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SERIES I: INTEGRATED SERVICES DIGITAL
NETWORK

Overall network aspects and functions – General network
requirements and functions

**Traffic control and congestion control at the
ATM Adaptation Layer type 2**

ITU-T Recommendation I.378

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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.

Source

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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ITU-T Recommendation I.378

Traffic control and congestion control at the ATM Adaptation Layer type 2

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; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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: Type 2 AAL specification*.
- [4] ITU-T Recommendation Q.2630.1 (1999), *AAL type 2 signalling protocol – Capability Set 1*.
- [5] ITU-T Recommendation Q.2630.2 (2000), *AAL type 2 signalling protocol – Capability Set 2*.
- [6] ITU-T Recommendation Y.1221 (2002), *Traffic control and congestion control in IP-based networks*.
- [7] ITU-T Recommendation I.366.2 (2000), *AAL type 2 service specific convergence sublayer for narrow-band services*.

2.2 Informative references

- [8] 3GPP TS 25.415 V3.5.0 (2000-12), *UTRAN Iu Interface User Plane Protocols*.

- [9] ETSI TS 126 071 V3.0.1 (2000-01), *Universal Mobile Telecommunication System (UMTS); Mandatory Speech Codec speech processing functions – AMR Speech Codec – General Description (3G TS 26.071 version 3.0.1 Release 1999)*.
- [10] ETSI TS 126 101 V3.0.0 (2000-01), *Universal Mobile Telecommunication System (UMTS); Mandatory Speech Codec speech processing functions; AMR Speech Codec Frame Structure (3G TS 26.101 version 3.0.0 Release 1999)*.

3 Abbreviations

This Recommendation uses the following abbreviations.

AAL type 2	ATM Adaptation Layer type 2
AMR	Adaptive Multi-Rate
ATC	ATM Transfer Capability
ATM	Asynchronous Transfer Mode
BPcps	CPS Token Bucket Size associated with the Peak CPS byte rate
BScps	CPS Token Bucket Size associated with the Sustainable 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
SRcps	Sustainable CPS byte rate
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 optimized.

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

This Recommendation defines the following terms:

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.

