The ATM Forum

Technical Committee

Audiovisual Multimedia Services :Video on Demand Specification 1.1

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ANNEXES

Introduction

Purpose

This document specifies the ATM Forum's Implementation Agreement for the carriage of audio, video, and data over ATM in support of Audio-visual Multimedia Services (AMS).

Scope

This Implementation Agreement addresses the carriage of MPEG-2 bit streams over ATM.

Phase 1 of this specification specifically addresses the requirements of Video on Demand using Constant Packet Rate (CPR) MPEG-2 Single Program Transport Streams (ISO/IEC 13818-1).

Phase 1 specifies:

- AAL requirements.
- the encapsulation of MPEG-2 Transport Streams into AAL-5 PDUs.
- the ATM signaling and ATM connection control requirements.
- the traffic characteristics.
- the Quality of Service characteristics.

The service profiles provide information on:

- Reference models for the service
- Parameter values for the carriage mechanism for the provision of the service.

This phase 1 specification will provide informational material on Service Profiles; i.e., VoD in phase 1. Later phases may include other retrieval services, conversational services, and high-quality broadcast.

Document Organization

Section 1 provides introductory material on scope, purpose, terminology and references. Section 2 provides information about the Video on Demand service. Section 3 provides information about the Video on Demand service configuration and scenarios expected. Section 4 specifies the System Structure / Protocol Reference Model. Section 5 specifies the Network Adaptation. Section 6 specifies the traffic parameters used . Section 7 specifies the QoS parameters used. Section 8 provides information and specifications on connection control. Section 9 provides information concerning session control.

Informative Annexes are provided on jitter, example networks, relating AMS QoS parameters to ATM layer QoS parameters, Cell Delay Variation Tolerance, proxy signaling capability , VoD service attributes and interim signaling arrangements.

Each following section of the document (after section 1) is marked as [Informative] or [Normative]. Compliance with this specification requires compliance with the sections marked as [Normative].

Terminology

Acronyms

AAL..............................ATM Adaptation Layer
ADSL...........................Asymmetric Digital Subscriber Loop
AMS ....Audio-visual Multimedia Services
ATM ....Asynchronous Transfer Mode

BICI ....Broadband Inter-Carrier Interface

CBR.............................Constant Bit Rate
CDV.............................Cell Delay Variation
CER.............................Cell Error Rate
CLR.............................Cell Loss Ratio
CMISE ....Common Management Information Service Element
CPCS...........................Common Part Convergence Sublayer
CPR.............................Constant Packet Rate
CTD.............................Cell Transfer Delay

DSM-CC.......................Digital Storage Media Command and Control
DSM-CC U-N................DSM-CC User to Network
DSM-CC U-U................DSM-CC User to User

ECBR...........................Errored Cell Block Rate

FTTC ....Fiber To The Curb
FTTH ....Fiber To The House

GCRA ....Generic Cell Rate Algorithm

IE ....Information Element(s)
ILMI ....Interim Local Management Interface
IWU.............................Inter Working Unit

HDT ....Head-end Distribution Terminal
HFC ....Hybrid Fiber/Coax

LEC.............................Local Exchange Carrier

MECBC.........................Maximum Errored Cell Block Count
MPEG ....Moving Pictures Experts Group
MPEG2-PCR................MPEG-2 Program Clock Reference

NPC ....Network Parameter Control
NSAP...........................Network Service Access Point
NVoD...........................Near Video-on-Demand

ONU ....Optical Network Unit
OSI..............................Open Systems Interconnection

PC ....Personal Computer
PCI ....Protocol Control Information
PCR.............................Peak Cell Rate

PDU ....Protocol Data Unit
PDV ....PDU Delay Variation
PES ....Packetized Elementary Stream
PS ....Program Stream
PSA ....Proxy Signaling Agent

QoS ....Quality of Service

ROT ....Receive Only Terminal

SAAL...........................Signaling ATM Adaptation Layer
SAP ....Service Access Point
SAR.............................Segmentation And Reassembly
SC ....Service Component
SDU ....Service Data Unit
SECBR..........................Severely Errored Cell Block Ratio
SNMP..........................Simple Network Management Protocol
SOT.............................Send Only Terminal
SPTS ....Single Program Transport Stream
SSCF...........................Service Specific Convergence Function
SSCOP..........................Service Specific Connection Oriented Protocol
STT ....Set Top Terminal

TCP/IP ....Transport Control Protocol / Internet Protocol
TS ....Transport Stream

UDP/IP.........................User Datagram Protocol / Internet Protocol
U-N..............................User to Network
UNI..............................User to Network Interface
UPC.............................Usage Parameter Control
U-U..............................User to User

VC...............................Virtual Connection
VIP..............................Video Information Provider
VoD.............................Video-on-Demand
VPCI............................Virtual Path Connection Identifier
VPI..............................Virtual Path Identifier

Definitions

MPEG-2 ....ISO/IEC 13818-x series specifications

Session.........association between two or more users, providing the capability to group together the resources needed for an instance of a service

SPTS ....A Single Program Transport Stream is an MPEG-2 compliant transport stream that contains a single program. Because it contains only a single program, an SPTS is referenced to a single time base. The time base is encoded into the SPTS using MPEG2-PCRs. An SPTS may contain multiple elementary streams. If the elementary streams require synchronized presentation, they reference the single timebase provided by the common MPEG2-PCRs.

Data Unit Naming Convention

The data unit naming conventions are adopted from Annex A/ I.363 [8].

Related Documents

Normative References

[1] ATM Forum, "ATM User-Network Interface Specification 3.0"

[2] ATM Forum, "ATM User-Network Interface Specification 3.1"

[3] ATM Forum, "Signaling 4.0 Specification"

[4] ATM Forum, "Traffic Management 4.0 Specification"

[5] ISO/IEC IS 13818-1 | ITU-T Recommendation H.222.0 , "Information Technology - Generic Coding of Moving Pictures and Associated Audio - Part 1: Systems "

[6] ITU-T Recommendation H.222.1, "Multimedia Multiplex and Synchronization for Audiovisual communication in ATM environments"

[7] ITU-T Recommendation H.310, "B-ISDN Audiovisual Communications Systems and Terminals"

[8] ITU-T Recommendation I.363, "B-ISDN ATM Adaptation Layer (AAL) Specification"

[9] ATM Forum, "Native ATM Services: Semantic Description, Version 1.0"

[10] ISO/IEC DIS 13818-6 , "Information Technology - Generic Coding of Moving Pictures and Associated Audio - Part 6: MPEG-2 Digital Storage Media - Command and Control (DSM-CC) "

[11] ISO/IEC IS 13818-2 | ITU-T Recommendation H.262 , "Information Technology - Generic Coding of Moving Pictures and Associated Audio - Part 2: Video "

[12] ISO/IEC IS 13818-3, "Information Technology - Generic Coding of Moving Pictures and Associated Audio - Part 3: Audio

[13] ITU-T Recommendation E.164, "Numbering Plan for the ISDN Era"

[14] ITU-T Recommendation F.722, "Broadband Videotelephony Services"

[15] ITU-T Recommendation I.211, "Integrated Services Digital Network General Structure and Service Capabilities - B-ISDN Service Aspects".

[16] ITU-T Recommendation H.245, "Line Transmission of Non-Telephone Signals - Control Protocol For Multimedia Communication"

[17] ITU-T Recommendation Q.2931, "B-ISDN DSS2 UNI Layer 3 Specification for Basic Call/Connection Control"

[18] ITU-T Recommendation I.356, "B-ISDN ATM Layer Cell Transfer Performance"

[19] ITU-T Recommendation I.371, "Traffic Control and Congestion Control in B-ISDN".

[20] ITU-T Recommendation Q.2110, "B-ISDN ATM Adaptation Layer Service Specific Connection Oriented protocol (SSCOP)"

[21] ITU-T Recommendation Q.2130, "B-ISDN SAAL Service Specific Co-ordination Function for Support of Signaling at the User to Network Interface(SSCF at UNI)"

[22] ITU-T Recommendation X.224 "Transport Layer protocol Specification"

[23] Digital Audio Visual Council, "DAVIC 1.0 Specification", Revision 3.1

[24] ISO/IEC IS 11172-3 "Information Technology-Coding of Moving Pictures and Associated Audio for digital Storage Media at up to about 1.5Mbit/s - Part 3 Audio.

Video-on-Demand Service Definition and Description [Informative]

This specification is in support of the DAVIC 1.0 Specification [23]. This specification is concerned with the interfaces required at the edge of the ATM Network in order to provide the VoD service. This specification is concerned with the ATM aspects of these interfaces.

Definition [Informative]

The Video-on-Demand (VoD) service is an asymmetrical service that involves several connections. VoD provides the transfer of digitally compressed and encoded video information from a server (typically a video server), to a client (typically a Set Top Terminal - STT or PC). At the destination decoder in the STT, the streams are reassembled, uncompressed, decoded, digital to analog converted and presented at a monitor.

General Description [Informative]

Video on demand is a video service where the end user has a pre-determined level of control on selection of the material viewed as well as the time of viewing. Video connections are established on demand via user-network signaling. One implication of this service is that the video program transmission is expected to be predominantly point-to-point from the Video Information Provider (VIP) to the individual user. Additional control features that involve user-user signaling such as 'restart', 'rewind', 'pause' and 'fast forward' may also be available as VoD service features. This implementation agreement does not address these user-user control service aspects.

The VoD service is likely to be used for entertainment purposes to allow subscribers access to a library of programs (e.g., movies) from a digital storage medium repository with a point-to-point connection. The point-to-point connection allows the user some control of the content such as pause, rewind, resume, etc. The most likely networks over which these applications will be provided are the Hybrid Fiber/Coax (HFC) network or a digital baseband network. Note that point-to-multipoint configurations (e.g., NVoD, staggercast etc.) are not considered within the scope of this specification.

The VoD service provides end-to-end communication of video and audio information. This communication will require synchronization of the audio and video streams within the STT. Additionally, MPEG-2 decoding and time base recovery will also be critical.

Annex F provides a table of VoD service attributes.

Video on Demand Service Configuration [Informative]

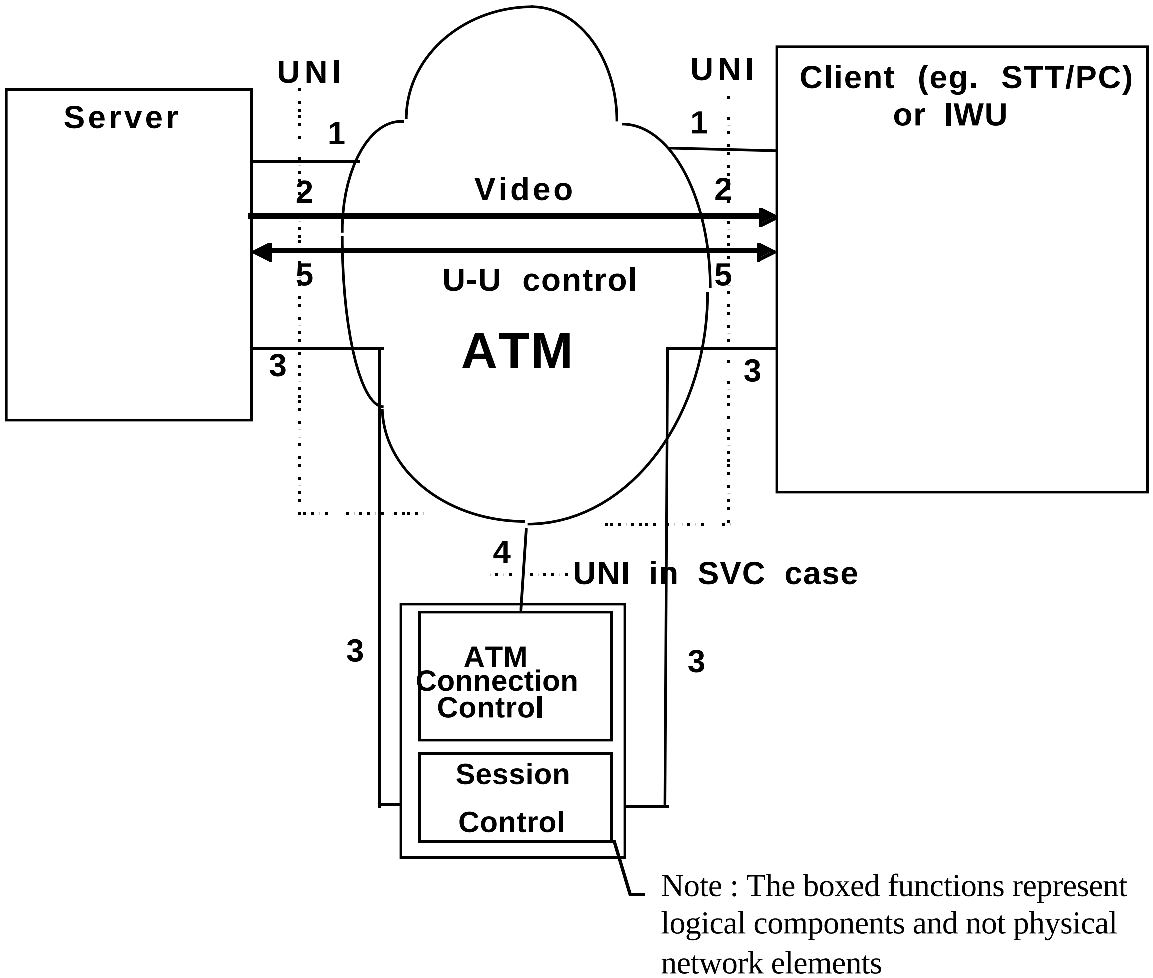


Figure 1 Video on Demand Reference Configuration

Figure 1 shows the reference configuration for the Video on Demand Service. The following interfaces are identified:

1. ATM Control Plane - User-Network Signaling (i.e., [3])
2. ATM User Plane - Principal Information Flow (i.e., MPEG-2 SPTS)
3. ATM User Plane - VoD session control information (e.g., DSM-CC U-N)
4. ATM Control Plane[1] - SVC proxy signaling ATM connection control (i.e., [3])
5. ATM User Plane - User-User control information (e.g. DSM-CC U-U)

As the figure is intended to be general, the following should be taken into account:

- The ATM network may use one (or more) of several different technologies/architectures: Hybrid Fiber-Coax (HFC), Fiber to the Curb (FTTC), Fiber to the Home (FTTH), Asymmetric Digital Subscriber loop (ADSL), SONET, etc.

- Several example network configurations are depicted in Annex B.

[1] Interface 4 would be in the ATM management plane if PVC connection management procedures were used in place of the SVC connection control procedures specified in this specification. PVC procedures are not specified in this specification.

- On the Client side, there may be multiple termination devices on the customer premises.
- This phase 1 specification assumes that multiple servers and multiple clients may be connected to the ATM network. It does not address the jurisdictional aspects of multiple service providers (e.g., Video Information Providers - VIPs).
- This specification recognizes that an IWU may be required to interface between the ATM network and other non-ATM (sub) networks that may exist between the ATM network and the end- user of the VoD service. Such an IWU shall act as a client of the ATM Network. Further definition of the IWU is beyond the scope of this specification.
- A specific implementation may not require all the interfaces identified in Figure 1. Refer to section 8 concerning ATM Connection Control options.
- Interfaces 1-5 identify separate information flows. These information flows are mapped as separate[2] VCs on the Physical UNIs at the interface to the ATM network.
- The figure shows all the ATM interfaces required for one VoD session. Implementations of servers, clients and ATM connection and session control functions may support multiple sessions. In some cases this may require the support of multiple physical UNIs.

The following sections describe the reference configurations from the perspectives of the user plane, control plane and management plane.

User Plane Reference Configuration [Informative]

Interfaces 2,3, and 5 from the reference configuration are in the ATM User Plane. The Protocol Reference Model is described in section 4.1. The client and server VoD architecture as applied to this reference model is described in section 4.2.

The user plane interfaces shall be compliant to [1],[2],[4] or higher level revisions of these specifications. When ATM control plane (signaling) VCs and user plane VCs are used on the same physical UNI, the same revision level of the user plane and control plane specifications shall apply i.e. [3] and [4] apply when signaling VCs are used on the same physical UNI as user plane VCs.

In some cases, physical UNIs may be provisioned that support only the user plane VCs or the control plane VCs, but not both simultaneously. Refer to section 8.

[2] In some applications, it may be feasible to combine the information flows of interface 2 and 5 into one asymmetric, bi-directional VC. The traffic characteristics of such an asymmetric, bi-directional VC are subject to further study.

Control Plane Reference Configuration [Informative]

Interfaces 1 and 4 from the reference configuration are in the ATM Control Plane. Table 1 provides a summary of the different types of connection options available to the implementors of the VoD Service. PVC provisioning and management options are not discussed further in this specification. Hybrid SVC/PVC connection control options are not discussed further in this specification. ATM SVC connection control options are specified in section 8.

