The ATM Forum
Technical Committee
Audiovisual Multimedia Services :Video on Demand Specification 1.0

af-saa-0049.000

December, 1995

I would like to thank the many contributors whose enthusiasm made this specification possible.

Steven A. Wright
Editor,
SAA AMS : Video On Demand Specification 1.0

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1. Introduction

1.1 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).

1.2 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.

1.3 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].

1.4 Terminology

1.4.1 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 .....Unreliable 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

1.4.2 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.

1.4.3 Data Unit Naming Convention

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

1.5 Related Documents

1.5.1 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 Communicatuions Systems and Terminals"

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

[9] ATM Forum, "Native ATM Transport Service"

[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.

2. 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.

2.1 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.

2.2 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.

3. Video on Demand Service Configuration [Informative]

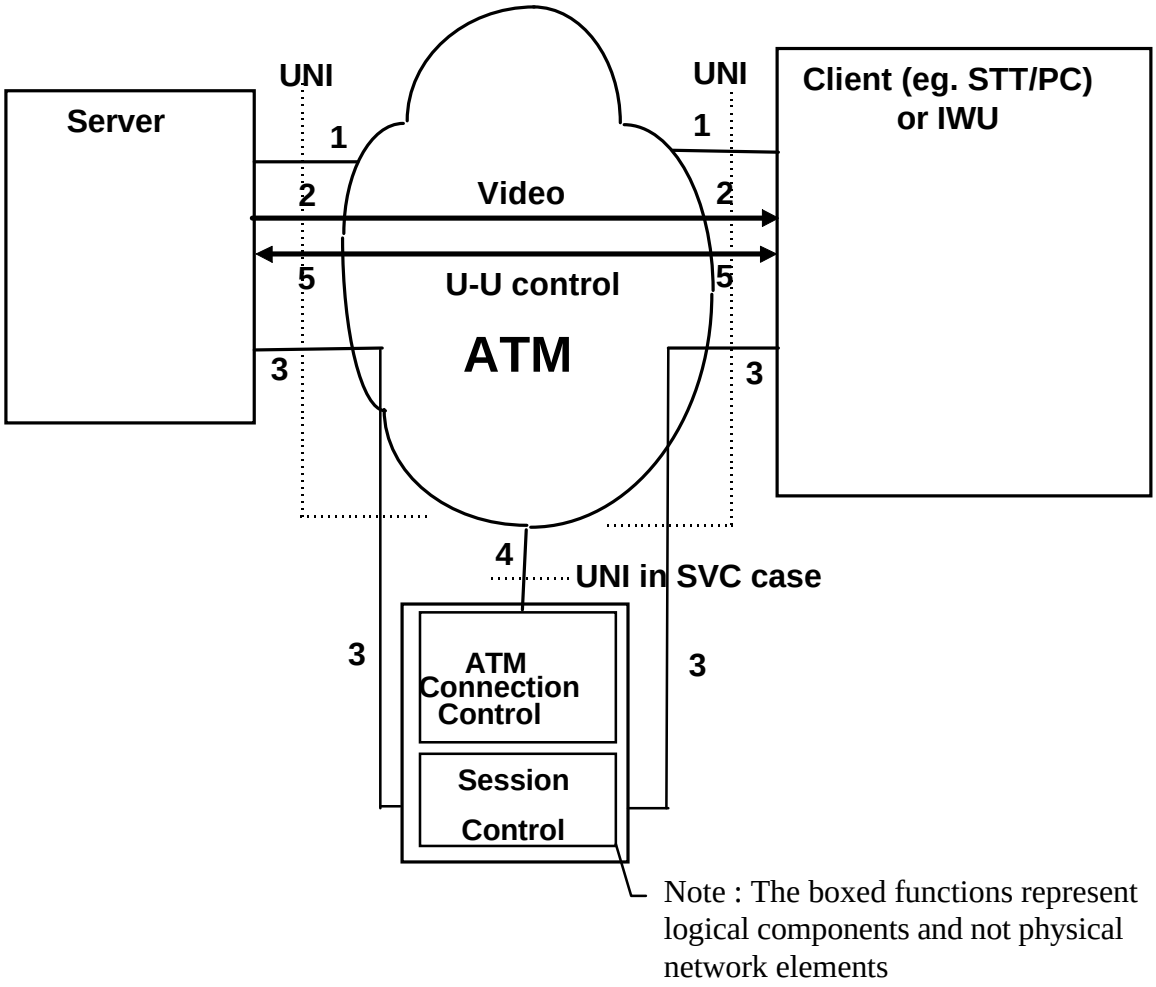


Figure 1 Video on Demand Reference Configuration

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.

