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Foreword

This final draft Interim European Telecommunication Standard (I-ETS) has been produced by the Multimedia Terminals and Applications (MTA) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Voting phase of the ETSI standards approval procedure.

An ETSI standard may be given I-ETS status either because it is regarded as a provisional solution ahead of a more advanced standard, or because it is immature and requires a "trial period". The life of an I-ETS is limited to three years after which it can be converted into an ETS, have it's life extended for a further two years, be replaced by a new version, or be withdrawn.

Proposed announcement date	
Date of latest announcement of this I-ETS (doa):	3 months after ETSI publication

Introduction

This I-ETS describes terminals for low bit-rate multimedia communication, utilizing ITU-T Recommendation V.34 [15] modems connected to the Public Switched Telephone Network (PSTN). The terminals described in this I-ETS may carry real-time voice, data, and video, or any combination, including videotelephony.

Terminals described in this I-ETS may be integrated into personal computers or implemented in stand-alone devices such as videotelephones. Support for each medium type (voice, data, video) is optional, but if supported, the ability to use a specified common mode of operation is required, so that all terminals supporting that medium type can interwork. This I-ETS allows more than one channel of each type to be in use. ITU-T Recommendations relating to this I-ETS are: H.223 [1], H.245 [2], H.263 [4] and G.723.1 [3].

This I-ETS makes use of the logical channel signalling procedures of ITU-T Recommendation H.245 [2], in which the content of each logical channel is described when the channel is opened. Procedures are provided for expression of receiver and transmitter capabilities, so transmissions are limited to what receivers can decode, and so that receivers may request a particular desired mode from transmitters. Since the procedures of ITU-T Recommendation H.245 [2] are also planned for use by ITU-T Recommendation H.310 (see annex E) for ATM networks, and ITU-T Recommendation H.323 (see annex E) for non-guaranteed bandwidth LANs, interworking with these systems should be straightforward.

Terminals described in this I-ETS may be used in multipoint configurations through Multipoint Control Unit (MCUs), and may interwork with ETS 300 145 [22] terminals on the Integrated Services Digital Network (ISDN), as well as with terminals on wireless networks.

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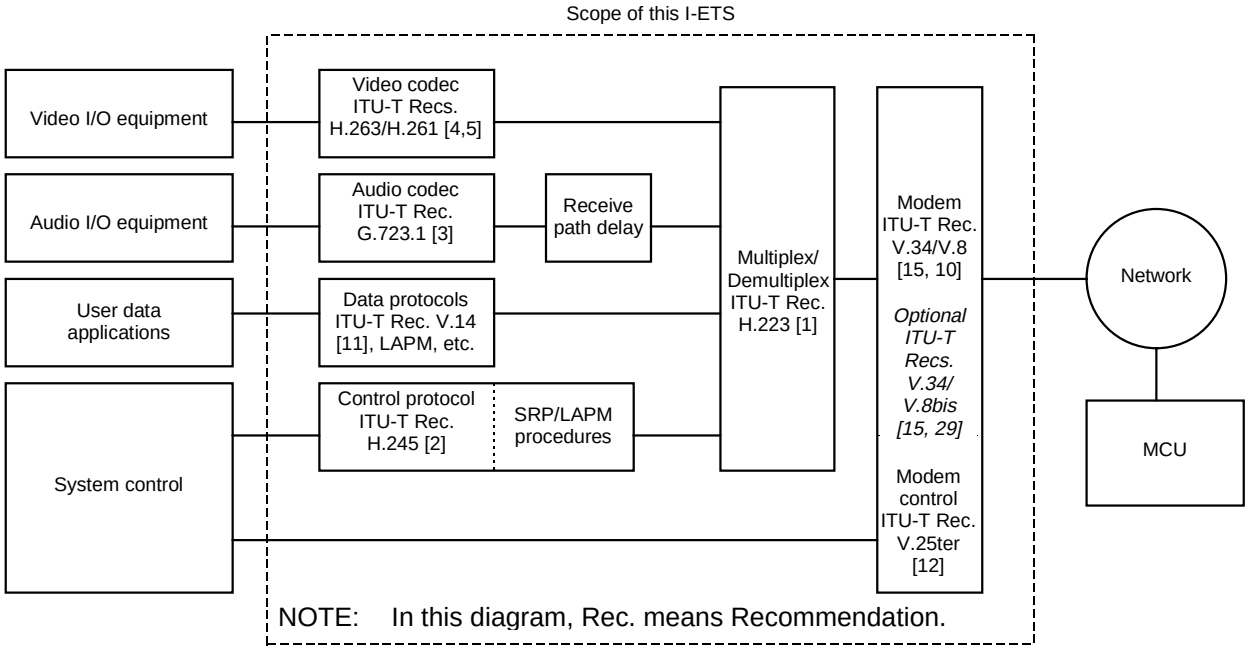
1 Scope

This Interim European Telecommunication Standard (I-ETS) covers the technical requirements for very low bit-rate multimedia telephone terminals connected to the Public Switched Telephone Network (PSTN).

Interworking with visual telephone systems on the Integrated Services Digital Network (ISDN) (described in ETS 300 145 [22]) and on mobile radio networks (known as the ITU-T Recommendation H.324 [26]/M series of Recommendations) are also covered.

Terminals described in this I-ETS provide real-time video, audio, or data, or any combination, between two multimedia telephone terminals over a PSTN voice band network connection. Communication may be either one-way or two-way. Multipoint communication using a separate Multipoint Control Unit (MCU) among more than two terminals described in this I-ETS is possible. MCUs and other non-terminal devices are not bound by the requirements in this I-ETS, but they should comply where practical.

The multimedia telephone terminals defined in this I-ETS can be integrated into PCs or workstations, or be stand-alone units.



NOTE: In this diagram Rec. means Recommendation

Figure 1: Block diagram of generic multimedia videophone system

1.1 Block diagram and functional elements

A generic multimedia videophone system is shown in figure 1. It consists of terminal equipment, a PSTN modem, PSTN network, MCU and other system operational entities. Implementations complying with this I-ETS are not required to have each functional element.

NOTE: Functions for interworking with a normal telephone are not depicted. The support of such a function is described in subclause 6.1.

1.2 System elements outside the scope of this I-ETS

The following system elements, covered by other (I-)ETSs and ITU-T Recommendations, are not subject to standardization, or are for other reasons outside the scope of this I-ETS:

- video input/output equipment including cameras and monitors, their control and selection, video processing to improve compression or provide split-screen functions;

- audio input/output equipment including handset or other types of acoustic cabinets, microphone(s) and loudspeaker(s), telephone instrument or equivalent, attached audio devices providing voice activation sensing, multiple microphone mixers, acoustic echo cancellation;

  NOTE 1: The audio characteristics of handset telephones supporting the analogue telephony services on the PSTN are normally subject to type approval by national regulatory authorities. I-ETS 300 677 [24] contains information about relevant national values and a proposed harmonized value for the audio characteristics of a handset telephone when attached to the PSTN.

  NOTE 2: There are no requirements in this I-ETS for the audio characteristics of a terminal communicating in a multimedia mode. Until such requirements are available, manufacturers are recommended to use I-ETS 300 245-2 [23] as a guide.

- data application equipment such as computers, non-standardized data application protocols, telematic visual aids such as electronic whiteboards, etc.;

- PSTN network interface supporting appropriate signalling, ringing functions and network termination. Human user system control, user interface and operation.

1.3 Functional elements covered by this I-ETS

The scope of this I-ETS is indicated by the elements within the dashed line of figure 1, which include:

- the Video codec (according to ITU-T Recommendations H.263 [4] or H.261 [5]) carries out redundancy reduction coding and decoding for video streams;

- the Audio codec (according to ITU-T Recommendation G.723.1 [3]) encodes the audio signal from the microphone for transmission, and decodes the audio code which is output to the speaker. Optional delay in the receiving audio path compensates for the video delay, so as to maintain audio and video synchronization;

- the Data Protocols support data applications such as electronic whiteboards, still image transfer, file exchange, database access, audiographics conferencing, remote device control, network protocols, etc. Standardized data applications include ITU-T Recommendation T.120 [17] for real-time audiographics conferencing, ITU-T Recommendation T.84 [16] simple point-point still image file transfer, ITU-T Recommendation T.434 [18] simple point-point file transfer, ITU-T Recommendations H.224 [8]/H.281 [9] far-end camera control, ISO/IEC TR9577 [25] network protocols including Point-to-Point Protocol (PPP), Internet Protocol (IP) and transport of user data using buffered ITU-T Recommendations V.14 [11] or V.42 [13]. Other applications and protocols may also be used via ITU-T Recommendation H.245 [2] negotiation;

- the Control Protocol (ITU-T Recommendation H.245 [2]) provides end-to-end signalling for proper operation of the terminal described in this I-ETS, and signals all other end-to-end system functions including reversion to analogue speech-only telephony mode. It provides for capability exchange, signalling of channels;

- the Multiplex Protocol (ITU-T Recommendation H.223 [1]) multiplexes transmitted video, audio, data and control streams into a single bit stream, and demultiplexes a received bit stream into various multimedia streams. In addition, it performs logical framing, sequence numbering, error detection, and error correction by means of retransmission, as appropriate to each media type;

- the Modem (ITU-T Recommendation V.34 [15]) converts the ITU-T Recommendation H.223 [1] synchronous multiplexed bit stream into an analogue signal that can be transmitted over the PSTN, and converts the received analogue signal into a synchronous bit stream that is sent to the Multiplex/Demultiplex protocol unit. ITU-T Recommendation V.25ter [12] is used to provide control/sensing of the modem/network interface, when the modem with network signalling and ITU-T Recommendation V.8 [10]/V.8bis (see annex E) functional elements is a separate physical item.

2 Normative references

This I-ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this I-ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU-T Recommendation H.223 (1995): "Multiplexing protocol for low bit rate multimedia communication".

[2] ITU-T Recommendation H.245 (1995): "Control protocol for multimedia communication".

[3] ITU-T Recommendation G.723.1 (1995): "Dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 kbit/s".

[4] ITU-T Recommendation H.263 (1995): "Video coding for low bit rate communication".

[5] ITU-T Recommendation H.261 (1993): "Video codec for audiovisual services at p x 64 kbit/s".

[6] ITU-T Recommendation H.233 (1994): "Confidentiality system for audiovisual services".

[7] ITU-T Recommendation H.234 (1994): "Encryption key management and authentication system for audiovisual services".

[8] ITU-T Recommendation H.224 (1994): "A real time control protocol for simplex applications using the H.221 LSD/HSD/MLP channels".

[9] ITU-T Recommendation H.281 (1994): "A far end camera control protocol for videoconferences using H.224".

[10] ITU-T Recommendation V.8 (1994): "Procedures for starting sessions of data transmission over the general switched telephone network".

[11] ITU-T Recommendation V.14 (1993): "Transmission of start-stop characters over synchronous bearer channels".

[12] ITU-T Recommendation V.25ter (1995): "Serial asynchronous automatic dialling and control".

[13] ITU-T Recommendation V.42 (1993): "Error-correcting procedures for DCEs using asynchronous-to-synchronous conversion".

[14] ITU-T Recommendation V.42bis (1990): "Data compression procedures for data circuit terminating equipment (DCE) using error correction procedures".

[15] ITU-T Recommendation V.34 (1994): "A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits".

[16] ITU-T Recommendation T.84/ISO/IEC 10918-3 (1996): "Information Technology - Digital compression and coding of continuous-tone still images Extensions".

[17] ITU-T Recommendation T.120 (1996): "Data protocols for multimedia conferencing".

[18] ITU-T Recommendation T.434 (1992): "Binary file transfer format for the telematic services".

[19] ISO/IEC 3309 (1991): "Information Technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures - Frame structure".

[20] ITU-T Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies".

[21] ETS 300 144: "Integrated Services Digital Network (ISDN); Audiovisual services; Frame structure for a 64 kbit/s to 1 920 kbit/s channel and associated syntax for inband signalling".

[22] ETS 300 145 (1994): "Integrated Services Digital Network (ISDN); Audiovisual services; Videotelephone systems and terminal equipment operating on one or two 64 kbit/s channels".

[23] I-ETS 300 245-2 (1994): "Integrated Services Digital Network (ISDN); Technical characteristics of telephony terminals; Part 2: PCM A-law handset telephony".

[24] I-ETS 300 677 (1996): "Public Switched Telephone Network (PSTN); Requirements for handset telephony".

[25] ISO/IEC TR9577 (1990): "Information Technology - Protocol identification in the network layer".

[26] ITU-T Recommendation H.324 (1996): "Terminal for low bit rate Multimedia Communication".

[27] ITU-T Recommendation V.24 (1993): "List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)".

[28] ITU-T Recommendation T.123 (1994): "Network specific data protocol stacks for multimedia conferencing".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this I-ETS, the definitions of ITU-T Recommendations H.223 [1] clause 3 and H.245 [2] clause 3 apply, in addition to the following:

Adaptation Layer - Service Data Unit (AL-SDU): The logical unit of information exchanged between the ITU-T Recommendation H.223 [1] multiplexer and the audio codec, video codec, or data protocol.

channel: A unidirectional link between two end-points.

codec: A coder/decoder, used to convert audio or video signals to/from digital format.

connection: A bi-directional link between two end-points.

control channel: Dedicated LCN 0 carrying system control protocol per ITU-T Recommendation H.245 [2].

data: Information streams other than control, audio and video, carried in a logical data channel (see ITU-T Recommendation H.223 [1]).

in-band signalling: Control signals sent within a specific logical channel other than the control channel, carrying information applicable only to that logical channel.

interworking adapter: A device connected to terminals or MCUs working according to two or more Recommendations, which translates the content of one or more logical channels to allow interoperation between otherwise incompatible equipment.