Connection /Control Type	**ATM Control Plane Interface (Connection Control)** (Figure 1 interfaces 1 or 4)	
PVC	Not Specified (Management or node specific procedures)	
Hybrid SVC/PVC	SVC Portion	[3]
	PVC Portion	Not Specified (Management or node specific procedures)
SVC	[3]	

Table 1 Control Plane Connection Type Summary

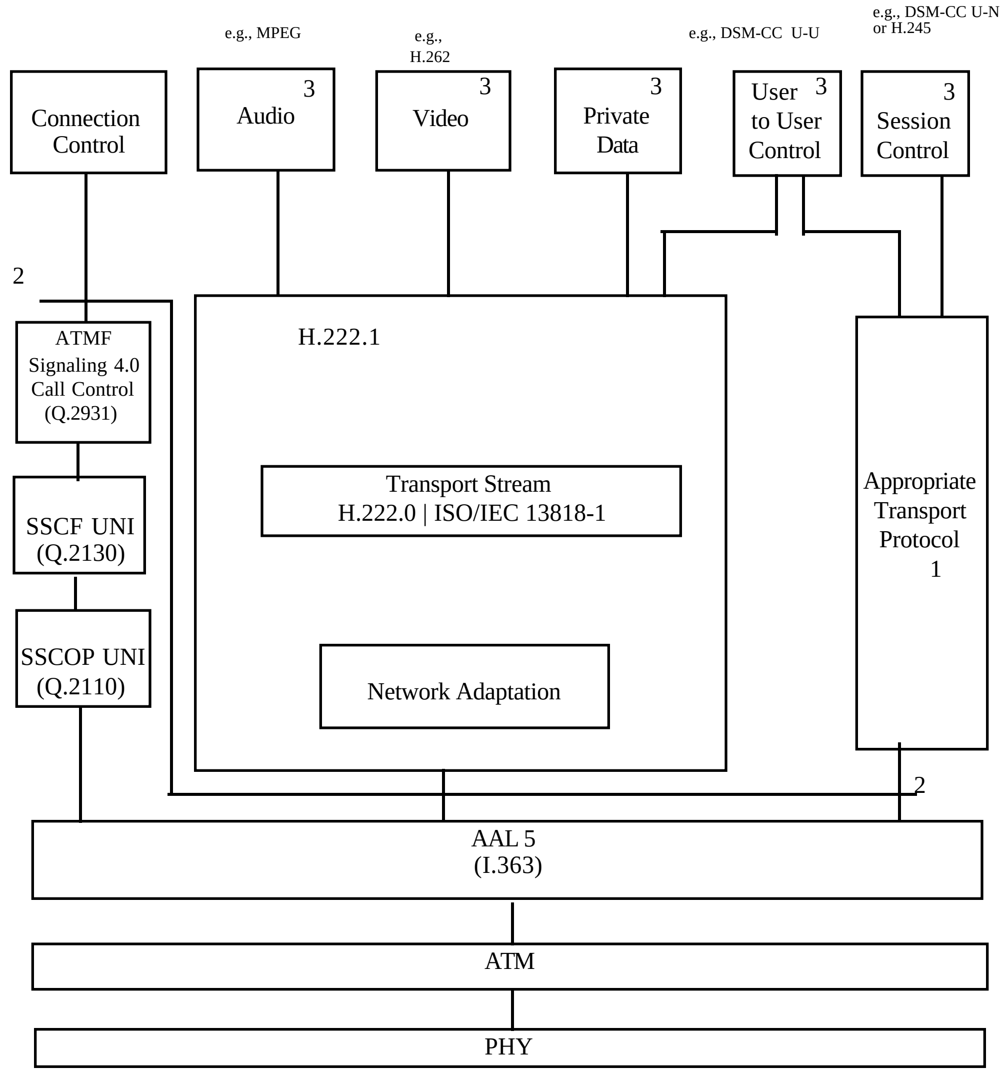
For Phase 1 VoD service, it is expected that the Clients , Servers , ATM connection control and session control are all served by a single carrier network. Thus there are no inter-carrier (BICI) control plane interfaces required.

Management Plane Reference Configuration [Informative]

Management procedures for generalized ATM networks are discussed in other specifications. The CMISE and SNMP (ILMI) protocols have been selected for the control of ATM networks for internal and external network managers respectively. Other groups within the ATM Forum are defining the MIBs to support such functions. (e.g., PVC connection management).

VoD System Structure / Protocol Reference Model [Normative]

VoD Protocol Reference Model [Normative]



Note 1. These operate over an ATM network. Other network types are not precluded, but other network types are beyond the scope of this specification. Selection of a specific transport protocol is beyond the scope of this specification. Examples of appropriate transport protocols for the service selection control protocols include - TCP/IP, UDP/IP, SSCOP[20], X.224[22].

Note 2. See "Native ATM Services: Semantic Description, Version 1.0" document [9] being developed by the ATM Forum SAA/API group.

Note 3. Application interoperability (e.g. H.262 [11], DSM-CC [10], H.245[16], MPEG [12]) is beyond the scope of this specification.

Figure 2 VoD Protocol Reference Model

The Video on Demand service requires the MPEG-2 transport stream (carried over Interface 2) to be constructed as a Single Program Transport Stream [5],[6],[7]. One SPTS shall be mapped into one ATM VC using the AAL-5 and Network Adaptation as described in section 5. Selection of a specific instance of program delivery corresponds to selection of a single ATM VC.

Figure 2 shows the VoD specification 1.0 protocol reference model. The Protocol Reference Model applies to all of the interfaces identified in Figure 1. Individual interfaces are not required to implement all of the options identified in the Protocol Reference Model.

ATM Control Plane Protocol Reference Model [Normative]

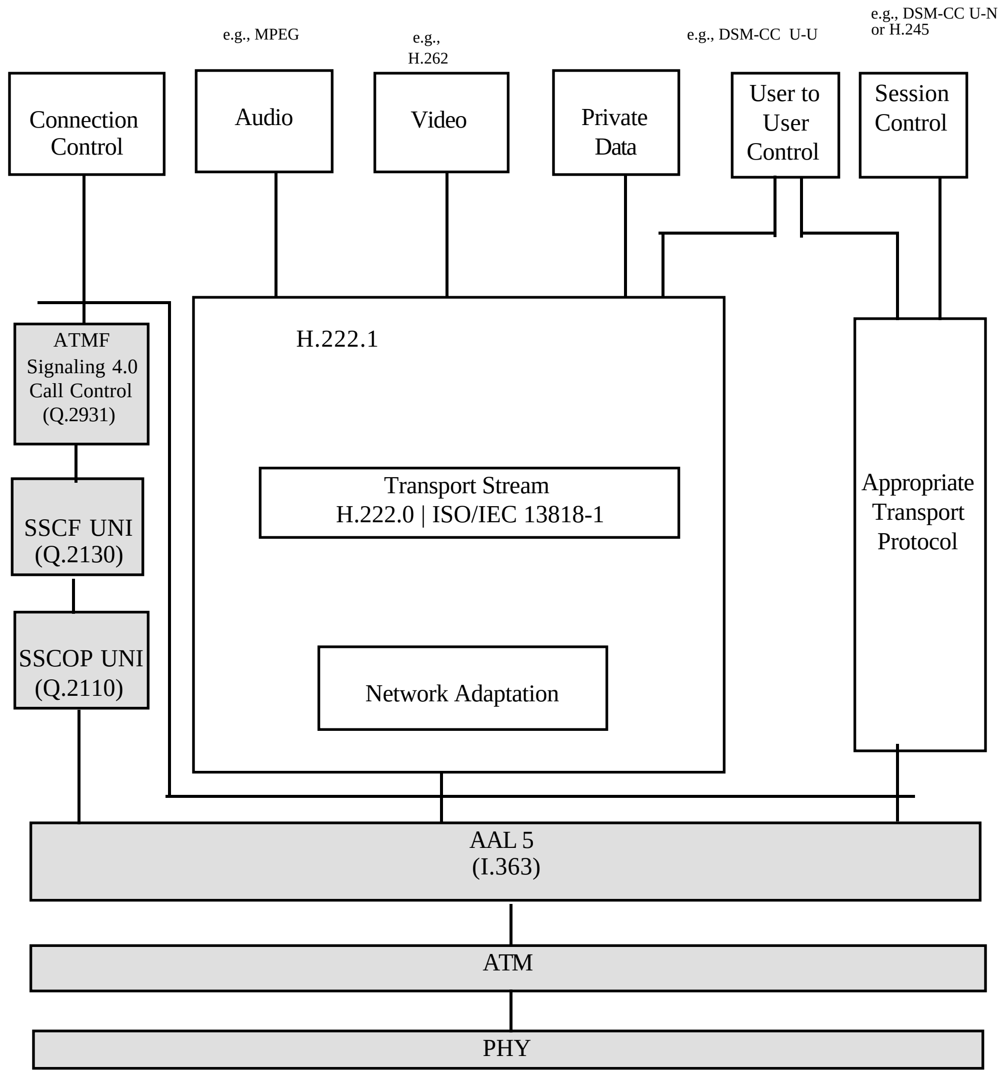
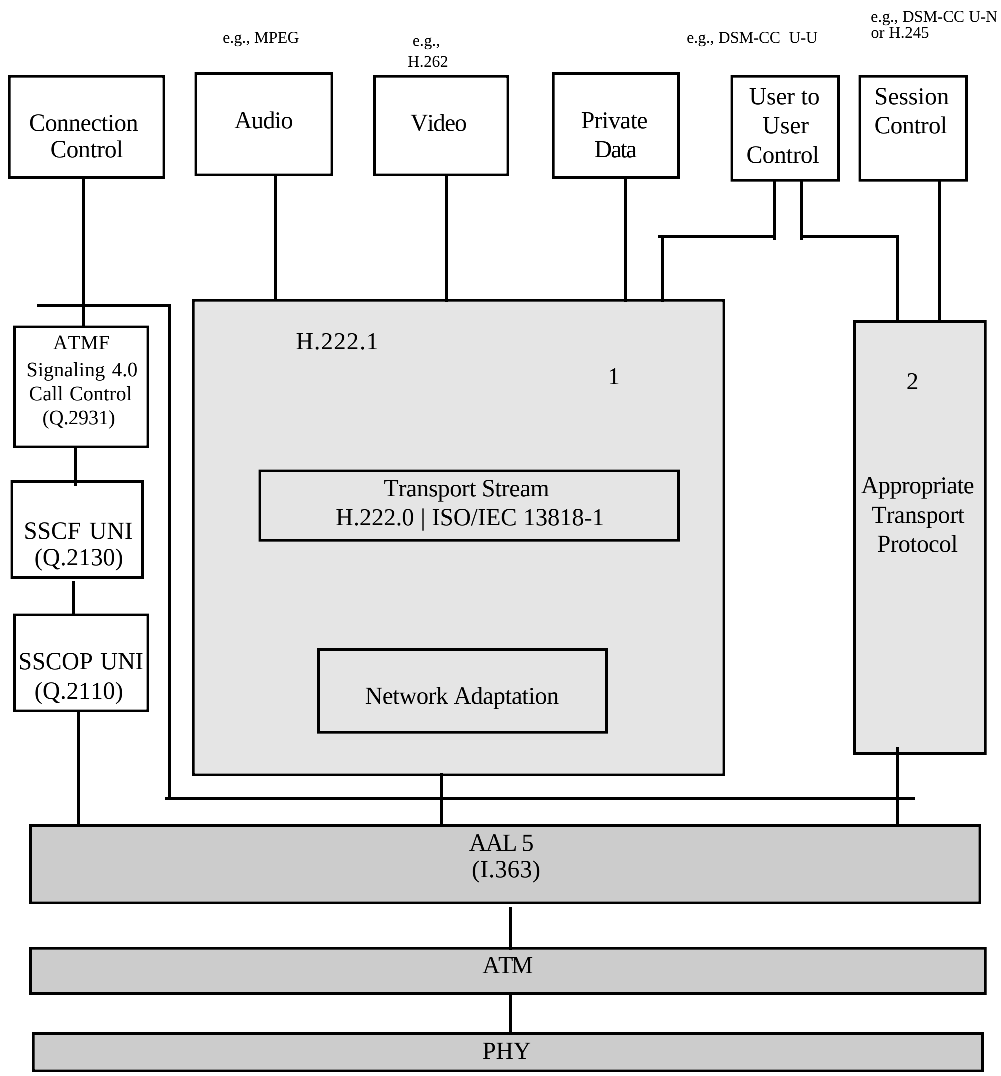


Figure 3 Control Plane Protocol Reference Model

The Interfaces 1 and 4 of the Reference Configuration (Figure 2) are control plane interfaces. These interfaces shall support the shaded protocol stack shown in Figure 3 including SSCOP [20], SSCF [21], Call Control [17] [3].

ATM User Plane Protocol Reference Model [Normative]

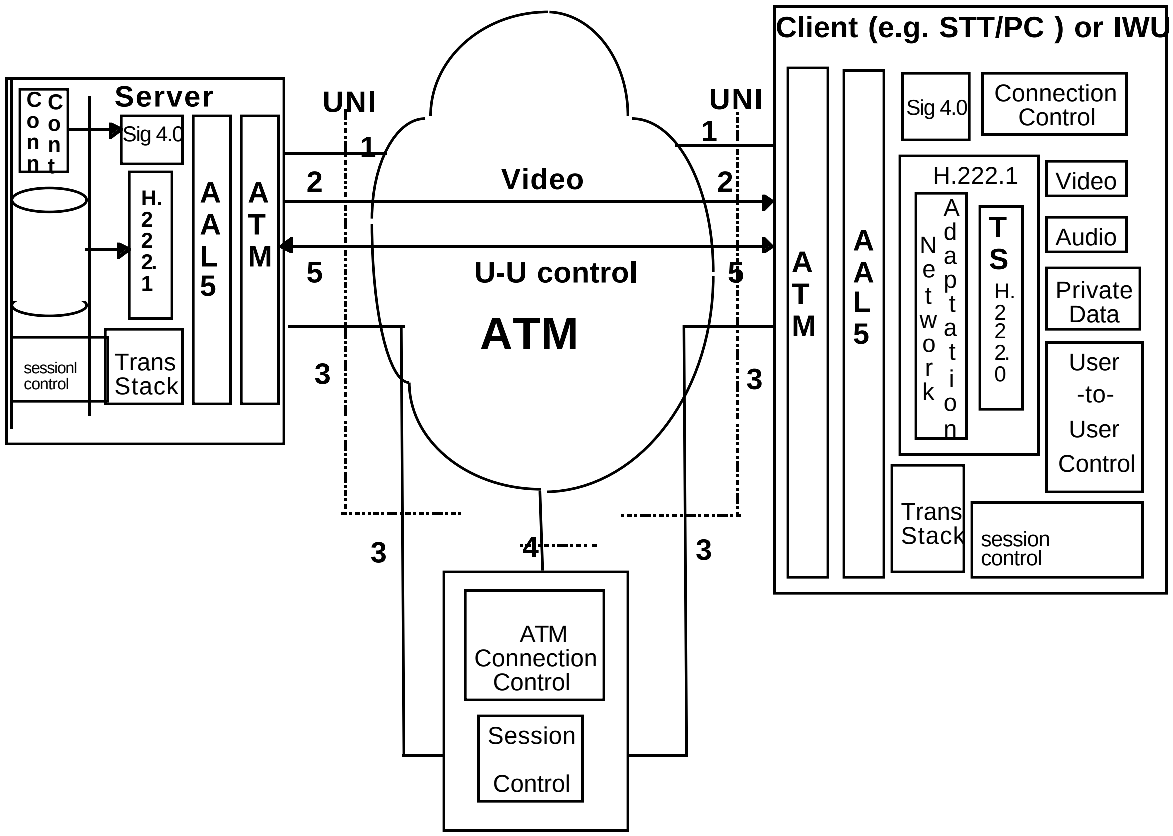
The Interfaces 2,3 and 5 of the Reference Configuration (Figure 2) are ATM user plane interfaces. These interfaces shall support the shaded protocol stacks shown in Figure 4 .



Note 1. H.222.1 network adaptation is required for Interface 2. It is optional for Interface 3 or 5.
Note 2. An appropriate transport protocol is required for Interfaces 3 and 5. This specification does not constrain the choice of an appropriate transport protocol. It is not required to be the same transport protocol used for interface 3 and interface 5. The transport protocol is not required for Interface 2.

Figure 4 User Plane Protocol Reference Model

Client-Server Architecture [Informative]



Note: In the case of an IWU terminating the ATM, the IWU does not necessarily terminate the MPEG-2 SPTS. The MPEG-2 SPTS may be transported to the end user on a different medium. Such interworking arrangements and other media are beyond the scope of this specification.

Figure 5 VoD Protocol Reference Model applied to Reference Configuration

Figure 5 highlights the essential components of the Protocol Reference Model necessary for transmitting stored video across an ATM network. The MPEG-2 data flows from a file system through H.222.1 [6] across an ATM Virtual Circuit (using AAL5) to the target system which may be a client system or IWU.

The information (movies, commercials etc.) is stored in MPEG-2 Single Program Transport Stream (SPTS) format. Since the video and audio information are already compressed and formatted as an MPEG-2 SPTS, no encoder or multiplexer is required to be present at the Server. The metadata associated with the MPEG-2 SPTS is implementation specific and will not be specified in detail in this specification. This metadata may provide information such as :

- identification that the compressed data is CPR MPEG-2 SPTS Format
- the MPEG-2 Bit Rate or Packet Rate
- and any other necessary QoS information

The session control exchange between the Client or the Server and the Session Controller is performed by an out-of-band data exchange (i.e., in a separate VC shown as interface 3 in the reference configuration). This data exchange provides the ATM address and correlation ID (i.e., DSM-CC sessionId or H.245 resource/correlation number). The session control can be implemented by mutual agreement between STT/PC vendors, session control vendors, and the Server application vendors, e.g. using ISO/IEC DSM-CC 13818-6 [16] (presently in Committee Draft Status, scheduled to become Draft International standard in November 1995 and International standard in March 1996).The information is used to establish interface 2 and interface 5 connections between the Server and the Client. The circuit setup is initiated by the Server or Client.