[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.

- Several example network configurations are depicted in Annex B.

- 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.

3.1 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

[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.

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.

3.2 *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

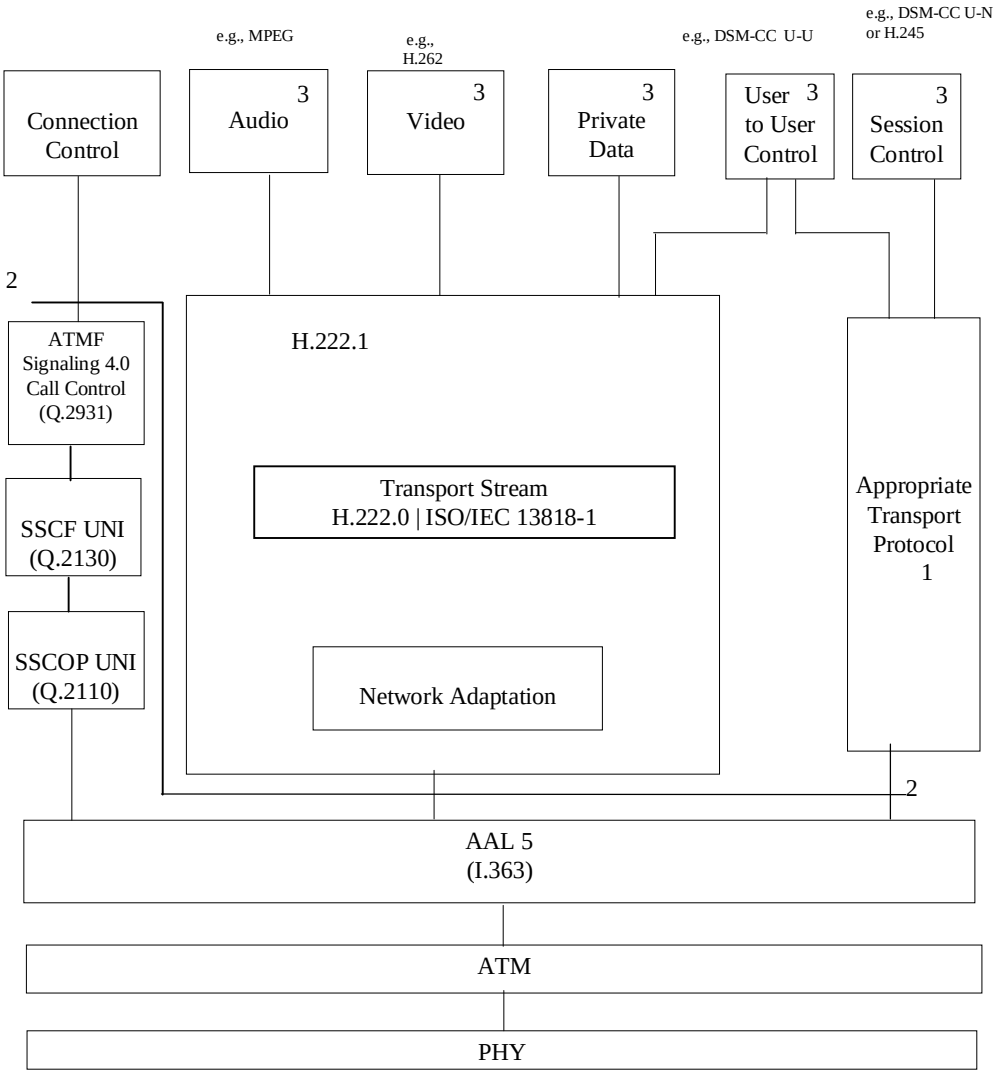
For Phase 1 VoD service, it is expected that the Clients , Servers , ATM connection control and session control are all served by a single carrier network. Thus there are no inter-carrier (BICI) control plane interfaces required.

3.3 *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).

4. VoD System Structure / Protocol Reference Model [Normative]

4.1 *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 Transport Services" 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.