LAPM/V.42: The link access procedures that are used in ITU-T Recommendation V.42 [13].

lip synchronization: Operation to provide the impression that speaking motion of the displayed person is synchronized with the voice sounds.

logical channel: One of several logically distinct channels carried over a single bit-stream.

medium: audio, video, or data.

multilink: The use of more than one physical connection to obtain a larger aggregate bit-rate.

multipoint: The simultaneous interconnection of three or more terminals to allow communication among several sites through the use of multipoint control units (bridges) which centrally direct the flow of information.

MUltipleX-Protocol Data Unit (MUX-PDU): The logical unit of information exchanged between the ITU-T Recommendation H.223 [1] multiplex layer and the underlying physical layer. It is a packet framed by High-level Data Link Control (HDLC) flags and using HDLC zero-bit insertion for transparency.

non-segmentable: The ITU-T Recommendation H.223 [1] mode of operation in which AL-SDUs need to be sent as consecutive octets in a single MUX-PDU (see Recommendation H.223 [1]).

segmentable: The ITU-T Recommendation H.223 [1] mode of operation in which AL-SDUs may be sent in separate multiplex slots carried on one or more MUX-PDUs (see ITU-T Recommendation H.223 [1]).

support: The ability to operate in a given mode, however a requirement to "support" a mode does not mean that the mode needs actually to be used at all times. Unless prohibited, other modes may be used by mutual negotiation.

videophone: A terminal capable of sending and receiving audio and video information simultaneously.

3.2 Abbreviations

For the purposes of this I-ETS, the following abbreviations apply:

AL	Adaptation Layer (see ITU-T Recommendation H.223 [1])
AL-SDU	Adaptation Layer-Service Data Unit
ATM	Asynchronous Transfer Mode
BAS	Bit-rate Allocation Signal
BCH	Bose, Chaudhuri, Hocquengham
CC	Communications Capabilities
CIF	Common Intermediate Format
CM	Call Menu signal
CRC	Cyclic Redundancy Check
C/R	Command/Response bit
DCE	Data Circuit terminating Equipment
DLCI	Data Link Connection Identifier
DTE	Data Terminal Equipment
EA	Address field Extension
ECS	Encryption Control Signal
EIV	Encryption Initialization Vector
FAS	Frame Aligment Signal
FCS	Frame Check Sequence
HDLC	High-level Data Link Control (see ISO/IEC 3309 [19])
IETF	Internet Engineering Task Force
IP	Internet Protocol
ISDN	Integrated Services Digital Network
IV	Initialization Vector
JBIG	Joint Bi-level Image experts Group
JFIF	JPEG File Interchange Format

JPEG	Joint Photographic Experts Group
JM	Joint Menu signal
LAN	Local Area Network
LAPM	Link Access Procedures for Modems (see ITU-T Recommendation V.42 [13])
LCN	Logical Channel Number (see ITU-T Recommendation H.223 [1])
LSB	Least Significant Bit
MCU	Multipoint Control Unit
MUX	MUltipleX
MSB	Most Significant Bit
NLPID	Network Layer Protocol IDentifier (see ISO/IEC TR9577 [25])
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
PSTN	Public Switched Telephone Network
QCIF	Quarter CIF
SDU	Service Data Unit (see ITU-T Recommendation H.223 [1])
SE	Session Exchange (see ITU-T Recommendation H.233 [6])
SPIFF	Still Picture Interchange File Format
SQCIF	Sub QCIF
SRP	Simple Retransmission Protocol (see annex A)
XID	eXchange IDentification

3.3 Conventions

References in this I-ETS to specific ITU-T Recommendation H.245 [2] message structures are presented **in this typeface**.

4 Functional requirements

4.1 Required elements

Implementations of this I-ETS are not required to have each functional element, except for the ITU-T Recommendation V.34 [15] modem, ITU-T Recommendation H.223 [1] multiplex, and ITU-T Recommendation H.245 [2] system control protocol, all of which shall be supported by all terminals complying with this I-ETS.

Terminals complying with this I-ETS and offering audio communication shall support the ITU-T Recommendation G.723.1 [3] audio codec. Likewise, the same terminals offering video communication shall support the ITU-T Recommendations H.263 [4] and H.261 [5] video codecs. Terminals complying with this I-ETS and offering real-time audiographic conferencing should support the ITU-T Recommendation T.120 [17] protocol suite. In addition, other video and audio codecs, and other data protocols, may optionally be used via negotiation over the ITU-T Recommendation H.245 [2] control channel.

If a modem external to a terminal compliant with this I-ETS is used, terminal/modem control shall conform to ITU-T Recommendation V.25ter [12].

The presence of optional facilities is signalled via the ITU-T Recommendation H.245 [2] control channel. If both ends support an optional facility, and choose to make use of it, the opening of a path to carry such information streams is negotiated according to the procedures of ITU-T recommendation H.245 [2].

NOTE: This I-ETS does not specify a particular implementation. Any implementation that provides the required functionality, and that conforms to the bit-stream format ultimately described by this I-ETS, is considered compliant.

4.2 Information streams

Multimedia information streams are classified into video, audio, data, and control as follows:

- video streams are continuous traffic carrying moving colour pictures. When used, the bit-rate available for video streams may vary according to the needs of the audio and data channels;

- audio streams are real-time, but may optionally be delayed in the receiver processing path to maintain synchronization with the video streams. In order to reduce the average bit-rate of audio streams, voice activation may be provided;

- data streams may represent still pictures, facsimile, documents, computer files, computer application data, undefined user data, and other data streams;

- control streams pass control commands and indications between remote counterparts. Terminal-to-modem control conforms to ITU-T Recommendation V.25ter [12] for terminals using external modems connected by a separate physical interface. Terminal-to-terminal control is according to ITU-T Recommendation H.245 [2].

4.3 Modems

Modems used as terminals compliant with this I-ETS shall operate in full duplex, synchronous mode and conform to ITU-T Recommendations V.34 [15] and V.8 [10]. Support of ITU-T Recommendation V.8bis (see annex E) is optional. The output of the ITU-T Recommendation H.223 [1] multiplexer shall be applied directly to the ITU-T Recommendation V.34 [15] synchronous data pump. When an external, non-integrated ITU-T Recommendation V.34 [15] modem is used, control between the modem and the terminal shall be via ITU-T Recommendation V.25ter [12]. In such cases the physical interface is implementation specific.

The use of the optional ITU-T Recommendation V.34 [15] auxiliary channel is reserved for further study.

4.4 Multiplexing

Logical channels of video, audio, data or control information may be transmitted, after the channels have been established according to the procedures of ITU-T Recommendation H.245 [2]. Logical channels are unidirectional, and are independent in each direction of transmission. Any number of logical channels of each medium type may be transmitted, except for the ITU-T Recommendation H.245 [2] control channel of which there shall be one. The multiplexing method used to transmit these logical channels shall conform to ITU-T Recommendation H.223 [1]. The optional exclusive-OR procedure in subclause 6.4.2 of ITU-T Recommendation H.223 [1] shall not be used by terminals compliant with this I-ETS.

The ITU-T Recommendation H.223 [1] multiplexer consists of a multiplex layer, which mixes the various logical channels into a single bit-stream, and an adaptation layer, which handles error control and sequence numbering, as appropriate to each information stream. The multiplex layer transfers logical channel information in packets called MUltipleXer-Protocol Data Units (MUX-PDUs), delimited by HDLC flags and using HDLC zero-bit insertion for transparency. Each MUX-PDU contains a one-byte header followed by a variable number of information field bytes. The header byte includes a multiplexing code, which specifies, by reference to a multiplex table, the mapping of the information field bytes to various logical channels. Each MUX-PDU may contain a different multiplex code, and therefore a different mix of logical channels.

I-ETS compliant terminals shall signal their ITU-T Recommendation H.223 [1] capabilities via the **H223Capability** message.

4.4.1 Logical channel numbers

Each logical channel is identified by a Logical Channel Number (LCN), in the range 0 to 65 535, which serves merely to associate logical channels with the corresponding entries in the ITU-T Recommendation H.223 [1] multiplex table. LCNs are selected arbitrarily by the transmitter, except that logical channel 0 shall be permanently assigned to the ITU-T Recommendation H.245 [2] control channel.

4.4.2 Multiplex table entries

Multiplex table entries are independent in each direction of transmission, and are sent from transmitters to receivers using the **MultiplexEntrySend** request message. Multiplex table entry 0 shall not sent, but shall be permanently assigned to logical channel 0, used for the control channel. Multiplex table entry 0 shall therefore be used for initial capability exchanges and transmission of initial multiplex table entries.

4.4.3 Flow control

Terminals compliant with this I-ETS shall respond to the **FlowControlCommand** message, which commands a limit to the overall bit rate of one or more logical channels, or the entire multiplexer.

When one or more logical channels are limited by the **FlowControlCommand**, other less restricted logical channels may increase their transmission rate. The limit applies to the content of the logical channel at the input to the multiplexer layer, before flags or zero-bit insertion are applied.

When the entire ITU-T Recommendation H.223 [1] multiplexer is limited by the **FlowControlCommand**, or when the terminal has no information to send, the terminal shall send HDLC flags in place of logical channel information. The limit applies to the entire multiplex output, including opening flags, header bytes, and inserted zero bits, but not including idle flags.

4.4.4 Error control

The multiplex layer of ITU-T Recommendation H.223 [1] does not perform error control, except for a Cyclic Redundancy Check (CRC) on the header byte. Error control for each logical channel is handled separately by the adaptation layers of ITU-T Recommendation H.223 [1], which may use a variety of error control techniques, including but not limited to error detection and retransmission.

4.4.5 Adaptation layers

ITU-T Recommendation H.223 [1] defines three Adaptation Layers (AL), AL1, AL2, and AL3. AL1 is intended primarily for variable-rate framed information, including unframed bytes treated as a single frame of indefinite length. AL2 is intended primarily for digital audio, and includes an 8-bit CRC and optional sequence numbers. AL3 is intended primarily for digital video and includes provision for retransmission.

The logical unit of information exchanged between the ITU-T Recommendation H.223 [1] multiplexer and the audio codec, video codec, data protocol, or control protocol is called an Adaptation Layer-Service Data Unit (AL-SDU).

Logical channels carried by the ITU-T Recommendation H.223 [1] multiplexer may be of either "segmentable" or "non-segmentable" type, as defined in ITU-T Recommendation H.223 [1], and signalled by ITU-T Recommendation H.245 [2] when each channel is opened. AL-SDUs of segmentable logical channels may be segmented by the ITU-T Recommendation H.223 [1] multiplexer. AL-SDUs of non-segmentable logical channels are not segmented by the ITU-T Recommendation H.223 [1] multiplexer. Generally, segmentable channels should be used for variable bit-rate information streams such as control, video, and data, while non-segmentable channels should be used for constant bit-rate streams such as audio.

Receivers shall signal their capability to process various adaptation layers and channel types according to ITU-T Recommendation H.245 [2]. Transmitters shall signal which adaptation layers, options, and channel type are used for each logical channel when opening the channel, according to ITU-T Recommendation H.245 [2].

4.5 Control channel

The control channel carries end-to-end control messages governing operation of the multimedia videophone system, including capabilities exchange, opening and closing of logical channels, mode preference requests, multiplex table entry transmission, flow control messages, and general commands and indications.

There shall be exactly one control channel in each direction within systems complying with this I-ETS, which shall use the messages and procedures of ITU-T Recommendation H.245 [2]. The control channel shall be carried on logical channel 0. The control channel shall be considered to be permanently open from the establishment of digital communication until the termination of digital communication; the normal procedures for opening and closing logical channels shall not apply to the control channel.

General commands and indications shall be chosen from the message set contained in ITU-T Recommendation H.245 [2]. In addition other command and indication signals may be sent which have been specifically defined to be transferred in-band within video, audio or data streams (see the appropriate Recommendation to determine if such signals have been defined).

ITU-T Recommendation H.245 [2] messages fall into four categories: Request, Response, Command, and Indication. Request messages require a specific action by the receiver, including an immediate response. Response messages respond to a corresponding request. Command messages require a specific action, but do not require a response. Indication messages are informative only, and do not require any action or response. Terminals compliant with this I-ETS shall respond to all supported commands and requests as specified in ITU-T Recommendation H.245 [2], and shall transmit accurate indications reflecting the state of the terminal.

NOTE 1: All control channel messages are sent over a link layer protocol which acknowledges correct receipt. This acknowledgment is distinct from the response messages, which convey content beyond that of correct receipt of the message.

Terminals compliant with this I-ETS shall be capable of parsing all **MultimediaSystemControlPDU** messages, and shall send and receive all messages needed to implement required functions and those optional functions which are supported by the terminal. All messages and procedures of ITU-T Recommendation H.245 [2] related to needed functions compliant with this I-ETS are required, except for those explicitly described as optional, or which are related to defined optional capabilities the terminal does not support. Terminals compliant with this I-ETS shall send the **FunctionNotSupported** message in response to unrecognized request, response, or command messages.

A control channel indication, **UserInputIndication**, is available for transport of user input alphanumeric characters from a keypad or keyboard, equivalent to the DTMF signals used in analogue telephony. This may be used to manually operate remote equipment such as voice mail or video mail systems, menu-driven information services, etc. Terminals compliant with this I-ETS shall support the transmission of user input characters "0-9", "*", and "#". Transmission of other characters is optional.

