INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.321

(02/98)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Systems and terminal equipment for audiovisual services

Adaptation of H.320 visual telephone terminals to B-ISDN environments

ITU-T Recommendation H.321

(Previously CCITT Recommendation)

ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Characteristics of transmission channels used for other than telephone purposes	H.10–H.19
Use of telephone-type circuits for voice-frequency telegraphy	H.20–H.29
Telephone circuits or cables used for various types of telegraph transmission or simultaneous transmission	H.30–H.39
Telephone-type circuits used for facsimile telegraphy	H.40–H.49
Characteristics of data signals	H.50–H.99
CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	H.220–H.229
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	**H.300–H.399**

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION H.321

ADAPTATION OF H.320 VISUAL TELEPHONE TERMINALS TO B-ISDN ENVIRONMENTS

Summary

This Recommendation describes technical specifications for adapting narrow-band audiovisual communications terminals, as defined in Recommendation H.320, to broadband ISDN environments. The terminal conforming to this Recommendation interworks with the same type of terminals (i.e. other H.321 terminals) accommodated in B-ISDN as well as existing H.320 terminals accommodated in N-ISDN. This revision defines an AAL-5 based stack in addition to the AAL-1 based stack.

Source

ITU-T Recommendation H.321 was revised by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 6th of February 1998.

FOREWORD

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

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

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

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

INTELLECTUAL PROPERTY RIGHTS

The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation H.321

ADAPTATION OF H.320 VISUAL TELEPHONE TERMINALS TO B-ISDN ENVIRONMENTS

(*revised in 1998*)

1 Scope

This Recommendation describes technical specifications for adapting narrow-band visual telephone terminals, as defined in Recommendation H.320, to broadband ISDN environments. The terminal conforming to this Recommendation interworks with the same type of terminals (i.e. other H.321 terminals) accommodated in B-ISDN as well as existing H.320 terminals accommodated in N-ISDN.

It is noted that some of the functionalities supported by H.321 terminals are also supported by broadband audiovisual terminals defined in Recommendation H.310. The interworking among H.310, H.321 and H.320 terminals is a mandatory requirement. Interworking between H.320 and H.321 terminals is achieved since the different H.321 terminals are defined in terms of the corresponding H.320 terminal types. (See 4.4 for more details.) Interworking between H.320/H.321 and H.310 terminals is achieved through a common set of H.320/H.321 functions (defined in Recommendation H.310). For example, in addition to supporting the Recommendation H.262 video (MPEG-2 video), H.310 terminals shall support Recommendation H.261 which is part of both Recommendation H.320 and Recommendation H.321.

In H.321 terminals, the adaptation of H.320 functions over B-ISDN is achieved through either ATM Adaptation Layer 1 (AAL-1) or ATM Adaptation Layer 5 (AAL-5). Both Segmentation and Reassembly (SAR) and Convergence Sublayer (CS) functions, as defined in Recommendations I.363.1 and I.363.5, are considered in this Recommendation.

H.321 terminals have the same inband functionalities as those supported by H.320 terminals, i.e. as defined in Recommendations H.242, H.230 and H.221. Extra broadband-related signalling functions, such as negotiation for the use of the Adaptive Clock Recovery method (asynchronous mode), can be accomplished through Q.2931 Information Elements as in Annexes A and C.

H.321 terminals on the public B-ISDN will conform to Annex A for the use of AAL-1. As an option, they may also operate according to Annex B for the use of AAL-5. H.321 terminals on customer premises networks may operate according to either Annex A or Annex B or both.

Interworking between AAL-1 and AAL-5 transports shall be accomplished by the use of an AAL-1/AAL-5 Interworking Unit on the customer premises, as specified in 7.3.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T Recommendation H.221 (1997), *Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices.*

- ITU-T Recommendation H.230 (1997), *Frame-synchronous control and indication signals for audiovisual systems*.
- ITU-T Recommendation H.242 (1997), *System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s*.
- ITU-T Recommendation H.243 (1997), *Procedures for establishing communication between three or more audiovisual terminals using digital channels up to 1920 kbit/s*.
- ITU-T Recommendation H.261 (1993), *Video codec for audiovisual services at p* $\times$ *64 kbit/s*.
- ITU-T Recommendation H.310 (1996), *Broadband audiovisual communication systems and terminals*.
- ITU-T Recommendation H.320 (1997), *Narrow-band visual telephone systems and terminal equipment*.
- ITU-T Recommendation H.322 (1996), *Visual telephone systems and terminal equipment for local area networks which provide a guaranteed quality of service.*
- ITU-T Recommendation I.356 (1996), *B-ISDN ATM layer cell transfer performance.*
- ITU-T Recommendation I.361 (1995), *B-ISDN ATM layer specification.*
- ITU-T Recommendation I.363.1 (1996), *B-ISDN ATM Adaptation Layer specification: Type 1 AAL*.
- ITU-T Recommendation I.363.5 (1996), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL*.
- ITU-T Recommendation I.371 (1996), *Traffic control and congestion control in B-ISDN*.
- ITU-T Recommendation I.413 (1993), *B-ISDN user-network interface.*
- ITU-T Recommendation I.580 (1995), *General arrangements for interworking between B-ISDN and 64 kbit/s based ISDN.*
- ITU-T Recommendation Q.2931 (1995), *B-ISDN Digital Subscriber Signalling System No. 2 – User-Network Interface (UNI) layer 3 specification for basic call/connection control.*

3 Definitions and abbreviations

3.1 Definitions

This Recommendation defines the following terms:

3.1.1 broadband: Bit rate including and beyond that of narrow-band.

3.1.2 circuit emulation: Emulation of the N-ISDN circuit-switched service by B-ISDN.

3.1.3 inband signalling: Signalling via BAS of the H.221 frame structure.

3.1.4 narrow-band: Bit rate ranging from 64 kbit/s to 1920 kbit/s. This channel capacity is provided as a single $B/H_0/H_{11}/H_{12}$-channel or a multiple of B/H0-channels.

3.1.5 outband signalling: Signalling via a subchannel not part of the $B/H_0/H_{11}$-channel in N-ISDN or equivalent channel in B-ISDN.

3.2 Abbreviations

This Recommendation uses the following abbreviations:

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
BCH	Bose-Chaudhuri-Hocquenghem
B-ISDN	Broadband aspects of ISDN
B-NT	Broadband Network Termination
B-TA	Broadband Terminal Adaptor
B-TE	Broadband Terminal Equipment
C&I	Control and Indication
CBR	Constant Bit Rate
CPCS	Common Part Convergence Sublayer
CRC	Cyclic Redundancy Check
CS	Convergence Sublayer
CSI	Convergence Sublayer Indication
FEC	Forward Error Correction
IE	Information Element
ISDN	Integrated Services Digital Network
IWU	Interworking Unit
LSD	Low-Speed Data
MCU	Multipoint Control Unit
NAL	Network Adaptation Layer
N-ISDN	Narrow-band aspects of ISDN
OAM	Operation and Maintenance
PDU	Protocol Data Unit
PHY	PHYsical layer
SAP	Service Access Point
SAR	Segmentation and Reassembly
SDT	Structured Data Transfer
SDU	Service Data Unit
SN	Sequence Number
SNP	Sequence Number Protection
SRTS	Synchronous Residual Time Stamp
SSCS	Service Specific Convergence Sublayer
TE	Terminal Equipment
VC	Virtual Channel

4 System description

4.1 Applications

This terminal can be used for various applications such as conversational services, distributive services, retrieval services, messaging services as the existing H.320 terminal can. This Recommendation does not specify any particular service.