4.1.1 ATM Control Plane Protocol Reference Model [Normative]

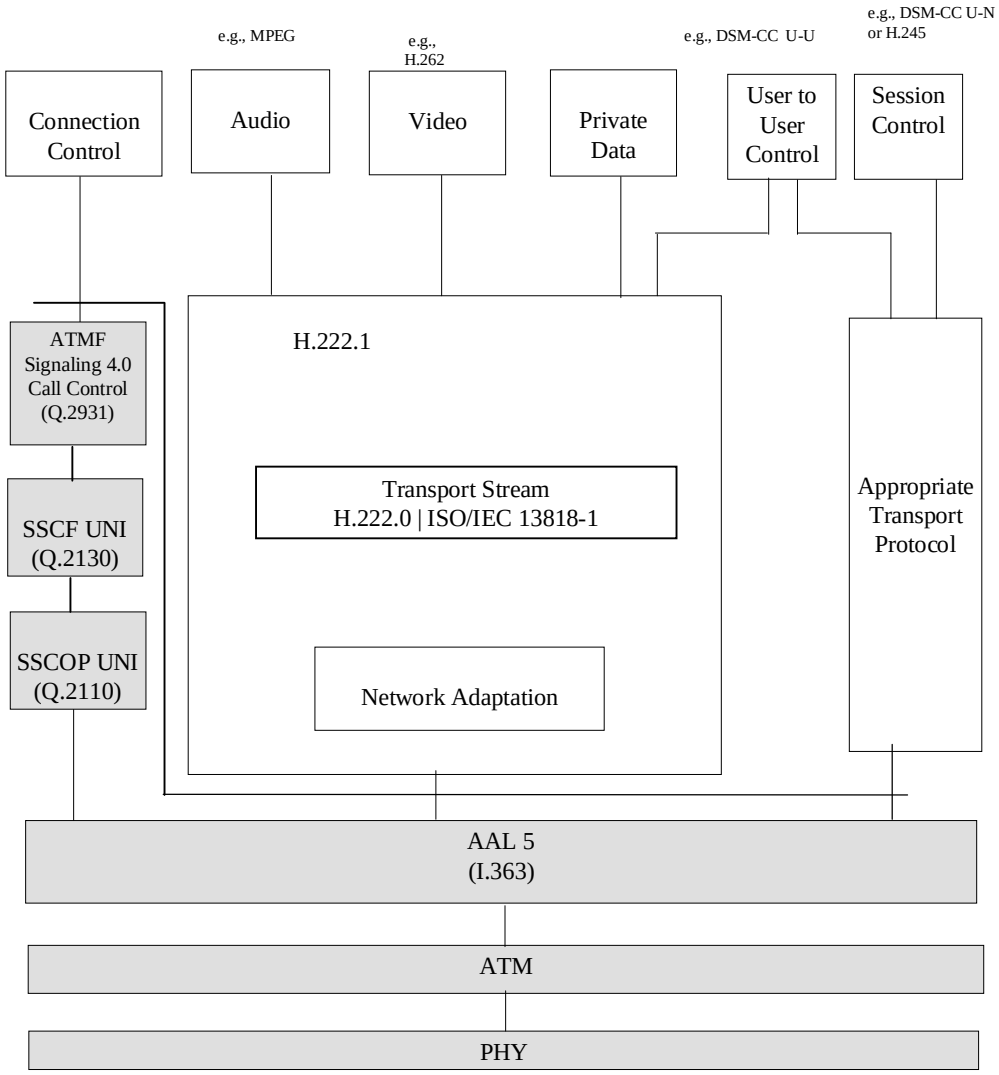
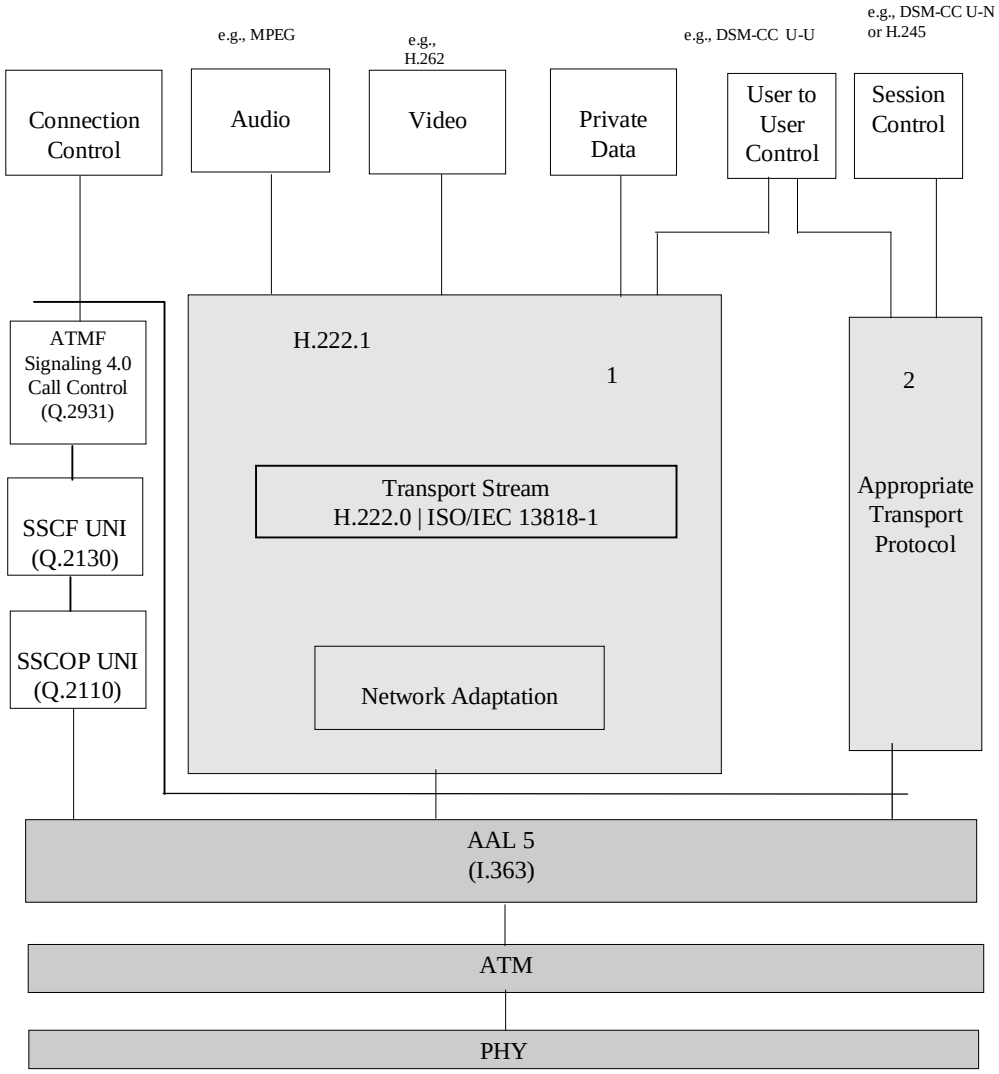