NOTE 2: If the encryption procedures of this I-ETS are in use, the control channel will not be encrypted. Users are therefore cautioned regarding the carriage of user data in the control channel, the use of non-standard messages and the confidentiality risk from traffic analysis of the control channel.

4.5.1 Capabilities exchange

Capabilities exchange shall follow the procedures of ITU-T Recommendation H.245 [2], which provides for separate receive and transmit capabilities, as well as a system by which the terminal may describe its ability to operate in various combinations of modes simultaneously.

Receive capabilities describe the terminal's ability to receive and process incoming information streams. Transmitters shall limit the content of their transmitted information to that which the receiver has indicated it is capable of receiving. The absence of a receive capability indicates that the terminal cannot receive (i.e. it is a transmitter only).

Transmit capabilities describe the terminal's ability to transmit information streams. Transmit capabilities serve to offer receivers a choice of possible modes of operation, so that the receiver may request the mode which it prefers to receive. The absence of a transmit capability indicates that the terminal is not offering a choice of preferred modes to the receiver (but it may still transmit anything within the capability of the receiver).

The transmitting terminal assigns each individual mode the terminal is capable of operating in a number in a **capabilityTable**. For example, ITU-T Recommendations G.723.1 [3] audio, G.728 (see annex E) audio, and Common Intermediate Format (CIF) and ITU-T Recommendation H.263 [4] video would each be assigned separate numbers.

These capability numbers are grouped into **AlternativeCapabilitySet** structures. Each **AlternativeCapabilitySet** indicates that the terminal is capable of operating in exactly one mode listed in the set. For example, an **AlternativeCapabilitySet** listing (ITU-T Recommendations G.711 [20], G.723.1 [3], G.728 (see annex E)) means that the terminal can operate in any one of those audio modes, but not more than one.

These **AlternativeCapabilitySet** structures are grouped into **simultaneousCapabilities** structures. Each **simultaneousCapabilities** structure indicates a set of modes the terminal is capable of using simultaneously. For example, a **simultaneousCapabilities** structure containing the two **AlternativeCapabilitySet** structures (ITU-T Recommendations H.261 [5], H.263 [4]) and (ITU-T Recommendations G.711 [20], G.723.1 [3], G.728 (see annex E)) means that the terminal can operate either of the video codecs simultaneously with any one of the audio codecs. The **simultaneousCapabilities** set (ITU-T Recommendations (H.261 [5]), (H.261 [5], H.263 [4]), (G.711 [20], G.723.1 [3], G.728 (see annex E))) means the terminal can operate two video channels and one audio channel simultaneously: One video channel as per ITU-T Recommendation H.261 [5], another video channel as per either ITU-T Recommendations H.261 [5] or H.263 [4], and one audio channel as per either ITU-T Recommendations G.711 [20], G.723.1 [3], G.728 (see annex E).

NOTE: The actual capabilities stored in the **capabilityTable** are often more complex than presented here. For example, each ITU-T Recommendation H.263 [4] capability indicates details including ability to support various picture formats at given minimum picture intervals, and ability to use optional coding modes. For a complete description, see ITU-T Recommendation H.245 [2].

The terminal's total capabilities are described by a set of **CapabilityDescriptor** structures, each of which is a single **simultaneousCapabilities** structure and a **capabilityDescriptorNumber**. By sending more than one **CapabilityDescriptor**, the terminal may signal dependencies between operating modes by describing different sets of modes which it can simultaneously use. For example, a terminal issuing two **CapabilityDescriptor** structures, one (ITU-T Recommendations (H.261 [5], H.263 [4]), (G.711 [20], G.723.1 [3], G.728 see annex E)) as in the previous example, and the other (ITU-T Recommendations (H.262 see annex E), (G.711 [20])), means the terminal can also operate the ITU-T Recommendation H.261 [5] video codec, but only with the low-complexity ITU-T Recommendation G.711 [20] audio codec.

Terminals may dynamically add capabilities during a communication session by issuing additional **CapabilityDescriptor** structures, or remove capabilities by sending revised **CapabilityDescriptor** structures. All terminals compliant with this I-ETS shall transmit at least one **CapabilityDescriptor** structure.

Non-standard capabilities and control messages may be issued using the **NonStandardParameter** structure. Note that while the meaning of non-standard messages is defined by individual organizations, equipment built by any manufacturer may signal any non-standard message, if the meaning is known.

Terminals may re-issue capability sets at any time, according to the procedures of ITU-T Recommendation H.245 [2].

4.5.2 Logical channel signalling

Each logical channel carries information from a transmitter to a receiver, and is identified by a LCN unique for each direction of transmission.

Logical channels are opened and closed using the **OpenLogicalChannel** and **CloseLogicalChannel** messages and procedures of ITU-T Recommendation H.245 [2]. When a logical channel is opened, the **OpenLogicalChannel** message fully describes the content of the logical channel, including media type, algorithm in use, ITU-T Recommendation H.223 [1] adaptation layer and any options, and all other information needed for the receiver to interpret the content of the logical channel. Logical channels may be closed when no longer needed. Open logical channels may be inactive, if the information source has nothing to send.

Logical channels described in this I-ETS are unidirectional. Asymmetrical operation therefore, in which the number and type of information streams is different in each direction of transmission, is allowed. However, if a receiver is capable only of certain symmetrical modes of operation, it may send a receive capability set that reflects its limitations. Terminals may also be capable of using a particular mode in only one direction of transmission.

Certain media types, including data protocols such as ITU-T Recommendation T.120 [17] and Link Access Procedures for Modems (LAPM), and video carried over AL3, inherently require a bi-directional channel for their operation. In such cases a pair of unidirectional logical channels, one in each direction, may be opened and associated together to form a bi-directional channel using the bi-directional channel opening procedures of ITU-T Recommendation H.245 [2]. Such pairs of associated channels need not share the same LCN, since LCNs are independent in each direction of transmission.

4.5.3 Mode preferences

Receivers may request transmitters to send a particular mode using the **RequestMode** message, which describes the desired mode. When in receipt of **multipointModeCommand** transmitters shall comply with such request. In other modes transmitters may deny such requests, but should comply if possible.

4.5.4 Interface to multiplex

The control channel shall be segmentable and use logical channel 0. All terminals compliant with this I-ETS shall support transmission of ITU-T Recommendation H.245 [2] control messages over the framed AL1 layer of ITU-T Recommendation H.223 [1] according to the procedures in annex A, which ensure reliable delivery by retransmission of errored frames.

Annex A defines a Simple Retransmission Protocol (SRP) as a data link layer for H.245. All terminals described in this I-ETS shall support the SRP defined in annex A. Terminals may optionally use LAPM / ITU-TRecommendation V.42 [13] as a data link layer instead of the SRP, if this mode is negotiated as per the procedure in annex A. In the LAPM / ITU-TRecommendation V.42 [13] mode several control messages may be streamed using the procedures of LAPM, avoiding a wait for acknowledgment of each frame before the next message may be sent.

More than one ITU-T Recommendation H.245 [2] control message may be sent in each SRP or LAPM frame.

4.5.5 Timer and counter values and protocol errors

All timers defined in ITU-T Recommendation H.245 [2] shall have periods of at least the maximum data delivery time allowed by the data link layer carrying ITU-T Recommendation H.245 [2], including any retransmissions. For SRP, this shall be a period of at least T401 x N400 (acknowledgment timer x retransmit counter).

The ITU-T Recommendation H.245 [2] retry counter (N100) should be at least 3.

If an ITU-T Recommendation H.245 [2] protocol error occurs, the terminal may optionally retry the ITU-T Recommendation H.245 [2] procedure or may take other appropriate action, such as disconnection or reversion to analogue telephony, depending on predetermined configuration.

4.6 Video channels

All terminals described in this I-ETS which offer video communication shall support both the ITU-T Recommendations H.263 [4] and H.261 [5] video codecs, except ETS 300 145 [22] interworking adapters (which are not terminals) do not have to support ITU-T Recommendation H.263 [4] (see subclause 6.2). The ITU-T Recommendations H.263 [4] and H.261 [5] codecs shall be used without Bose, Chaudhuri, Hocquengham (BCH) error correction and without error correction framing. There are five standardized image formats: 16CIF, 4CIF, CIF, Quarter Common Intermediate Format (QCIF), and Sub Quarter Common Intermediate Format (SQCIF). Video may be supported in either one direction (transmit or receive) or both directions.

CIF and QCIF are defined in ITU-T Recommendation H.261 [5]. For the ITU-T Recommendation H.263 [4] algorithm, SQCIF, 4CIF and 16CIF are defined. For the ITU-T Recommendation H.261 [5] algorithm, SQCIF is any active picture size less than QCIF, filled out by a black border, and coded in the QCIF format. For all these formats, the pixel aspect ratio is the same as that of the CIF format.

NOTE 1: The resulting picture aspect ratio for ITU-T Recommendation H.263 [4] SQCIF is different from the other formats.

Table 1 shows which picture formats are required, and which are optional for terminals described in this I-ETS which support video.

Table 1: Picture formats for video terminals

Picture format	Luminance pixels	Encoder		Decoder	
		ITU-T Recommendation H.261 [5]	ITU-T Recommendation H.263 [4]	ITU-T Recommendation H.261 [5]	ITU-T Recommendation H.263 [4]
SQCIF	128 x 96 for ITU-T Rec. H.263 [4] (note 3)	Optional (note 3)	Required (notes 1 and 2)	Optional (note 3)	Required (note 1)
QCIF	176 x 144	Required	Required (notes 1 and 2)	Required	Required (note 1)
CIF	352 x 288	Optional	Optional	Optional	Optional
4CIF	704 x 576	Not defined	Optional	Not defined	Optional
16CIF	1408 x 1152	Not defined	Optional	Not defined	Optional

NOTE 1: Optional for ETS 300 145 [22] interworking adapters.
NOTE 2: Mandatory to encode one of the picture formats QCIF and SQCIF; optional to encode both formats.
NOTE 3: ITU-T Recommendation H.261 [5] SQCIF is any active size less than QCIF, filled out by a black border, coded in QCIF format.

All video decoders shall be capable of processing video bitstreams of the maximum bit-rate which can be received by the implementation of the ITU-T Recommendation H.223 [1] multiplexer (maximum ITU-T Recommendation V.34 [15] rate for single link, 2 × rate for double link, etc.).

Which picture formats, minimum number of skipped pictures, and algorithm options can be accepted by the decoder is determined during the capability exchange using ITU-T Recommendation H.245 [2]. After that, the encoder is free to transmit anything which is in line with the decoder's capability. Decoders which indicate capability for a particular algorithm option shall also be capable of accepting video bit-streams which do not make use of that option.

When each video logical channel is opened, the maximum operating mode to be used on that channel is signalled to the receiver. The picture header within the video bit-stream indicates which mode is actually used for each picture, within the stated maximum. Receivers may signal, via ITU-T Recommendation H.245 [2], a preference for a certain mode.

NOTE 2: The maximum mode signalled includes maximum picture format, algorithm options, etc. For example, a video logical channel opened for CIF format may transmit CIF, QCIF, or SQCIF pictures, but not 4CIF or 16CIF. A video logical channel opened with only the **unrestrictedVector** and **arithmeticCoding** options may use neither, either, or both options, but shall not use options which were not signalled.

Other video codecs, and other picture formats, may also be used via ITU-T Recommendation H.245 [2] negotiation. More than one video channel may be transmitted, as negotiated via the ITU-T Recommendation H.245 [2] control channel.

NOTE 3: The method of continuous presence multipoint operation, in which a single picture is divided into multiple sub-pictures, should not be used by terminals described in this I-ETS. Instead, multiple logical channels of video should be used.

4.6.1 Interface to multiplex

All terminals described in this I-ETS offering video communication shall support the required video codecs in segmentable logical channels using ITU-T Recommendation H.223 [1] adaptation layer AL3, and using a control field of at least one byte. Support of retransmission is required in encoders, with a minimum AL3 **SendBufferSize** of 1 024 bytes.

The size of each AL-Service Data Unit (SDU), and their alignment with the video bit-stream, is determined by video encoders, within the limit of the maximum AL3 SDU size the receiver indicates it is capable of. Video pictures may span more than one AL-SDU. ITU-T Recommendation H.261 [5] AL-SDUs are not required to align with logical structures in the video bit-stream. ITU-T Recommendation H.263 [4] encoders shall align picture start codes with the start of an AL-SDU.

NOTE: ITU-T Recommendation H.263 [4] pictures are a whole number of bytes in length, since encoders add fill zero bits at the end of each picture as needed to fill out the final byte.

If video communication is supported only in one direction (transmit or receive), the ITU-T Recommendation H.223 [1] adaptation layer AL3 protocol for the reverse direction shall also be supported, even if no video information will be sent on the reverse channel. Since the AL3 protocol requires a reverse channel for operation, logical channels using AL3 shall be opened using the ITU-T Recommendation H.245 [2] procedures for opening associated logical channels in each direction of transmission (bi-directional channels).

While ITU-T Recommendation H.223 [1] AL3 allows for the retransmission of video information with detected errors, the receiving terminal may decide not to request a retransmission, based on factors including but not limited to: the measured network delay, the error rate, whether the terminal is part of a multipoint conference, whether there is interworking with a ETS 300 145 [22] terminal, and the effectiveness of its error concealment techniques.

When a video codec receives an AL-DRTX indication from an ITU-T Recommendation H.223 [1] AL3, indicating that the local AL3 layer was unable to satisfy a retransmission request, it shall encode the next video picture in the INTRA coding mode.

