PCR so that the ATM cells of the resulting ATM VCC are conforming.

If the AAL type 2 path is an SBR VCC, then shaping with respect to the PCR and SCR is required. A similar shaping requirement holds for other ATM Transfer Capabilities (ATCs) if they are used for an AAL type 2 path.

APPENDIX I: MAPPING OF AAL TYPE 2 TRAFFIC PARAMETERS

This appendix contains informative text.

In this appendix a relationship between some of the AAL type 2 link characteristics (ALC) defined in [4] and the AAL type 2 parameters in this recommendation is provided.

[4] defines the maximum CPS-SDU bit rate (in bit/s) and the maximum CPS-SDU size (in bytes) as follows:

- The **maximum CPS-SDU bit rate** is defined as the maximum bandwidth, available to the AAL type 2 served user in the specified direction. The maximum bandwidth is the maximum ratio of the amount of bits transported during the inter-departure time between subsequent CPS-SDUs, and that inter-departure time. Allowed values are 0 to 2048 kbit/s.

- The **maximum CPS-SDU size** is defined as the largest CPS-SDU size, in octets, allowed to be sent during the holding time of the connection.

Remark 1: Both parameters do no include the CPS packet headers.

On the other side, this recommendation defines the rate PRcps (in byte/s) and the maximum allowed CPS packet size Mcps (in bytes). Both parameters do include the CPS packet headers.

To establish a relationship between maximum CPS-SDU bit rate and the maximum CPS-SDU size on one side and the parameters PRcps and Mcps on the other side, it is assumed that the AAL type 2 source sends a CPS packet every time interval T (in seconds). It is also assumed that no control frames are used on this connection.

Then the parameters are related as follows:

$$PRcps = \frac{\max imum\ CPS\ SDU\ bit\ rate}{8} + \frac{3[bytes]}{T}$$

$$Mcps = maximum\ CPS\text{-}SDU\ size + 3\ [bytes]$$

This relationship is illustrated in two examples:

Example 1:

For a compressed speech AAL type 2 speech connection with T = 20 ms = 0.02 s one gets

$$PRcps = \frac{\max imum\ CPS\ SDU\ bit\ rate}{8} + 150[byte/s]$$

Example 2:

For a 64 kbit/s transparent data connection that sends 40 bytes CPS-SDUs every 5 ms one gets that T=0.005 s and

$$PRcps = (\frac{64\,000}{8} + \frac{3}{0.005})[byte/s] = 8600[byte/s]$$

Remark 2: Such a relationship between the average CPS-SDU bit rate and the sustainable CPS packet byte rate does not hold.

Remark 3: If an interval T is not known, then this rate conversion formula does not apply anymore.

APPENDIX II: GUIDELINES FOR CHOOSING AAL2 PARAMETER VALUES FOR CONECTIONS WITH CONTROL FRAMES

This appendix contains informative text.

Section 5.3.2 of I.371aal2 defines the following traffic parameters:

- The maximum allowed CPS packet size Mcps

- The peak CPS byte rate PRcps

- The CPS token bucket size BPcps associated with the peak CPS rate

- The sustainable CPS packet byte rate SRcps

- The CPS token bucket size BScps associated with the sustainable CPS rate

In section 5.3.2.2, it is also stated that for a given AAL type 2 connection, the traffic parameters apply to all CPS packets whether they contain user data or control information.

Control frames occur e.g. when the user plane protocol (see [7]) as specified by 3GPP is used by a connection in support mode: the PDU type 14 frames then contain control information (e.g. rate control frames).

This appendix gives some guidance on how to choose the values of the above parameters for an AAL2 connection in case there are CPS packets containing control information in addition to CPS packets containing user data.

Assume that the parameters were chosen according to the CPS packets containing user data. When there are also CPS packets containing control information the following should be taken into account:

- The CPS token bucket size BPcps for the peak CPS rate has to be increased to allow at least one extra control frame.

- The rate PRcps should be slightly increased. If many control frames are expected, the rate may need to be significantly increased.

- The maximum allowed CPS packet size Mcps may have to be increased to the maximum CPS packet size needed for control frames (if this values is larger than Mcps). In particular, if control frames are longer than 48 bytes including the header, then at least two CPS packets are needed to transport the control frame. If the first of these CPS packets is 48 bytes long, then a maximum allowed CPS packet size Mcps of 48 bytes is required for this connection.

- The rate SRcps should be slightly increased (if applicable). If many control frames are expected, the rate may need to be significantly increased. This applies only if the sustainable CPS packet byte rate is used.

- The CPS token bucket size BScps for the sustainable CPS rate has to be increased to allow at least one extra control frame. This applies only if the sustainable CPS packet byte rate is used.

Note: Increasing the CPS token bucket sizes is needed because CPS packets containing a control frame may arrive at any time, e.g. right after a CPS packet containing user data for the same connection.

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APPENDIX III: INFORMATION ON THE SOURCE TRAFFIC TYPE

This appendix contains informative text.

In section 5.3.2.3, a source traffic type is defined. In section 6.2, the source traffic type is used for variable bandwidth connections with stringent delay requirements as part of the AAL type 2 transfer capability VBW-S.

The main purpose of the introduction of the source traffic type was to provide some information in addition to the peak CPS byte rate. With this additional information the connection admission control can then allocate less bandwidth than the peak CPS byte rate under certain circumstances. The allocated bandwidth depends on the CAC mechanism used and is implementation specific.

One example for source traffic type is AMR coded speech. When such a source traffic type is chosen, the CAC can take advantage of the information and allocate less bandwidth than the peak CPS byte rate for such a connection because AMR codecs send well below their peak CPS byte rate during silence periods.

For all VBW-S connections where no specific source traffic type is provided, the CAC should assume the worst case which is that the connection sends with the specified peak CPS byte rate all the time.

From the CAC viewpoint, it is preferable to define only a small number of different source traffic types. A source traffic type for a connection should only be used, if it is possible to find out if a connection sends traffic that does not match the source traffic type chosen by the connection.