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Purpose: Discussion/Proposal

1. Introduction

One of the key requirements of broadband audiovisual terminals, which are based on ITU-T (draft) recommendation H.32X, is their compliance with narrowband ISDN (H.320) terminals [1]. This requirement ensures that an H.32X-based premises equipment will inter-operate with H.320 and H.32Y [2] terminals. In addition, the ITU-TS Experts Group for Very-Low Bitrate Visual Telephony is planning to support certain modes of H.320 in the new H.32P recommendation (videophone terminals over PSTN). This, again, can make H.320 a common communication mode between H.32X and H.32P terminals.

Recommendation H.320 defines several types of terminals based on their capabilities in supporting different transfer rates, audio, and video coding modes. In fact, by considering Table 2/H.320, one can recognize 28 H.320-compliant terminal types [4]. Furthermore, additional capabilities are defined by the H.221 specification as part of the Bit Allocation Signal (BAS) command and capability messages. Therefore, a clear and consistent interpretation of the H.320 mode(s) supported by recommendation H.32X is required.

In previous AVC contributions (see for example [5]), a good effort was made in defining several H.320 modes of operations that an H.32X terminal should support. It has been proposed that H.32X terminals be categorized into three classes: Class 1, 2, and 3. A Class 1 terminal operates in an H.320/H.32Y mode only[1], and possesses H.320 and AAL-1 capabilities. In addition to these (i.e., H.320 and AAL-1) capabilities, Class 2 and 3 terminals have higher capabilities (e.g., H.262 video, MPEG-2 audio, etc.).

In this contribution, we build on the previous contributions by considering, in more detail, the different capabilities of H.320 terminal types as outlined in both the H.320 and H.221 recommendations. The focus, in here, is on high-end (i.e., Class 2 and higher using the proposed classification in [5]) H.32X terminals and their support of H.320 capabilities (see footnote 1). Therefore, throughout the remaining of this contribution, an *H.32X terminal* refers to a higher-end terminal type that supports H.262 video and MPEG-2 audio (layer 2). Several issues are raised and solutions are proposed.

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1. It is not clear what is the advantage of defining a Class-1 H.32X terminal that can be classified as an H.32Y terminal. Should another class of H.32X terminals be defined for H.32Z terminals? The AVC Experts Group may want to consider the discussion of this issue. This kind of classification may create some ambiguity in the mind of terminal vendors and users. The focus should be on defining H.32X terminals that support *both* (i) distinct (new and enhanced) capabilities (e.g., H.262 video) and (ii) inter-operability features (e.g., H.261 video and other H.320 capabilities).

2. H.320 Transfer Rate Capabilities

The transfer rate of an H.320 terminal can range from 64 kbit/s to 1.92 Mb/s. The different transfer rate modes[1] supported are shown in Table 1. It is important to note that for most transfer rates two modes of transmission are possible. For example, if the total transfer rate is 128 kbit/s, then the signal can occupy either (i) two 64 kbit/s channels including a Service Channel (SC), i.e. FAS and BAS signals, in each B channel, or (ii) a single 128 kbit/s channel that includes a single SC. Therefore, it is important to specify the number of SC channels that an H.32X terminal will support in addition to the total transfer rate.

Table 1: H.320 Transfer Rate Modes

Transfer Rate Mode	Terminal Type	Total Transfer Rate (Kbit/s)	ISDN Channel(s)	Comments
a	X_a	64	B	Transmission takes place through a *single* 64 kbit/s channel with a single service channel (FAS and BAS).
b	X_b	128	2B	Transmission can take place through *n* 64 kbit/s channels with a service channel (FAS and BAS) in each. In here, *n* can be 2, 3, 4, 5, or 6. A terminal that supports a transfer mode with a rate of *n*x64 kbit/s is capable of supporting all other *m*x64 kbit/s modes, when $m < n$.
c	X_c	192	3B	
d	X_d	256	4B	
e	X_e	320	5B	
f	X_f	384	6B	
g	Y_1	384	H_0	Transmission takes place through a *single* 384 kbit/s channel with a single service channel (FAS and BAS) in the first 64 kbit/s time-slot. All other rates lower than 384 kbit/s (i.e., 64, 128, 192, 256, and 320 kbit/s) should be supported under this mode with a single SC channel in the first 64 kbit/s time-slot.