4.2 System configuration

The H.321 terminal is mapped onto the B-ISDN reference configuration, which is described in Recommendation I.413, as shown in Figure 1.

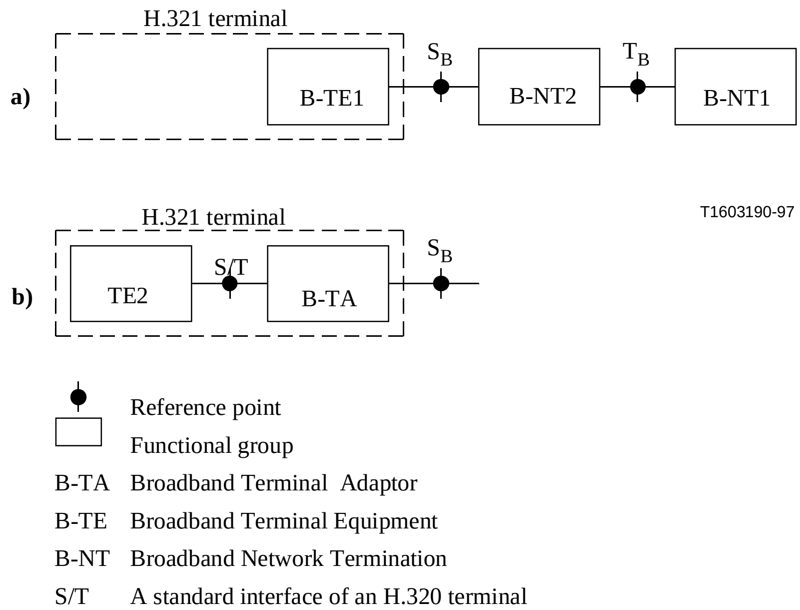


Figure 1/H.321 – Reference configuration

There are two possible implementations of an H.321 terminal. The first one is of an integrated design which includes H.320, ATM Adaptation Layer (AAL), and ATM functions in a single terminal unit (i.e. B-TE1 in Figure 1).

The second implementation consists of an H.320 terminal equipment (TE2) and a Broadband Terminal Adaptor (B-TA). In this case, an H.320 signal (i.e. with an H.221 framing format) is transmitted at the interface between the H.320 terminal equipment (TE2) and the terminal adaptor (B-TA). Moreover, terminal-to-network signalling is performed in B-TA with possible interaction with TE2.

4.3 Generic terminal architecture

A generic architecture of an H.321 terminal [corresponding to the configuration of Figure 1 a)] is shown in Figure 2, where constituent elements and corresponding Recommendations are indicated. The figure includes the following functional units: a video I/O equipment, an audio I/O equipment, a telematic equipment, a system control unit, video and audio codecs, an audio delay unit and a mux/demux unit. These functional units are defined in 3.1/H.320.

The AAL, ATM, and physical units provide the adaptation and interface functions required for accommodating an H.321 terminal over a broadband network.

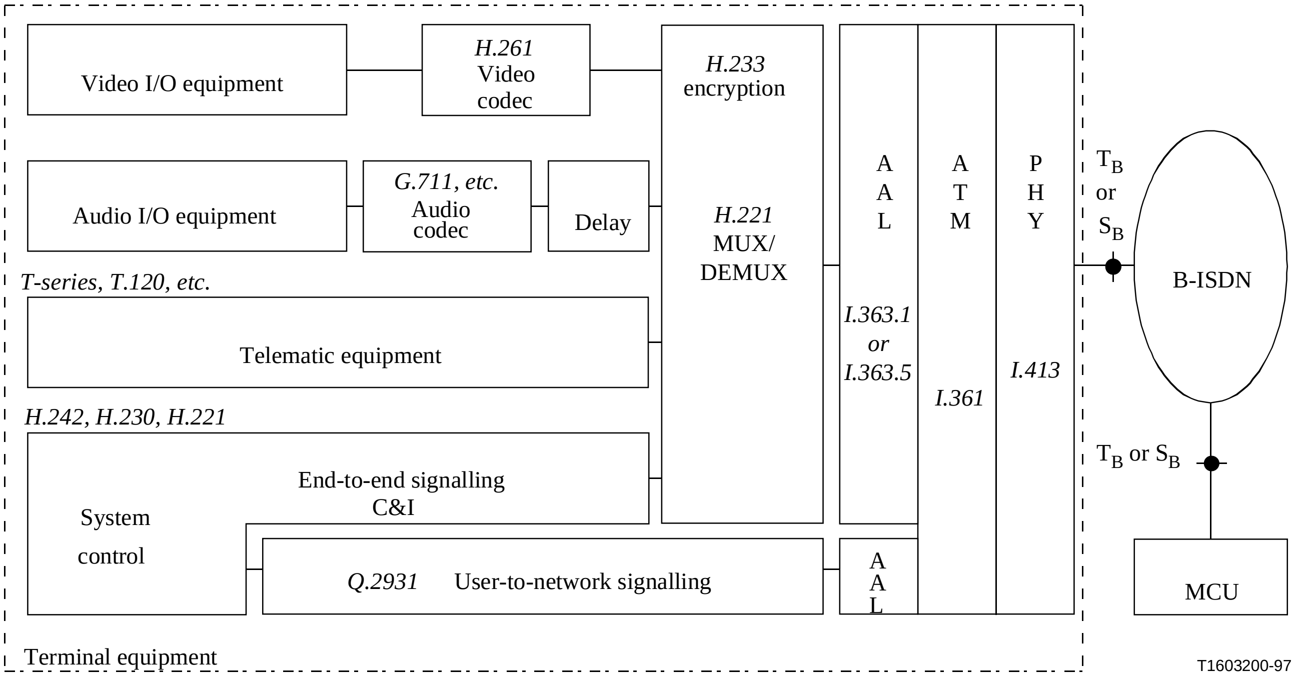


Figure 2/H.321 – Protocol stack of the H.321 terminal

4.4 Terminal type

H.321 terminals vary according to the channel access capability (e.g. B, H_0 and H_{11}/H_{12}), bit rate classes and audiovisual coding schemes. H.321 terminals are defined in terms of the corresponding terminal type in Recommendation H.320. Table 1/H.320 outlines the different communication and audiovisual coding modes supported.

The number of ATM VCs that shall be supported by a given H.321 terminal is the **same** as the number of N-ISDN channels (i.e. B- or H_0-channels) supported by the corresponding H.320 terminal.

For example, under the 2B transfer mode, two separate VCs are established between two H.321 terminals. Synchronization between the two VCs is achieved through the multiframe structure described in Recommendation H.221. An H.320 terminal using the 2B transfer mode (i.e. two B-channels over an N-ISDN network) can communicate with an H.321 terminal that is capable of supporting the 2B mode (i.e. two B-channels each of which is carried by an ATM VC over a B-ISDN network through circuit emulation, using either AAL-1 or AAL-5 or both). Figure 4 a) illustrates the transfer mode of multiple channels over multiple VCs.

– The mode of Figure 4 a) is mandatory for H.321 terminals that support multiple B- or H_0-channels.

– The mode of Figure 4 b) is for further study.

– The mode of Figure 4 c) is mandatory for H.321 terminals that support a single B-, H_0-, H_{11}-, or H_{12}-channel or a single multirate $n \times 64$ kbit/s channel.

4.5 Point-to-point communication

An H.321 terminal may have a variety of capabilities. In point-to-point communications, a common set of them is determined on a call-by-call basis through the communication procedures defined in Recommendation H.242.