Other video codecs, adaptation layers and options may be used via ITU-T Recommendation H.245 [2] negotiation.

4.7 Audio channels

All terminals described in this I-ETS which offer audio communication shall support both the high and low rates of the ITU-T Recommendation G.723.1 [3] audio codec. ITU-T Recommendation G.723.1 [3] receivers may optionally be capable of accepting silence frames. The choice of high rate, low rate, or silence is made by the transmitter, and is signalled to the receiver in-band in the audio channel, as part of the syntax of each audio frame. Transmitters may switch G.723.1 [3] rates on a frame-by-frame basis, based on bit-rate, audio quality, or other preferences. Receivers may signal, via ITU-T Recommendation H.245 [2], a preference for a particular audio rate or mode. Audio may be supported in either one direction (transmit or receive) or both directions.

Alternative audio codecs may also be used, via ITU-T Recommendation H.245 [2] negotiation. Coders may omit sending audio signals during silent periods after sending a single frame of silence, or may send silence background fill frames if such techniques are specified by the audio codec Recommendation in use.

More than one audio channel may be transmitted, as negotiated via the ITU-T Recommendation H.245 [2] control channel.

NOTE: Each audio channel is independent. Grouping of audio channels into stereo pairs or other synchronized groups is for further study.

4.7.1 Delay compensation

The ITU-T Recommendations H.263 [4] and H.261 [5] video codecs require some processing delay, while the ITU-T Recommendation G.723.1 [3] audio codec involves much less delay. Lip synchronization is not mandatory, but if it is to be maintained, additional delay needs to be added in the audio path to compensate. Terminals described in this I-ETS shall not add delay for this purpose in the transmitting audio path. Instead, since video and audio coder delays may vary according to implementation, they shall signal, via **H223SkewIndication** messages in the control channel, the average skew by which their transmitted video signal trails the audio signal.

Intermediate processing points such as Multipoint Control Units (MCUs) or interworking adapters may alter the video/audio skew (see subclause 8.3), and shall transmit appropriately modified video/audio skew indications, reflecting their transmitted streams. Video signals shall not precede audio signals; if necessary, video path delay shall be added to prevent this.

Receiving terminals may optionally use this information to add appropriate delay in the audio path to achieve lip synchronization.

4.7.2 Maximum delay jitter

Audio AL-SDUs shall be transmitted periodically at an interval determined by the audio codec Recommendation in use (audio frame interval). The transmission of each audio AL-SDU at the ITU-T Recommendation H.223 [1] multiplexer shall commence no later than 10 ms after a whole multiple of the audio frame interval, measured from transmission of the first audio frame (audio delay jitter). Transmitters capable of further limiting their audio delay jitter may so signal using the **maximumDelayJitter** parameter of the **H223Capability** message, so that receivers may optionally reduce their jitter delay buffers.

4.7.3 Interface to multiplexer

All terminals described by this I-ETS which offer audio communication shall support the ITU-T Recommendation G.723.1 [3] codec using ITU-T Recommendation H.223 [1] adaptation layer AL2. The use of the sequence number option of AL2 is optional, but is not recommended for ITU-T Recommendation G.723.1 [3], since sequence numbers are generally not useful when the maximum delay jitter is less than the audio frame interval.

For all frame-oriented audio codecs, AL-SDUs shall be transmitted in non-segmentable logical channels. Receivers shall signal the maximum number of audio frames they are capable of accepting in a single audio AL-SDU. Transmitters may send any whole number of audio frames in each AL-SDU, up to the maximum stated by the receiver. Transmitters shall not split audio frames across AL-SDUs, and shall send whole numbers of bytes in each audio AL-SDU.

NOTE 1: Sample based codecs, such as ITU-T Recommendation G.711 [20], shall be considered to be frame-oriented, with a frame size of one sample.

For audio algorithms such as ITU-T Recommendation G.723.1 [3] which use more than one size of audio frame, audio frame boundaries within each AL-SDU shall be signalled in-band to the audio channel. For audio algorithms which use a fixed frame size, audio frame boundaries shall be implied by the ratio of AL-SDU size to audio frame size.

Other adaptation layers and options may be used via ITU-T Recommendation H.245 [2] negotiation.

NOTE 2: Transmitters using alternative audio codecs should also support AL2, unless another adaptation layer has been specified for use with a particular codec.

4.8 Data channels

All data channels are optional. Standardized options for data applications include:

- ITU-T Recommendation T.120 [17] series for point-to-point and multipoint audiographic teleconferencing including database access, still image transfer and annotation, application sharing, real-time file transfer, etc.;

- ITU-T Recommendation T.84 [16] Still Picture Interchange File Format (SPIFF) point-to-point still image transfer cutting across application borders;

- ITU-T Recommendation T.434 [18] point-to-point telematic file transfer cutting across application borders;

- ITU-T Recommendation H.224 [8] for real-time control of simplex applications, including ITU-T Recommendation H.281 [9] far end camera control;

- network link layer, as per ISO/IEC TR9577 [25] (supports Internet Protocol (IP) and Point-to-Point Protocol (PPP) network layers, among others);

- unspecified user data from external data ports.

These data applications may reside in an external computer or other dedicated device attached to the terminal defined by this I-ETS through an ITU-T Recommendation V.24 [27] or equivalent interface (implementation dependent), or may be integrated into the terminal decribed by this I-ETS itself. Each data application makes use of an underlying data protocol for link layer transport. For each data application supported by the terminal, this ITU-T Recommendation V.24 [27] requires support for a particular underlying data protocol to ensure interworking of data applications.

NOTE: The ITU-T Recommendation H.245 [2] control channel is not considered a data channel.

Standardized link layer data protocols used by data applications include:

- buffered ITU-T Recommendation V.14 [11] mode for transfer of asynchronous characters, without error control;

- LAPM / ITU-TRecommendation V.42 [13] for error-corrected transfer of asynchronous characters. Additionally, depending on application, ITU-T Recommendation V.42bis [14] data compression may be used;

- HDLC frame tunnelling for transfer of HDLC frames;

- transparent data mode for direct access by unframed or self-framed protocols.

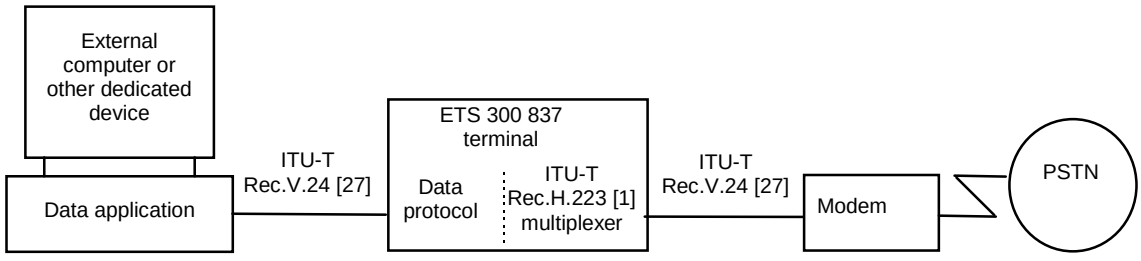
All terminals described in this I-ETS offering real-time audiographic conferencing should support the ITU-T Recommendation T.120 [17] protocol suite.

All data protocols shall operate within ITU-T Recommendation H.223 [1] logical channels. All protocol procedures referring to link establishment or link termination (including setup and disconnection of physical channels) shall be interpreted as referring to opening and closing of logical channels, and shall not affect the physical link described in this I-ETS. For all protocol procedures which distinguish between an originator and an answerer, the master terminal described in this I-ETS, determined according to the **MasterSlaveDetermination** procedure, shall be the originator, and the slave terminal shall be the answerer.

More than one data channel, or more than one protocol may be used at the same time (each in a separate logical channel), as negotiated via the ITU-T Recommendation H.245 [2] control channel. Other data protocols and applications may be used via ITU-T Recommendation H.245 [2] negotiation.

4.8.1 Data protocols

This subclause describes these data protocols as if they are resident in the terminal, connected through a ITU-T Recommendation V.24 [27] interface to an external computer or other dedicated device running the data application, as shown in figure 2. The ITU-T Recommendation V.24 [27] interface may be replaced by a logical equivalent. Terminals described in this I-ETS with integrated data applications need not implement procedures related to the ITU-T Recommendation V.24 [27] interface which have no net effect on the transmitted bit-stream.



NOTE: In this figure, the word Rec. means Recommendation.

Figure 2: Data application - data protocol interface

Terminals offering any data protocol described here shall support that protocol using segmentable logical channels and ITU-T Recommendation H.223 [1] adaptation layer AL1, in the framed or unframed mode as specified below. Other ALs may be used if receivers indicate the capability to do so via ITU-T Recommendation H.245 [2] negotiation.

4.8.1.1 Buffered ITU-T Recommendation V.14

In the buffered ITU-T Recommendation V.14 [11] mode, asynchronous characters and BREAK signals arriving at the ITU-T Recommendation V.24 [27] interface shall be converted to a synchronous bit-stream using the procedures of ITU-T Recommendation V.14 [11]. Operation at the ITU-T Recommendation V.24 [27] interface shall use buffering and flow-control across the Data Terminal Equipment/Data Circuit terminating Equipment (DTE/DCE) interface as described in subclause 7.9 of ITU-T Recommendation V.42 [13] and subclause 1.3 of ITU-T Recommendation V.14 [11].

The resulting bit-stream shall be placed into the bytes of an unframed AL1 AL-SDU, preserving the original bit ordering (least significant bit first). The unframed AL-SDU should be transferred to the underlying AL in a streaming mode, without waiting for the end of the AL-SDU (which will never occur).

If receipt of characters at the ITU-T Recommendation V.24 [27] interface pauses, the terminal may omit transmission of octets containing only stop bits (because the line is idle), after transmitting the byte containing the final character, plus at least two stop bits.

The receiver shall perform the reverse operation.

4.8.1.2 LAPM / ITU-TRecommendation V.42

In the LAPM / ITU-TRecommendation V.42 [13] mode, asynchronous characters and BREAK signals arriving at the ITU-T Recommendation V.24 [27] interface shall be transferred to the far-end using the procedures of ITU-T Recommendation V.42 [13] in the LAPM mode. The alternative procedure of annex A/ITU-T Recommendation V.42 [13] is not required.

The procedures of ITU-T Recommendation V.42 [13] shall be followed, except that:

- the flag sequence and transparency procedures of subclause 8.1.1.2 of ITU-T Recommendation V.42 [13] shall not be performed, as the ITU-T Recommendation H.223 [1] multiplexer provides equivalent functions. Instead, the entire content of each frame between the opening and closing flags shall be placed in a single framed AL1 AL-SDU, without application of the zero-bit insertion transparency procedure;

- the detection phase of ITU-T Recommendation V.42 [13] shall be bypassed, proceeding directly to the protocol establishment phase;

- aborts shall be sent using the procedure of ITU-T Recommendation H.223 [1], instead of the procedure in ITU-T Recommendation V.42 [13];

- only frames shall be sent; interframe time filling flags shall not be sent.

The receiver shall perform the reverse operations.

If ITU-T Recommendation V.42bis [14] data compression is to be used, it shall be negotiated in-band to the LAPM / ITU-T Recommendation V.42 [13] channel according to the procedures of ITU-T Recommendation V.42bis [14].

Since the LAPM / ITU-TRecommendation V.42 [13] protocol requires a reverse channel for operation, logical channels shall be opened using the ITU-T Recommendation H.245 [2] procedures for opening associated logical channels in each direction of transmission (bi-directional channels).

Terminals covered by this I-ETS and declaring capability for LAPM / ITU-TRecommendation V.42 [13] in only one direction of transmission shall support its protocol for the reverse direction, even if no payload data will be sent on the reverse channel.

4.8.1.3 HDLC frame tunnelling

In the High-level Data Link Control (HDLC) frame tunnelling mode, HDLC frames arrive at the ITU-T Recommendation V.24 [27] interface from the data application.

If the ITU-T Recommendation V.24 [27] interface is operating synchronously, inserted zero bits shall be removed and the entire content of each frame between the opening and closing flags shall be placed in a single framed AL1 AL-SDU, for transmission through the ITU-T Recommendation H.223 [1] multiplexer. Aborts shall be sent using the procedure of ITU-T Recommendation H.223 [1]. Only frames shall be sent; flags (including interframe time filling flags) shall not be sent.

If the ITU-T Recommendation V.24 [27] interface is operating asynchronously, HDLC frames arrive at the ITU-T Recommendation V.24 [27] interface encoded as a sequence of asynchronous characters using byte-stuffing according to subclause 4.5.2 of ISO/IEC 3309 [19] instead of the usual zero-bit insertion transparency procedure of HDLC. This recognized alternative to the zero-bit insertion procedure makes the implementation of HDLC protocols over asynchronous serial links possible. Typical personal computer serial ports do not support synchronous operation, making this operation mode important. In particular, the PSTN basic mode profile of ITU-T Recommendation T.123 [28] specifies this mode of operation.

If operating asynchronously, the terminal shall receive HDLC frames at the ITU-T Recommendation V.24 [27] interface according to the procedure given in annex B. After execution of the receiver procedure in annex B, the entire content of each frame between the opening and closing flags shall be placed in a single framed AL1 AL SDU, without application of the zero-bit insertion or byte-stuffing transparency procedures, for transmission through the ITU-T Recommendation H.223 [1] multiplexer. Aborts shall be sent using the procedure of ITU-T Recommendation H.223 [1]. Only frames shall be sent; flags (including interframe time filling flags) shall not be sent.