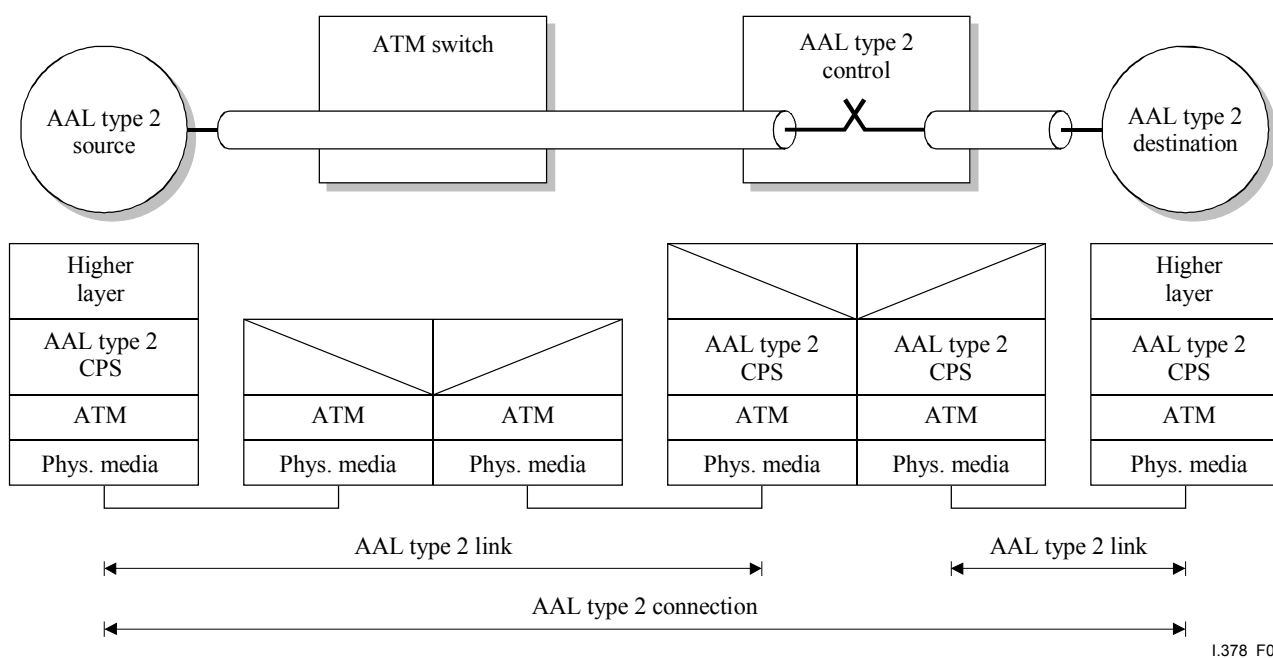


Figure 1/I.378 – Reference configuration for one AAL type 2 connection

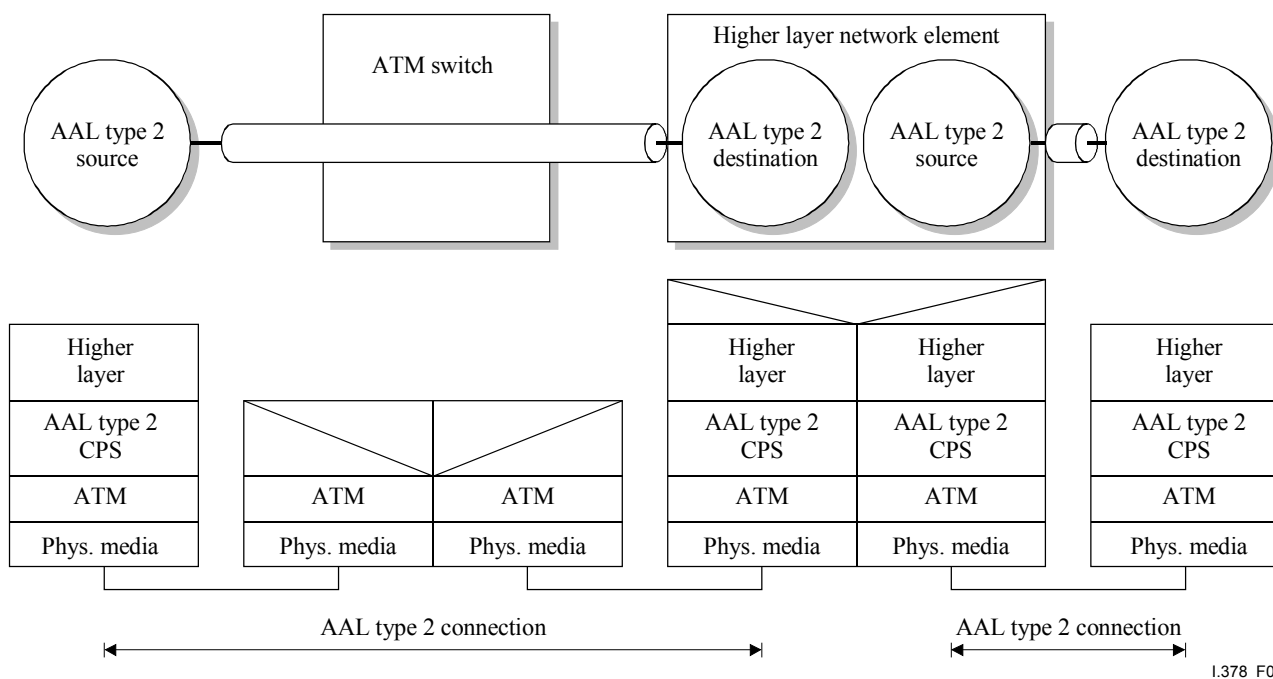


Figure 2/I.378 – Reference configuration for concatenated AAL type 2 connections

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.

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 AAL type 2 traffic parameters that may be used in the AAL type 2 traffic descriptor are defined below.

5.3.2.1 Definition of the maximum allowed CPS packet size

The maximum allowed CPS packet size M_{cps} is expressed in bytes. 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 M_{cps} .

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 characterize an AAL type 2 rate and the associated burstiness.

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

- a CPS byte rate expressed in byte/s;
- a CPS token bucket size expressed in bytes.

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 PR_{cps} expressed in byte/s;
- a CPS token bucket size BP_{cps} associated with PR_{cps} ; BP_{cps} is expressed in bytes.