Figure 3 Control Plane Protocol Reference Model

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].

4.1.2 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 .

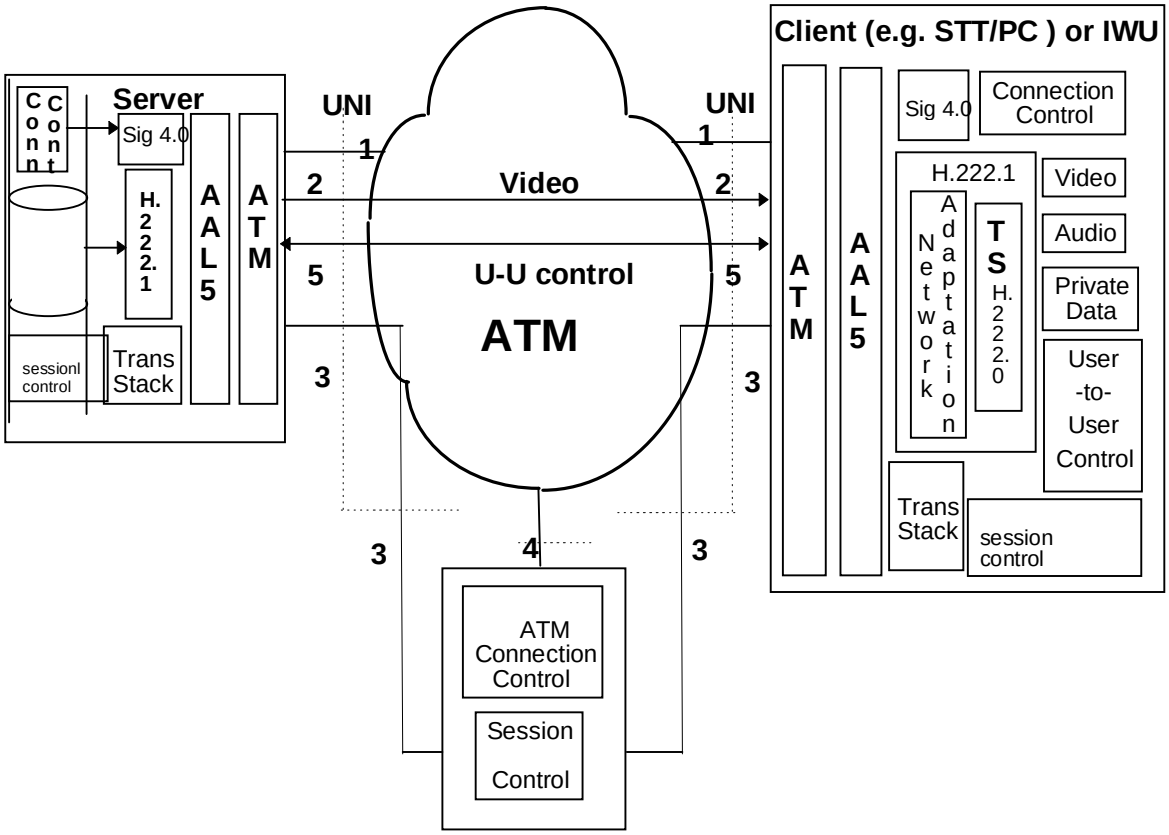


Note 1. H.222.1 network adaptation is required for Interface 2. It is optional for Interface 3 or 5.

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

4.2 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.

5. 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).

5.1 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.

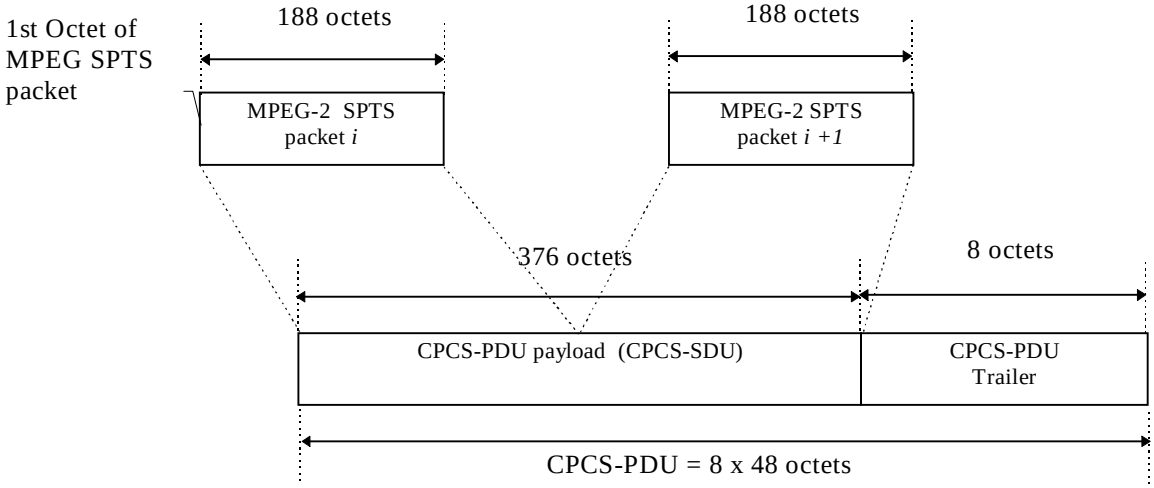


Figure 6 Format of AAL-5 PDU Containing 2 TS Packets

5.2 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 [18].

6. Traffic Parameters **[Normative]**

6.1 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]).

6.2 *ATM Layer Traffic Description* **[Normative]**

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

6.2.1 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.

6.2.2 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].

6.2.3 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.

7. Quality of Service Parameters [Normative]

7.1 ATM Layer QoS Parameters [Normative]

7.1.1 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.

7.1.2 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.

8. 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.

8.1 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.

8.2 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.