The receiver shall perform the reverse operation. The choice of asynchronous or synchronous ITU-T Recommendation V.24 [27] interface is a local matter and does not need to be signalled to the far end.

NOTE: Since the HDLC byte-stuffing transparency procedure serves only to transport HDLC frames across an asynchronous interface, integrated terminals containing the HDLC protocol (ITU-T Recommendation T.120 [17], H.224 [8] or other) may omit the byte stuffing/unstuffing procedure, directly placing each HDLC frame in an AL-SDU, since the stuffing and unstuffing procedures cancel each other out inside the terminal. However, such integrated terminals shall still signal the HDLC frame tunnelling data protocol, for proper interworking with far-end terminals.

4.8.1.4 Transparent data

In the transparent data mode, bytes arriving at the ITU-T Recommendation V.24 [27] interface shall be placed directly into the bytes of an unframed AL-SDU, preserving the original bit ordering (least significant bit first). No framing or transparency procedure shall be applied. The unframed AL-SDU should be transferred to the underlying AL in a streaming mode, without waiting for the end of the AL-SDU (which will never occur).

The receiver shall perform the reverse operation.

NOTE: The transparent data protocol may be considered equivalent to a variable-rate synchronous data channel, as it simply transports bytes without any additional framing or protocol.

4.8.2 Data applications

Data applications make use of an underlying data protocol, as described in the previous subclause. This subclause describes these data applications as if they are resident in an external computer running the application, connected through an ITU-T Recommendation V.24 [27] interface to the terminal. The ITU-T Recommendation V.24 [27] interface may be replaced by a logical equivalent. Data applications integrated with the terminal may choose to omit procedures related to the ITU-T Recommendation V.24 [27] interface which have no net effect on the transmitted bit-stream.

4.8.2.1 ITU-T Recommendation T.120 multimedia teleconferencing applications

The ITU-T T.120 [17] series of Recommendations (see annex E) is for point-to-point and multipoint audiographic teleconferencing including database access, still image transfer and annotation, application sharing, real-time file transfer, etc.

All terminals described in this I-ETS which offer real-time audiographic conferencing should support the ITU-T Recommendation T.120 [17] protocol suite.

Terminals described in this I-ETS which support ITU-T Recommendation T.120 [17] shall use the PSTN basic mode profile protocol stack specified in ITU-T Recommendation T.123 [28], except that when arriving at the ITU-T Recommendation V.24 [27] interface from the ITU-T Recommendation T.120 [17] protocol implementation, the HDLC frame tunnelling data protocol described above shall be used. Terminals shall declare the ITU-T Recommendation T.120 [17] capability and mode only if they are compliant with this paragraph.

Since ITU-T Recommendation T.120 [17] requires a reverse channel for operation, ITU-T Recommendation T.120 [17] logical channels shall be opened using the ITU-T Recommendation H.245 [2] procedures for opening associated logical channels in each direction of transmission (bi-directional channels).

NOTE: ITU-T Recommendation T.120 [17] data can also be transported as unspecified user data, but this mode is discouraged, since terminals will not be able to automatically negotiate use of ITU-T Recommendation T.120 [17] in this mode.

4.8.2.2 ITU-T Recommendation T.84 (SPIFF) point-to-point still image transfer cutting across application borders

This application supports the point-to-point transfer of ITU-T Recommendation T.84 [16] (SPIFF) still images (Joint Photographic Experts Group (JPEG), Joint Bi-level Image experts Group (JBIG) or Facsimile Group 3/4 coded) through application borders (e.g. a digital photocamera connected through a ITU-T Recommendation V.24 [27] interface to the sending terminal, and a digital photoprinter connected through another ITU-T Recommendation V.24 [27] interface to the receiving terminal).

The file exchange format to be used for ITU and ISO/IEC applications crosscutting application borders is defined in ITU-T Recommendation T.84/ISO/IEC 10918-3 [16].

ITU-T Recommendation H.245 [2] should be used for the determination of still image profiles supported by the end-applications and the selection of an appropriate profile.

The data protocol used shall be as described in subclause 6.8.1.2 of LAPM / ITU-TRecommendation V.42 [13].

NOTE: The ITU-T Recommendation T.120 [17] protocol series (ITU-T Recommendation T.126, see annex E) also performs still image transfer, among many other functions, within the framework of audiographic teleconferencing, and is preferred for such applications. ITU-T Recommendation T.84 [16] is concerned with passing still images over one or more application borders using the ITU-T/ISO/IEC standardized common file-interchange format. The ITU-T Recommendation T.84 [16] SPIFF file exchange format is backwards compatible with JPEG File Interchange Format (JFIF) and also the predecessor "defacto standard" JPEG file format widely used in PC applications and on the Internet. ITU-T Recommendation T.126 (see annex E) is also compatible with this file format.

4.8.2.3 ITU-T Recommendation T.434 point-to-point telematic file transfer cutting across application borders

This application supports the point-to-point transfer of ITU-T Recommendation T.434 [18] defined telematic files through application borders (e.g. an intelligent memory card connected to the sending terminal, and a computerized database connected through an ITU-T Recommendation V.24 [27] interface to the receiving ITU-T Recommendation H.324 [26] terminal).

The data protocol used shall be as described in subclause 6.8.1.2 of LAPM/V.42 [13].

NOTE: The ITU-T Recommendation T.120 [17] protocol series (ITU-T Recommendation T.127 (see annex E), which also uses ITU-T Recommendation T.434 [18]) performs file transfer, among many other functions, within the framework of audiographic teleconferencing, and is preferred for such applications. The ITU-T Recommendation T.434 [18] application is concerned with point-to-point passing of telematic files over one or more application borders without implementing the entire protocol set of the T.120 [17] series (see annex E) of ITU-T Recommendations, which is needed for file sharing among many users in a collaborative working environment.

4.8.2.4 ITU-T Recommendation H.224 real-time control protocol, for ITU-T Recommendation H.281 far-end camera control

ITU-T Recommendation H.224 [8] is for real-time simplex device control. The only currently standardized application is ITU-T Recommendation H.281 [9] for far-end camera control.

Terminals described in this I-ETS supporting ITU-T Recommendation H.224 [8] shall use the HDLC frame tunnelling protocol to transport HDLC frames. There shall be no more than one ITU-T Recommendation H.224 [8] channel in use and references in that recommendation to the LSD channel of ETS 300 144 [21] shall be interpreted as referring to the ITU-T Recommendation H.224 [8] logical channel. The maximum transmission time requirements of ITU-T Recommendation H.224 [8] shall be met, with the logical channel considered as operating at 4 800 bps, regardless of the actual channel bit-rate.

4.8.2.5 Network link layer

The network link layer data application supports ISO network layer protocols defined by ISO/IEC TR9577 [25], which include IP and Internet Engineering Task Force (IETF) Point-to-Point Protocol (PPP), among others. The particular network layer protocol to be used shall be identified in ITU-T Recommendation H.245 [2] data application capability and data mode messages using the Network Layer Protocol Identifier (NLPID) as defined in ISO/IEC TR9577 [25].

For the NLPID application, the link layer which is defined for use with asynchronous PSTN modems shall be used. If this link layer uses HDLC framing, the HDLC Frame Tunnelling protocol shall be supported by the terminal. Otherwise, the terminal shall support the transparent data protocol.

NOTE: Use of the NLPID is extensively described in IETF RFC 1490 (see annex E).

4.8.2.6 External data ports and unspecified user data

All terminals complying with this I-ETS and offering external data ports for transport of unspecified user data shall support both the buffered ITU-T Recommendation V.14 [11] data protocol mode and the HDLC frame tunnelling mode. Means shall be provided to configure the terminal for ITU-T Recommendation T.120 [17] protocol on external data ports. If so configured, the HDLC frame tunnelling protocol and ITU-T Recommendation T.120 [17] capability and mode shall be used by the terminal.

Other data protocols may optionally be used by ITU-T Recommendation H.245 [2] negotiation.

5 Terminal procedures

Provision for communication is comprised of the following steps:

- phase A: call set-up of voiceband channel;
- phase B: initial analogue telephony communication;
- phase C: establishment of digital communication, modem training;
- phase D: initialization;
- phase E: communication;
- phase F: end of session;
- phase G: change of communication mode and call clearing.

5.1 Phase A - call set-up of voiceband channel

The calling terminal shall request the connection according to procedures for analogue telephony, according to national standards.

When a call is initiated by a terminal which is external to the modem (a separate physical item connected by an interface), the procedures of ITU-T Recommendation V.25ter [12] shall be used. Upon successful completion of call set up, the terminal shall proceed to phase B.

5.2 Phase B - initial analogue telephony communication

5.2.1 ITU-T Recommendation V.8 [10] procedure

When the procedures of ITU-T Recommendation V.8 [10] are in use, phase B shall be bypassed, proceeding directly to phase C.

5.2.2 ITU-T Recommendation V.8bis procedure

When the procedures of ITU-T Recommendation V.8bis (see annex E) are in use, an optional phase B begins when the called party has answered. Phase B is normal analogue telephony voice mode. In this mode users have the opportunity to speak before proceeding to multimedia telephony.

If the terminal is conditioned to go directly into digital communication mode, phase B shall be bypassed, proceeding directly to phase C. If the terminal is conditioned for initial analogue telephony voice mode, the terminal shall proceed to phase C when:

- the user manually causes the terminal to initiate a ITU-T Recommendation V.8bis (see annex E) transaction; or

- the terminal detects an initiation signal from the distant terminal.

5.3 Phase C - establishment of digital communication, modem training

5.3.1 ITU-T Recommendation V.8 procedure

The terminal shall follow the call start-up procedure described in ITU-T Recommendation V.8 [10]. The calling terminal should not transmit ITU-T Recommendation V.8 [10] calling tones CT, CI, or CNG. The answer terminal shall support ITU-T Recommendation V.8 [10] Call-Menu/Joint-Menu (CM/JM) exchanges and shall transmit answer tone without waiting for call signals. Terminals complying with this I-ETS should signal the ITU-T Recommendation V.8 [10] call function and shall not signal an ITU-T Recommendation V.8 [10] protocol category.

If the ITU-T Recommendation V.8 [10] start-up procedure detects an ITU-T Recommendation V.34 [15] modem, the start-up procedure for that modem shall be followed. Upon completion of the modem start-up procedure and establishment of digital communication, the terminal shall proceed to phase D - initialization.

If the ITU-T Recommendation V.8 [10] procedure fails to detect an ITU-T Recommendation V.34 [15] modem, or the handshake and the establishment of the digital connection is not successful, after a suitable period the calling terminal may, depending on predetermined configuration, go to telephony mode, disconnect the line, or go to another operating mode more suitable for the detected modem. Such other modes are outside the scope of this I-ETS.

NOTE: The terminal shall wait for a suitable call set-up period, in addition to processing, signal detection, and maximum round-trip delays, before deciding on further action.

5.3.2 ITU-T Recommendation V.8bis procedure

The terminal shall follow the call start-up procedure described in ITU-T Recommendation V.8bis (see annex E). If the ITU-T Recommendation V.8bis (see annex E) procedure detects that the distant terminal is not capable of ITU-T Recommendation V.8bis (see annex E), but is capable of ITU-T Recommendation V.8 [10], the phase C procedure for ITU-T Recommendation V.8 [10] shall be followed. If the ITU-T Recommendation V.8bis (see annex E) procedure detects a distant ITU-T Recommendation H.324 [26] terminal supporting the capabilities desired for this call, the ITU-T Recommendation V.34 [15] start-up procedure shall be followed. Upon completion of the ITU-T Recommendation V.8bis (see annex E) procedures and establishment of digital communication, the terminal shall proceed to phase D.

NOTE: Some successful ITU-T Recommendation V.8bis (see annex E) transactions result in a return to telephony mode (Phase B).

If the ITU-T Recommendation V.8bis (see annex E) procedure fails, results in a return to analogue telephony, or the handshake and the establishment of the digital connection is not successful after the period specified in ITU-T Recommendation V.8bis (see annex E), the calling terminal may, depending on predetermined configuration, go to telephony mode, disconnect the line, or go to another operating mode more suitable for the detected modem. Such other modes are outside the scope of this I-ETS.

5.4 Phase D - initialization

After digital communication has been established, a minimum of 16 HDLC flags shall be transmitted in order to ensure synchronization. Following this, system to system communication shall be initiated using the ITU-T Recommendation H.245 [2] control channel. Since no multiplex table entries have yet been sent to the receiver, initial control messages shall be sent using multiplex table entry 0.

Terminal system capabilities are exchanged by transmission of the **TerminalCapabilitySet** message. This capability PDU shall be the first message sent. The **MasterSlaveDetermination** message shall also be sent at this time, in which the terminals exchange random numbers, according to the procedure in ITU-T Recommendation H.245 [2], to determine the master and slave terminals. Terminals complying with this I-ETS shall be capable of operating in both master and slave modes, and shall set **terminalType** to 128 and set **statusDeterminationNumber** to choose a random number in the range 0 to 2_{24}-1. Only one random number shall be chosen by the terminal for each call, except in the case of identical random numbers, as described in ITU-T Recommendation H.245 [2].

If the initial capability exchange or master/slave determination procedures fail, these should be retried at least twice before the terminal abandons the connection attempt and proceeds to phase G.

NOTE: The range of **terminalTypes** from 0 to 127 is reserved for possible use by MCUs or other non-terminal devices which may need to be slave at all times and the range 129 to 255 is reserved for possible use by MCUs or other non-terminal devices which may need to be master at all times.