Network Adaptation [Normative]

All equipment conformant with this specification shall support the following network adaptation.

The MPEG-2 Single Program Transport Stream (SPTS) packets shall be mapped into the ATM Adaptation Layer Type 5 (AAL5) with a NULL Service Specific Convergence Sublayer.

In the mapping, one to N MPEG-2 Transport Streams (TS) packets are mapped into an AAL5-SDU.

For Switched Virtual Circuits (SVCs), the value of N is established via ATM Signaling 4.0 at call setup using the AAL5 Maximum CPCS-SDU negotiation procedure. The AAL5 Maximum CPCS-SDU size that is signaled is N*188 bytes (N being the number of TS packets). This procedure is defined in the ATM Forum Signaling 4.0 specification. N used to form the AAL5-SDUs shall be the Maximum CPCS-SDU Size / 188.

For Permanent Virtual Circuits (PVCs), the default value of N is two (Maximum CPCS-SDU size = 376 bytes). Other values of N may be selected by bilateral agreement between the settop user and the server via network provisioning.

Furthermore, in order to insure a base level of interoperability, all equipment shall support N = 2 (CPCS-SDU size = 376 bytes).

In summary, the mapping shall be:

1 Each AAL5-SDU shall contain (the negotiated) N MPEG-2 SPTS packets, unless there are fewer than N packets left in the SPTS. In the case when there are fewer than N packets left in the SPTS, the final CPCS-SDU contains all of the remaining packets.

2 The value of N is established via ATM signaling using N = the AAL5 CPCS-SDU size divided by 188. The default AAL5 CPCS-SDU size is 376 octets, which is two TS packets (N = 2).

3 In order to ensure a base level of interoperability, all equipment shall support the value N=2 (AAL5 CPCS-SDU size of 376 octets).

Base level of N=2 [Normative]

When N=2, the Network Adaptation shall be as follows:

- ATM Adaptation Layer Type 5 (AAL5) with a NULL Service Specific Convergence Sublayer shall be used.

- An AAL5 PDU shall contain two TS Packets unless it contains the last TS Packet of the SPTS.
- An AAL5 PDU shall contain one MPEG2 SPTS Packet if that MPEG-2 TS Packet is the last *TS* Packet of the SPTS.

When an AAL5 PDU contains two SPTS Packets, which have length 188 octets, the AAL5 CPCS-SDU has length 376 octets. This AAL5 CPCS-SDU, together with the CPCS-PDU Trailer of 8 octets, requires 384 octets and maps into 8 ATM cells with zero CPCS padding octets. This is illustrated Figure 6.

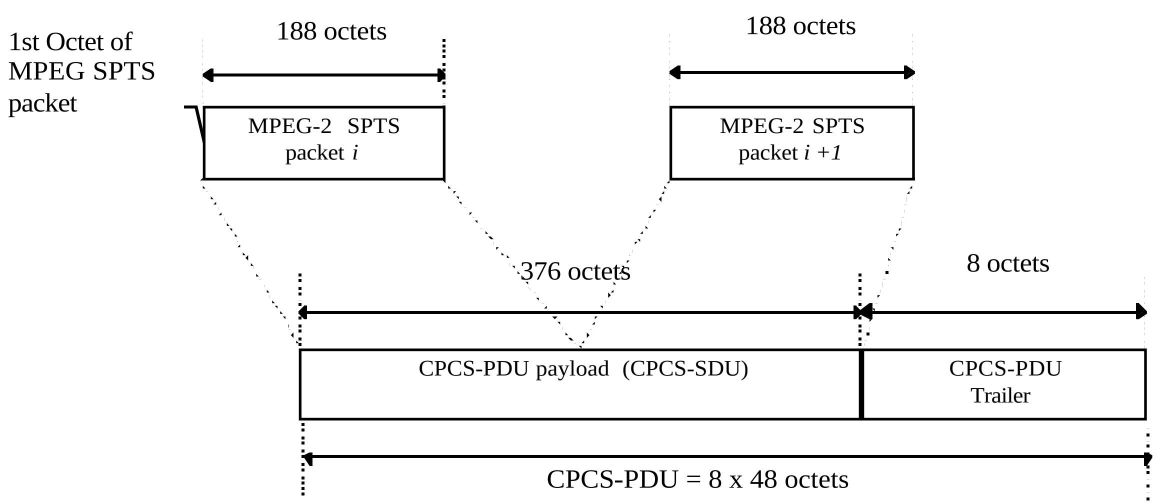


Figure 6 Format of AAL-5 PDU Containing 2 TS Packets

AAL-5 Action on Corrupted PDUs [Normative]

When a receiver receives a corrupted AAL5 CPCS-PDU that has a correct length field, system performance may be improved by passing the corrupted data, together with an indication that it is corrupted, from the adaptation layer to the demultiplexer layer, rather than simply discarding the data in the adaptation layer. This is an end station implementation option [8].

Traffic Parameters [Normative]

Interfaces/ Connections Summary [Informative]

Interfaces 1 through 5 from Figure 1 may be mapped as separate VCs. The Interface 2 and Interface 5 information flows may be combined into one asymmetric VC.

Interface 1 is the VC reserved for normal SVC signaling operations at the UNI. Information concerning the traffic description of this VC is provided in [3].

Interface 2 is the VC(s) that will carry the principal information flow(s)(i.e. MPEG-2 SPTS). The following sections provide further information on the traffic characteristics of this VC.

Interface 3 is an ATM User plane VC that carries Session Control information. The traffic description of this interface is implementation specific. In the absence of specific application information concerning Interface 3, implementors may wish to consider using the traffic description of other signaling VCs (e.g. that provided [3]).

Interface 4 is the VC(s) used for ATM Proxy Signaling connection control (as specified in the [3]). Information concerning the traffic description of this VC is provided in [3]. Note that additional bandwidth may be required to accommodate the signaling when the PSA acts for many end points.

Interface 5 is one or more VC(s) for User to User control information. The traffic description of this interface is implementation specific. In the absence of specific application information concerning Interface 5, implementors may wish to consider using the traffic description of other signaling VCs (e.g. that provided [3]).

ATM Layer Traffic Description [Normative]

The following sections provide information on the traffic description for Interface 2 connections.

Relationship between the MPEG-2 SPTS rate and ATM cell rate [Informative]

The source MPEG-2 SPTS is considered a CPR stream of information. After network adaptation, the resulting cell stream shall use the ATM layer traffic descriptor of CBR.

Consider a MPEG-2 SPTS with a Transport Stream rate of M packets per second.

Using the default mapping exclusively then -

ATM layer Peak Cell Rate = 4*M cells per second.

ATM Layer Traffic Shaping [Normative]

Traffic at the egress of the server shall be shaped to conform to the CBR traffic contract negotiated with the ATM network. Note that traffic shaping is required to occur on a per VC basis by [19] and [4].

ATM Layer Traffic Contract Parameter - $CDV_{tolerance}$ [Normative]

In the traffic contract, some jitter of the cell interval from the theoretical arrival time derived from the Peak Cell Rate is permitted. Annex A provides some discussion of potential sources of jitter for this application. The Generic Cell Rate Algorithm (GCRA) provides a constraint on the amount of such jitter where the network performs policing functions (i.e. UPC and NPC functions). The maximum allowable jitter is specified in the $CDV_{tolerance}$ parameter of the UPC/NPC function in the network.

Server implementations may introduce some CDV on the cell stream (e.g. due to cell multiplexing of multiple VCs onto a single physical UNI. The network operator shall specify the $CDV_{tolerance}$ parameter value (s) that apply to the VCs at the server interface. The VCs from the server shall comply with the negotiated traffic contract or else the network may discard cells in accordance with the GCRA policing mechanism identified in [4].

Server implementors should note that the value of the $CDV_{tolerance}$ parameter specified by the network operator includes delay variation (jitter) terms due to ATM layer operations and also PHY layer operations. Refer to Annex A for further information on jitter terms. Refer to Annex D for further information on the traffic description and selecting values of the $CDV_{tolerance}$ parameter.

Quality of Service Parameters [Normative]

ATM Layer QoS Parameters [Normative]

Delay Parameters [Normative]

There are two delay parameters to be specified:

- peak-to-peak-CDV
- maximum CTD

These parameters are defined in [4] as negotiated parameters for the CBR service category. The peak-to-peak CDV parameter provides information on the delay variation (jitter) of ATM cells as seen by the receiving end of an ATM connection. Set Top Terminal implementors are cautioned that jitter terms due to processing above the ATM layer (e.g., due to Network Adaptation processes) may also apply. Refer to Annex A for additional information on jitter terms.

The peak-to-peak CDV parameter should not be confused with the $CDV_{tolerance}$ parameter associated with the per VC UPC functions of the ATM network. The $CDV_{tolerance}$ parameter is not a negotiated parameter. Annex D provides additional information on selection of specific values of the $CDV_{tolerance}$ parameter.

Accuracy and dependability parameters [Normative]

There are three accuracy and dependability parameters to be specified :

- Cell Loss Ratio (CLR)
- Cell Error Ratio (CER)
- Severely Errored Cell Block Ratio (SECBR)

Annex C shows the relationships of the two accuracy and dependability parameters (ECBR, MECBC) to these ATM layer parameters. These parameters are defined in Appendix A of [1],[2] and [4]. In [4], CLR is a negotiated parameter . CER and SECBR are not negotiated parameters and their values are specified by service contracts or other means. CLR may be indicated as a QoS class or as a QoS parameter.

Connection Control [Normative]

Between the VoD Server and the VoD Client (or IWU), VC(s) shall be established for the U-U control and video (interfaces 2 and 5 of the reference diagram). These can be either PVC(s) or SVC(s).

SVCs are established through the ATM network by control plane signaling. The control plane signaling uses [3].

PVCs are established through the ATM network by management plane procedures . These procedures are out of the scope of this specification.

Network Assumption [Normative]

For Phase 1 VoD, it is expected that the clients , servers and ATM connection control and session control are all served by a single carrier network. Thus there are no inter-carrier (BICI) interfaces required.

SVC(s) Connection Setup Capabilities [Normative]

SVC(s) shall be established based on one of the following approaches in compliance with [3]:

- call/control without PSA assistance (also called : first party)
- proxy signaling
- combinations of the above

An out-of-Band service selection and control (session management) protocol such as ISO/IEC MPEG-2 DSM-CC User-to-Network messages or H.245 shall be used. Such protocols exchange messages through the user plane of ATM and AAL-5. This specification provides the ATM connection control functions which DSM-CC User-to-Network messages require for its session management in the ATM network. If DSM-CC is used, then session control may be used to obtain the necessary information for connection establishment.

First Party Connection Reference Model [Informative]

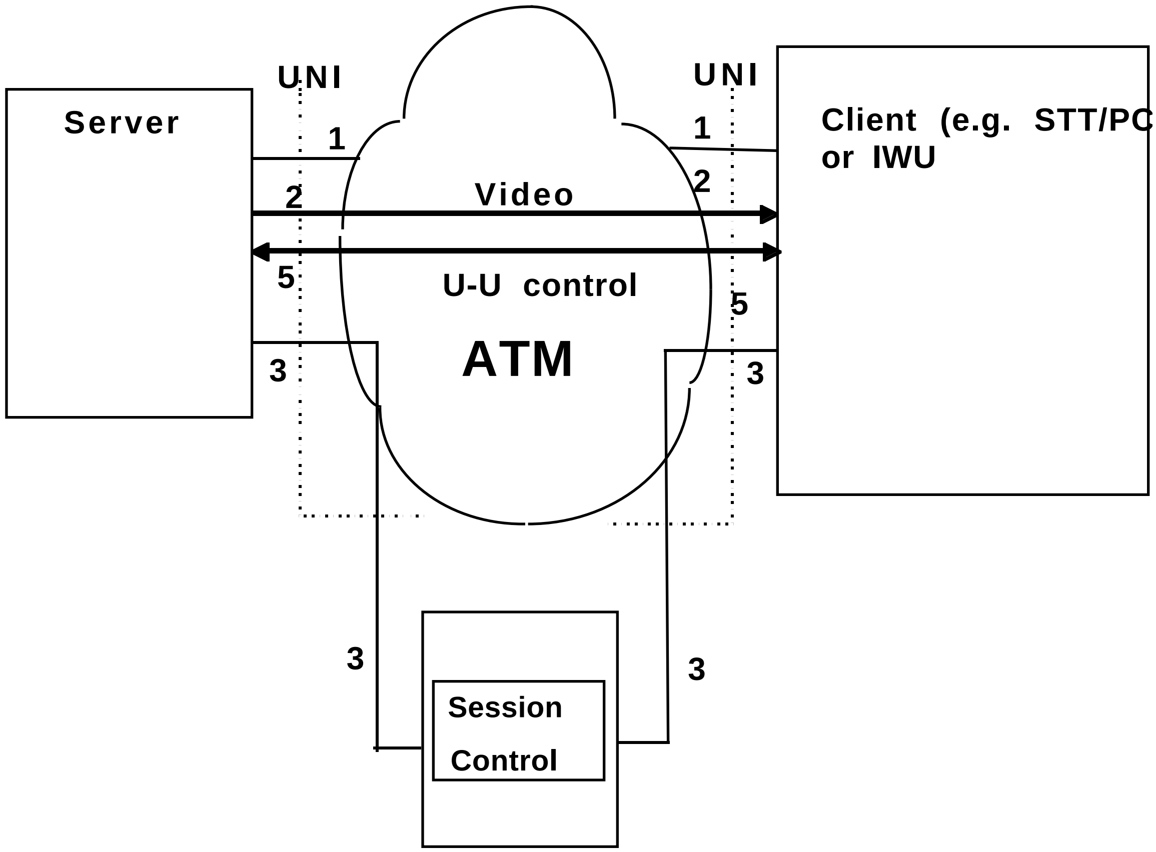


Figure 7 First Party Connection Reference Model

First party call setup uses the basic call /control procedure as defined in [3]. Figure 7 shows the connection control reference model for the first party case. In this case, ATM connections are requested directly by the servers and client equipment. There is no proxy agent to provide ATM connection control.

Proxy Signaling Connection Model [Informative]

Two stages are involved in VoD connection scenario:

I. Server (Video Information Provider) Selection
II. Program (e.g. movie) selection

For the server selection , the client interacts with a session controller (e.g., Level-1 Gateway) using Interface 3. During session control message exchanges, the session controller offers the client a list (menu) of servers (VIPs) to select from. Upon selection of a server (by the user), the server is informed of this session request. When the server agrees to establish the session, session controller instructs the ATM connection controller to establish an ATM connection between the client and the server. The ATM connection controller then signals the ATM network to establish a virtual connection.

The program selection takes place by means of client - server control messages in the ATM user plane via interface 5. This implies that the VC for interface 5 connection shall be established prior to any VC for interface 2.

The signaling interface between the ATM connection controller and the ATM network is [3]. It should be noted that the ATM connection controller will act on behalf of the client and /or the server to establish ATM connections between these two parties.

The interface between both the client and the server to the network is a UNI without signaling capability. PVCs are assumed to be provisioned between the end-user and the session controller, and between the server and the session controller to carry session control messages for establishment of a session between the client and the server.

Implementations of the ATM Connection Control function may be distributed across several network elements. This may be appropriate for ease of administration and/or to allow for significant differences in the network segments. Decisions on when to distribute ATM connection control functions are implementation specific. In the case of a distributed implementation of the ATM connection control function, the individual instances shall act as independent PSAs or collections of independent PSAs. Each PSA shall act in compliance with [3]. Refer to Annex E for further information on PSAs. In addition to the details provided in [3], additional study is required to determine the proper protocol and procedures to allow UNIs controlled by failed PSAs or signaling links to continue to be controlled during such outages.

The general proxy signaling model can be refined into some simpler scenarios:

- neither Server nor Client support signaling
- Server supports signaling, but Client does not.
- Client supports signaling, but Server does not

The case where a client or server has the capability for signaling, but chooses not to support it for specific operations, is implementation specific.