A traffic flow is within the peak CPS byte rate PR_{cps} if it passes a token bucket or GBRA with rate PR_{cps} and bucket size BP_{cps} .

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 SR_{cps} expressed in byte/s;
- a CPS token bucket size BS_{cps} associated with SR_{cps} ; BS_{cps} is expressed in bytes.

A traffic flow is within the sustainable CPS byte rate SR_{cps} if it passes a token bucket or GBRA with rate SR_{cps} and bucket size BS_{cps} .

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 characterize the traffic. Source traffic type for an AAL type 2 connection is an information that indicates that the source usually does not send with its peak CPS byte rate. The source traffic type also gives details as to what extent the connections sustainable CPS byte rate lies below the peak byte rate when sustained over many such connections with the same source traffic type. A source traffic type is an element of the source traffic type set. More information on the source traffic type set is contained in Appendix III. All source traffic type values in the source traffic type set should meet the following requirement: It is possible to determine independently of the behaviour of other connections whether a connection matches a specified source traffic type.

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 PR_{cps} and CPS token bucket size BP_{cps} as specified for the GBRA and TB in 5.3.2.2.1.
- The maximum allowed CPS packet size M_{cps} 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 fulfils 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 fulfils 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 fulfils 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 GBRA's 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 controls 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 utilization.

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. For example, 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 the 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

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.

NOTE 1 – Both parameters do not include the CPS packet headers.

On the other hand, this Recommendation defines the rate PR_{cps} (in byte/s) and the maximum allowed CPS packet size M_{cps} (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 the one hand and the parameters PR_{cps} and M_{cps} on the other, 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:

$$PR_{cps} = \frac{\text{maximum CPS SDU bit rate}}{8} + \frac{3[\text{bytes}]}{T}$$

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

This relationship is illustrated in two examples:

Example 1:

For a compressed speech AAL type 2 speech connection with $T = 20 \text{ ms} = 0.02 \text{ s}$, one gets

$$PR_{cps} = \frac{\text{maximum CPS SDU bit rate}}{8} + 150[\text{byte/s}]$$

Example 2:

For a 64 kbit/s transparent data connection that sends 40-byte CPS-SDUs every 5 ms, one gets that $T = 0.005 \text{ s}$ and

$$PR_{cps} = \left(\frac{64000}{8} + \frac{3}{0.005} \right) [\text{byte/s}] = 8600 [\text{byte/s}]$$

NOTE 2 – Such a relationship between the average CPS-SDU bit rate and an average CPS packet byte rate does not hold.

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

Appendix II

Guidelines for choosing AAL 2 parameter values for connections with control frames

Clause 5.3.2/I.378 defines the following traffic parameters:

- the maximum allowed CPS packet size M_{cps} ;
- the peak CPS byte rate PR_{cps} ;
- the CPS token bucket size BP_{cps} associated with the peak CPS rate;
- the sustainable CPS packet byte rate SR_{cps} ;
- the CPS token bucket size BS_{cps} associated with the sustainable CPS rate.

In 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, for example, when the user plane protocol (see [8]) 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 AAL 2 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 value 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 necessary 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.

Appendix III

Information on the source traffic type and source traffic type set

In 5.3.2.3, a source traffic type is defined. In 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 AAL type 2 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.

The supported source traffic types are elements of a specified source traffic type set. From the CAC viewpoint, it is preferable to keep the source traffic type set small and therefore to define only a small number of different source traffic types. Only source traffic types should be used for which it is possible to determine, independently of the behaviour of other connections, whether a connection matches the source traffic type chosen by the connection. Whether a connection matches the source traffic type could be determined by using test equipment, for example.

The set of source traffic types is defined by ITU-T in this Recommendation. It may be enlarged in the future if new source traffic type values are identified that fulfil the following conditions:

- they apply to a significant portion of AAL 2 connections;
- they meet the above requirements for source traffic types;
- their introduction helps to increase the AAL 2 network efficiency.

Two elements of an initial source traffic type set are:

- source traffic type unknown;
- AMR coded speech

In cases where the value "Source traffic type unknown " is chosen for a VBW-S connection, the CAC should assume the worst case, which is that the connection transmits with the specified peak CPS byte rate all the time.

The value "AMR coded speech" may be used for AAL type 2 connections that carry AMR coded speech (see [9], [10], or [7]). 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.

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