1. Other transfer rates (e.g., 512 and 1472 kbit/s), which are specified in the H.221 BAS signal command and capability messages, are not explicitly shown in recommendation H.320. These rates, however, can be supported by terminals capable of receiving higher rates (e.g., 1536 kbit/s).

Table 1: H.320 Transfer Rate Modes

Transfer Rate Mode	Terminal Type	Total Transfer Rate (Kbit/s)	ISDN Channel(s)	Comments
h	Y_2	768	$2H_0$	Transmission can take place through *n* 384 kbit/s channels with a service channel (FAS and BAS) in each. In here, *n* can be 2, 3, or 4. A terminal that supports a transfer mode with a rate of *n*x384 kbit/s is capable of supporting all other *m*x384 kbit/s modes, when $m < n$.
i	Y_3	1152	$3H_0$	
j	Y_4	1536	$4H_0$	
k	Z_α	1536	H_{11}	Transmission takes place through a *single* 1536 kbit/s channel with a single service channel (FAS and BAS) in the first 64 kbit/s time-slot. All other rates lower than 1536 kbit/s (i.e., 64, 128,.., and 1472 kbit/s) should be supported under this mode with a single SC channel in the first 64 kbit/s time-slot.
l	Y_5	1920	$5H_0$	Transmission takes place through *five* 384 kbit/s channels with a service channel (FAS and BAS) in each. This terminal supports all other *m*x384 kbit/s modes, when $m < 5$.
m	Z_β	1920	H_{12}	Transmission takes place through a *single* 1920 kbit/s channel with a single service channel (FAS and BAS) in the first 64 kbit/s time-slot. All other rates lower than 1920 kbit/s (i.e., 64, 128,.., 1472, and 1536 kbit/s) should be supported under this mode with a single SC channel in the first 64 kbit/s time-slot.

It is proposed that the AVC Experts Group adapt one of the following alternatives:

1. H.32X terminals should support transfer modes **f**, **l**, and **m**. These modes correspond to H.320 terminal types $\mathbf{X}_f$, $\mathbf{Y}_5$, and $\mathbf{Z}_\beta$, respectively[1]. This option provides a comprehensive inter-operability with all possible H.320 transfer rate modes. Moreover, this option implies that an H.32X terminal should be capable of accepting as many as six B or five H_0 channels (simultaneously) and synchronizing them using the multiframe and channel numbering schemes provided by H.221.
2. H.32X terminals should support transfer mode **m** only (terminal type $\mathbf{Z}_\beta$). Under this option all transfer rates, i.e. 64, 128,..., 1536, and 1920 kbit/s, are supported with a *single* SC channel in the first 64 kbit/s time-slot (I-channel). Under this mode, however, an H.32X terminal can not accept multiple B or H_0 channels, and consequently can not synchronize among them. This may not be acceptable for many common narrowband ISDN applications.
3. H.32X terminal should support transfer modes **b**, **h**, and **m.** These modes correspond to H.320 terminal types $\mathbf{X}_b$, $\mathbf{Y}_2$, and $\mathbf{Z}_\beta$, respectively. This alternative provides an H.32X terminal the capability to inter-operate with a wide range of common H.320 terminals. Moreover, this alternative implies that an H.32X terminal should be capable of accepting only two B or two H_0 channels (simultaneously) and synchronizing them using the multiframe and channel numbering schemes provided by H.221.

It is proposed that an H.32X terminal should support, at minimum, two SC channels (alternative 3 above). The support of a higher number of SC channels (i.e., more than two) should be optional. Moreover, it is important to specify if H.32X terminals should provide support for restricted networks (i.e., 56 kbit/s signals in 64 kbit/s channels) or not. It is proposed that H.32X terminals support the restricted transfer mode.