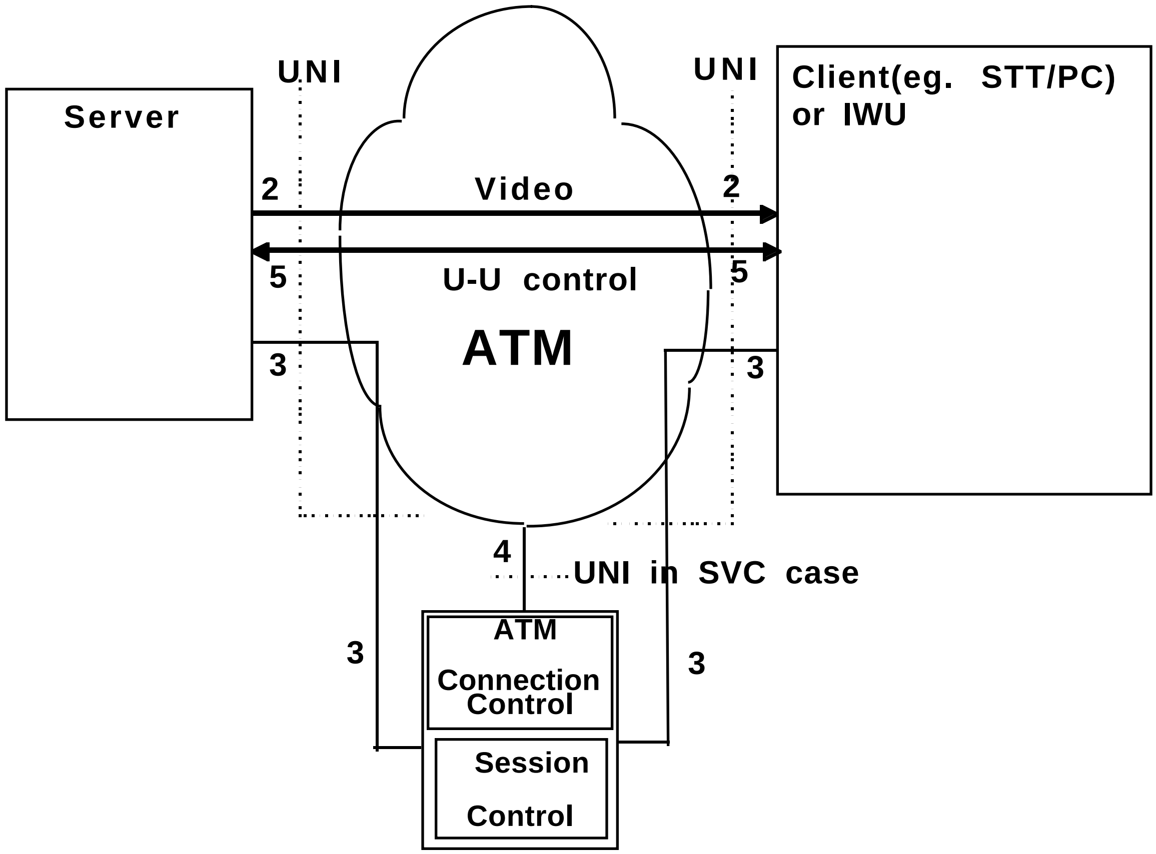


Figure 8 proxy signaling when neither Server nor Client support signaling

Figure 8 shows the proxy signaling reference model in the case when neither Server nor Client support signaling. In this case there is no interface 1 between the Server or Client and the network.

Proxy Signaling when Server supports signaling, but Client does not [Informative]

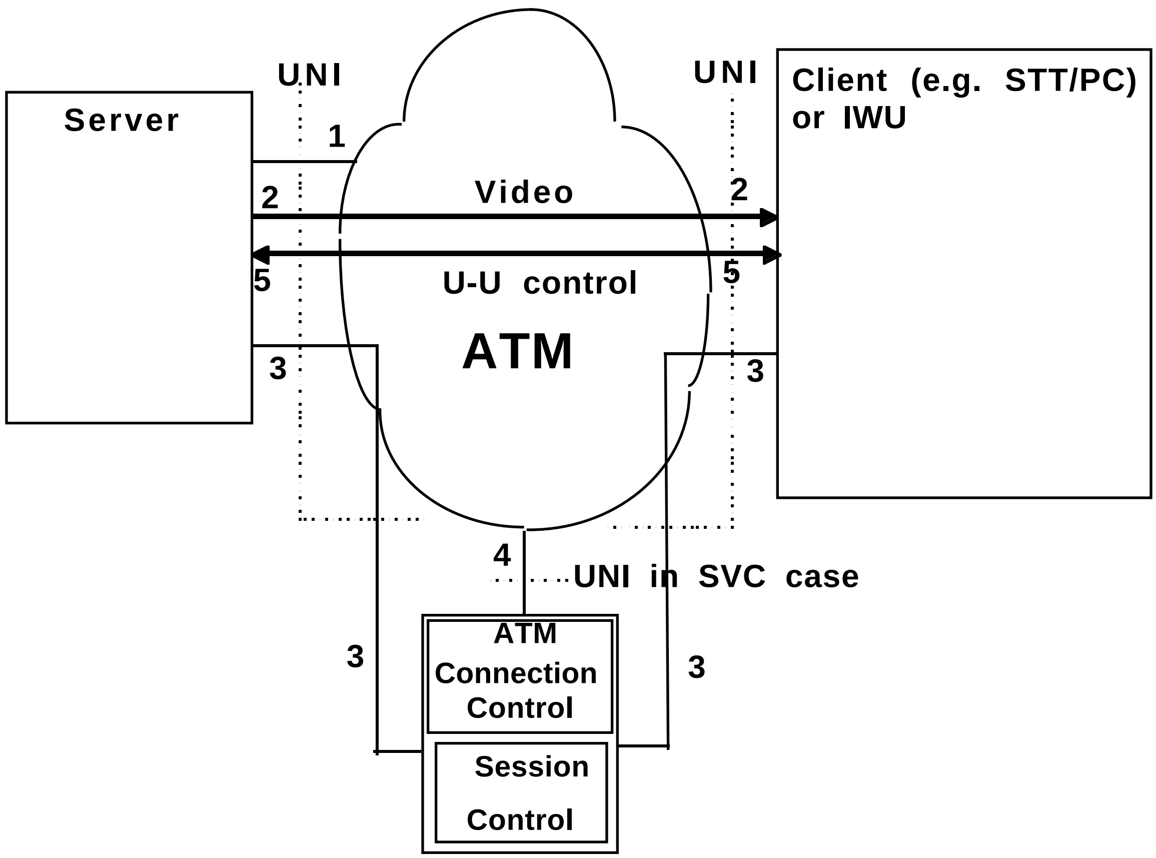


Figure 9 Proxy Signaling when Server supports signaling, but the client does not

Figure 9 shows the proxy signaling reference model in the case when Server supports signaling, but the Client does not. In this case there is no interface 1 between the Client and the network.

Proxy Signaling when Client supports signaling, but Server does not. [Informative]

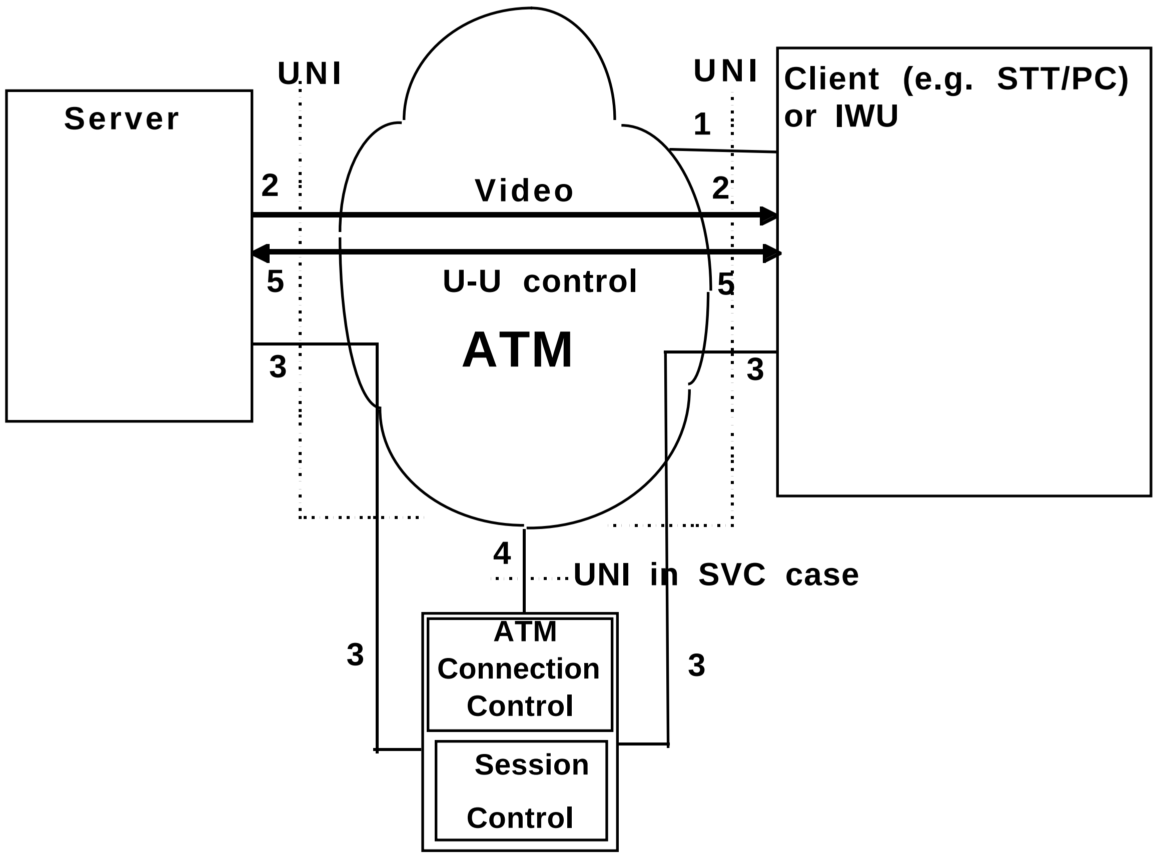


Figure 10 Proxy signaling when the Client supports signaling, but the server does not.

Figure 10 shows the proxy signaling reference model in the case when Client supports signaling, but the Server does not. In this case there is no interface 1 between the Server and the network.

ATM Signaling Requirements **[Normative]**

[3] has the capability to indicate/negotiate:

- Asymmetrical upstream and downstream bandwidth requirements
- Constant Bit Rate (CBR) operation
- The AAL5 Maximum CPCS SDU size. The maximum number of MPEG-2 TS packets per AAL-5 PDU can be easily derived from this.

In addition, the following signaling parameters are needed by the VoD application and shall be passed through both private and public ATM networks:

- QoS Parameters (as individual parameters or QoS Class parameters)
- Generic Identifier Transport I.E. is a parameter that indicates the correspondence of the VC to a certain previously established request carried outside ATM signaling

Interfaces / Connections [Informative]

Interfaces 1 through 5 from Figure 1 may be mapped as separate VCs. One Interface 2 connection and one Interface 5 connection may be established as a single asymmetric VC.

Interface 1 is the VC reserved for normal SVC signaling operations at the UNI. The information elements required to establish or release other VCs required for the service (e.g., Interface 2, 5) shall be sent over this interface according to the procedures of [3]. This signaling VC is provisioned at subscription time for the Client or Server.

Interface 2 is the VC that will carry the User-to-User information (i.e. MPEG-2 SPTS). The following sections provide further information on the information elements required to establish this VC. This VC is established last.

Interface 3 is an ATM User plane VC that carries Session Control information. This VC may be established by PVC or SVC operations. If SVC operations are used to establish the VC, the information elements and procedures of [3] be used. This VC is established prior to any VCs corresponding in Interface 2 or 5.

Interface 4 is the VC(s) used for Proxy Signaling (i.e., ATM connection control). This shall be identified as a signaling VC on the UNI between the ATM network and the network element performing the ATM Connection Control function. The information elements required to establish or release other VCs required for the service (e.g., Interface 2, 5) shall be sent over this interface according to the procedures of [3]. Note that additional provisioning information is required in the ATM network for interface 4 (compared to Interface 1). Refer to Annex E for further information. This signaling VC is provisioned when the PSA/ATM Connection controller is deployed. The PSA must be re-provisioned to accommodate changes in the Clients and Servers that are served by the PSA. Some Implementations of Interface 4 may carry the signaling for many end points. In order to increase the reliability of the VoD service delivery , implementors may wish to implement some form of redundancy at this interface. Interface 4 redundancy may be implemented at the physical layer (e.g. SONET 1+1 Automatic Protection Switching) or at a higher layer. Selection of a particular redundancy scheme is beyond the scope of this specification.

Interface 5 is one or more VC(s) for User to User control information. When required by the service, Interface 5 should be established using the same control technique (SVC or PVC) as the Interface 2 VC. When SVC operations are used to establish VCs for Interface 5, the information elements and procedures from [3] shall be used. This VC shall be established prior to any VC corresponding to Interface 2. The Generic Identifier Transport IE used in establishing the Interface 5 connection should be consistent with the associated Interface 2 connection(s).

ATM Signaling Information Elements Required [Normative]

The following Information Elements are required in the SETUP Message to establish communications for Interface 2.

Required for VoD	Information Element	Notes
X	Protocol discriminator	
X	Call Reference	
X	Message type	
X	Message length	
X	AAL Parameters	
X	ATM Traffic descriptor	
X	Broadband bearer capability	
X	Broadband repeat indicator	
O	Broadband low layer information	
X	Generic Identifier Transport	
X	Broadband Higher layer information	
O	Notification Indicator	
X	Called party number	
X	Called party subaddress	
O	Calling party number	
O	Calling party subaddress	
OP	Connection identifier	
O	QoS parameter	
O	End-to-end transit delay	
O	Extended QOS Parameters	
C	Broadband sending complete	
NA	Transit network selection	User-->Network network assumption : does not cross BICI
NA	Endpoint reference	IE used for multipoint operation which is beyond scope of this specification

NA - Not Applicable for the VoD Service
X - Required for the VoD Service
O - Optional for the VoD Service
C - Conditional (if appropriate for the network being used) for the VoD Service
OP - Optional (if Proxy Signaling is used see Signaling 4.0 for proper setting)

Figure 11 ATM Forum Signaling 4.0 Information Elements

The Figure 11 identifies the information Elements (IEs) that are carried by the messages of [3]. All Information Elements may be sent in both directions (U-N and N-U) unless otherwise specified.

ATM Signaling Information Elements Coding Requirements [Normative]

The IE’s shall be set in accordance with [3]. The following are guidelines for setting of selected parameters in the various IE’s required for the establishment of the Principal Information Flow (i.e. across Interface 2) for the VoD service.

AAL Parameters I.E. **[Normative]**

Information Element	Value	Notes
AAL type	AAL-5.	
Forward Maximum AAL-5 CPCS SDU size	N*188 bytes.	Default value for the video service component in this specification is 376 bytes. N is an integer.
Backward Maximum AAL-5 CPCS-SDU size	0 bytes if Video Service Component is unidirectional, otherwise Implementation Specific	
SSCS Type	Null	

ATM Traffic Descriptor I.E. **[Normative]**

The video service component Peak Cell Rate is calculated with MPEG-2 encoded rate plus AAL5 overhead. Refer to section 6.2.1 for further information on calculating the Peak Cell Rate. The ATM Traffic Descriptor includes only the user plane information rate for the service components in that one VC.

The video service component PCR may be specified using CLP =0 and / or CLP=0+1. Video service component specific use of CLP=1 marking is for further study.

Information Element	Value	Notes
Forward Peak Cell Rate	implementation and program selection specific	Set to the Peak Cell Rate value required for the video service component (MPEG-2 SPTS)
Backward Peak Cell Rate	0 cells/ sec if Video Service Component is unidirectional, otherwise Implementation Specific	

Broadband bearer capabilities I.E. **[Normative]**

Information Element	Value	Notes
Bearer Class	BCOB-X	

Broadband Transfer Capability (BTC)	Constant Bit Rate	
User Plane Connection configuration	Point-to-Point	

Broadband Higher layer information I.E. **[Normative]**

Information Element	**Value**	**Notes**
High Layer Information Type	'0000011'	Vendor-Specific Application ID
OUI Type	'00A03E'x	ATM Forum OUI
Application ID	'00000002'x	ATM Forum VOD

QOS Parameters I.E. **[Normative]**

These QoS parameters shall be coded in accordance with the requirements of [3].

Generic Identifier Transport I.E. **[Normative]**

This parameter shall be coded in accordance with the requirements of [3]. Generic Identifier Transport Information Element is a generic parameter that indicates the correspondence of the VC to a certain previously established request carried outside ATM signaling. There are two cases foreseen in the current signaling standards (based on the selection of session management protocol - DSM-CC [10]or H.245 [16]).

DSM-CC Case

Information Element	**Value**	**Notes**
session identifier	DSM-CC sessionId	

resource correlation number	DSM-CC resourceNum	

H.245 Case

Information Element	**Value**	**Notes**
Session/Resource	Identifier for the virtual circuit	H.245 resource/correlation number

***Other Information Elements* [Normative]**

The remaining Information Elements shall be coded in accordance with the requirements of [3].

Note that some of the Information Elements require the use of valid ATM network endpoint addresses. Valid ATM network endpoint addresses are defined in [3]. These address formats include native E.164 and the Designated Country Code (DCC), International Code Designator (ICD) and E.164 [13] versions of the ATM End System Address (AESA) address format.

Session Control [Informative]

Session control procedures depend on the network to manipulate the ATM network resources, that will be used in the communications between the servers and clients. Examples of session control protocols include:

- ISO/IEC MPEG-2 DSM-CC [10]
- H.245[16]

Specification of specific session control procedures is beyond the scope of this specification.

End To End Jitter [Informative]

Introduction

Transporting time critical information streams using higher protocol layers requires the exchange of timing information between the protocol layers. The layer adaptation processes between protocol layers transform the jitter of one layer into the jitter of another layer. Within each layer, there are processes (e.g., switching) that introduce additional jitter terms. A comprehensive framework is needed to assemble all these different jitter terms.