4.6 Multipoint communication

An H.321 terminal can participate with other H.321 or H.320 terminals in multipoint communications through MCUs which are accommodated in B-ISDN or N-ISDN. An example of a multipoint configuration is shown in Figure 3. The necessary communication procedures are found in Recommendation H.243.

5 Infrastructure

5.1 Audio coding

See Recommendation H.320.

5.2 Video coding

See Recommendation H.320.

5.3 Multimedia multiplexing and synchronization

As per Recommendation H.221.

5.4 End-to-end control

Mandatory Control and Indication signals are defined in Table 4/H.320. Other C&I signals are defined in Recommendation H.230.

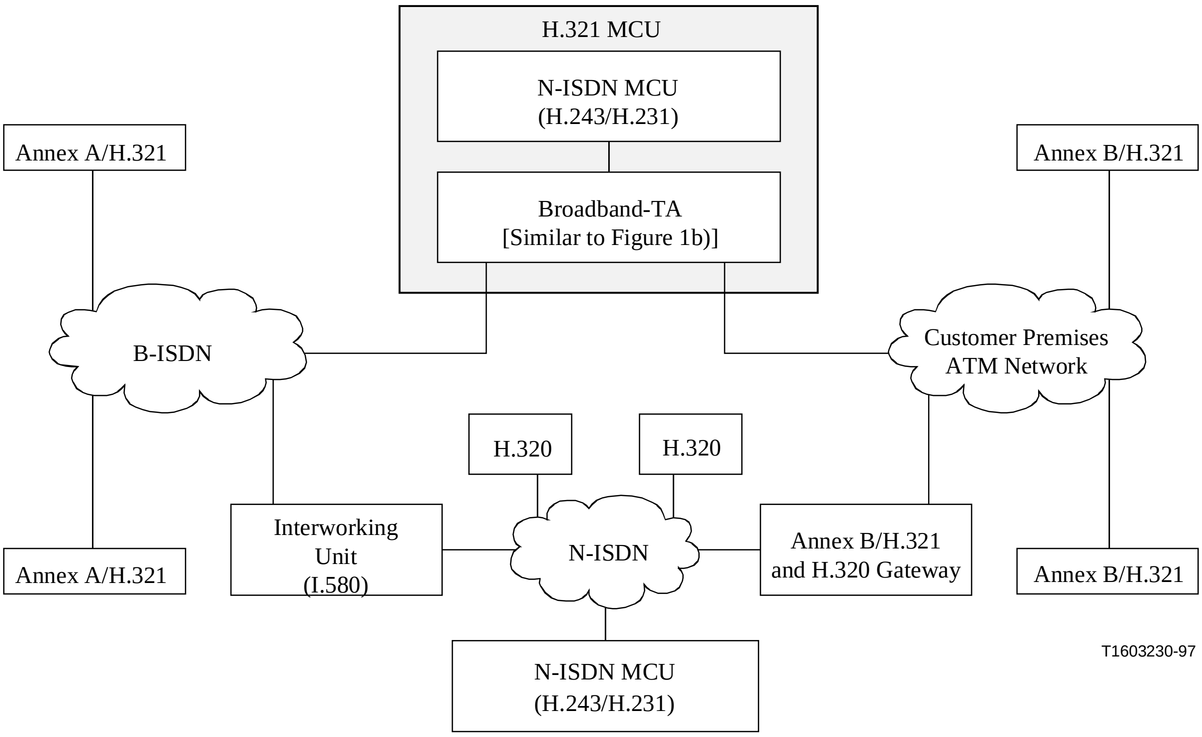


Figure 3/H.321 – An example of a multipoint configuration for H.321/H.320 terminals

5.5 Communication procedures

As per Recommendations H.242 and H.243.

5.6 AAL functions

Segmentation and Reassembly (SAR) and Convergence Sublayer (CS) functions of either AAL Type 1 (AAL-1) or AAL Type 5 (AAL-5) or both shall be supported by H.321 terminals. The SAR and CS functions depend on the choice of ATM Adaptation Layer, and are specified in Annex A (AAL-1) and Annex B (AAL-5).

Figure 4 shows a functional architecture for the SAR and CS functions and their interfaces within an H.321 terminal.

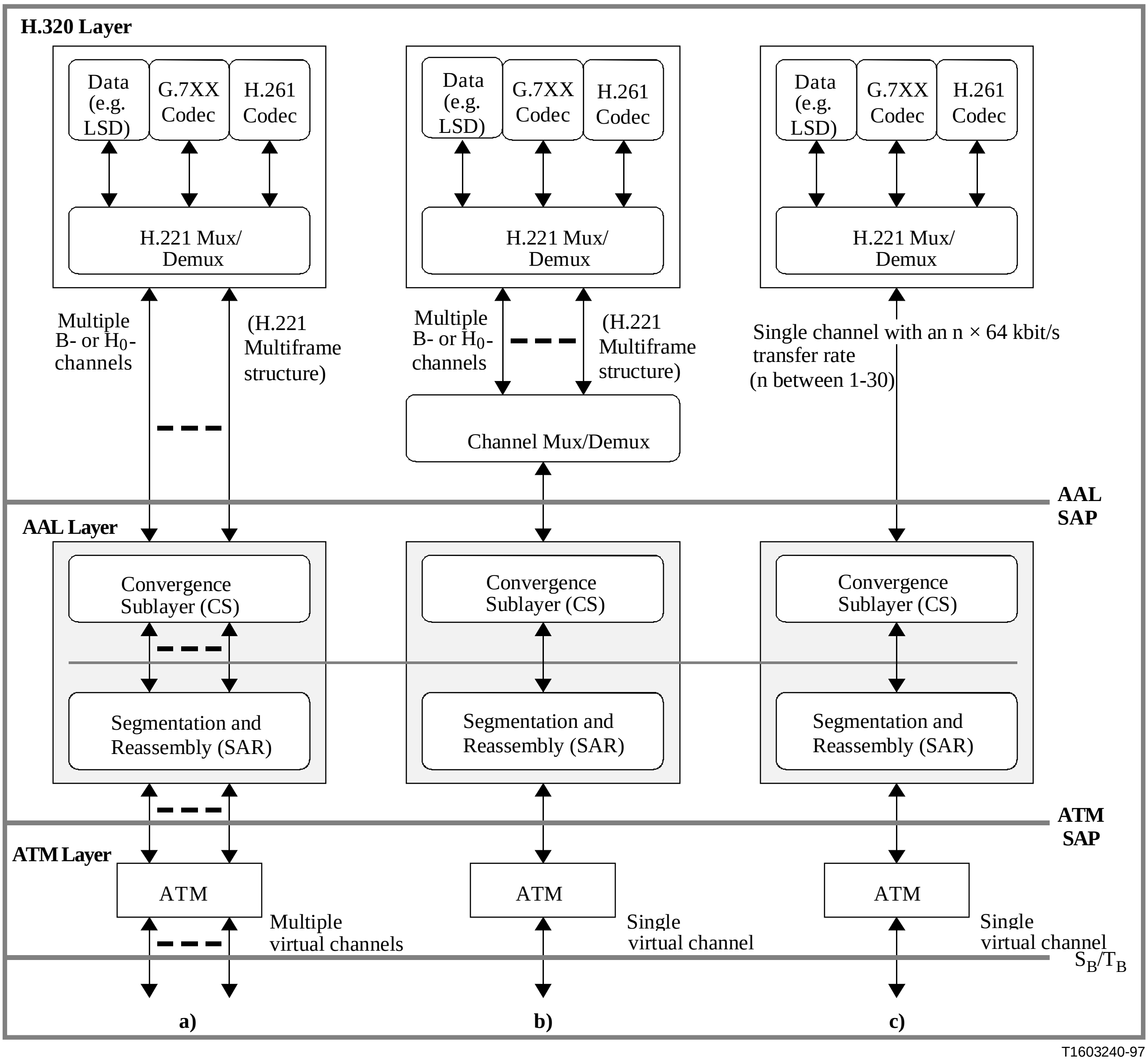


Figure 4/H.321 – AAL layer interfaces for H.321 terminals with single and multiple virtual channels

