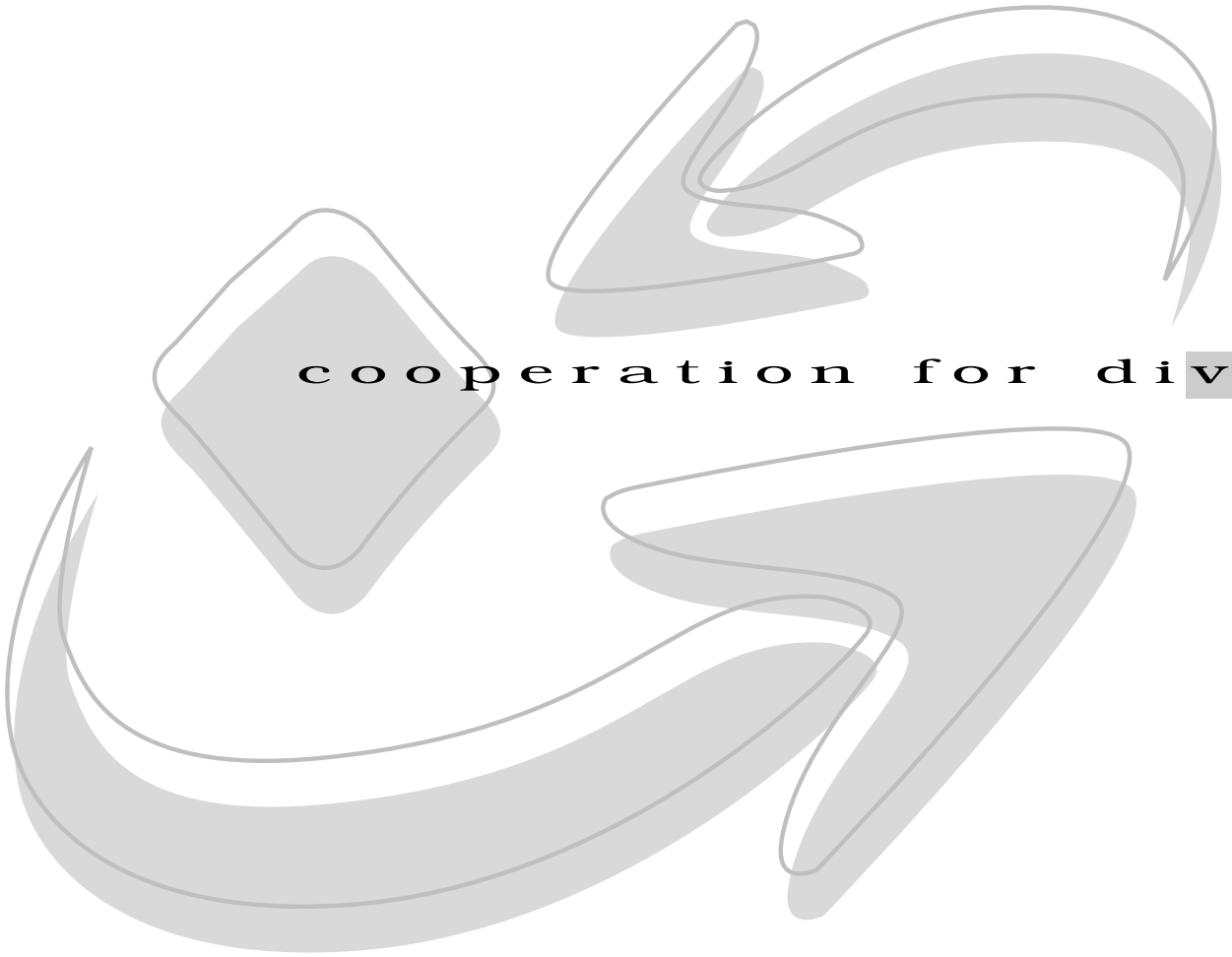


H.320 Two Bearer Channel Specification, 1.0

versit™

versit Update

versit is a multivendor development initiative of the communication and computer industries, founded by Apple, AT&T, IBM and Siemens. The *versit* parties believe that great potential exists in improving the nature of communications in the business world—allowing companies to better manage their quality, productivity, customer satisfaction and cost of operations, while expanding the market opportunities for a variety of product and service vendors. *versit* parties will jointly define and support open specifications that facilitate and promote the interoperability of advanced personal information and communication devices, networks and services.

The *versit* vision is to enable diverse communication and computing devices, applications and services from competing vendors to interoperate in all environments. Through developing a series of specifications for interoperability among diverse communications and computing devices, applications, networks and services, *versit* 's vision could become a reality.

versit 's primary development areas are in:

- Personal Data Interchange (PDI)
- Computer Telephone Integration (CTI)
- Conferencing and Messaging (C&M)
- Wired and Wireless connectivity

versit specifications are directed at both the decision makers and the implementation teams of:

- Equipment Manufacturers
- Independent Software Vendors
- Information Service Providers
- Online Service Providers
- Software Houses
- Users

versit specifications will be made available to any interested party. In turn, *versit* encourages the support of their goals by any interested party providing feedback on *versit* specifications.

All comments relating to *versit* or the material within this specification should be submitted to:

versit
(800) 803-6240
(201) 327-2803 (Outside USA)
H320@versit.com
http://www.versit.com

Contents

Section 1 : Introduction

This specification provides detailed information regarding the terminal interface of a *versit* -compliant H.320 terminal. It describes the interactions between two *versit* -compliant H.320 terminals in point-to-point operations and the interactions between a *versit* -compliant terminal and a *versit* -compliant Multipoint Control Unit (MCU) in multipoint conferences.