8.2.1 First Party Connection Reference Model [Informative]

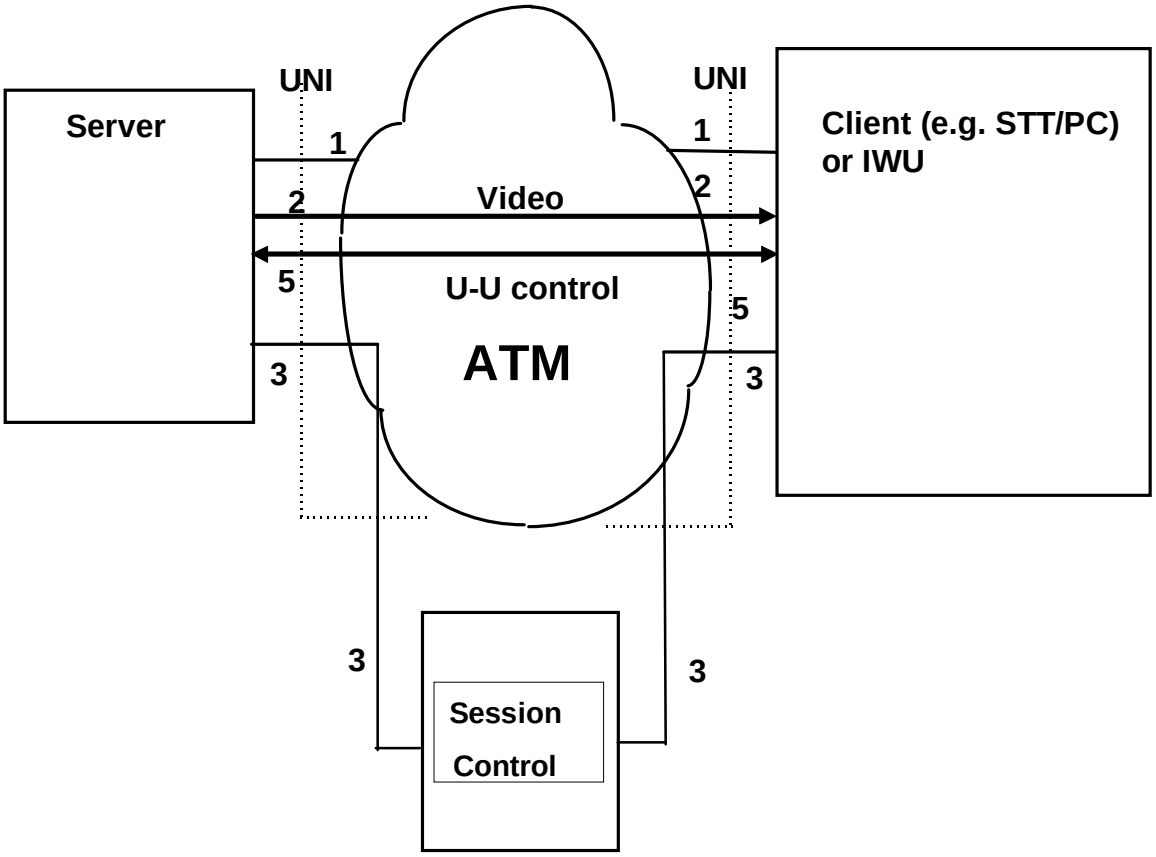


Figure 7 First Party Connection Reference Model

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 equipments. There is no proxy agent to provide ATM connection control.

8.2.2 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.