Three transfer modes are shown in the figure: multiple channels over multiple VCs, multiple channels over a single VC and a single channel over a single VC. H.321 terminal that supports the transfer of multiple channels shall support the mode illustrated in Figure 4 a). H.321 terminals that only support the transfer of a single channel (e.g. single B or H_0) shall support the mode illustrated in Figure 4 c). Support of the transfer mode illustrated in Figure 4 b) is for further study.

5.7 Call control

The Q.2931 Information Elements used to set up a call depend on the choice of ATM Adaptation Layer, and are specified in Annexes A and B.

5.8 Synchronization of 8 kHz timing

Synchronization of the 8 kHz timing is achieved through the procedure defined in Annex C.

5.9 ATM Transfer Capability

The ATM transfer capability DBR shall be used as specified in Recommendation I.371.

6 Terminal equipment

6.1 Audio source and arrangement

See Recommendation H.320.

6.2 Video source and arrangement

See Recommendation H.320.

6.3 Data and other auxiliary equipment

See Recommendation H.320.

6.4 Optional enhancements

Under study.

6.5 Error resilience

In B-ISDN environments, a communication channel may suffer from occasional bit errors and cell losses. Audio and video source coding/decoding have inherent or built-in error correction or resilience mechanisms such as the BCH FEC code in Recommendation H.261 which provides an appropriate protection against random bit error events.

7 Intercommunications

Intercommunications between H.321 terminals that depend on the choice of ATM Adaptation Layer are specified in Annexes A and B.

7.1 Intercommunication among H.321 terminals

A common mode of (Recommendation H.320) operation among H.321 terminals shall be determined as described in Recommendation H.320. Moreover, when an H.321 terminal is communicating with another H.321 terminal, several possibilities exist regarding the number of virtual channels needed between the two terminals. Both single and multiple VC scenarios are shown in Figure 5.

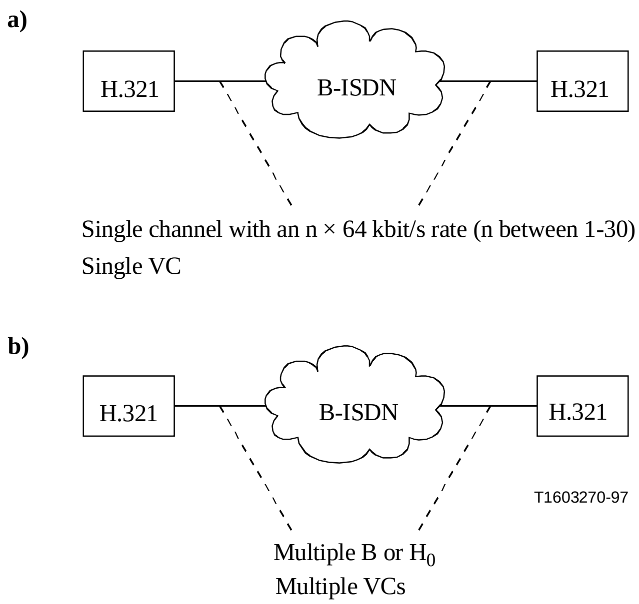


Figure 5/H.321 – Interworking scenarios between H.321 terminals

7.2 Intercommunication with N-ISDN terminals

H.321 terminals have the capability of interworking with H.320 terminals through the network support of interconnection between B-ISDN and N-ISDN. Interconnection based on AAL-1 is specified in Recommendation I.580. Interconnection based on AAL-5 requires an Annex B and H.320 gateway as described in B.1.

7.2.1 Intercommunication with H.320

A common mode of (Recommendation H.320) operation among H.320 and H.321 terminals shall be determined as described in Recommendation H.320. Moreover, several modes of communications are possible between H.320 and H.321 terminals, depending on, for example, the number of channels used. Examples of these communication modes are shown in Figure 6.

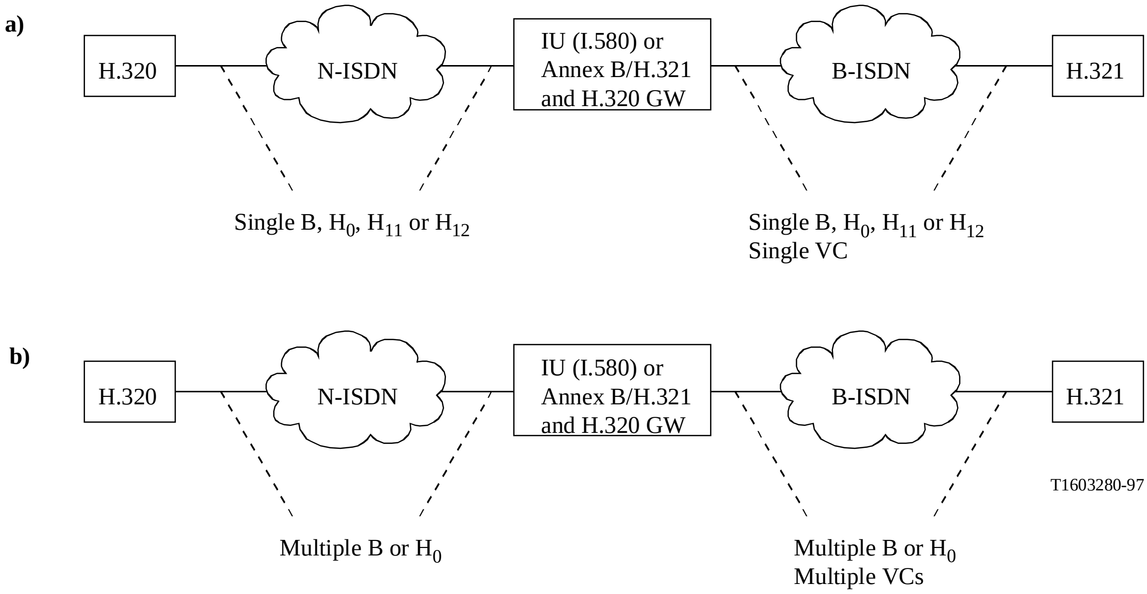


Figure 6/H.321 – Interworking scenarios among H.320 and H.321 terminals

7.2.2 Intercommunication with telephony

H.321 terminals shall be able to interwork with telephones accommodated in N-ISDN and PSTN using G.711 audio.

7.3 Intercommunication between AAL-1 and AAL-5

The following procedures describe the use of an AAL-1/AAL-5 Interworking Unit as shown in Figure 7.

1) An H.321 terminal sends a SETUP to another H.321 terminal. If the AAL type of the receiving terminal matches the AAL type in the SETUP, the normal connection procedures are followed.

2) If the AAL type in the SETUP does not match the type of the receiving terminal, a Generic Identifier Transport (GIT) Information Element (IE) may optionally be included in the RELEASE COMPLETE. This GIT IE can contain the address of an AAL-1/AAL-5 Interworking Unit known to the destination terminal that rejected the call.