3. Audio Coding Capabilities

The three audio coding standards[2] supported by H.320 terminals are G.711 (64 and 56 kbit/s), G.722 (48, 56, and 64 kbit/s), and G.728 (16 kbit/s). All H.320 terminals must support the G.711 (both *A* and μ-law) modes.

Among the 28 H.320 terminal types (defined in Table 2/H.320 [4]), 11 terminals support the G.728 standard. Furthermore, at a transfer rate of 64 kbit/s, G.728 audio is required, in combination with H.261, for the transfer of video and audio signals. Therefore, if an H.32X terminal must support (i) the 64 kbit/s transfer rate mode, and (ii) the transfer of (H.261) video signal at that (64 kbit/s) rate, then an H.32X terminal should support the G.728 audio coding standard.

Similarly, 19 H.320 terminal types support the G.722 audio coding standard. In addition, all of the H.320 terminals that support a transfer rate of 384 kbit/s signals and higher provide the G.722 audio coding capability [4].

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1. All Y terminals has to support the 6B-H_0 (compatibility) function defined in the H.221 standard.

2. The H.221 BAS command and capability messages define another audio coding mode: "Au-ISO". The AVC group should discuss the possibility of supporting this mode (i.e., the transfer of ISO-based audio signals within an H.221 frame) by H.32X terminals.

Therefore, and based on the above observations, an H.32X terminal should support both the G.728 and G.722 audio coding standards, in addition to the G.711 modes.

4. Video Coding Modes

H.261 is the only[1] video coding mode supported by H.320 terminals. Two critical parameters should be specified as part of the H.261 mode: (1) the picture format (CIF and/or QCIF), and (2) the Minimum Picture Interval (MPI). An H.32X terminal should support both the CIF and QCIF formats, and 1/29.97 MPI mode[2].

5. Data Modes

The following data types are defined by the H.221 BAS command and capability messages:

1. *Low Speed Data (LSD)*

   An H.320 terminal may accept a LSD with a rate of 300 to 64,000 bits/second

2. *High Speed Data (HSD)*

   An H.320 terminal may accept a HSD with a rate of 64, 128, 192, 256, 320, or 384 kbit/s.

3. *Multi-Layer Protocol (MLP)*

   An H.320 terminal may accept a 4 or 6.4 kbit/s MLP in the SC channel. It may also accept an MLP data with a maximum rate of 64 kbit/s in the first 64 kbit/s channel (I-channel).

4. *High-speed MLP (H-MLP)*

   High MLP signals may be accepted with a data rate of 62.4, 64, 128, 192, 256, 320 or 384 kbit/s.

These data modes are supported by a wide range of H.320 terminals. It is important that the AVC group discuss the possibility of having some of these data modes as mandatory modes for H.32X terminals. This is especially important for multipoint teleconferencing applications[3]. It is proposed that an H.32X terminal should support, at minimum, the LSD mode.

6. Framing, Multiplexing, and Synchronization

All H.320 terminals use the H.221 framing structure for multiplexing and synchronization. The H.221 multiframe[4] structure and functions defined in H.221 should be supported by H.32X terminals when multiple channels are used (e.g., two 64 or 384 kbit/s channels).

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1. The H.221 BAS command and capability messages define two other video coding modes: "Video-ISO" and "Vid-imp", which is reserved for a (future) improved video coding algorithm. The AVC group should discuss the possibility of supporting the ISO-based mode (i.e., the transfer of ISO-based video signals within an H.221 frame) by H.32X terminals.

2. This MPI mode also implies the support of the 2/29.97, 3/29.97, and 4/29.97 MPI modes.

3. The support of a data mode may only include the capability of *opening* a data channel even if the terminal is not attached to any data equipment. This is very desirable for multipoint teleconferencing when a data channel is used among the communicating terminals. In this case, if a terminal is not capable of opening a data channel, then it losses its capability to transmit and receive video. (See the H-series standards for more details.)

4. The multiframe and channel numbering scheme synchronizes the signals transmitted over the different channels.

7. Control and Indication Signals

The video, Multipoint Control Unit (MCU), maintenance, conference, and terminal control and indication signals defined in Table 4/H.320 should be supported by H.32X terminals [4]. The support of other signals such as the Single-Byte Extension (SBE) and Multiple-Byte Extension (MBE) should also be considered by the AVC group. It is proposed that an H.32X terminal should support the SBE capability.