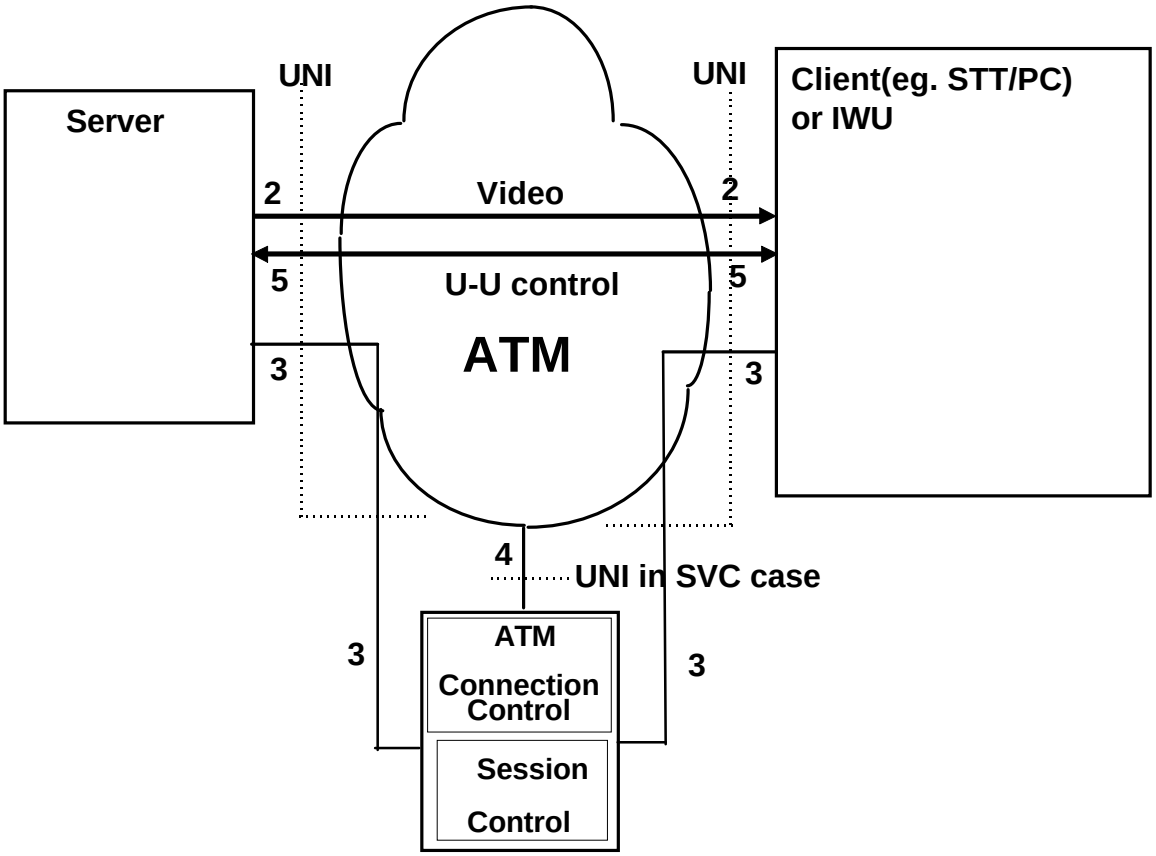


Figure 8 proxy signaling when neither Server nor Client support signaling

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.

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

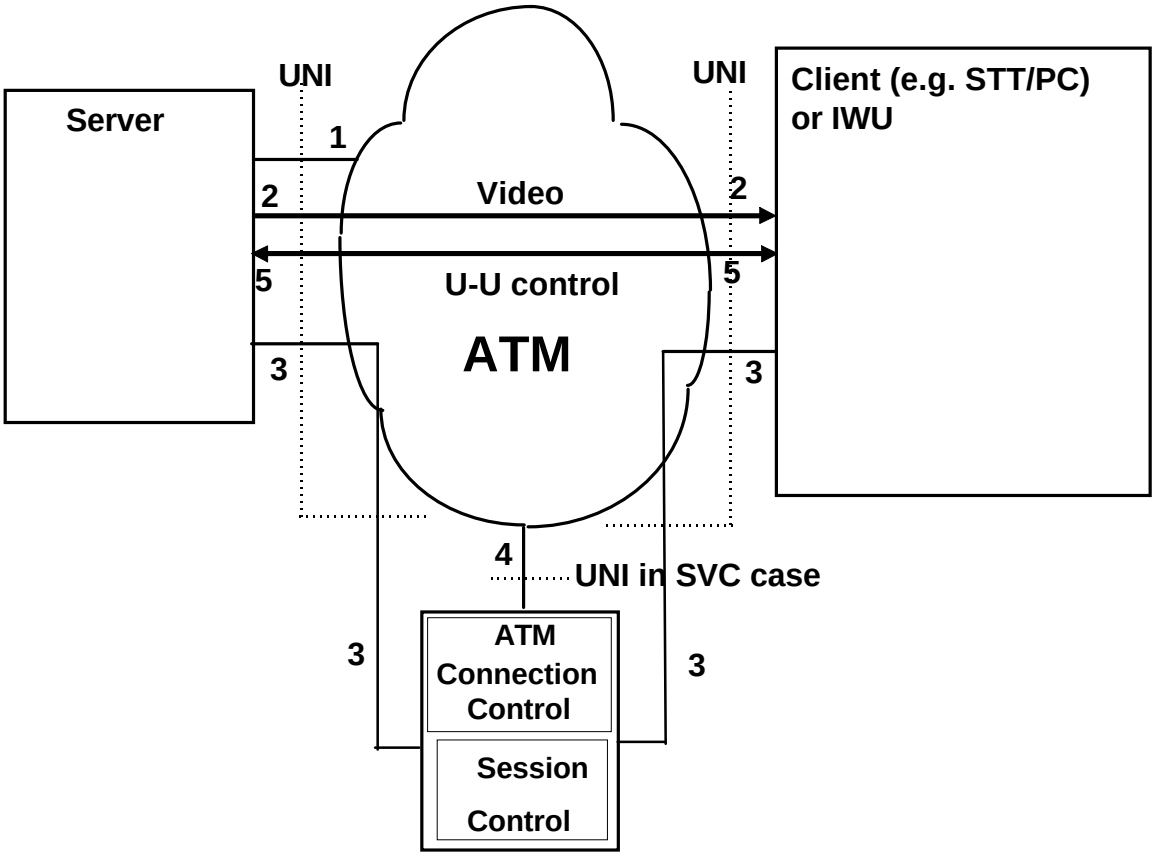


Figure 9 Proxy Signaling when Server supports signaling, but the client does not

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.