   NOTE – The address shall be contained in the End Station Identifier which is pending definition and approval from Study Group 11.

3) The originating H.321 terminal may use the address contained in the GIT IE from the RELEASE COMPLETE to send a new SETUP to the specified AAL-1/AAL-5 Interworking Unit. The address of the destination H.321 terminal shall be included as a GIT IE, since the SETUP itself addresses the AAL-1/AAL-5 Interworking Unit.

4) The AAL-1/AAL-5 Interworking Unit shall use the address contained in the GIT IE of the SETUP it receives from the originating H.321 terminal as the destination address for a new SETUP to the destination H.321 terminal. Once both channels have been established, the Interworking Unit shall perform AAL-1/AAL-5 conversion.

If the originating H.321 terminal has *a priori* knowledge that an Interworking Unit is required and knows the address of an Interworking Unit, it may skip steps 1 and 2 and use its known address directly in steps 3 and 4, in order to speed call establishment.

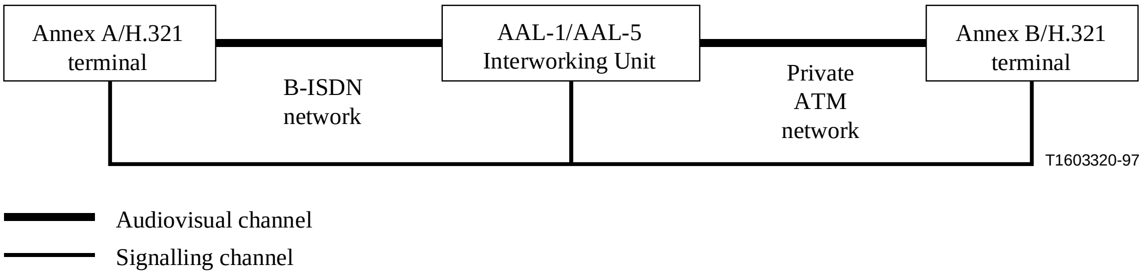


Figure 7/H.321 – Insertion of AAL-1/AAL-5 Interworking Unit

7.4 Intercommunication with audiovisual terminals connected to other networks

See Recommendation H.246.

ANNEX A

The use of ATM Adaptation Layer Type 1

A.1 Scope

This annex describes the use of ATM Adaptation Layer Type 1 (AAL-1) for transporting an H.320 stream over a broadband network.

A.2 AAL functions

At the AAL Service Access Point (AAL-SAP) the CS sublayer receives AAL Service Data Units (AAL-SDUs) from the H.320 layer. The AAL-SDU is an octet of a constant bit rate (CBR) H.320 signal. The SAR sublayer receives a 47-byte CS Protocol Data Unit (PDU) from the convergence sublayer, and adds one byte of SAR header to generate the 48-byte SAR-PDU. The SAR-PDU is passed to the ATM layer across the ATM-SAP. The ATM layer adds the five-byte ATM header and forms the 53-byte ATM cell.

A.2.1 Convergence sublayer functions

The only CS function supported by H.321 terminals is the Structure Data Transfer (SDT) mode. It is important to note that all H.321 terminals are required to support this function at all times[1]. The SDT mode includes the transfer of the SDT pointer for all n × 64 transfer rates except for the single B (i.e. 64 kbit/s) case as specified in Recommendation I.363.1. The SDT mode shall be used both when H.321 terminals are communicating with H.320 terminals, and when H.321 terminals are communicating among themselves over a B-ISDN network. It is also important to note that when multiple B-channels are established over multiple VCs, then the SDT pointer is **not** used in the individual channels[2] (although the aggregate transfer rate is a multiple of 64 kbit/s). To ensure compatibility with Recommendation I.580, the SDT pointer shall be sent in a single VC carrying a single H_0, H_{11} or H_{12} ISDN channel[3].

---

1 It is important to distinguish between the SDT mode and the SDT pointer. According to Recommendation I.363, the SDT pointer is always used in the SDT transfer mode except for the single B-channel case.

2 This includes the commonly used 2 × 64 kbit/s (2B) connection mode over two virtual channels.

3 This is true for both cases Figure 4 a) and Figure 4 c).

Because the mean time between cell loss events is expected to be acceptably long for the applications supported by H.321 terminals, the short or long FEC interleaver options of the AAL type 1 convergence sublayer are not supported.

A.2.2 SAR sublayer functions

In addition to mapping between the CS-PDU and SAR-PDU, in H.321 terminals the SAR sublayer provides the following functions:

a) *Sequence numbering*

At the transmitting end, the SAR sublayer receives a sequence number from the Convergence Sublayer for each CS-PDU. This number occupies 3 bits of the 4-bit Sequence Number (SN) field of the SAR-PDU byte header. At the receiving end, the sequence number value is passed to the CS.

b) *CS indication*

The SAR sublayer indicates the existence of the Convergence Sublayer. In H.321 terminals, and as explained above, when the convergence sublayer SDT pointer is present, coding of the Convergence Sublayer Indication (CSI) bit and the SDT pointer byte shall be done according to Recommendation I.363.1. The Synchronous Residual Time Stamp (SRTS) function is **not** used in H.321 terminals.

c) *Error protection*

The SAR sublayer protects the SN field (i.e. the 3-bit sequence number value and the CSI bit) using a 4-bit Sequence Number Protection (SNP) field. The SNP is divided into a 3-bit CRC code to protect the SN field, and an even parity to protect the resulting 7-bit code (4-bit SN plus 3-bit CRC).

A.2.3 Cell Delay Variation

The Cell Delay Variation shall conform to the stringent requirement on CDV tolerance as described in 5.4.1.3/I.371.

A.3 Call control

Since an H.321 terminal is, in principle, a B-ISDN terminal emulating a N-ISDN service, then a call is established through the procedures defined in clause 6/Q.2931[4].

A.3.1 Digital connection

The out-of-band signalling functional unit of an H.321 terminal shall use, during the call-connection procedure, the Q.2931 Information Elements (IEs) shown in Table A.1 if the intent is to establish a digital connection capable of carrying an audiovisual multiplex. These IEs are part of the SETUP message[5] (Table 3-19/Q.2931) used when initiating a 64 kbit/s based circuit-mode ISDN service call over a broadband ISDN network.

---

[4] That clause of Recommendation Q.2931 outlines the requirements for supporting:
a) 64 kbit/s based circuit-mode ISDN services in B-ISDN; and
b) access signalling interworking between N-ISDN and B-ISDN.

[5] Other Q.2931 messages may also use these IEs.