A simple end-to-end model of the transport connection for a time critical information stream is introduced using the standard trail and connection nomenclature from G.803 [i]. This model then serves as the basis for identification and discussion of several different jitter phenomena. In particular, this layering approach separates the cumulative jittering effects that occur within each layer from the transformational jitter effects of layer adaptation. To aid the proper accumulation and transformation of the jitter, it is helpful to keep all jitter measures to the same accuracy (e.g., Probability [peak-to-peak jitter exceeding value] < 10^{-10}).

For real network services based on ATM connections, there may be many different jitter effects present. This is not intended to be a comprehensive analysis of all jitter components for all types of services. Examples of the jitter terms associated with the transport of an MPEG-2 Single Program Transport Stream are described.

End to End Connection Model

An MPEG-2 Single Program Transport Stream is encapsulated in an AAL-5 PDU and then transmitted as ATM cells over a SONET transport network from a source equipment to a sink equipment. A diagram can be drawn using the G.803 notation to show the adaptation functions that are required to transform the characteristic information of one trail layer into another. The various sources of jitter can be associated with either the layer adaptation functions or the connection termination functions. The relative importance of these sources of jitter may be different in each layer. The VC-4 layer and ATM VC layer are identified in G.803.

Jitter is dimensioned in units of time. More specifically, jitter terms describe a time deviation from some expected significant instant *for a specific signal type*. Each layer of the G.803 model represents a different specific signal type. This signal type is referred to as the 'characteristic information' that is transported by that layer. Jitter should be expressed in terms that are relative to the characteristic information of the layer concerned (e.g., Cell Delay Variation for the ATM VC layer, PDU Delay Variation (PDV) for AAL-5 PDUs, etc.).

Layer Synchronization

In order to understand the propagation of jitter through these networks, it is important to understand the timing configurations possible. The public networks typically provide a synchronization source that is traceable to national standards. In some applications, the source equipment may generate its own timing. The different layers can be operated with independent synchronization. There may be advantages for this in particular deployment scenarios. If two layers have different independent timing, the layer adaptation processes must accommodate this by including, for example, a rate adaptation process.

SONET Network Example

The SONET bitstream is typically synchronized to the public transmission network. In this case, the timing should be traceable to stratum 1 standards. In stand alone configurations, or during fault conditions, SONET equipment can operate from stratum 3 references.

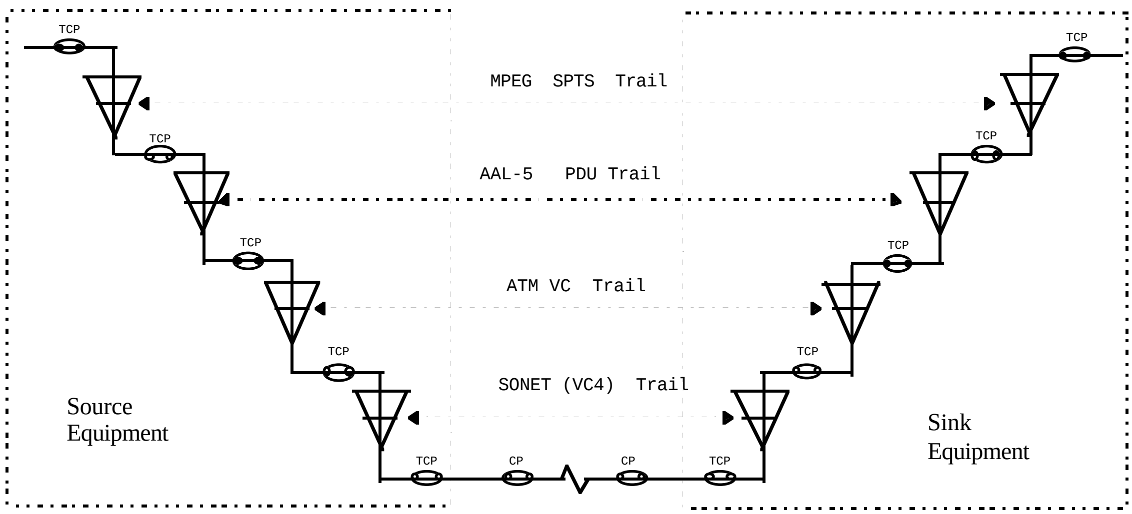


Figure 0-1 SONET Network Example

ATM Network Example

The ATM Network example is similar to the SONET network example, except that connections are made at the ATM layer rather than the SONET layer. In this case, additional jitter terms due to the ATM layer connection processes will be present.

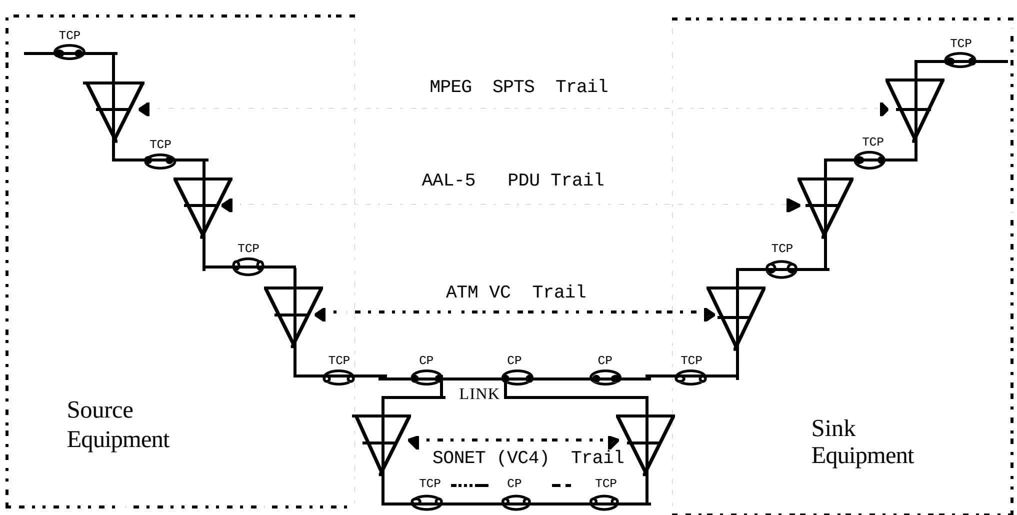


Figure 0-2 ATM Network Example

HFC Network Example

The HFC Network example is similar to the ATM network example, in that connections are made at the ATM layer rather than the SONET layer. In addition, the MPEG TS packets are remapped into a new modulation scheme for transport over the HFC cable plant. In this case, additional jitter terms due to the remapping between the ATM transport and the HFC transport processes, as well as jitter introduced by the HFC modulation scheme will be present. The jitter terms present in a particular deployment are highly implementation dependent and may be affected by many aspects, e.g. buffering, remapping of MPEG-2 PCRs etc as well as the network topology.

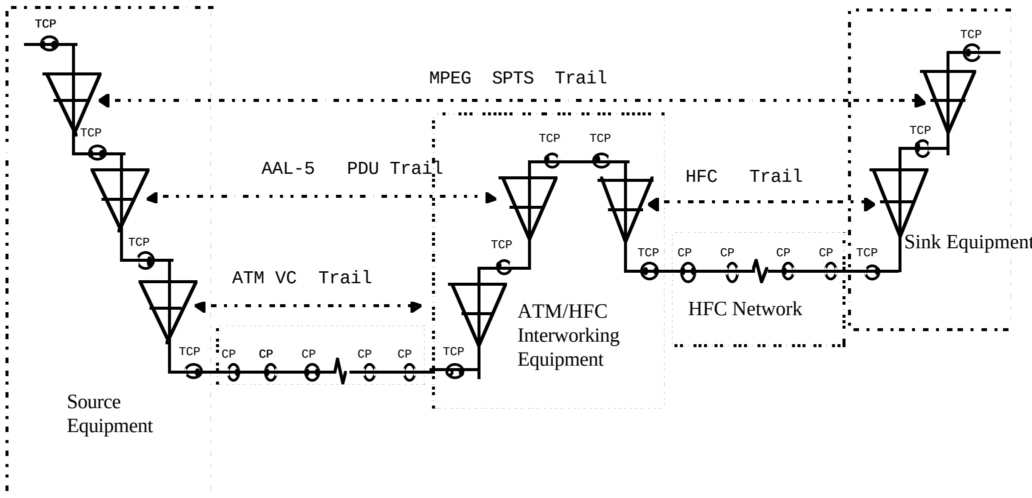


Figure 0-3 HFC Network Example

Layer Adaptation Processes

Generic Processes

Rate Adaptation

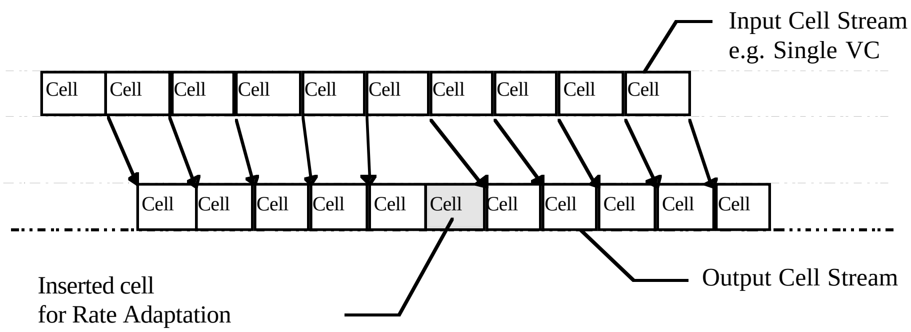


Figure 0-4 Rate Adaptation Example

Rate adaptation, or rate decoupling, occurs when the characteristic information rates of two layers are different. When this occurs, additional "stuffing" information is inserted in order to maintain the transmission rate of the higher bit rate stream. Rate decoupling is a layer adaptation process. It could be used between any two layers with independent timing. Figure 0-4 shows an example where an ATM cell stream (e.g. a single VC) is rate adapted into a higher rate cell stream. In this case, the stuffing is quantized to one cell period.

Cell rate decoupling in the ATM Forum UNI 3.0 specification[ii] refers to an ATM layer process where the sending process inserts "unassigned" cells as necessary to form a contiguous cell stream. ITU-T uses the term to refer to a PHY layer process that involves the insertion of "idle" cells. Both processes result in a displacement of a source traffic cell by one or more cell periods .

Multiplexing

Consider the cell stream comprising one VC that is to be mixed into a composite cell stream with other cells. The CDV of a VC is affected by the other traffic in the composite ATM cell stream. The ATM cell stream contains cells from many VCs as well as overhead cells such as OA&M cells and rate adaptation cells ("idle" or "unassigned").

The CDV of a VC cell stream is quantized with a granularity of the cell period of the composite ATM cell stream. The jitter functions associated with cell switching or multiplexing may result in CDV quantization steps greater than one cell. The maximum CDV quantization step is related to the burst size that can exist in cells extraneous to the VC. The burst lengths tend to increase as the utilization of a composite ATM cell stream increases. Hence the CDV can be expected to be related to the utilization of a particular ATM connection.

The existence of correlating traffic patterns between different VCs may also complicate the analysis. Multiple VCs with the same nominal CBR rate may produce repetitive effects over multiple cell periods. VBR traffic is more likely to be non stationary in nature.

Traffic Shaping

Traffic shaping can be applied in various ways. One could introduce traffic shaping at the AAL-5 level , or at the MPEG-2 level. One could argue that a CPR MPEG-2 SPTS has already been shaped (to a constant packet rate). The most common use of the term is associated with shaping of traffic on a single connection by end user equipment (e.g., CPE) in order to comply with the traffic contract agreed between the user and the network operator.

ATM Traffic shaping is applicable to all Broadband Transfer Capability types except UBR. In the case of a VC with a traffic contract specifying a CBR traffic descriptor, end user equipment may be required to provide buffering and scheduling functions at the source in order to ensure that cells of that VC comply with the cell spacing requirements expected of a CBR cell stream. Delay variations in these buffering and scheduling functions of the end user equipment may result in additional jitter terms.

PDU Segmentation

A PDU consist of the SDU from the next highest layer plus the PDU-specific information (e.g., AAL-5 CS-PDU trailer fields). The time to make a PDU from an SDU (e.g., appending length, CRC-32, etc. for AAL-5) is assumed to be constant. The PDU is divided into some integer number of 48-byte ATM cell payloads. The cells from the PDU are associated with a VCC, and are multiplexed onto the ATM link as described in section A-3.1.2 above. The cells from the PDU may be metered out in any burst size up to the PDU size, at a rate proportional to the PDU rate such that the process receiving the PDU should neither overflow or underflow its PDU buffer. i.e.,

cell rate = PDU rate * PDU size (cells) / burst size (cells)

The delay to segment a PDU is constant, and depends on the time to transfer the individual cells:

PDU segmentation delay = 1 / cell rate

PDU Re-Assembly

The process of reassembly of cells into a PDU takes an interval of time that is assumed to be equal to the time to accumulate the necessary number of cells. The time to extract the PDU from the accumulated cells is assumed to be constant and negligible in magnitude compared with one cell period. The cell arrival times are assumed to be jittered by some probabilistic CDV function. Figure 0-5 shows the basic model of cell arrival and PDU re-assembly. The nominal PDU interval (in this example) is 8 times the nominal cell interval. The actual PDU interval value adds the CDV values from the last cell of the current PDU and the previous PDU.

The cumulative distribution of the PDV could be considered as a sample distribution drawn from the cumulative CDV population. The central limit theorem would suggest that samples would tend toward the mean rather than extremes. Since this is essentially an infinite population, and the sample size is also infinite, the effect due to such sampling is likely to be small. A worst case assumption is that a peak to peak CDV of less than x mS with a confidence of 10^{-10} implies a peak to peak AAL-5 PDV of less than x mS with a confidence of 10^{-10}.

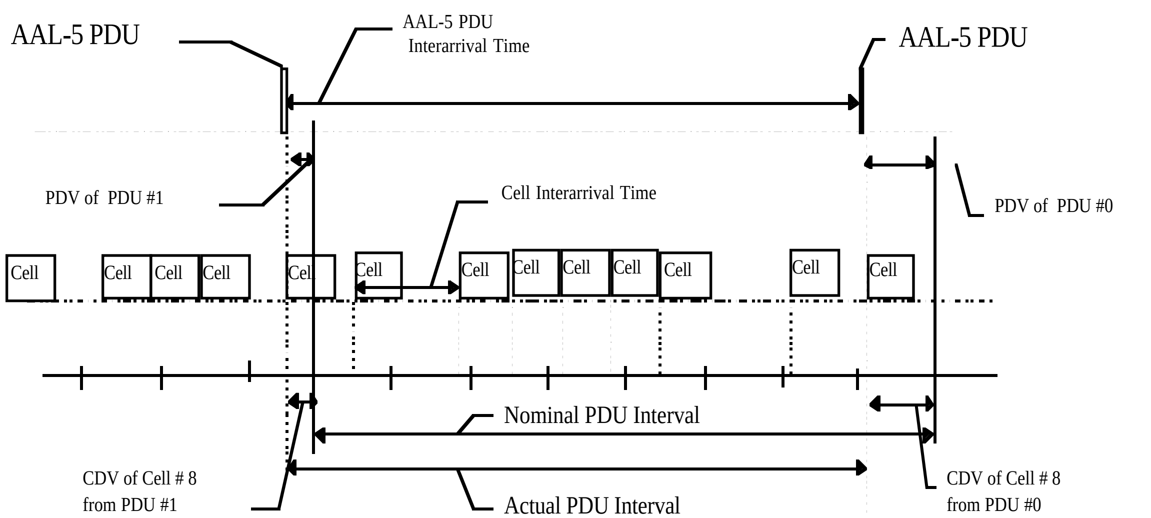


Figure 0-5: CBR Model for CDV

SDU Accumulation

When more than one MPEG-2 Transport Stream Packet is used to fill an AAL-5 SDU, the first TS packet to arrive at the SDU accumulation function is delayed until the last packet to be inserted in the AAL-5 PDU arrives. If we assume that the SDU accumulation process takes a fixed delay, then the first TS packet suffers a rate dependent delay equal to the number of TS packets in the AAL-5 PDU. For a two TS packet AAL-5 SDU, the delay is one TS Packet period at the Transport Stream rate. The last TS packet suffers only the fixed delay of the SDU accumulation process. If multiple TS packets are sent in one SDU, then the intermediate packets suffer proportional delays. A similar dis-accumulation function can also be seen. The delay suffered by different TS packets depends on the position within the AAL-5 PDU. This is illustrated in Figure 0-6.

The delay is rate dependent. For a 1Mb/s Transport Stream, each TS packet represents 1µS of delay. For a 10Mb/s Transport Stream, each TS packet represents only 100nS of delay. This buffer size required to accommodate this delay during dis-accumulation is not rate dependent - it is fixed by the maximum AAL-5 PDU size.

MPEG2-PCR / AAL-5 SDU Alignment

The specification does not require alignment of MPEG2-PCRs with AAL-5 SDUs - i.e. it is “PCR unaware”.