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

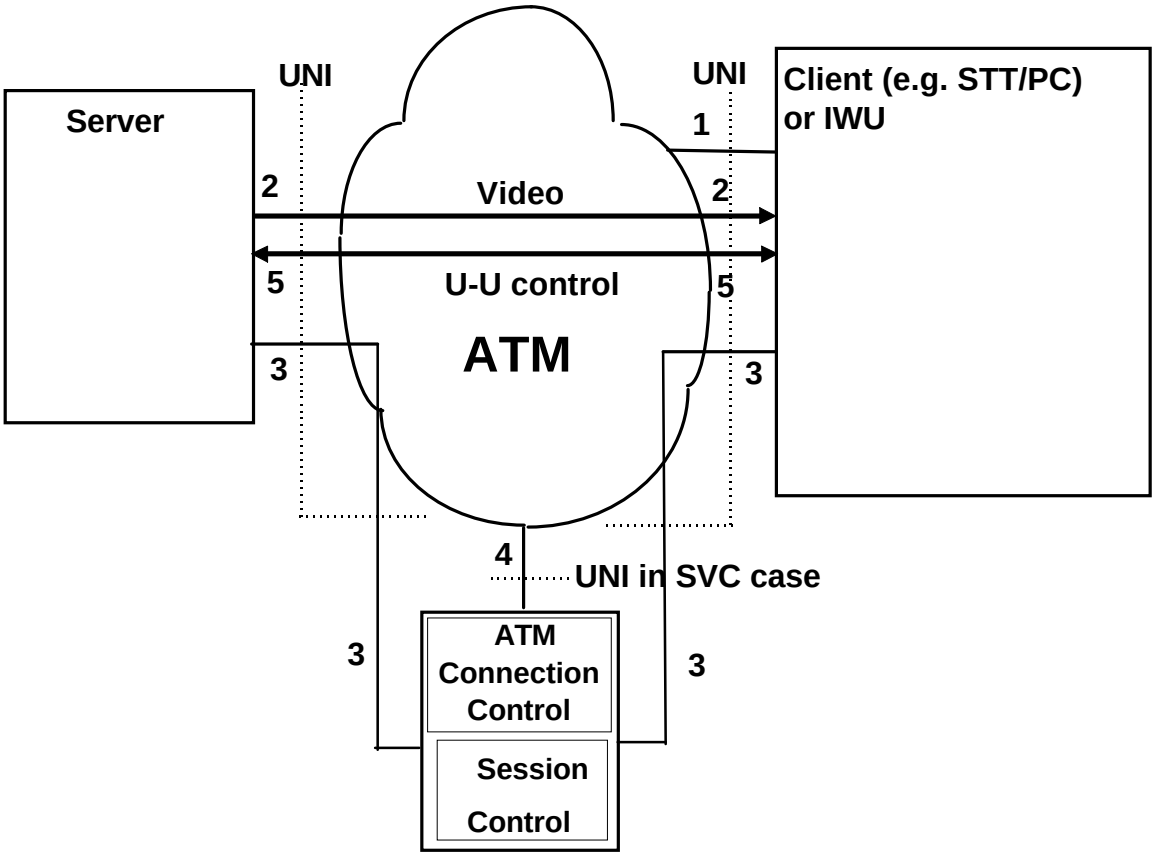


Figure 10 Proxy signaling when the Client supports signaling, but the server does not.

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.

8.3 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:

- The 'Terminal Protocol Identification' and 'Multiplexing Capability' shall be exchanged between the systems.

- 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

8.3.1 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).

8.3.2 ATM Signaling Information Elements Required [Normative]

The following Information Elements are required 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	
O	Cause	
O	Call State	
X	Called party number	
X	Called party subaddress	
O	Calling party number	
O	Calling party subaddress	
X	Connection identifier	
X	QoS parameter	
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

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.

8.3.3 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.

8.3.3.1 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	

8.3.3.2 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	

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

Information Element	Value	Notes
Bearer Class	BCOB-X	
Traffic Type	Constant Bit Rate	
Timing Requirements	End-to-End Timing Not Required	End to End timing is provided by the user (application) not the network.
User Plane Connection configuration	Point-to-Point	

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

Information Element	Value	Notes
Higher Layer Information Type	'0000101'	refer to ITU-T SG15 terminal selection protocol
Terminal Protocol Identification	refer to [7]	H.310 (ROT) -client & (SOT) - server [7]
Forward Multiplexing Capability	'0001'	Transport Stream
Backward Multiplexing Capability	'0000'	No Multiplex

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

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

8.3.3.6 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
virtual Channel ID	H.245 resource/correlation number	

8.3.3.7 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.

9. 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.