8. Communications Procedure

H.32X terminals should support the communication procedures outlined in H.242.

9. Encryption

Some H.320 terminals are capable of transmitting and receiving the Encryption Control Service (ECS) channel (within the SC channel). The ECS channel capability and associated functions as defined in recommendations H.233 and H.234 should be optional for H.32X terminals.

10.Error Detection and Correction

There are three main error correction/detection mechanisms available for H.320 terminals:

1. *H.261 Forward Error Correction (FEC) Code*

   This is a BCH (511, 493) code with two-error correcting capabilities.
2. *H.221 Error Detection Code*

   This is a 4-bit CRC code for end-to-end (in-service) monitoring.
3. *BAS Error Correcting Code*

   This is a (16,8) double error correcting code.

Although the H.261 FEC and H.221 CRC4 codes are optional (for H.320 terminals), it is proposed that H.32X terminals should support both of these codes since they are supported by most existing terminals. The BAS double-error correcting code is mandatory for H.320 terminals, and therefore should be supported by H.32X.

11.Conclusion and Summary

In summary, the H.32X specification should clearly identify the H.320 modes and capabilities that are supported. These capabilities and their proposed level of support (Mandatory or Optional) is outlined in Table 2. Similar tables are required for identifying H.32X inter-operability modes with H.32Y and H.32P terminals. For the H.32Y case, all of the H.320 capabilities and modes shown in Table 2 are applicable. However, additional entries will be required to address ATM Adaptation Layer (AAL) issues.

Table 2: H.32X Support of H.320 Capabilities

H.320 Capability	H.320 Mode or Sub-Capability	H.32X Support Level
Transfer Rate	a, b (B, 2B)	M
	c-f (3B-6B)	O
	g, h (H_0, $2H_0$)	M
	i, j, l ($3H_0$, $4H_0$, $5H_0$)	O
	k, m (H_{11}, H_{12})	M
	Restricted	M
Audio Coding	G.711 (A & μ-law)	M
	G.722 (48, 56, 64)	M
	G.728	M
	ISO	O
Video Coding	H.261	M
	ISO	O
	Improved Video (reserved)	O
	Picture Format: CIF & QCIF	M
	CIF Minimum Picture Interval: 1/29.97	M
	QCIF Minimum Picture Interval: 1/29.97	M

Table 2: H.32X Support of H.320 Capabilities

H.320 Capability	H.320 Mode or Sub-Capability	H.32X Support Level
Data	LSD	M
	HSD	O
	MLP	O
	H-MLP	O
Framing	H.221 Frame	M
	H.221 Multiframe	M
	1-2 Service Channels	M
	3-6 Service Channels	O
Control and Indication	Video	M
	MCU	M
	Maintenance	M
	Conference	M
	Terminal	M
	SBE	M
	MBE	O
	Other	O
Communication Procedure	H.242	M
	H.243	M
Encryption	ECS Channel	O
	H.233	O
	H.234	O

Table 2: H.32X Support of H.320 Capabilities

H.320 Capability	H.320 Mode or Sub-Capability	H.32X Support Level
Error Correction/ Detection	H.261 BCH Code	M
	H.221 CRC4 Code	M
	BAS Code	M

References

[1] ITU-T Draft Recommendation H.32X, "Broad-band audiovisual communication systems and terminal equipment," March, 1994.

[2] ITU-T Draft Recommendation H.32Y, "Adaptation of existing H.320 terminal to broad-band ISDN networks," March, 1994.

[3] R. Schaphorst, "Status report of the ITU-TS Experts Group for Very-Low Bitrate Visual Telephony," MPEG94/053, March 1994.

[4] CCITT Draft revised Recommendation H.320, "Narrow-band visual telephone systems and terminal equipment," Study Group XV, Geneva, May 4-15,1992

[5] Document AVC-609, "Multimedia multiplex and AAL for high quality videoconferencing," March 3, 1994