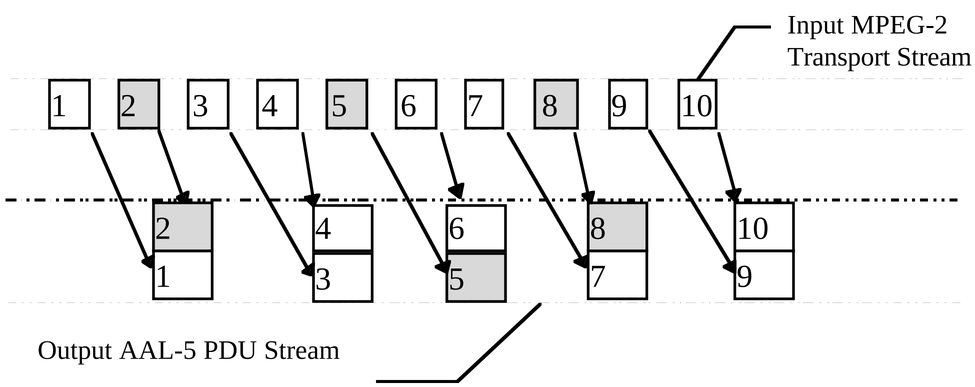


Figure 0-6 Example Non-Alignment of MPEG-2PCRs with AAL5 PDU Boundary

The interval between insertions of a MPEG-2PCR into the MPEG TS is not strictly constrained by the MPEG standards. The maximum interval between MPEG-2PCRs is constrained to 100mS.

One method to align MPEG2PCR timestamps within AAL-5 SDU’s for stored program replay is to pre-process the Transport Stream to ensure that the MPEG-2PCRs are inserted into the stream at intervals based on an integral multiple of the (fixed) AAL-5 PDU size.

SDU Dis-accumulation

The AAL-5 PDU structure provides for multiple MPEG SPTS packets to be multiplexed into one AAL-5 SDU. When dis-accumulating this SDU, these SPTS packets become available at the same time. This burstiness may create problems for the next (higher) layer. While the segmentation and reassembly function can be expected to preserve the order of the packets, this SDU dis-accumulation operation represents a severe jitter as shown in Figure 0-7. Successive MPEG SPTS packets would be sent resulting in successive inter-arrival intervals of zero and twice the nominal interarrival rate. If a buffer of the MPEG SPTS packets is required, then the control of the buffers could become complex. Sending the TS packets as soon as they become available treats MPEG SPTS packets uniformly.

The jitter term varies according to the bandwidth assumption. For a nominal CBR MPEG bit rate, the jitter term is one MPEG SPTS packet period.

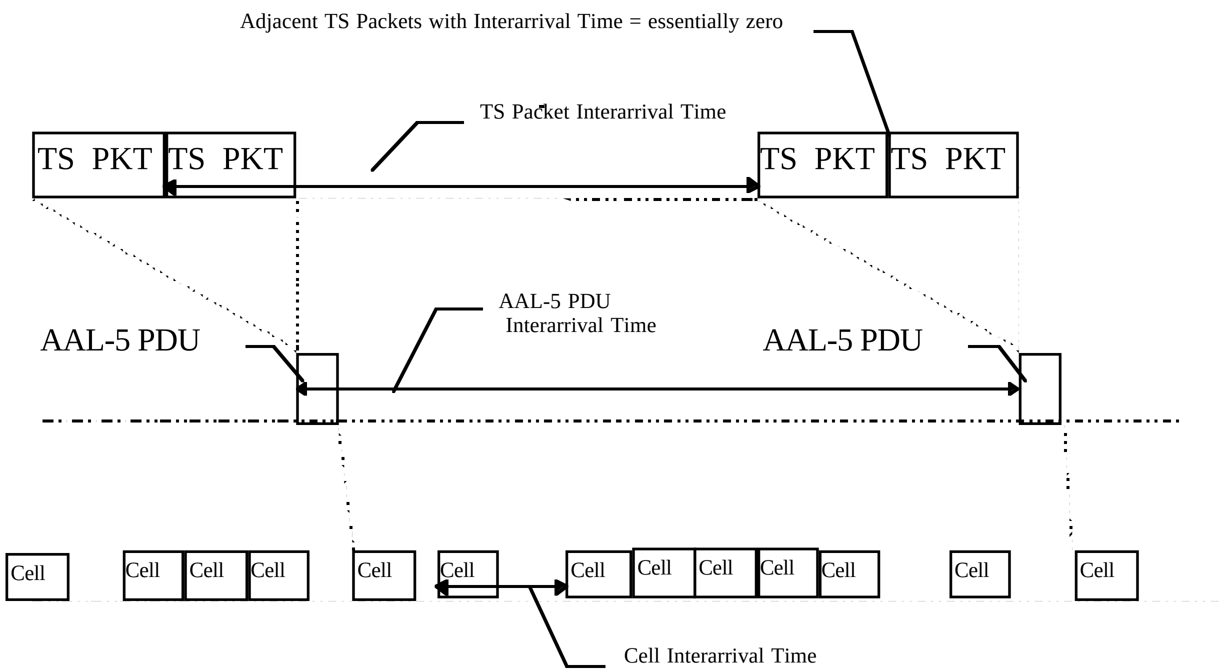


Figure 0-7 Demultiplexed TS Packets

Specific Layer Adaptations

Specific layer adaptation functions apply between specific layers.

ATM Cell Stream to/from SONET

SONET layer jitter effects can be caused by normal equipment tolerances and environmental variations. Physical layer jitter effects associated with the recovery of the bit level timing is well documented by T1X1 and others. There are some systematic jitter effects associated with the frame structure of the SONET frame but these are regular in nature.

For example, one of the largest SONET jitter terms is associated with the systematic jitter introduced by the SONET frame header. At OC-3c rates, the jitter magnitude is 9 octets representing one row of header information. 9 octets is less than the cell period of 53 octets. SONET systematic jitter terms are typically eliminated by the pointer manipulation buffers associated with layer adaptation function of the SONET trail termination equipment. Some equipments may provide a burst interface to the higher layer. For the purposes of this contribution, we assume that the payload provided from the SONET layer to the ATM Layer is a contiguous payload bitstream.

The ATM layer may operate in a manner synchronized to the incoming SONET payload stream. Some equipments may terminate multiple SONET payload streams. Rate adaptation of the incoming SONET payload stream to an internal time reference is a typical layer adaptation process to accommodate this. If the incoming SONET payload stream is not jittered, the rate adaptation process would introduce a systematic jitter based on the rate difference. Jitter in the timing of the SONET payload stream would be manifest at the ATM layer as randomization of the insertion point of the rate decoupling cells.

The jitter transformation of this layer adaptation process is not linear. A jitter quantization effects occurs. Consider a contiguous ATM cell stream recovered from a SONET layer. The local timing of the cell intervals is fixed. Jitter at the cell level must occur in discrete intervals equal to the cell period. Hence small jitter effects from the SONET layer can be aggregated into a probabilistic jitter function with a magnitude of 1 cell period. At OC-3c rates, one cell period is approximately 3µS.

AAL-5 PDU stream to/from ATM

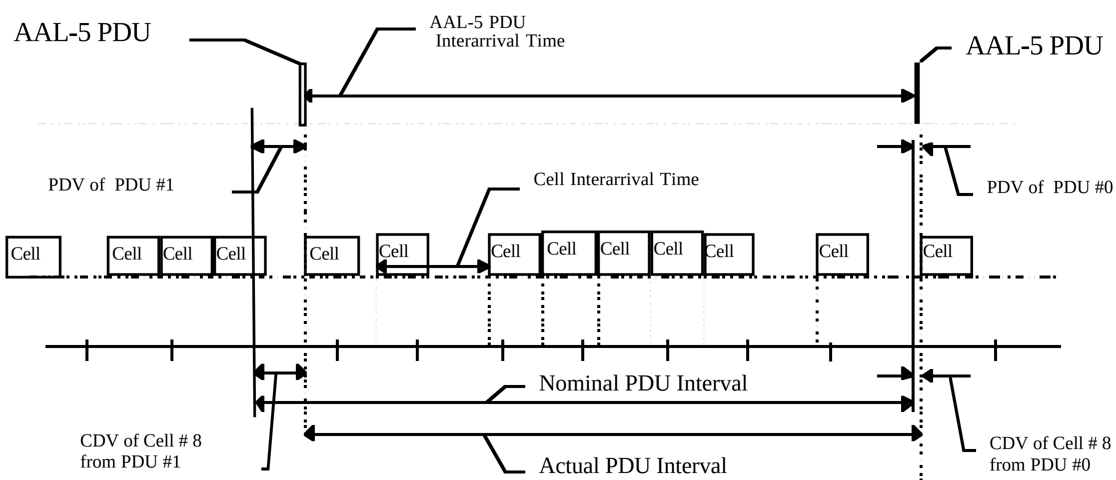


Figure 0-8 AAL-5 PDU Stream to/from ATM

When the AAL-5 PDU is available, it is segmented into ATM cells with constant delay, and multiplexed with other cells on the same physical interface. The jitter on the AAL-5 PDU when reassembled at the receiving end depends on the CDV between the AAL-5 PDU sender and receiver. The actual PDU interarrival time adds the CDV values from the last cell of the current and previous PDU to the nominal PDU interarrival time. For a CBR cell stream, the CDV will be less than or equal to x msec, to some quantile, as derived from the cell delay distribution function. Then, the delay distribution on the PDU interarrival time will be equal to the convolution of the cell delay distribution with itself. The value for x, and the method to derive it, are for further study.

MPEG-2 Transport Stream to/from AAL-5 PDU Stream

The delay to accumulate TS packets into an AAL-5 PDU is constant, and depends on the number of packets per PDU and the packet rate:

PDU Accum. Delay = (# packets/PDU)/(Packet rate)

For a 6 Mbps packet rate, and the assumption of two TS packets per PDU, the PDU delay is 501.34 microseconds.

Dis-accumulating the TS packets from the AAL-5 PDU causes all the packets to become available at the same time, producing a maximum jitter on the packets equal to the PDU accumulation delay as shown above.

Jitter Accumulation from Connections in a Trail

In an end to end service delivery multiple connections can be made at the different layers. The effect on the jitter of such connections may be different in each layer. In some cases, the sequential connections within a layer can accumulate jitter.

SONET connections

The nature of SONET connections preserves the Synchronous Payload Envelope (SPE) timing at the source rate. Within specified limits, the timing jitter and frequency deviations of intermediate SONET connections are essentially eliminated by the SONET pointer mechanisms. The desynchronizer buffers associated with SONET pointer mechanism can reduce the jitter to less than 1 bit period in magnitude (< 7 nS at OC-3 rates). There is transmission delay, but no significant increase in delay variation. The result is that jitter present in the SPE at the source is essentially transferred to the sink at the termination of the SONET SPE.

ATM connections

Cell level multiplexing and cross connection functions would occur (at the ATM VC level CTPs) in arbitrary networks with ATM level cross-connections. Cell level multiplexing in an arbitrary ATM network introduces a jitter or Cell Delay Variation (CDV) into the cells of the VC carrying the time critical information. This CDV is constrained per switch by various specifications[iii].

Various approaches could be taken to characterizing the jitter distribution of an arbitrary network of ATM switches. One approach is to simply add the worst case CDV of the successive switches in the ATM network. A more sophisticated approach requires describing the CDV at each switch as a probability density function (pdf). The cumulative effect of successive switches is the described by the convolution of these individual pdfs. Both mechanisms require a specific number of switches to be considered. ATM BISDN standards are international in scope. Hence we must consider enough switches for international public network connections. However, for service definition across an arbitrary public network, some aggregate specification must simply be assumed for the CDV.

A CDV accumulation mechanism is required for the QoS negotiation and service assurance signaling in the switched network. Convolution is a computationally intensive process that is unsuitable for the real -time processing demands of a CDV accumulation algorithm used for the signaling algorithms. Simple addition of the individual specification for CDV generated within a specific switch is likely to lead to a significant overestimate of the actual CDV generated within the switch network. The ATM Forum BICI specification version

1.1 proposes a $\sqrt{n}$ estimator for accumulating the CDV generated end to end by a network.

The role of $CDV_{tolerance}$ specifications at NPC locations and other traffic shaping functions that may be performed by the network require further study.

The accumulation algorithms for the QoS parameters will be specified in the ATM Forum Traffic Management Specification 4.0.

A maximum peak-to-peak CDV of 1mS (p-p, $\alpha=10^{-10}$) across the ATM layer is commonly assumed. This assumption is based on the DS-3 circuit emulation jitter absorption delay buffer size specified by Bellcore [iv]. Other assumptions are equally possible.

AAL-5 PDU Connections

In an ATM network, connections are performed at the ATM layer, not at the AAL-5 layer. Other types of networks, and some IWUs may perform connections at the AAL-5 layer. Such connections may introduce additional jitter terms. These aspects are beyond the scope of this IA.

MPEG Transport Stream Connections

In the delivery of the VoD service, there may be some elements that perform operations on the MPEG-2 SPTS directly , (e.g. splicing operations etc.) If such operations are performed in real time on a SPTS, then additional jitter terms may be introduced. These aspects are beyond the scope of this IA

End to End Jitter Budgets

The aggregate jitter expected for a particular implementation can be calculated by identifying and combining the individual jitter terms associated with the layer adaptation functions and layer cross-connection functions.

The jitter tolerance of the MPEG-2 transport Stream decoder is not clearly specified in ISO/IEC International Standard 13818-1. It is clear from the MPEG-2 system model that there are different defects that can result from jitter on the MPEG-2 Transport Stream, depending on the data that is jittered. As a simple approach, we can consider two basic jitter tolerance figures. One for TS packets containing general data. The jitter consequence here is overflow or underflow of the decoder's buffers.

A second jitter tolerance can be associated with the TS packets containing MPEG-2PCRs. A MPEG-2PCR is a timestamp used to recover the MPEG system clock for the decoder. The system clock recovery function of the decoder can be considered a type of Phase Locked Loop (PLL). The parameters of that PLL will determine the capture range and tracking range that can be provided. Jitter on a MPEG-2PCR can be considered as an error step function into the PLL. If the error step exceeds the PLL tracking range, then decoder will lose its lock on the MPEG system clock, resulting in degraded performance.

Further study may reveal other jitter constraints on the MPEG-2 Transport Stream, e.g. , concerning jitter on PTS, DTS timestamps, etc. For the purposes of developing a jitter budget for the VoD service, we need to assume a specification for the jitter tolerance of the MPEG-2 Stream. The following is proposed for maximum peak to peak jitter for MPEG-2 Transport Stream Packets:

- without MPEG-2PCRs………… x mS
- with MPEG-2PCRs ……………. y mS, (where $y \leq x$)

The values for x and y are currently for further study. If $y > x$, the decoder PLL can track jitter deviations of greater magnitude than its buffers and a separate specification is not necessary. Previous contributions have identified 1mS of CDV across the ATM network. This identifies a minimum. Aggregating other jitter terms will increase the required jitter tolerance. The MPEG-2 standards do not normatively bound the jitter tolerance.

MPEG standards mention[3] 4mS being intended as the maximum amount of jitter expected in a well behaved system. This figure is related to the multiplexing of multiple Transport Streams and is not directly relevant to the end-to-end jitter budget discussion.

[3] ISO/IEC 13818-1 | ITU-T Rec. H.222.0 "Information Technology - Generic Coding of Moving Pictures and Associated Audio - Part 1: Systems" Annex D .

Example Networks [Informative]

Telco Hybrid Fiber Coax Networks

ATM may be terminated in the video node (A type of IWU) or the STT/PC for the hybrid fiber coax network shown in Figure 0-1.

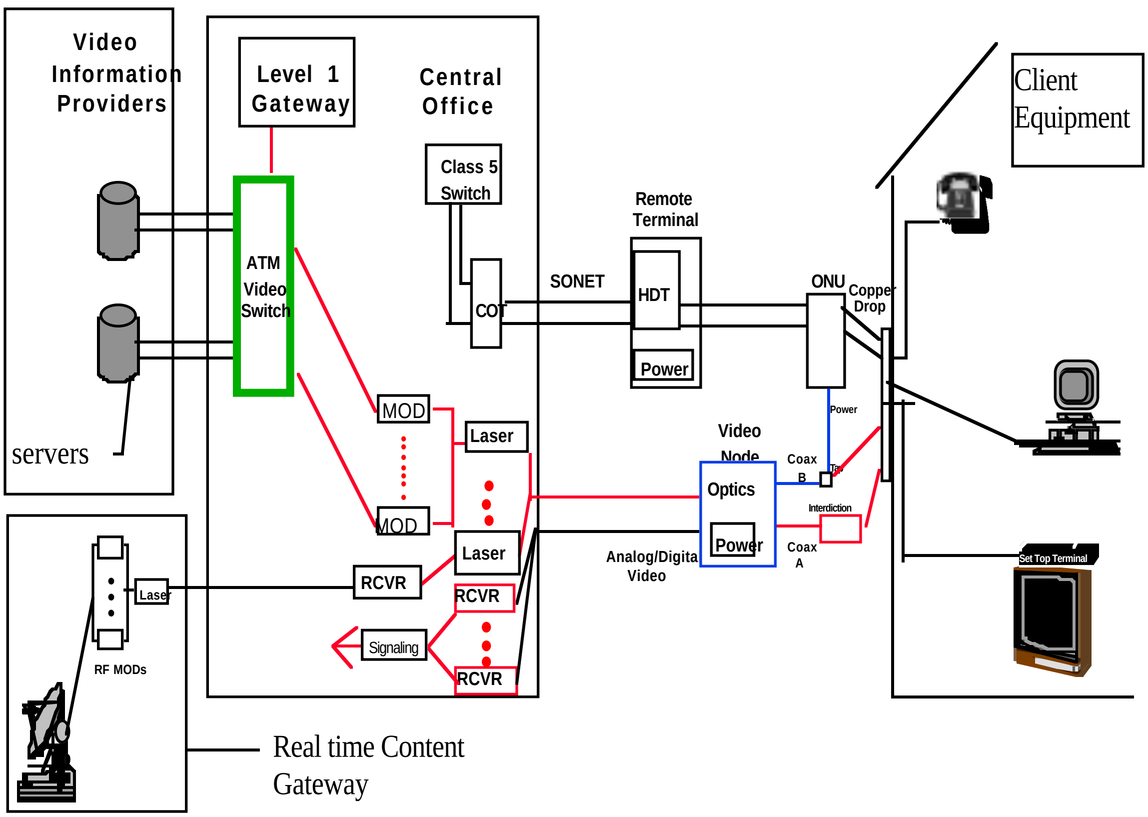


Figure 0-1 Hybrid Fiber Coax Network VoD Example

Digital Baseband Networks

ATM is terminated in the STT for the digital baseband network reference configuration shown in Figure 0-2.