After these procedures are complete, and the far-end's capabilities have been received, the procedures of ITU-T Recommendation H.245 [2] may then be used to open logical channels for various information streams. Multiplex table entries may be sent before or after logical channels are opened, but information shall not be transmitted over a logical channel until the channel is open, and an appropriate ITU-T Recommendation H.223 [1] multiplex table entry has been defined.

5.4.1 Exchange of video by mutual agreement

The indication **videoIndicateReadyToActivate**, "Video Indicate Ready-to-activate", is defined in ITU-T Recommendation H.245 [2]. Its use is optional, but when used the procedure shall be as follows:

- Terminal X has been set so that video is not transmitted until the remote terminal has also indicated readiness to transmit video. Terminal X shall send the indication **videoIndicateReadyToActivate** when the initial capability exchange has been completed, but shall not transmit a video signal until it has received either **videoIndicateReadyToActivate** or incoming video.

A terminal which has not been set in this optional way is not obliged to wait until receipt of **videoIndicateReadyToActivate** or video before initiating its video transmission.

5.5 Phase E - communication

During a session the procedures for changing logical channel attributes, capability, receive mode, etc. shall be carried out as defined in Recommendation ITU-T Recommendation H.245 [2].

5.5.1 Rate changes and retrains

During phase E communication, the modem may retrain or alter its rate of data transmission, with or without momentary disruption of data transmission and loss of data. Upon any such momentary disruption of data transfer, the terminal shall not restart phase D, but shall remain in phase E and execute the normal error recovery procedures according to ITU-T Recommendation H.223 [1].

5.5.2 Involuntary disconnection

Should the terminal detect involuntary, unrecoverable loss of modem communication, or of the underlying PSTN connection, the terminal shall immediately proceed to phase G, analogue telephony mode or line disconnection, bypassing phase F.

5.6 Phase F - end of session

Either terminal may initiate the end of the session. The initiating terminal shall use following procedures:

1) for each logical channel carrying video, it shall stop sending video at the end of a complete SDU and then close the logical channel;

2) it shall close all logical channels carrying data and audio;

3) it shall transmit the message **EndSessionCommand**, and then discontinue all ITU-T Recommendation H.245 [2] message transmissions. This message shall contain an indication to the far end regarding the mode the terminal will enter after the end of the session (disconnect line, analogue telephony, or other mode);

4) on subsequent receipt of **EndSessionCommand** from the remote end, it shall proceed to phase G, except that if the initiating terminal indicated an intention to disconnect the line after the end of session, the terminal shall not wait for receipt of **EndSessionCommand** from the remote end, but shall proceed directly to phase G.

A terminal receiving **EndSessionCommand** without first having transmitted it shall follow (1) to (3) in subclause 5.6, then proceed to phase G.

5.7 Phase G - change of communication mode and call clearing

If the terminal arrived at phase G by involuntary disconnection, it shall disconnect or revert to analogue telephony, depending on predetermined configuration.

A terminal wishing to terminate a call shall first initiate session end procedure described in phase F.

In phase G, the terminal shall proceed as it indicated in the **EndSessionCommand** message. If it indicated a change to another digital communication mode, it shall begin the new mode at the equivalent of phase D. Otherwise, it shall initiate the cleardown procedures defined in ITU-T Recommendation V.34 [15], except that it shall not physically disconnect the PSTN connection if it indicated an intention to revert to analogue telephony mode.

These procedures ensure that:

- the distant terminal does not erroneously invoke a fault procedure;

- the human user gets the right indications via tones and announcements from the network exchange;

- relevant messages can be displayed for the human user by the terminal.

6 Interoperation with other terminals

6.1 Speech only terminals

Videophones complying with this I-ETS shall support interoperation with analogue speech-only telephones.

6.2 ETS 300 145 multimedia telephone terminals attached to the ISDN

Interoperation with multimedia telephone terminals over the Integrated Services Digital Network (ISDN) (see ETS 300 145 [22]) can be provided by:

- using an interworking function; or

- using dual-mode (ISDN and PSTN) terminals on the ISDN.

An interworking function compliant with this I-ETS / ETS 300 145 [22] can be located at the interface between ISDN and PSTN signals. It transcodes the ITU-T Recommendation H.223 [1] and ETS 300 144 [21] multiplexers and the content of control, audio, and data logical channels between the ETS 300 145 [22] protocols and those compliant with this I-ETS.

In order to ease communication between terminals complying with this I-ETS and ETS 300 145 [22] terminals via interworking functions, terminals compliant with this I-ETS which support video shall support the ITU-T Recommendation H.261 [5] video codec in the QCIF picture format so that the additional delay of video transcoding can be avoided. When this mode is in use, interworking functions shall insert and remove ITU-T Recommendations H.261 [5] and H.263 [4] BCH error correction and error correction framing as appropriate for each terminal type. Terminals complying with this I-ETS shall respond to the **FlowControlCommand**, so that transmitted video streams can be matched to the ETS 300 145 [22] video bit rate in use by the ETS 300 144 [21] multiplex.

Dual-mode (ETS 300 145 [22] and terminals compliant with this I-ETS) terminals on the ISDN shall send PSTN signals compliant with this I-ETS by the use of a "modemfunction", which generates and receives a ITU-T Recommendation V.34 [15] analogue signal encoded as an ITU-T Recommendation G.711 [20] audio bit-stream over the ISDN.

6.3 Multimedia telephone terminals over mobile radio

It is expected that multimedia telephone terminals will also be used on mobile radio networks. Rate matching between wireless terminals and PSTN terminals can be achieved by the use of the **FlowControlCommand**. Wireless operation is for further study.

7 Optional enhancements

7.1 Data facilities

A terminal may have physical I/O ports for external telematic and other equipment, or there may be data applications within the terminal itself. Data transmission may be activated and deactivated by local action. When a logical channel is opened to carry data originating at a port, the **portNumber** parameter of the ITU-T Recommendation H.245 [2] **OpenLogicalChannel** message should contain the number of the relevant port, so that data on the logical channel may be routed to a corresponding port at the far-end, if so desired by the far-end user. For example, in the case where a terminal has general-purpose physical I/O ports intended for connection to telematic or other equipment, such ports might be labelled "1", "2", "3", etc. up to the number of actual ports.

7.2 Encryption

Encryption may optionally be used by terminals complying with this I-ETS. Encryption, including selection of algorithm and key exchange, shall conform to the procedures of ITU-T Recommendations H.233 [6] and H.234 [7] with the following modifications to the procedures defined in ITU-T Recommendation H.233 [6]. The ability to support encryption shall be signalled by the presence of the **h233EncryptionTransmitCapability** and **h233EncryptionReceiveCapability** parameters of the **Capability** message.

In ITU-T Recommendation H.233 [6], specific reference is made to ETS 300 144 [21] in describing how encryption takes place. In applying ITU-T Recommendation H.233 [6] to terminals complying with this I-ETS, references to ETS 300 144 [21], Frame Aligment Signal (FAS), and Bit-rate Allocation Signal (BAS) channels therein shall be ignored and appropriate substitute recommendations be taken from this subclause. Messages referred to as carried in the ITU-T Recommendation H.221 (see annex E) Encryption Control Signal (ECS) channel shall be re-interpreted as being carried within the **encryptionSE** parameter of the **EncryptionCommand** or Encryption Initialization Vector (EIV) logical channel, as specified in subclause 7.2.1.

7.2.1 EncryptionSE messages

ITU-T Recommendation H.233 [6] Session Exchange (SE) messages shall be carried in the **encryptionSE** parameter of the **EncryptionCommand** message. Since the ITU-T Recommendation H.245 [2] control channel is carried on a reliable data link layer using retransmission of errored frames, the error protection bits described in ITU-T Recommendation H.233 [6] shall not be applied to SE messages.

The ITU-T Recommendation H.233 [6] header for SE messages shall have the binary value 00000000, indicating an SE message in a single block, not followed by related blocks.

The ITU-T Recommendation H.233 [6] media identifier value shall be binary 00000000, which shall indicate encryption of all logical channels except for the EIV and ITU-T Recommendation H.245 [2] control channels. The use of other values is for further study.

NOTE: Non-standard encryption algorithms may be referenced in SE messages after associating a non-standard algorithm with a ITU-T Recommendation H.233 [6] Algorithm Identifier value using the **encryptionAlgorithmID** parameter of the **EncryptionCommand** message.

7.2.2 EIV channel

The EIV logical channel is used for the transmission of ITU-T Recommendation H.233 [6] Initialization Vector (IV) messages.

To ensure accurate synchronization of the IV messages with the ITU-T Recommendation H.223 [1] multiplexer bit-stream, the EIV channel is an independent logical channel which shall be non-segmentable, and shall use adaptation layer AL2 of the ITU-T Recommendation H.223 [1] multiplexer. The entire IV message, exactly as defined in ITU-T Recommendation H.233 [6], including error protection bits, shall be placed in a single AL-SDU. The sequence number option of AL2 shall not be used.

Messages carried within the EIV channel shall retain the error protection mechanism of ITU-T Recommendation H.233 [6].

7.2.3 Encryption procedure

The encryptor shall produce a pseudo-random bit-stream (cipher stream) corresponding to all bits output by the ITU-T Recommendation H.223 [1] multiplex prior to insertion of flags and application of the HDLC zero-bit insertion procedure.

When encryption is activated according to ITU-T Recommendation H.233 [6], the ITU-T Recommendation H.223 [1] bit-stream shall, prior to flag insertion and application of the HDLC zero-bit insertion procedure, be exclusive-ORed with the pseudo-random bit-stream generated by the encryptor. However, the exclusive-OR procedure shall not be applied to the ITU-T Recommendation H.223 [1] header byte and all bytes belonging to the ITU-T Recommendation H.245 [2] control channel or EIV channel, which shall all be passed transparently to the HDLC zero-bit insertion and flag insertion stage.

For each transmitted ITU-T Recommendation H.223 [1] header byte or byte belonging to the EIV or control channels, eight bits shall be discarded from the pseudo-random bit-stream generated by the encryptor. Nothing is discarded from the pseudo-random bit-stream for transmitted flags or for bits added by the HDLC zero-bit insertion process.

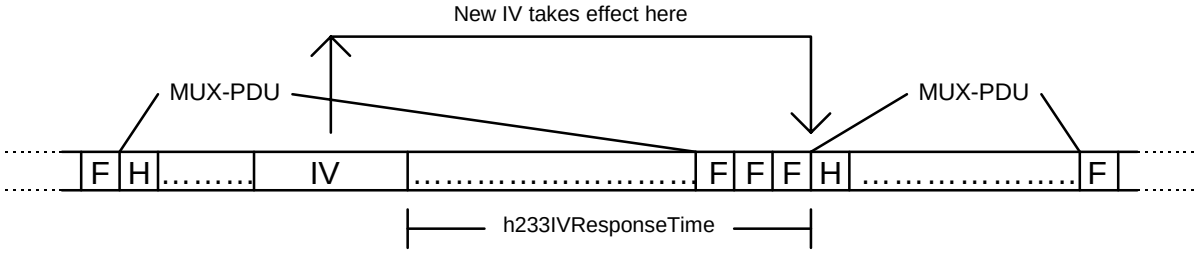
The receiver shall apply the reverse procedure.

7.2.4 Encryption initialization vectors

Once an encrypted session is in progress, the transmitter should periodically send new IV messages in order to limit the duration of repeated pseudo-random bit-streams in the event of a collision with a previously used state of the pseudo-random bit-stream generator. The frequency of these messages is left to the discretion of the implementor.

As shown in figure 3, new IVs take effect at the start of the next ITU-T Recommendation H.223 [1] MUX PDU following the MUX-PDU containing an IV message. The old IV continues in effect through the entirety of the MUX-PDU containing the IV message, at the end of which any remaining pseudo-random bits generated using the old IV are discarded. In order for the receiver to have time to process the new IV before needing to use it, the transmitter shall wait a minimum time after sending the last byte of the IV message, as specified by the receiver's **h233IVResponseTime** capability, before starting transmission of the next MUX-PDU. If necessary, the transmitter shall send idle flags to meet the receiver's **h233IVResponseTime** requirement.

NOTE: Definition, by the implementor, of an appropriate ITU-T Recommendation H.223 [1] multiplex table entry allows bytes from other logical channels to follow an IV message within the same MUX-PDU so that no transmission bandwidth is squandered in meeting the receiver's IV processing delay requirement.



F = flag, H = header byte, **...** = logical channel byte

Figure 3: Encryption IV synchronization

7.2.5 Error recovery

In the event of line errors that cause flag emulation, flag erasure, or erroneous HDLC zero-bit removal, it is possible that a newly received flag, signifying the end of the previous MUX-PDU, will not align with the byte boundaries of the preceding data. In order to maximize the resilience of the encryption system against synchronization loss under these circumstances, the decryptor should, for each new flag received, re-align its pseudo-random bit-stream generator to the nearest byte boundary. This allows recovery from up to at least three zero-bit removal errors between valid flags, although it does not provide any protection against flag emulation or erasure.

In the event that the receiver suspects that it has lost encryption synchronization it shall send an **encryptionIVrequest** command, except that it should not re-send such commands at intervals less than the maximum expected round-trip response time.

Upon receipt of an **encryptionIVrequest** command, the transmitter shall, at its earliest opportunity, send a new IV message, except that it should ignore **encryptionIVrequest** commands received within the minimum expected round-trip response time since sending the last IV message.

7.3 Multilink

Provision for multilink operation is for further study.

8 Multipoint considerations

Terminals compliant with this I-ETS may be used in multipoint configurations via interconnection through MCUs, as indicated in figure 4 (cascaded MCU operation is for further study).