Table A.1/H.321 – Q.2931 information elements – Digital connection over AAL-1

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for digital connection over AAL-1
Narrow-band Bearer Capability (N-BC)	Information transfer capability	• Unrestricted Digital Information (UDI) • Restricted Digital Information (RDI) • UDI with tone/announcement (UDI-TA)
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s • 2 × 64 kbit/s • 384 kbit/s • 1536 kbit/s • 1920 kbit/s • Multirate (64 kbit/s base rate)
	Rate multiplier	• 2 to the maximum number of B-channels
	User information layer 1 protocol	• Recommendations H.221 and H.242
Broadband Bearer Capability (B-BC)	Bearer class	• BCOB-A
	Susceptibility to clipping	• Susceptible to clipping
	Call configuration	• Point-to-point
ATM traffic descriptor	Forward peak cell rate (for CLP 0+1)	(Variable: depends on the transfer rate)
	Backward peak cell rate (for CLP 0+1)	
AAL parameters	AAL type	• AAL-1
	Subtype identifier	• Circuit Transport
	CBR rate	• 64 kbit/s • n × 64 kbit/s
	Multiplier	• 2 to the maximum value of n (in n × 64 kbit/s) supported by the H.321 terminal (Note 1)
	Source clock frequency recovery method	• Null (synchronous) • Adaptive Clock Method (Note 2)
	Error correction method	• Null (no error correction is provided) (Note 3)
	Structure data transfer block size	(Note 4)
	Partially filled cells method	• 47
End-to-end transit delay	Cumulative transit delay value	(Under study)
	Maximum end-to-end transit delay value	

Table A.1/H.321 – Q.2931 information elements – Digital connection over AAL-1 *(continued)*

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for digital connection over AAL-1
Quality of Service (QOS)	(Under study)	
Narrow-band Low Layer Compatibility (N-LLC) (Note 5)	Information transfer capability	• Unrestricted Digital Information (UDI) • Restricted Digital Information (RDI) • UDI with tone/announcement (UDI-TA)
	Negotiation indicator	• Out-band negotiation not possible • Out-band negotiation possible
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s • 2×64 kbit/s • 384 kbit/s • 1536 kbit/s • 1920 kbit/s • Multirate (64 kbit/s base rate)
	Rate multiplier	• 2 to the maximum number of B-channels
	User information layer 1 protocol	• Recommendations H.221 and H.242
Narrow-band High Layer Compatibility (N-HLC)	(Note 6)	
OAM traffic descriptor	(Under study)	

NOTE 1 – It is important to note that, when H.321 terminals are communicating with H.320 terminals, then the multipliers 6, 24 and 30 shall be used for the H_0, H_{11}, and H_{12} transfer rates, respectively. On the other hand, when H.321 terminals are communicating among themselves over a B-ISDN network, then all integer values between 2 and 30 can be used, subject to any limitation of H.221 BAS codes for allowed information transfer rates.

NOTE 2 – There are two possible solutions for recovering the source clock in H.321 terminals:

1) if a common clock is available at both ends, then this clock is used to recover timing and synchronize both ends as usually done in a synchronous circuit transport;
2) when a common clock is not available, then the Adaptive Clock Recovery method is used.

Therefore, in H.321 terminals, the Synchronous Residual Time Stamp (SRTS) approach is not needed, and consequently is not supported by this Recommendation.

NOTE 3 – H.321 terminals shall work without an error correction method; however, if an error correction method is supported, the terminal shall provide a fall back mechanism in order to work without an error correction method.

Table A.1/H.321 – Q.2931 information elements – Digital connection over AAL-1 *(concluded)*

NOTE 4 – As noted in A.2.1, the SDT mode shall be supported by all H.321 terminals supporting AAL-1. See A.2.1 for more details. It is also important to note that when multiple B-channels are established over multiple VCs, the SDT pointer is not used in the individual channels (although the aggregate transfer rate is a multiple of 64 kbit/s). NOTE 5 – The (optional) N-LLC information element is used for compatibility checking between the two communicating ends. The attributes in here shall not be in conflict with the attributes specified in the N-BC information element. NOTE 6 – The (optional) N-HLC information element is used for compatibility checking between the two communicating ends. See Recommendations Q.931 and Q.939.

A.3.2 Telephony connection

An H.321 terminal shall use the Q.2931 IEs shown in Table A.2 if the intent is to establish a simple telephony connection.

Table A.2/H.321 – Q.2931 information elements – Telephony connection over AAL-1

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for telephony connection over AAL-1
Narrow-band Bearer Capability (N-BC)	Information transfer capability	• Speech • 3.1 kHz audio
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s
	User information layer 1 protocol	• Recommendation G.711 μ-law • Recommendation G.711 A-law
Broadband Bearer Capability (B-BC)	Bearer class	• BCOB-A
	Susceptibility to clipping	• Susceptible to clipping
	Call configuration	• Point-to-point
ATM traffic descriptor	Forward peak cell rate (for CLP 0+1)	• 171 cells/s (Note 1)
	Backward peak cell rate (for CLP 0+1)	• 171 cells/s (Note 1)
AAL parameters	AAL type	• AAL for voice
End-to-end transit delay	Cumulative transit delay value	(Under study)
	Maximum end-to-end transit delay value	(Under study)
Quality of Service (QOS)	(Under study)	

Table A.2/H.321 – Q.2931 information elements – Telephony connection over AAL-1 *(concluded)*

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for telephony connection over AAL-1
Narrow-band Low Layer Compatibility (N-LLC) (Note 2)	Information transfer capability	• Speech • 3.1 kHz audio
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s
	User information layer 1 protocol	• Recommendation G.711 μ-law • Recommendation G.711 A-law
Narrow-band High Layer Compatibility (N-HLC)	(Note 3)	
OAM traffic descriptor	(Under study)	
NOTE 1 – These values are based on AAL for voice (AAL-1 with a payload of 47 octets per cell) for user information and zero cell rate allocation for OAM cells. NOTE 2 – The (optional) N-LLC information element is used for compatibility checking between the two communicating ends. The attributes here shall not conflict with the attributes specified in the N-BC information element. NOTE 3 – The (optional) N-HLC information element is used for compatibility checking between the two communicating ends. See Recommendations Q.931 and Q.939.		

ANNEX B

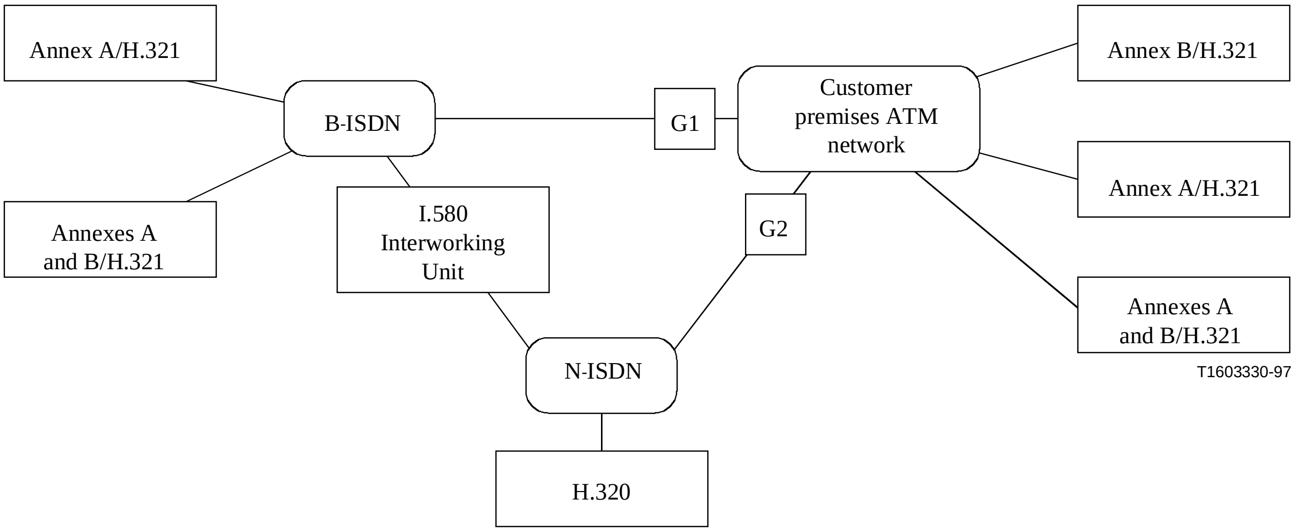
The use of ATM Adaptation Layer Type 5

B.1 Scope

This annex describes the use of ATM Adaptation Layer Type 5 (AAL-5) for transporting an H.320 stream over a broadband network.