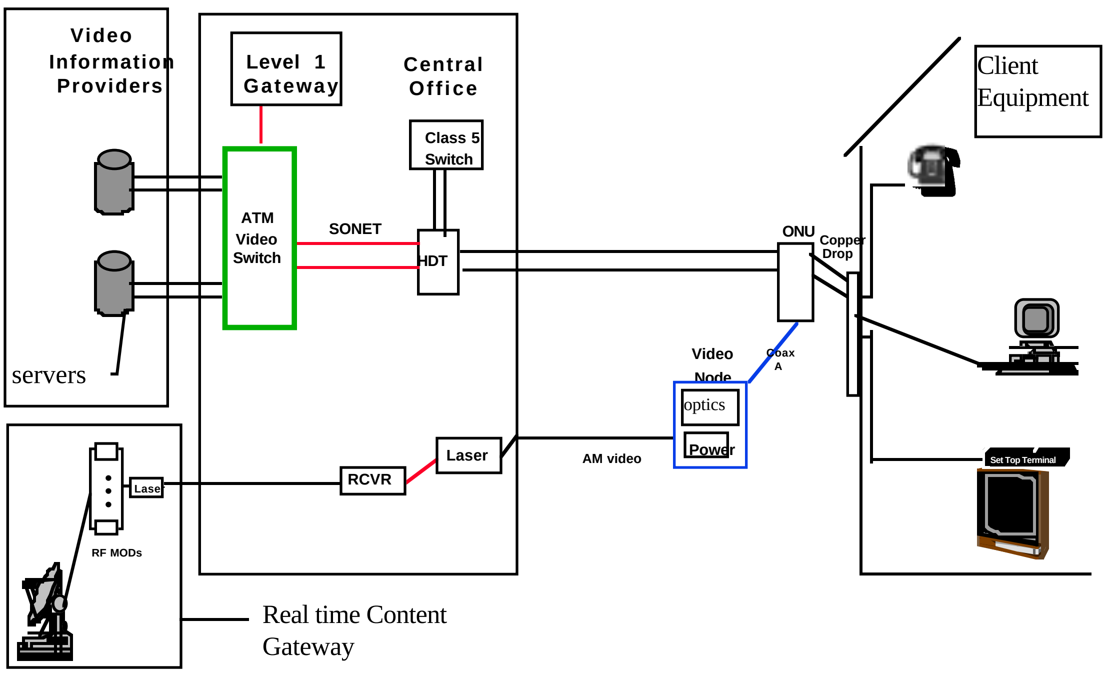


Figure 0-2 Digital Baseband Network VoD Example

Telecommunications Network Example

The VoD network example shown in Figure 0-3 presents two types of access network, namely an Asymmetrical Digital Subscriber Loop (ADSL) over existing copper pairs and a fiber passive optical network (PON). Both carry broadband and narrowband traffic, i.e., Plain Old Telephone Service (POTS) and VoD.

For the optical network, the ATM transmission may terminate at the PON head end (H/E), the optical
network unit (ONU), or in the set top terminal. Whereas for copper distribution, the ATM transmission may terminate at the ADSL exchange unit (EU), the ADSL remote unit (RU) or in the STT (or PC or IWU).

The core network is based on a number of ATM switches. The session controller/ ATM connection controller (L1GW) is likely to be implemented using the functionality of the intelligent network (IN), i.e., the service control point (SCP) and the intelligent peripheral (IP).

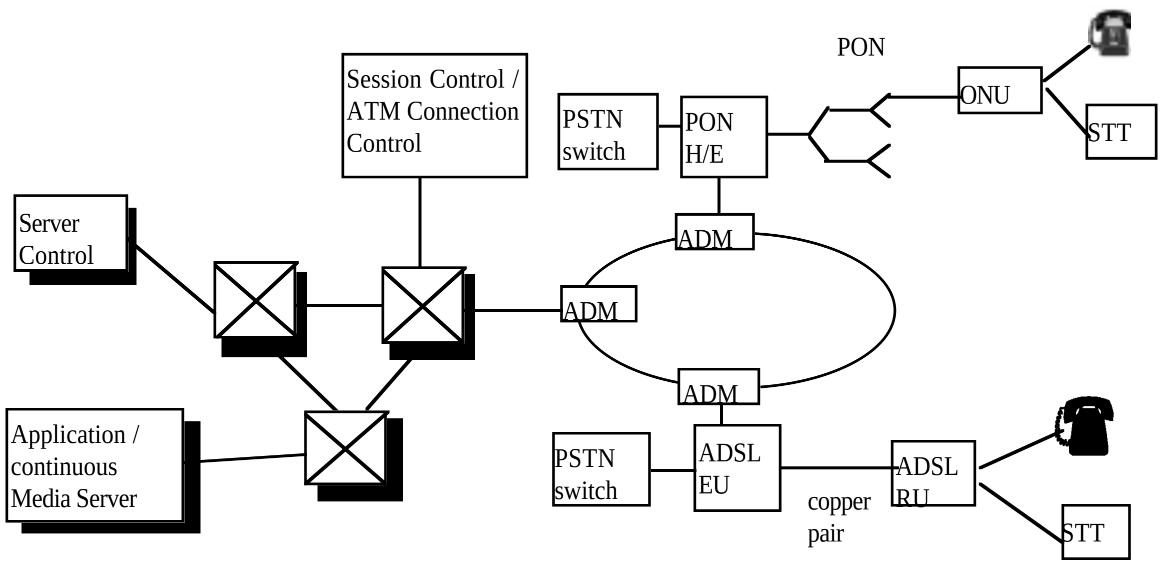


Figure 0-3 Telecommunications Network Example

For a given session the end user can ‘direct dial’ the destination VoD server, if known. However, it is more likely that the user will choose to be connected through to a L1GW which will provide navigation facilities, specifically a choice of service providers (SPs) to which that user subscribes or can access. SPs can be brokers who might offer information as the best server to choose for a given movie but don’t actually offer movies themselves, or the end SP who offers detailed navigation and content, i.e., movies.

The L1GW ‘connects’ the user to the server control (L2GW) of the chosen SP, either directly by setting up the connection or by telling either the user (or SP) the address of the party to call. Similarly a SP acting as a broker can ‘forward’ the address of a user to the chosen destination server. The server control provides detailed navigation assistance to the user.

Two types of server are indicated, namely application servers and continuous media servers (CMS) both of which could be integrated into a single ‘box’ with a single network address

or be separate. Application servers tend to be general purpose computers, whereas CMS tend to be massively parallel computing platforms.
The concepts of session and connection need to be understood. A session exists from the time the user pushes the 'go' button to request service. At any given time, a given session can utilize any number of connections (or even zero connections). Some entity has to manage the session, i.e., the session manager. The session manager could reside in the STB, in the L1GW or with the SP(s).

Hybrid Fiber/Coax Cable TV Networks

Cable TV networks may be used as part of the delivery network for the VoD Service. Figure 0-4 provides an example network architecture of the type currently planned by various cable TV network operators.

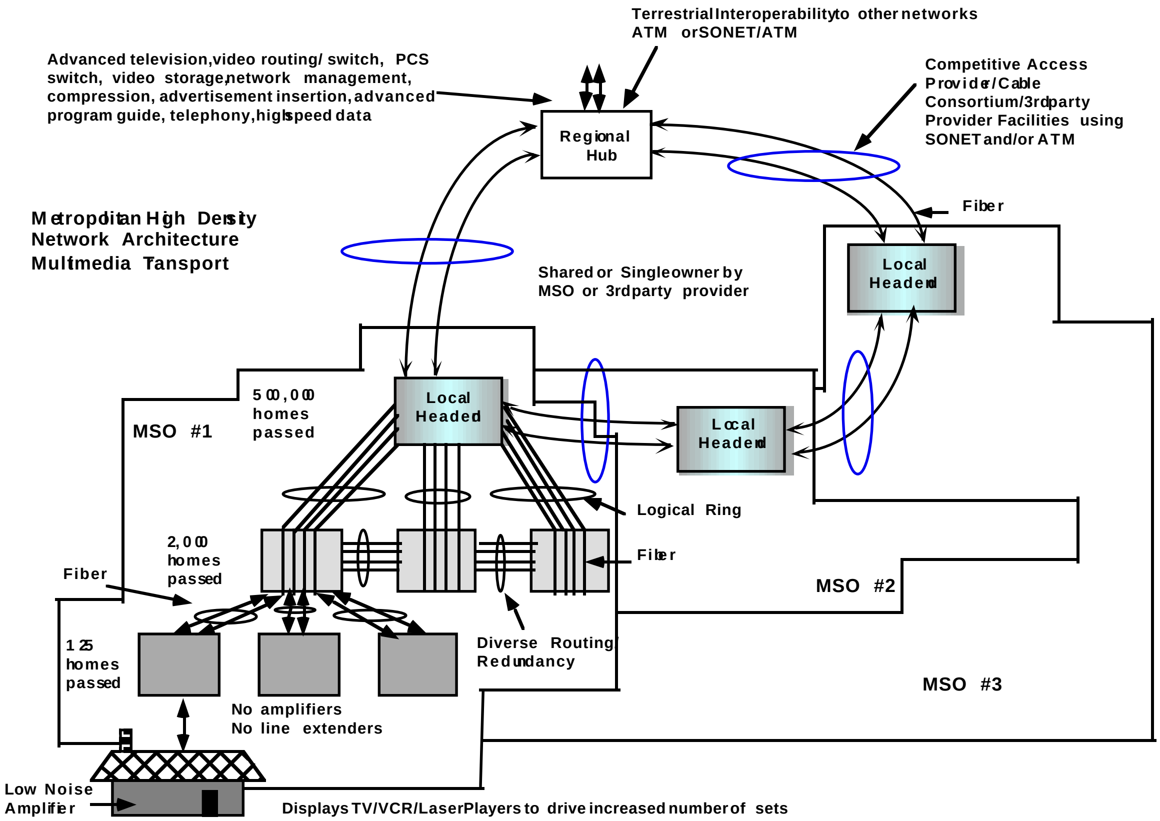


Figure 0-4 Cable TV Network Example

Cable television HFC architecture often includes the implementation of the regional hub concept. A regional hub is a centralized facility that utilizes a rich network topology to interconnect headends that are located in a common geographic area. This topology may interconnect a single cable operator's central headends or the headends from any number of Multiple System Operator's (MSO's) in adjacent serving areas. The regional hub can provide an access point to other networks and a common centralized platform for deployment of advanced services.

Fiber optic cables span from the local headends to fiber hubs that are geographically centered among approximately 2,000 passed. These hubs feed fiber nodes that serve about 125 homes passed. The connections between the local headends, fiber hubs fiber nodes and hub-to-hub interconnections provide virtual ring capability and physical routing diversity.

Currently, about 14% of the typical HFC network consists of trunk, with local distribution accounting for 36% of the network and 50% of the network is deployed in the drop. The trunk is fiber optic cable and the remainder of the infrastructure is coaxial.

AMS QoS Parameters [Informative]

AMS Control Plane QoS Parameters for VoD

SAA-AMS expects the following parameter to be of interest for evaluating the performance of VoD applications:

- *Latency for ATM Connection Establishment/Release* This includes the time for the *Setup* message to be sent from a client (e.g., STT/PC) to the ATM Network, and the time for that connection control function to establish or release a connection or session in that ATM network. Specific values are implementation dependent. Information concerning this performance aspect may be provided by the service provider , if necessary.

AMS User Plane Quality of Service Parameters

Two Quality of Service (QoS) parameters are identified that can be used to capture the accuracy and dependability aspects of AMS services. These AMS QoS parameters are defined from the AMS service users' perspectives. There is a given relationship between these user-oriented service specific QoS parameters and the network-oriented service independent ATM layer QoS parameters - this allows an appropriate ATM layer connection to be established in order to be able to deliver the service. Annex C describes the relationship between the two AMS QoS parameters and the relevant ATM layer QoS parameters.

For AMS services, the effect of either a single error or a burst error is essentially the same if the error is confined within a single cell block of consecutive cells associated with a given ATM connection. Therefore, the two AMS QoS parameters, Errored Cell Block Rate and Maximum Errored Cell Block Count, are defined in terms of cell blocks. In this document, a cell block is defined as a sequence of cells transmitted consecutively on a given ATM connection. This should not be confused with the term 'cell block' as used by [4]. Cell blocks are non-intersecting and contiguous within a VC. A received cell block is an Errored Cell Block if one or more errored cells, lost cells, or miss-inserted cells are observed in that received cell block. For AMS services, cell block size is application dependent; however, a cell block can be at most 1536 cells in length.

Errored Cell Block Rate (ECBR)

Errored Cell Block Rate , ECBR, is defined as:

$$ECBR = N / T_{ECBR}$$

Where N is the total number of errored cell blocks observed during a specified time interval $T_{ECBR.}$. The value of T_{ECBR} is for further study. The value of $ECBR$ can range from at least once per second to more than once per 2 hours.

Maximum Errored Cell Block Count (MECBC)

Maximum Errored Cell Block Count , *MECBC*, is defined as the maximum number of errored cell blocks observed in any time interval of a specified length T. The commitment associated with this QoS parameter in general is a statistical commitment; that is, the observed number of errored cell blocks in any time interval of specified length T will be less than *MECBC* with a probability of $1\text{-}10^{-\alpha}$. The values of T and α are for further study.

AMS QoS Parameters in Relation to ATM Layer QoS Parameters

This annex describes how the two AMS accuracy/dependability QoS parameters can be approximated by the corresponding ATM layer accuracy/dependability QoS parameters. The detailed definition of a complete list of ATM layer QoS parameters can be found in ITU-T Recommendation I.356 and the ATM Forum Traffic Management 4.0 Specification. The following symbols are used in showing the relationship between the two AMS accuracy/dependability QoS parameters and the corresponding ATM Layer accuracy/dependability QoS parameters.

ECBR……….the Errored Cell Block Rate in cell blocks per second,
MECBC …….the Maximum Errored Cell Block Count observed in any time interval T,
B…………….the average number of cells per cell block,
r.…………….the average cell rate in cells per second of the ATM connection,
P_b……………the probability of a cell block being an errored cell block,
CLR…………the Cell Loss Ratio, an ATM Layer QoS parameter,
CER…………the Cell Error Ratio, an ATM Layer QoS parameter,
CMR ………..the Cell Mis-insertion Rate in cells/second, an ATM Layer QoS parameter,
SECBR……..the Severely Errored Cell Block Ratio, an ATM Layer QoS parameter

Since *CER* , *CLR* and *SECBR* all represent ratios of different sources of cell error to (approximately) the total number of cells transmitted, they can be aggregated to approximate the ratio of errored cell block outcomes to total cells transmitted (excluding miss-inserted cells). Therefore, the AMS QoS parameter , *ECBR*, can be approximated by ATM Layer QoS parameters as follows:

$$ECBR = r \times (CER + CLR + SECBR) + CMR$$

The probability that no more than *MECBC* errored cell blocks are observed during any time interval T is given by

$$\sum_{i=0}^{MECBC} \binom{M}{i} P_b^i (1 - P_b)^{M-i}$$

where M is the average number of cell blocks (truncated to an integer value) sent on the given ATM connection during any time interval T, i.e.,

$$M \approx \left\lceil \frac{r \times T}{B} \right\rceil$$

The statistical commitment to *MECBC* is captured by the parameter α, as described in the following equation,

$$10^{-\alpha} \geq 1 - \sum_{i=0}^{MECBC} \binom{M}{i} P_b^i (1 - P_b)^{M-i}$$

P_b, the probability of an errored cell block , can be approximated by dividing the average number of errored cell blocks observed in time interval *T*, by the average number of blocks sent in the same time interval, that is

$$P_b = \frac{ECBR \times T}{M}$$

Cell Delay Variation Tolerance [Informative]

When several VCs are multiplexed together, by the Server, into a multiple VC ATM Cell stream for transport over a single physical UNI, there may be some Cell Delay Variation introduced by the multiplexing process. The ATM network can accommodate some Cell Delay Variation by selecting an appropriate value of for the $CDV_{tolerance}$ parameter of the UPC/NPC function.

The $CDV_{tolerance}$ parameter value is specified by the network operator. The $CDV_{tolerance}$ parameter value is not a negotiable (signaled) parameter. The $CDV_{tolerance}$ parameter value is static for the duration of the call. The network operator may choose to maintain the $CDV_{tolerance}$ parameter value as static for a particular interface (e.g. based on the line rate) , or for a particular service.