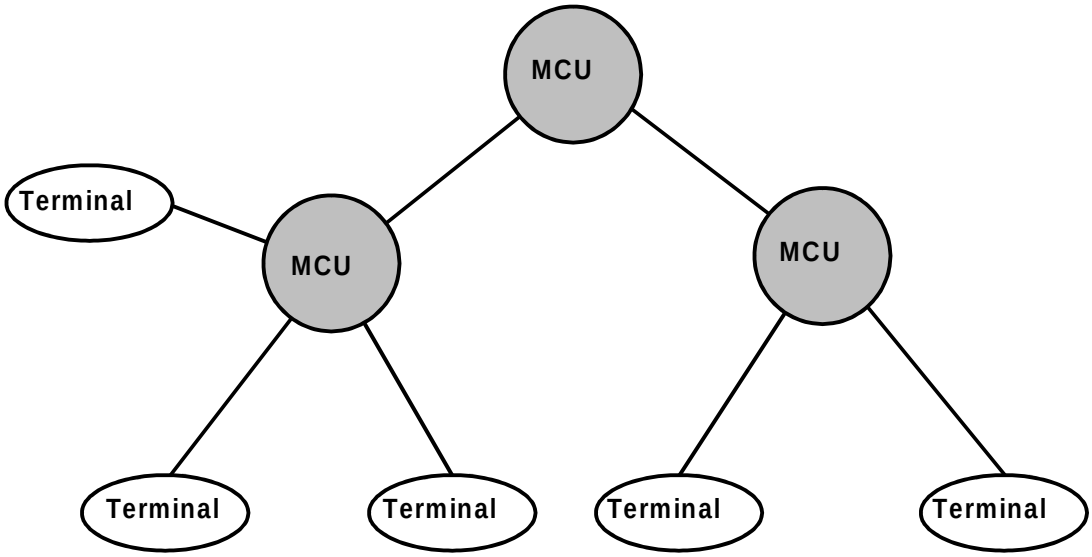


Figure 4: Multipoint configuration

8.1 Establishment of common mode

MCUs may force terminals into a particular common mode of transmission by sending to the terminal a receive capability set listing only the desired mode of transmission. Terminals compliant with this I-ETS shall obey the **MultipointModeCommand** message.

8.2 Multipoint rate matching

Since the modems on each link in a multipoint configuration may be operating at different bit rates, MCUs may choose to send **FlowControlCommand** messages to limit the transmitted bit rates to those which can be sent to receivers.

8.3 Multipoint lip synchronization

In a multipoint configuration, each terminal compliant with this I-ETS may be transmitting a different **H223SkewIndication** message for associated video and audio channels. To enable lip synchronization at receiving terminals, MCUs shall transmit accurate **H223SkewIndication** messages. MCUs may accomplish this by adding delay to equalize the audio/video skew for all transmitting terminals or when switching between broadcasting terminals, may transmit a new **H223SkewIndication** message reflecting the audio/video skew of the current broadcaster.

8.4 Multipoint encryption

In a multipoint configuration the MCU is considered to be a trusted entity. Each port of the MCU encrypts/decrypts the ITU-T Recommendation H.223 [1] bit-stream from the terminal or MCU attached to that port as though it were an terminal in accordance with subclause 7.2 of ITU-T Recommendation H.223 [1].

8.5 Cascaded MCU operation

Multipoint operation in a cascaded MCU configuration is for further study.

9 Maintenance

9.1 Loopbacks for maintenance purposes

Some loopback functions are defined in ITU-T Recommendation H.245 [2] to allow verification of some functional aspects of the terminal, to ensure correct operation of the system and satisfactory quality of the service to the remote party. The message loopback off (**MaintenanceLoopOffCommand**) requires that all loopbacks currently in effect be turned off.

9.1.1 Normal mode

Normal (no loopback) operation mode is illustrated in (a) of figure 5.

9.1.2 System loopback

Operation in system loopback mode is for further study.

9.1.3 Media loopback

Media loopback operates at the analogue I/O interface (towards modem). Upon receiving the mediaLoop request, loopback of the content of the selected logical channel shall be activated as close as possible to the analogue interface of the video/audio codec towards the video/audio codec, so that decoded and recoded media content is looped, as indicated in (c) of figure 5. While in this mode, the terminal shall respond normally to received data, including ITU-T Recommendation H.245 [2] messages. Media loopback provides a subjective test of terminal operation through the far-end codec for human user evaluation. It should be used only on video and audio channels.

This loopback is optional, and should be used only on logical channels opened using the bi-directional channel procedures of ITU-T Recommendation H.245 [2].

9.1.4 Logical channel loopback

Logical channel loopback operates in the ITU-T Recommendation H.223 [1] multiplexer (toward modem). Upon receiving the **logicalChannelLoop** request, each received ITU-T Recommendation H.223 [1] MUX-SDU for the specified logical channel shall be looped back to the transmitter on the corresponding reverse logical channel, as indicated in (d) of figure 5. While in this mode, the terminal shall respond normally to received data, including ITU-T Recommendation H.245 [2] messages.

This loopback is optional, and should be used only on logical channels opened using the bi-directional channel procedures of ITU-T Recommendation H.245 [2].

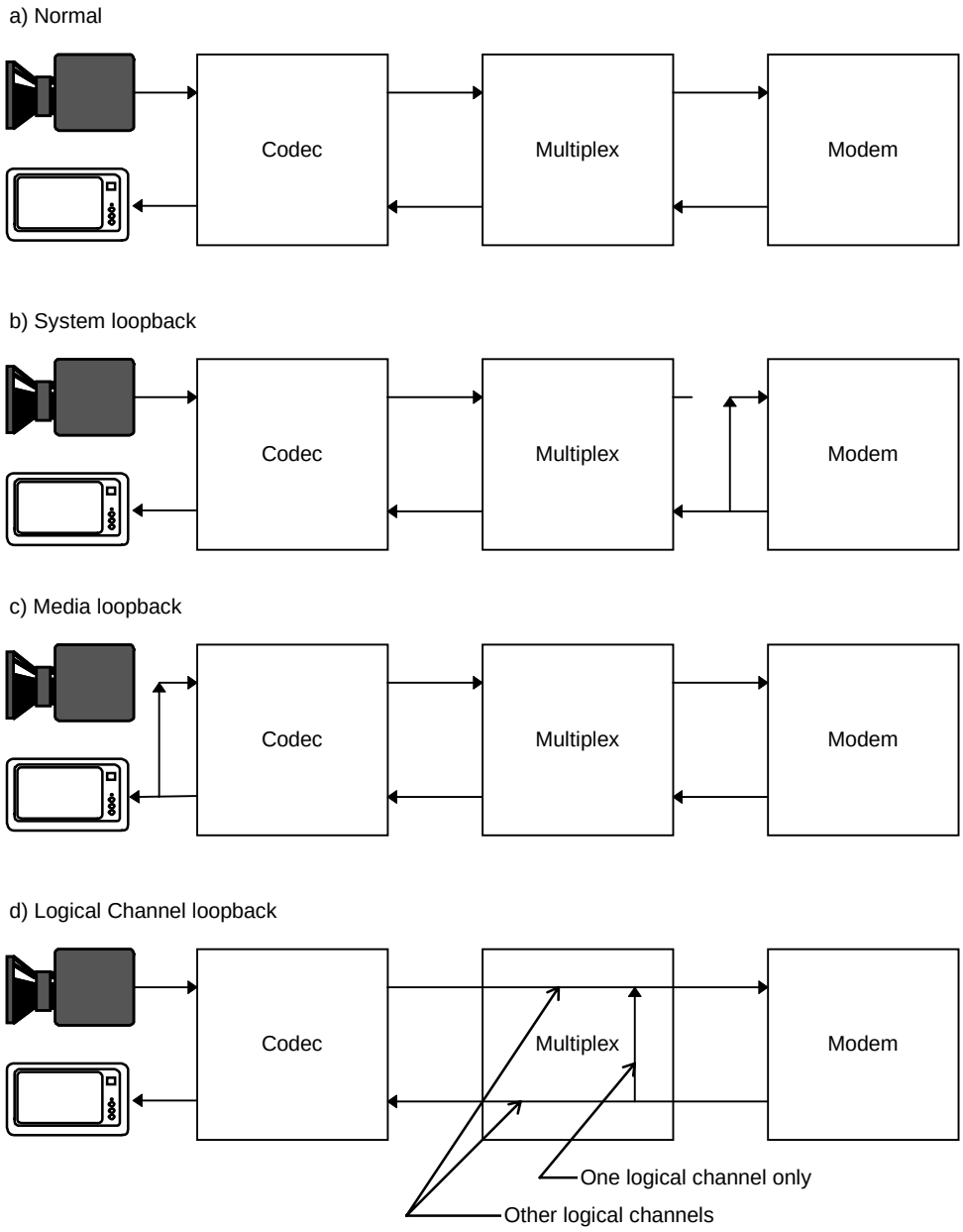


Figure 5: Loopback

Annex A (normative): Protocol stack for control channel

This annex defines the data protocol stack for use with the control channel of terminals which comply with this I-ETS.

A.1 General

Figure A.1 shows the control channel protocol stack for use with this I-ETS.

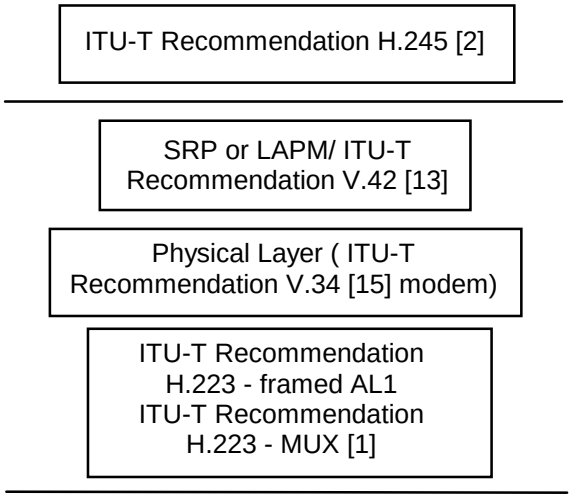


Figure A.1: Protocol stack for control channel

The control protocol of ITU-T Recommendation H.245 [2] requires a reliable link layer for proper operation.

Two means of transporting **MultimediaSystemControlPDU** messages are defined: SRP frames and LAPM / ITU-TRecommendation V.42 [13] frames. In the SRP mode each SRP command frame needs to be acknowledged with an SRP response frame before the next command can be transmitted. In the LAPM / ITU-TRecommendation V.42 [13] mode, multiple frames may be sent in a streaming mode, before an acknowledgment is received for the first frame. All terminals shall support the SRP mode, and shall use SRP as the ITU-T Recommendation H.245 [2] link layer upon initial communication. The LAPM / ITU-TRecommendation V.42 [13] mode is optional, and is preferred for use by complex terminals.

In both cases, bits produced by the ITU-T Recommendation X.691 (see annex E) encoding process shall be put into the byte of an information field, with the first bit generated going into the MSB of the first byte, and progressing down to the LSB of the last byte. One or more complete **MultimediaSystemControlPDU** messages may be sent in each information field, to be transported in a single SRP or LAPM frame.

Terminals complying with this I-ETS and capable of using LAPM / ITU-TRecommendation V.42 [13] as the control channel link layer, shall so indicate by setting the **transportWithI-frames** parameter of the **H223Capability** structure true. Such terminals, upon receiving the corresponding indication from the far-end terminal, shall henceforth, and without further notification of intent, proceed to establish an error corrected connection according to the procedures given in subclause 6.8.1.2 and subsequently transmit control channel messages only using LAPM / ITU-T Recommendation V.42 [13] for the duration of the connection. The terminal shall, however transmit a SRP response message in reply to any SRP command message received.

The transition to LAPM / ITU-T Recommendation V.42 [13] mode shall take place regardless of the state of any ITU-T Recommendation H.245 [2] transactions in progress; any pending transactions shall proceed using LAPM / ITU-TRecommendation V.42 [13] for transfer of additional messages.

NOTE: Since the ITU-T Recommendation H.245 [2] control channel is not considered a data channel, ability to operate the control channel over LAPM / ITU-TRecommendation V.42 [13] is signalled only in the **transportWithI-frames** parameter of **H223Capability**, and is not signalled as a data protocol.

A.2 SRP mode

All terminals shall support the transfer of **MultimediaSystemControlPDU** messages using SRP mode. Each SRP frame shall be placed in a single framed AL1 AL-SDU.

NOTE: The procedures of the SRP mode are based on those of eXchange IDentification (XID) frame transfer in ITU-T Recommendation V.42 [13].

A.2.1 SRP command frames

SRP command frames, as shown in figure A.2, shall be used to send ITU-T Recommendation H.245 [2] control messages. All fields shall be formatted as specified in Recommendation H.223 [1] (note that these formats are consistent with ITU-T Recommendation V.42 [13]).

Header (1 byte)	Sequence number (1 byte)	Information field (one or more ASN.1 messages)	FCS (2 bytes)

Figure A.2: Format of SRP command frames for MultimediaSystemControlPDU messages

The SRP command frame header byte shall have the value binary 11111001 (decimal 249). This may be considered equivalent to an HDLC address byte with the Data Link Connection Identifier (DLCI) value 62, Command Response bit (C/R) bit set to 0, and Address field Extension (EA) bit set to 1.

The sequence number shall be set arbitrarily by a terminal for the first SRP command frame sent and shall be incremented modulo 256 for each new SRP command frame sent. Retransmissions of the same SRP frame, sent according to the procedures below, shall not increment the sequence number, but shall use the same sequence number as the original transmission, so that receivers can distinguish between separate valid messages and retransmissions of a single message (possibly sent in error if the original SRP response frame was lost).