Figure B.1 illustrates the scope of this annex.

The primary use for this mode of transport is within a customer premises network. Operation based on AAL-5 is an extension to H.321 (1996), which uses AAL-1 exclusively. It is anticipated that terminals that implement this Annex may support only AAL-5 and that interworking to Annex A/H.321 terminals may require a customer premises gateway (AAL-1/AAL-5 interworking unit).



G1 AAL-1/AAL-5 Interworking Unit
G2 Annex B/H.321 and H.320 Gateway

Figure B.1/H.321 – The scope of Annex B/H.321

B.2 Terminal architecture

Figure B.2 shows the architecture of an Annex B/H.321 terminal.

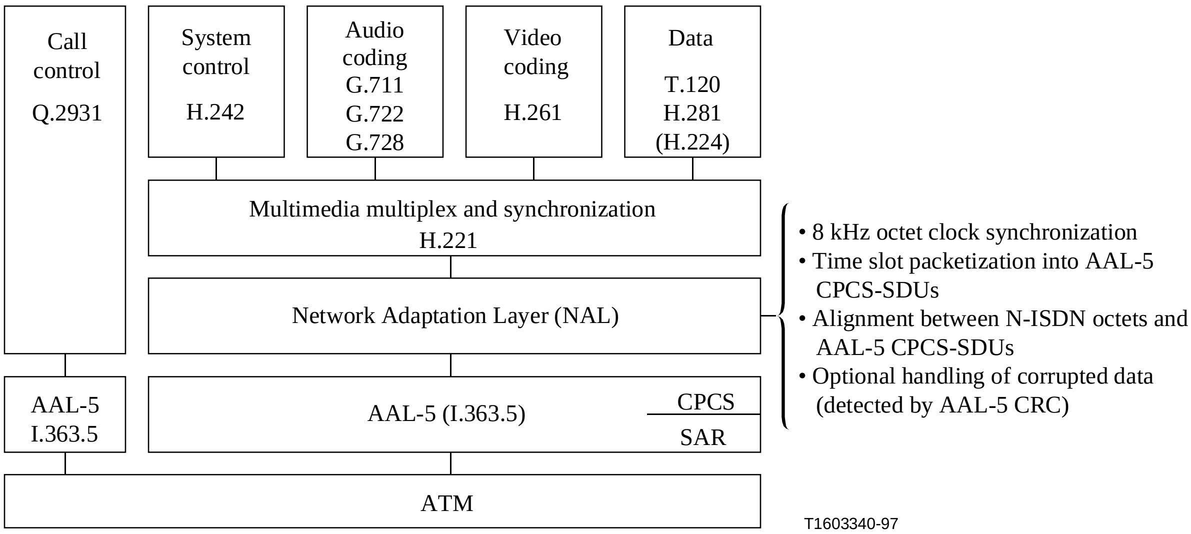


Figure B.2/H.321 – Architecture of an Annex B/H.321 terminal

B.3 Network Adaptation Layer

The functions of the Network Adaptation Layer (NAL) are:

- reproduction of the received 8 kHz octet timing (see Annex C);
- choosing between adaptive and independent transmit clocks (see Annex C);
- alignment of N-ISDN octets with AAL-5 CPCS-SDU octets;

- interleaving of N-ISDN time slots into AAL-5 CPCS-SDUs;
- determination of AAL-5 CPCS-SDU size;
- optional handling when the AAL-5 CPCS detects an erroneous SDU.

NOTE – This NAL is a general mechanism for the transport of N-ISDN services over AAL-5 and is independent of the specific applications H.321 and H.320. The NAL functionally corresponds to an SSCS and may be replaced by an SSCS in the future.

B.3.1 Alignment of octets

The NAL shall align N-ISDN octets with octets of the CPCS-SDU frame.

B.3.2 Interleaving of time slots

The NAL shall begin each CPCS-SDU with the first time slot. The size of the CPCS-SDU shall be a multiple of the number of time slots being carried on the ATM VC.

B.3.3 Determination of packet size

The size of the CPCS-SDU shall be negotiated via the Forward and Backward Maximum CPCS-SDU Size in the AAL Parameters information element. These values shall be the actual CPCS-SDU size to be used for the duration of the call.

The CPCS-SDU size may be varied from call to call, depending on the purpose of a particular H.321 connection.

To recover robustly from lost cells and late cells without the use of sequence numbers, the packetization delay (the time needed to collect enough octets to fill the CPCS-SDU size) should be greater than the expected cell delay variation. According to Table 2/I.356, 3 ms is an upper bound on cell delay variation for the real-time QOS Class 1 (stringent class).

For the special case of a single 64 kbit/s B-channel used for a simple telephony connection, the CPCS-SDU size shall be any multiple of 8 between 8 and 40, with 40 being the preferred value.

Table B.1 is provided as an example.

Table B.1/H.321 – H.321 packetization examples

Channel bit rate	Cells per packet	Packet size	Packetization delay
64 kbit/s	1	40 octets	5.00 ms
384 kbit/s	6	276 octets	5.75 ms
1536 kbit/s	24	1128 octets	5.88 ms
1920 kbit/s	30	1410 octets	5.88 ms

B.3.4 Optional error handling procedures

Two kinds of error can affect the transport of CPCS-SDUs:

- Cell loss can be detected by checking the length field of the CPCS trailer.
- Bit errors can be detected by checking the CRC field of the CPCS trailer.

In both cases, in order to improve adaptive clock recovery or to support the operation of forward error correction in the application data stream, the NAL may employ the AAL-5 option to pass a sequence of corrupted CPCS-PDUs to the higher layer along with a suitable error indication. The use of such corrupted data by the NAL is implementation dependent.

B.4 AAL functions

Segmentation and Reassembly (SAR) and Convergence Sublayer (CS) functions of AAL Type 5 (AAL-5) shall be supported by Annex B/H.321 terminals.

B.4.1 Convergence sublayer functions

At the AAL Service Access Point (AAL-SAP) the CS sublayer receives AAL Service Data Units (AAL-SDUs) from the NAL. The AAL-SDU is a number of octets of a constant bit rate (CBR) H.320 signal. It is mapped directly to a CPCS-SDU, and its size is determined by the Maximum CPCS-SDU Size parameter negotiated for its direction of travel.

When a CRC error is detected at the AAL-5 CPCS, an indication of the error shall be passed to the NAL.

B.4.2 SAR sublayer functions

In addition to mapping between the CS-PDU and SAR-PDU, in H.321 terminals the SAR sublayer provides the following functions:

a) *PDU Length*

   At the transmitting end, the SAR sublayer receives a length from the CS sublayer for each CS-PDU. This length occupies 16 bits of the 8-byte trailer of the SAR-PDU. At the receiving end, the length is passed to the CS.

b) *Error Protection*

   The SAR sublayer protects the entire CS-SDU with a 32-bit CRC.

B.5 Call control

Since an H.321 terminal is, in principle, a B-ISDN terminal emulating a N-ISDN service, then a call is established through the procedures defined in clause 6/Q.2931.

B.5.1 Digital connection

The out-of-band signalling functional unit of an H.321 terminal shall use, during the call-connection procedure, the Q.2931 Information Elements (IEs) shown in Table B.2 if the intent is to establish a digital connection capable of carrying an audiovisual multiplex.