If considerable information is available about the architecture of the Server, it may be possible to develop a queuing model that describes the CDV that can be expected to be generated. It is not practical to do this for a large number of different server architectures.

A simpler approach making suitable assumptions for the server configuration is required. For a dedicated video server, it may be reasonable to assume that the VCs are all based on CBR traffic characteristics. The bandwidth allocated for other Broadband Transfer Capability types is assumed negligible.

The worst case is likely to occur when all of the VCs destined for one specific physical UNI arrive at the Server's VC multiplexing function at the same time. If *n* VCs are to be multiplexed together, then a burst of *n* cells may be generated (one per VC). If there is a random sequencing of VCs in the cell burst then a specific cell may suffer a cell delay variation of *n-1* cell periods at the line rate. Careful design of the scheduling functions associated with the server VC multiplexer should be able to reduce this considerably.

Other CDV generating effects besides VC multiplexing should also be considered. systematic jitter effects from the physical layer overhead can be approximated as a CDV of one cell period (or less) at the line rate. Similarly support of OAM cells etc. may also introduce an additional 1 cell CDV.

Hence for a physical UNI carrying an ATM multiplex with 6 CBR VCs , a worst case CDV of 7 cell periods at the line rate is a reasonable estimate. i.e. for *n* VCs, use *n+1* cell periods (line rate) as the $CDV_{tolerance}$ parameter value. For a group of CBR VCs with the same Shape Rate (Peak Cell Rate), the burst of *n* VCs should be less than 1/Peak Cell Rate i.e. back to back cells are not expected in this shaped traffic stream. Table 2 provides examples of the delay that could be introduced by clumping groups of cells at different ATM cell rates.

Line Rate (cells /sec)	ATM Cell Rate	Cell Period	5 Cell Periods	10 Cell Periods	20 Cell Periods	50 Cell Periods
	cells /sec	µS	µS	µS	µS	µS
DS-3 Line Rate (PLCP mapping)	96000	10.42	52.08	104.17	208.33	520.83
DS-3 Line Rate (HEC mapping)	104268	9.59	47.95	95.91	191.81	479.53
OC-3c line rate	353200	2.83	14.16	28.31	56.63	141.56
OC-12c line rate	1416900	0.71	3.53	7.06	14.12	35.29

Table 2 Examples of n Cell Periods at line rate

Consider the following examples:

1) A server is expected to generate a maximum of 7 VCs with Peak Cell Rate of 5Mb/s each on a DS-3 (HEC mapping) interface:

n = 7 VCs

$CDV_{tolerance} = (n+1) * 9.59\ \mu S = 76.72\ \mu S$

2) A server is expected to generate a maximum of 19 VCs with Peak Cell Rate of 7.5Mb/s each on an OC-3c interface:

n=19

$CDV_{tolerance} = (n+1) * 2.83\ \mu S = 56.6\ \mu S$

Note that these are just examples to assist a network operator in choosing appropriate values. The network operator should also consider the potential tradeoff between $CDV_{tolerance}$ and link utilization. As the CDV tolerance increases, the link utilization will decrease (for the same CLR). These guidelines are for the UNI from the Server. Other UNIs with different traffic mixes may require a different approach.

The network operator may also wish to consider other aspects (e.g. equipment limitations, administrative convenience etc.) in selecting appropriate values to offer. Bellcore's GR-1110-CORE (Issue 1, September 1994, Table 6-2, page 6-10) specifies a set of specific $CDV_{tolerance}$ values that Bellcore deemed appropriate for administering the UPC function in a Broadband Switching System.

Proxy Signaling Capability [Informative]

*[**Note:** The proxy signaling capability description is derived from the ATM Forum Signaling 4.0 specification. In the event of discrepancies in the description of the functions, the ATM Forum Signaling 4.0 specification should be considered as definitive.]*

The proxy signaling capability is described in the Annex 2 of the 4.0 ATM Forum Signaling 4.0 Specification .

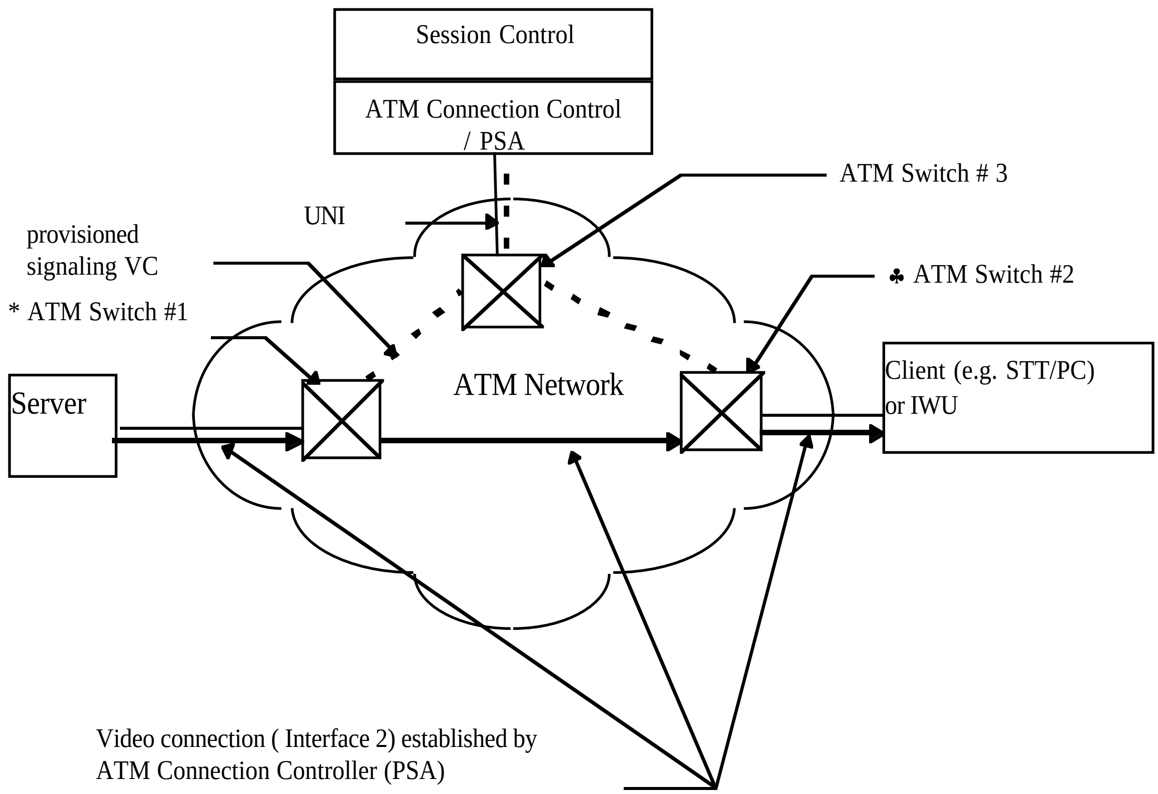
Facility Description

Proxy signaling is an optional capability for both the network and the user. This capability, when supported, requires prior agreement (e.g., subscription) between the user and the network. Proxy signaling allows a user called the Proxy Signaling Agent (PSA) to perform signaling for one or more users that do not support signaling.
Within a VoD service environment the proxy signaling call model is performed with the ATM Connection Controller being the PSA (refer to section 8). The ATM Connection Controller/PSA is acting on behalf of both the Client and/or the Server. The PSA not being connected to the same switch as the one the user it is acting for is qualified as remote proxy signaling agent.

In the following only the case where neither the Server nor the Client support signaling is described. The case where either the Server or the Client support signaling can be easily deduced.

Provisioning

The ATM Connection Controller/PSA must provision one or more signaling VCs and (if needed) an ILMI VC to each of the switches where there are UNIs controlled by the ATM Connection Controller/PSA. The ATM switch to which the ATM Connection Controller/PSA is directly connected will treat these VCs as PVCs and need not be aware of the intended use.



* Signaling endpoint is ATM Switch #1

♣ Signaling endpoint is ATM Switch #2

Figure 0-1 Proxy Signaling Example

Interfaces

- The provisioned signaling VCs from the ATM Connection Controller terminates on the ATM switch where the Client / Server is located. Thus every switch which has a user (Client or Server) under the control of an ATM Connection Controller/PSA must support the ATM Forum Signaling 4.0 specification.
- The Client and the Server have a UNI 3.0 (or higher) interface with the ATM network which has no signaling VC.

Procedure

At subscription time the controlled Client(s) and Server(s) should provide the following information for each signaling VC:

- The list of directory numbers that are routed to the ATM Connection Controller/PSA over the signaling VC.
  (Information provided to the ATM switch on which the Clients and Servers are located)

- A mapping of VPCI values to a specific UNI and VPI combination for each VP controlled by the ATM Connection Controller/PSA over a signaling VC. (Information provided to the ATM Connection Controller/PSA)

- The VPI and VCI for the signaling VC and of the associated ILMI VC (if present).

The switches where the clients and servers are directly connected must support ATM Forum Signaling 4.0 (non associated signaling).

Message flow

Assuming that neither the VIP nor the C1...Cn end users have signaling capability, a call established by the VIP to the end user would require the following set of message exchanges.

Call/Connection at the originating interface

The ATM Connection Manager/PSA sends over the signaling VC which corresponds to the Server a SETUP message with the address of the Client in the called user address IE, the VIP VPCI and possibly VCI in the connection identifier IE.

The ATM switch to which the Server is connected will send back:

- a CALL PROCEEDING or a CONNECT message specifying the VCI and confirming the VPCI or confirming both VPCI/VCI
  or
- a RELEASE COMPLETE message denying the availability of the requested VPCI/VCI.

For more detail please refer to §5.1.2.2/Q.2931.

Call/Connection at the destination interface

On an incoming call, offered to the ATM Connection Controller, the ATM network can only specify one of the following two options:

Option 1:
Only case a): << Exclusive VPCI, any VCI >> **AND** case c): << No indication >> of §5.2.3.2/Q.2931 shall be used.
Option 2:
Only case c) << No indication is included >> of §5.2.3.2/ Q.2931 shall be used.

In the incoming call offering side, the node to which the Client is connected shall send through the client related signaling VC a SETUP message with the Client address as the called user address and an explicit VPCI (option (a) §5.2.3.2/Q.2931) or no connection identifier (option (c) §5.2.3.2/Q.2931). In the first message sent back to the network, the ATM connection Controller/PSA shall specify the connection identifier to be used.

Message Sequence Chart

In the following diagram a message is given only two IEs (for simplicity) : the called user address and the connection identifier.

ACC	Nserver	NClient	ACC
SETUP(@Client, $VPCI_v/VCI_v{}^{*}$)	|	|	
------------------------------------->	|	|	
CALL PROCEED($VPCI_v/VCI_v$)	|	|	
<-------------------------------------	|	|	SETUP(@Client, $VPCI_e{}^{\sim}$)
	|	|	------------------------------->
	|	|	CALL PROCEEDING($VPCI_e/VCI_e$)
	|	|	<-------------------------------
	|	|	CONNECT
	|	|	<-------------------------------
	|	|	CONNECT ACKNOWLEDGE
CONNECT	|	|	------------------------------->
<-------------------------------------	|	|	
CONNECT ACKNOWLEDGE	|	|	
------------------------------------->	|	|	

ACC = ATM Connection Controller
NServer = network node to which the server (VIP) is connected
NClient= network node to which the client is connected
VPCI/VCI* = Option a) or b) of §5.1.2.4.2/Q.2931 is used
VPCI~ = Option a) or c) If option c) is used no connection identifier IE is sent by the network. A connection identifier IE with the VPCI/VCI of the End User will be sent by the first message in response to the SETUP message sent by the Connection Manager.
CALL PROCEEDING is an optional message in both directions.

Table of VoD Service Attributes [Informative]

The attributes of the Video on Demand Service can be summarized using the tabular format described in I.211 and F.722.

SERVICE ATTRIBUTES	VALUES OF ATTRIBUTES
1. Information Transfer Capability, Service Components (SC)	
1.1 Mandatory Service Components	SC no. 1 High Quality Video [4] SC no. 2 High Quality Audio [2]
1.2 Optional Service Components	SC no. 3 to n Unrestricted Digital Information [2]
2. Information Transfer Mode	ATM
2.1 Connection Mode	Connection Oriented
2.2 Broadband Transfer Capability (Service Specific)	SC no. 1&2 : CBR SC no. 3-n: implementation specific
3. Information Transfer Rate (service specific)	SC no. 1&2: Peak Cell Rate (CBR) SC no 3-n: implementation specific
4. Structure (service specific)	SC no: 1&2 multiplexed as MPEG-2 Single Program Transport Stream via AAL-5 in one VC. SC no. 3-n : implementation specific
5. Establishment of Communication	demand, reserved
6. Symmetry	SC no. 1&2: unidirectional SC 3-n: unidirectional, bi-directional symmetric
7. Communication configuration	point-to-point
Access Attributes	
8. Access Channels and rates	
8.1 for user information	VC no. 1: SC no. 1&2 VC no. 3-n : SC no. 3-n
8.2 for signaling	signaling VC
9. Access protocols	
9.1 Signaling access protocol - physical layer	ATM Forum Signaling 4.0
9.2 signaling access protocol - ATM layer	ATM Forum Signaling 4.0
9.3 signaling access protocol	ATM Forum Signaling 4.0
9.4 signaling access protocol - layer 3 above AAL	ATM Forum Signaling 4.0
9.5 information access protocols - PHY layer	for further study
9.6 Information Access protocols - ATM layer	I.150, 1.361
9.7 Information Access Protocols - AAL	AAL-5

[4] Service components SC1 and SC2 are multiplexed as MPEG-2 SPTS. An MPEG-2 SPTS may also contain Private Data. In this case, MPEG-2 Private Data could be considered a unidirectional instance of SC 3.

SERVICE ATTRIBUTES	VALUES OF ATTRIBUTES
GENERAL ATTRIBUTES	
10 Supplementary Services	for further study
11 Quality of Service (service Specific)	for further study
12 Interworking capabilities	with other video retrieval services (for further study)
13. Operational and Commercial aspects	for further study

Interim Connection Management Arrangements Prior to ATM Forum Signaling 4.0 Specification [Informative]

First Party Interim Signaling Arrangements

To use UNI 3.1 for 1st Party Connection Setup for Video-on-Demand, the signaling parameters should be set in accordance with section 8 (ATM Signaling Setup Information Elements) but with the following use of the Broadband High Layer Information (B-HLI), Low Layer Information (B-LLI) and the Quality of Service Parameter.

1) To allow the VOD Application ID and a correlation ID to be exchanged in an UNI 3.1 environment,:

- Set the Broadband Low Layer information I.E. to -

Field	**Value**	**Notes**
User Information Layer 3 Protocol	‘01011’b	ISO/IEC TR 9577 (Protocol Identification in the Network Layer)
ISO/IEC TR 9577 IPI	‘10000000’b	Initial Protocol Identifier in Bytes 7a and 7b
SNAP ID	‘00’b	Octet 8 SNAP
OUI Type	‘00A03E’x	ATM Forum OUI
PID	‘0002’x	Lower two bytes of the ATM Forum VOD ID

- The B-HLI shall contain a correlation id such as the 7 byte DSM-CC session/resource ID (as defined in Annex D of [10]) by setting the high layer information type to “user specific”

Field	Value	Notes
Higher Layer Information Type	'0000001' b	User Specific
Octets 6 - 13		Max. of 7 byte correlation id: • DSM-CC Resource/Session Identification • H.245 Correlation Id • etc.

2) For the Quality of Service Parameter, use QoS Class in accordance with what your network provider has defined for carrying VOD services.

Proxy Signaling Interim Arrangements

Prior to the availability of ATM Forum Signaling 4.0, proxy signaling can be implemented by using the existing text in the current ATM Forum Signaling 4.0 draft on proxy signaling. This is considered a complete and self contained specification of the proxy signaling capability. It requires the use of existing procedures defined by ITU-T in their Recommendation Q.2931.

ATM Forum UNI 3.1 mandates that ATM connection resources (e.g. VPI/VCI) are assigned only by the network. This limitation does not exist in ATM Forum Signaling 4.0, since it allows either the user or the network to assign these parameters. Proxy signaling requires VC negotiation capability which enables the Proxy Signaling Agent (PSA) , a user of the ATM network , to select the interface and VPI/VCI for an incoming or outgoing call to use. The ITU-T recommendation Q.2931 supports VC negotiation capability and hence, can be used, in the interim, in place of the ATM Forum Signaling 4.0 specification.

Third Party Interim PVC Arrangements

Where SVC capability is not available, the client to server connection may be a PVC, provided that PVCs with acceptably low latency can be configured dynamically between the end-user and the server. In this case, the dynamic configuration of PVCs takes place using management plane procedures.

[i] ITU-T Recommendation G.803, "Digital Networks - Architectures of Transport Networks Based on the synchronous Digital Hierarchy (SDH)", 03/93.

[ii] ATM Forum "User-Network Interface Specification", version 3.0 Prentice Hall September 1993.

[iii] Bellcore TA-NWT-001110 "Broadband ISDN Switching System Generic Requirements", Issue 2 August 31, 1993, Table 5.8 pg 60.

[iv] Bellcore TA-NWT-001110 "Broadband ISDN Switching System Generic Requirements" Issue 2 August 31,1993, table 5.12 pg 62.