The information field shall contain a whole number of bytes, not to exceed 2 048 bytes, representing one or more **MultimediaSystemControlPDU** messages. The procedure specified by ITU-T Recommendation X.691 (see annex E) shall be used to fill any spare bits in the last byte.

The Frame Check Sequence (FCS) field shall contain a 16-bit CRC, applied to the entire frame content, as described in ITU-T Recommendation V.42 [13] subclause 8.1.1.6.1.

A.2.2 SRP response frames

SRP response frames shall be used to acknowledge correct receipt of SRP command frames from the far-end. Each SRP response frame shall consist of a header byte and FCS field only, and shall not contain any other fields.

The SRP response frame header byte shall have the value binary 11111011 (decimal 251). This may be considered equivalent to an HDLC address byte with the DLCI value 62, C/R bit set to 1, and EA bit set to 1.

The FCS field shall contain a 16-bit CRC, applied to the entire frame content, as described in ITU-T Recommendation V.42 [13] subclause 8.1.1.6.1.

A.2.3 SRP procedure at transmitter

The SRP procedure makes use of an acknowledgement timer T401 and retransmission counter N400.

The period of T401 is a local matter; the two terminals may operate with different periods of T401. Appendix IV of ITU-T Recommendation V.42 [13] shows the various factors that influence T401.

The maximum value of N400 is a local matter; the two terminals may operate with different maximum values of N400. While no default maximum is specified for N400, it should be at least 5.

When the terminal transmits a new SRP command frame, timer T401 shall then be started and the retransmission counter, N400, reset. No additional SRP command frames shall be sent until a response SRP frame with correct header and FCS is received, or timer T401 expires.

If a valid SRP response frame is received, a new SRP command frame, with an incremented sequence number, may be transmitted.

If timer T401 expires before receipt of a valid SRP response frame, the terminal shall:

- retransmit the SRP command (with the same sequence number) as above;
- restart timer T401; and
- increment the retransmission counter (N400).

After retransmission of the SRP command N400 times and failure to receive a valid SRP response, the terminal shall consider modem communication to be lost, and take appropriate action.

A.2.4 SRP procedure at receiver

On receipt of an SRP command frame with correct header and FCS the receiving terminal shall acknowledge by transmitting an SRP response frame within 500 ms.

If the received SRP command frame has the same sequence number as the previously received command frame, it shall not be passed to the ITU-T Recommendation H.245 [2] layer, since it is a retransmission of an already-processed command.

Receipt of all other frames shall be ignored, except that if the terminal has signalled ability to operate in LAPM / ITU-TRecommendation V.42 [13] mode, the receiver shall check the DLCI value of received frame header. If the DLCI value matches that specified for use in the LAPM / ITU-TRecommendation V.42 [13] mode, the terminal shall respond according to the procedures of LAPM / ITU-TRecommendation V.42 [13], as described in A.3.

A.3 LAPM / ITU-T Recommendation V.42 mode

Terminals may optionally support the transfer of **MultimediaSystemControlPDU** messages using LAPM / ITU-TRecommendation V.42 [13].

SRP frames shall be used to transfer **MultimediaSystemControlPDU** messages before LAPM / ITU-T Recommendation V.42 [13] transmission is initiated but shall not be used for this purpose after LAPM / ITU-T Recommendation V.42 [13] transmission has been used.

In the LAPM / ITU-T Recommendation V.42 [13] mode, the information field, as defined for the SRP mode above, shall be placed into a single LAPM / ITU-TRecommendation V.42 [13] I-frame and transferred using procedures of LAPM / ITU-TRecommendation V.42 [13], as in subclause 6.8.1.2, except that the procedures for opening logical channels shall not be used, as the control channel is considered already open at the start of digital communication.

The address field shall be one byte with the 6-bit DLCI field set to binary 111111 (decimal 63).

ITU-T Recommendation V.42bis [14] data compression should not be used.

Default values for all ITU-T Recommendation V.42 [13] parameters shall be as specified in the recommendation, except for N401, maximum number of bytes in an information field, which shall have a default value of 2 048 bytes, in order to accommodate large capability sets.

Annex B (normative): HDLC frame structure transparency for asynchronous transmission

When operating in the HDLC frame tunnelling mode, the terminal shall implement the following procedures taken from ISO/IEC 3309 [19] subclause 4.5.2 at the asynchronous ITU-T Recommendation V.24 (see annex E) interface:

- the control escape byte is a transparency identifier that identifies a byte occurring within a frame to which the following transparency procedure is applied. The encoding of the escape byte is given in figure B.1;

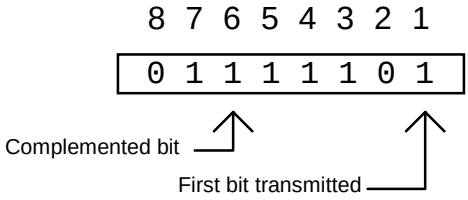


Figure B.1: Control escape byte for HDLC frame tunnelling procedure

- the transmitter shall examine the frame content between the opening and closing flag sequences (01111110) including the address, control, and FCS fields and, following completion of the FCS calculation, shall:

  a) upon the occurrence of the flag or a control escape byte, complement the 6th bit of the byte; and

  b) insert a control escape byte immediately preceding the byte resulting from the above prior to transmission;

- the receiver shall examine the frame content between the two flag bytes and shall, upon receipt of a control escape byte and prior to FCS calculation:

  a) discard the control escape byte; and

  b) restore the immediately following byte by complementing its 6th bit.

Other byte values may optionally be included in the transparency procedure by the transmitter.

Annex C (informative): Bit and octet order

This appendix is supplied as a summary of bit and byte order in this I-ETS, including ITU-T Recommendations H.223 [1], H.261 [5], H.263 [4], H.245 [2] and G.723.1 [3]. In case of any discrepancy the normative text of the various recommendations take precedence over this annex.

ITU-T Recommendations H.261 [5], H.263 [4], G.723.1 [3] and H.245 [2] each produce a sequence of bits which are delivered as bytes to the ITU-T Recommendation H.223 [1] multiplexer. Within this sequence of bits there are fields of various lengths, in some cases aligned with byte boundaries. In the case of ITU-T Recommendations H.261 [5], H.263 [4], G.723.1 [3] and H.245 [2] these fields are ordered MSB first. Figure B.1 illustrates this, with "M" indicating the MSB of each field and "L" indicating the LSB of each field.

Figure B.1: Output from ITU-T Recommendations H.261/H.263/G.723/H.245

Upon delivery to the ITU-T Recommendation H.223 [1] multiplexer, this bit sequence is split into bytes, each with a defined MSB/LSB position, as shown in figure B.2.

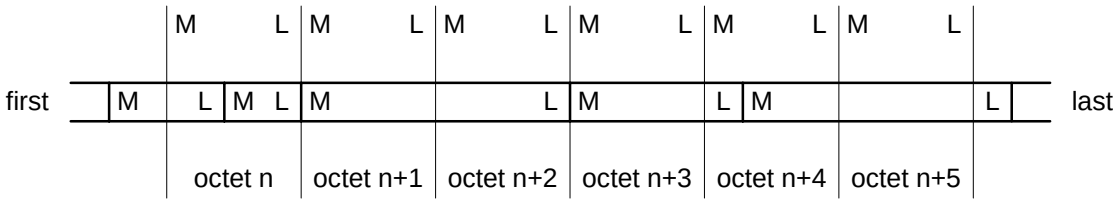


Figure B.2: Output split into bytes

The ITU-T Recommendation H.223 [1] multiplexer then transmits each of these bytes in the order LSB first (the reverse of the original order), applying the transparency procedure (inserting a "0" after each sequence of five "1" s) as it does so.

For example, a sequence of six bytes, with hexadecimal values 0x92, 0xF1, 0x39, 0x35, 0x31, 0x30 would be transmitted as shown in figure B.3.

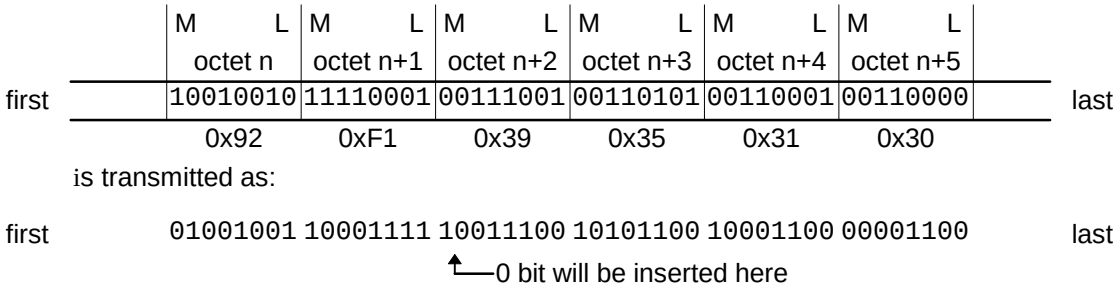


Figure B.3: Example sequence

Annex D (informative): ITU-T Recommendation V.8bis codepoints

ITU-T Recommendation V.8bis (see annex E) capability exchange may be used during call set-up to help terminals quickly decide, in the most common cases, if operation in a mode compliant with this I-ETS is desired. ITU-T Recommendation V.8bis (see annex E) capabilities indicate only the most basic and commonly used modes, and are not a substitute for ITU-T Recommendation H.245 [2] procedures. If an operational mode not signalled by ITU-T Recommendation V.8bis (see annex E) is desired, the terminal needs to complete call establishment and perform an ITU-T Recommendation H.245 [2] capabilities exchange to determine if the far-end terminal supports the desired mode.

Within the ITU-T Recommendation V.8bis (see annex E) Communications Capabilities (CC) field for terminals complying with this I-ETS, the CC field is formatted into one or more sub-fields. Each sub-field ends with the byte in which bit [n] is set to 1. Following the first sub-field, the remaining sub-fields, if present, shall appear in the same order in which the bits indicating their presence are transmitted.

NOTE 1: Implementors should refer directly to ITU-T Recommendation V.8bis (see annex E) for the actual bit assignments.

In the first sub-field the following bits are allocated:

Name	**Meaning**
Video	To be set only if bi-directional video is supported as per this I-ETS (subclause 4.6).
Audio	To be set only if bi-directional audio is supported as per this I-ETS (subclause 4.7).
Encryption	To be set only if encryption is supported as per this I-ETS (subclause 7.2).
Data	Indicates that a data subfield is present. Shall be set only if one or more bits in the data subfield are set.

NOTE 2: Possible future allocations include Profiles.

In the Data subfield, the following bits are allocated:

Name	**Meaning**
ITU-T Recommendation T.120 [17]	To be set only if ITU-T Recommendation T.120 [17] conferencing is supported as per subclause 4.8.2.1.
ITU-T Recommendation T.84 [16]	To be set only if ITU-T Recommendation T.84 [16] still image transfer is supported as per subclause 4.8.2.2.
ITU-T Recommendation T.434 [18]	To be set only if ITU-T Recommendation T.434 [18] file transfer is supported as per subclause 4.8.2.3.
ITU-T Recommendation V.42 [13]	To be set only if ITU-T Recommendation V.42 [13] user data is supported as per subclauses 4.8.1.2/4.8.2.6 of the present document.
ITU-T Recommendation V.14 [11]	To be set only if ITU-T Recommendation V.14 [11] user data is supported as per subclauses 4.8.1.1/4.8.2.6.
PPP	To be set only if IETF Point-to-Point protocol is supported via the Network Layer NLPID as per subclause 4.8.2.5.

NOTE 3: Other modes beside those indicated in ITU-T Recommendation V8bis (see annex E), such as unidirectional modes, may be supported by terminals as signalled via ITU-T Recommendation H.245 [2] capabilities exchange.

Annex E (informative): Bibliography

- ITU-T Recommendation G.728 (1992): "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".

- ITU-T Recommendation H.221 (1995): "Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices".

- ITU-T Recommendation H.230 (1993): "Frame-synchronous control and indication signals for audiovisual systems".

- ITU-T Recommendation H.262 (1995): "Generic coding of moving Pictures and Associated Audio: Video - ISO/IEC 13818-2".

- ITU-T Recommendation T.30 (1993): "Procedures for document facsimile transmission in the general switched telephone network".

- ITU-T Recommendation T.35 (1991): "Procedure for the allocation of CCITT defined codes for non-standard facilities".

- ITU-IT Recommendation T.51 (1993): "Latin based coded character sets for telematic services".

- ITU-T Recommendation T.126 (1995): "Multipoint still image and annotation protocol".

- ITU-T Recommendation T.127 (1995): "Multipoint binary file transfer protocol".

- ITU-T Recommendation X.680 (1994): "Information Technology: Abstract Syntax Notation One (ASN.1): Specification of basic notation".

- ITU-T Recommendation X.691 (1995): "Information technology: ASN.1 encoding rules: Specification of Packed Encoding Rules (PER) Common text with ISO/IEC".

- IETF RFC 1490: "Multiprotocol Interconnect over Frame Relay, A. Malis et al, July 1993".

- IETF RFC 1661: "The Point to Point Protocol, W. Simpson, July 1994".

- ITU-T Recommendation V.8bis (1996): "Procedures for the identification and selection of common modes of operation between data circuit terminating equipment (DCE) and between data terminal equipment (DTE) over the general switched telephone network and on leased point-to-point telephone-type circuits".

History

Document history			
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