Table B.2/H.321 – Q.2931 information elements – Digital connection over AAL-5

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for digital connection over AAL-5
Narrow-band Bearer Capability (N-BC)	Information transfer capability	• Unrestricted Digital Information (UDI) • Restricted Digital Information (RDI) • UDI with tone/announcement (UDI-TA)
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s • 2 × 64 kbit/s • 384 kbit/s • 1536 kbit/s • 1920 kbit/s • Multirate (64 kbit/s base rate)
	Rate multiplier	• 2 to the maximum n (in n × 64 kbit/s) supported by the H.321 terminal
	User information layer 1 protocol	• Recommendations H.221 and H.242
Broadband Bearer Capability (B-BC)	Bearer class	• BCOB-A
	Susceptibility to clipping	• Susceptible to clipping
	Call configuration	• Point-to-point
ATM traffic descriptor	Forward peak cell rate (for CLP 0+1)	(Variable: depends on the transfer rate)
	Backward peak cell rate (for CLP 0+1)	(Variable: depends on the transfer rate)
AAL parameters	AAL type	• AAL-5
	Forward maximum AAL-5 CPCS-SDU size	(Variable: depends on the transfer rate) (Note 1)
	Backward maximum AAL-5 CPCS-SDU size	(Variable: depends on the transfer rate) (Note 1)
	SSCS type	• Null
End-to-end transit delay	Cumulative transit delay value	(Under study)
	Maximum end-to-end transit delay value	(Under study)
Quality of Service (QOS)	(Under study)	

Table B.2/H.321 – Q.2931 information elements – Digital connection over AAL-5 *(concluded)*

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for digital connection over AAL-5
Narrow-band Low Layer Compatibility (N-LLC) (Note 2)	Information transfer capability	• Unrestricted Digital Information (UDI) • Restricted Digital Information (RDI) • UDI with tone/announcement (UDI-TA)
	Negotiation indicator	• Out-band negotiation not possible • Out-band negotiation possible
	Transfer mode	• circuit
	Information transfer rate	• 64 kbit/s • 2 × 64 kbit/s • 384 kbit/s • 1536 kbit/s • 1920 kbit/s • Multirate (64 kbit/s base rate)
	Rate multiplier	• 2 to the maximum n (in n × 64 bit/s) supported by the H.321 terminal
	User information layer 1 protocol	• Recommendations H.221 and H.242
Narrow-band High Layer Compatibility (N-HLC)	(Note 3)	
OAM traffic descriptor	(Under study)	
NOTE 1 – See B.3.3 for a discussion of AAL-5 packetization and its impact on this value. NOTE 2 – The (optional) N-LLC information element is used for compatibility checking between the two communicating ends. The attributes here shall not conflict with the attributes specified in the N-BC information element. NOTE 3 – The (optional) N-HLC information element is used for compatibility checking between the two communicating ends. See Recommendations Q.931 and Q.939.		

B.5.2 Telephony connection

An H.321 terminal shall use the Q.2931 IEs shown in Table B.3 if the intent is to establish a simple telephony connection.

Table B.3/H.321 – Q.2931 information elements – Telephony connection over AAL-5

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for telephony connection over AAL-5
Narrow-band Bearer Capability (N-BC)	Information transfer capability	• Speech • 3.1 kHz audio
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s
	User information layer 1 protocol	• Recommendation G.711 μ-law • Recommendation G.711 A-law
Broadband Bearer Capability (B-BC)	Bearer class	• BCOB-A
	Susceptibility to clipping	• Susceptible to clipping
	Call configuration	• Point-to-point
ATM traffic descriptor	Forward peak cell rate (for CLP 0+1)	• 200 cells/s (Note 1)
	Backward peak cell rate (for CLP 0+1)	• 200 cells/s (Note 1)
AAL parameters	AAL type	• AAL-5
	Forward maximum AAL-5 CPCS-SDU size	• Any multiple of 8 between 8 and 40
	Backward maximum AAL-5 CPCS-SDU size	• Any multiple of 8 between 8 and 40
	SSCS type	• Null
End-to-end transit delay	Cumulative transit delay value	(Under study)
	Maximum end-to-end transit delay value	(Under study)
Quality of Service (QOS)	(Under study)	
Narrow-band Low Layer Compatibility (N-LLC) (Note 2)	Information transfer capability	• Speech • 3.1 kHz audio
	Transfer mode	• Circuit
	Information transfer rate	• 64 kbit/s
	User information layer 1 protocol	• Recommendation G.711 μ-law • Recommendation G.711 A-law

Table B.3/H.321 – Q.2931 information elements – Telephony connection over AAL-5 *(concluded)*

Q.2931 information element	Information element parameter(s)	Parameter value(s) for H.321 terminals for telephony connection over AAL-5
Narrow-band High Layer Compatibility (N-HLC)	(Note 3)	
OAM traffic descriptor	(Under study)	
NOTE 1 – These values are based on AAL-5 for voice (AAL type 5 with a payload of 40 octets per cell) for user information and no cell rate allocation for OAM cells. NOTE 2 – The (optional) N-LLC information element is used for compatibility checking between the two communicating ends. The attributes in here shall not be in conflict with the attributes specified in the N-BC information element. NOTE 3 – The (optional) N-HLC information element is used for compatibility checking between the two communicating ends. See Recommendations Q.931 and Q.939.		

ANNEX C

Alternatives for 8 kHz timing of H.321 terminals

C.1 Scope

This annex describes the use of 8 kHz clocks within H.321 terminals. It describes conditions under which the transmit clock shall be slaved to an adaptively recovered receiver clock.

C.2 Receiver clock

If a network clock source is available, it shall be used by the receiver part of an H.321 terminal.

If the network clock source is not available, the receiver shall reproduce the 8 kHz clock of the remote transmitter using the adaptive clock method.

When interworking with N-ISDN terminals, an adaptive clock should converge to an approximation of the network reference clock available at the Interworking Unit to N-ISDN. When interworking with another H.321 terminal, the adaptive clock should converge to an approximation of the remote terminal's transmitter clock.

C.3 Transmitter clock

There are three possible sources for the transmitter clock of an H.321 terminal:

- a network reference clock source;
- the adaptive 8 kHz clock of the receiver;
- an independently generated clock source.

If a network clock source is available, it shall be used by the transmitter part of an H.321 terminal. If no network clock source is available, the transmitter shall use the procedures of C.4 to choose either the adaptive 8 kHz clock of the receiver or an independent clock source.

C.4 Choosing between adaptive and independent clocks

The procedures of this subclause apply only when a network clock source is not available. They are designed to prevent both ends of a connection from choosing adaptive timing, which would create an unstable loop.

- If an H.321 terminal receives a Q.2931 call-related message with parameter "X" in a Notification Indicator IE, the transmitter of that terminal shall use an independent clock source.
- When an H.321 terminal without a network clock source sends a SETUP message, parameter "X" shall be included in the Notification Indicator IE and the transmitter shall prepare to use the adaptive clock of the receiver. It shall revert to an independent clock source if the response to SETUP or any later message contains parameter "X" in a Notification Indicator IE.

  NOTE – Parameter "X" is pending definition and approval from Study Group 11.
- An H.321 terminal shall be capable of providing both an adapted clock and an independent clock to its transmitter, whichever is called for in a given connection.

ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	**Audiovisual and multimedia systems**
Series I	Integrated services digital network
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure
Series Z	Programming languages