In many aspects, the terminal/terminal interactions are the same as terminal/MCU interactions. Descriptions for terminal/terminal interactions are separately provided only when necessary. Terminal and MCU requirements, including required BAS codes and procedures, are specified for two levels of services: basic level *versit* service and enhanced level *versit* service. A terminal can become either basic level or enhanced level *versit* -compliant when all the corresponding requirements are met. A MCU becomes *versit* -compliant only when it meets both the basic and enhanced level requirements.

The purpose of this specification is to achieve interoperability among H.320 terminals and MCUs at a level higher than H.320 mandatory capabilities. *This specification only serves as minimal requirements and does not preclude terminal and MCU vendors from implementing functions above and beyond this specification (e.g., G.722, 384K, etc.).*

This specification assumes that the reader is an H.320 terminal developer already familiar with the H-series specifications for point-to-point and multipoint video conferencing.[1]

1.1 Related Specifications

The ITU-T[2] H-series specifications for the point-to-point and multipoint behavior of H.320 terminals are an important set of related specifications. This terminal interface specification was written based upon the March 1993 version of the H-series specifications. Several BAS codes addressed in this specification are not covered in the final March 1993 H-series specifications, but are included in the new version of the H.320 specifications that were adopted in February 1995. These codes are identified with a special mark in this specification (refer to section 1.3 on page 3).

Applications for copies of ITU-T recommendations can be addressed to one of the following three addresses:

International Telecommunications Union
Place des Nations
CH-1211
Geneva, Switzerland
TEL: +41 22 730 5111
FAX: +41 22 733 7256

1. All future references to MCU within this document assume *versit* -compliance, although the words "*versit* -compliant" are not repeated for each instance.
2. ITU-T (International Telecommunications Union - Telecommunications), formerly CCITT.

Omnicom, Inc.
115 Park Street SE
Vienna, Va 22180 USA
TEL: (703) 281-1135
FAX: (703) 281-1505

Omnicom International, Ltd.
First Floor, Forum Chambers, The Forum
Stevenage, Herts, United Kingdom SG1 1EL
TEL: +44 438 742424
FAX: +44 438 740154

1.1.1 Point-to-Point Standards

In the fall of 1990, the ITU-T approved the H-series recommendations for point-to-point video conferencing, including:

- H.221 Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices.
- H.230 Frame synchronous control and indication signals for audiovisual systems.
- H.242 System for establishing communications between audiovisual terminals using digital channels up to 2 Mbit/s.
- H.261 Video codec for audiovisual services at Px64 kbit/s.
- H.320 Narrow-band visual telephone systems and terminal equipment.

Several ITU-T audio standards are supported by H.221. Those of interest are:

- G.711 μ-law or A-law PCM audio at either of three bit rates: 48, 56 and 64Kbps.
- G.722 7 kHz audio at either of three bit rates: 48, 56 and 64Kbps.
- G.728 LD-CELP Audio at 16Kbps.

Collectively, the H-series standards provide an initial plan for standardized videophone services. *versit* terminals and MCUs are required to support all the above H-series and audio standards.

1.1.2 Multipoint Standards

In March 1993, text for the MCU standard for H.320 was adopted. The major components are:

- H.231 MCUs for audiovisual systems using digital channels up to 2 Mbit/s.
- H.243 Basic MCU procedures for establishing communications between three or more audiovisual terminals using digital channels up to 2 Mbit/s. Among the features covered in H.243 are chair-control and multipoint data broadcasting based on token passing.

1.2 Specification Organization

This specification is organized into the following sections:

- “Section 1 : Introduction” presents a general introduction and scope of this specification, including reference information for further information.
- “Section 2 : H320 Overview” is an overview of a generic H.320 terminal and MCU.
- “Section 3 : *versit* -Compliant Endpoint and MCU” is a summary of *versit* terminal and MCU general features and conference modes.
- “Section 4 : BAS Codes” is a summary of *versit* required BAS codes.
- “Section 5 : Terminal Support for Point-to-Point and Multipoint Operations” is a mapping of BAS codes to the MCU features and recommended terminal behaviors. This section applies to multipoint operations only.
- “Section 6 : H.320 Procedures” is a description of H.320 procedures for multipoint conference establishment, terminal operations, and conference termination.
- “Section 7 : Illustrative Scenarios” presents scenarios illustrating terminal/MCU interactions for common multipoint operations.
- “Appendix A : Terminology and Acronyms” defines acronyms and terms used in the specification.
- “Appendix B : H.221 BAS Message Exchange” presents tables that illustrate the H.221 BAS messaging for various sequences. This appendix applies to multipoint operations only.

1.3 Specification Presentation

The following presentation aids are used in this specification:

- When appropriate, descriptions of H.320 procedures are accompanied by the relevant specification and section number in brackets (e.g., [H.221, section 2.3]).
- Tables used in the H-series recommendations are reproduced, where appropriate, to provide a familiar basis to understand MCU functionality.
- BAS capabilities, commands, and control and indication codes are **bolded**.
- Several BAS codes were not covered in the March 1993 H-series specifications, but are in the new version of the H.320 specifications that were adopted in February 1995. The codes are indicated in this specification using a double-dagger (‡).

Section 2 : H.320 Overview

2.1 General

The ITU-T H.320 standards describe the frame structure and terminal procedures for multimedia communication multiplexed over one or more digital channels. The total bandwidth of the connection(s) is divided into several bit rate allocations containing audio, video, data, and control signaling information. A portion of the control signal, the Frame Alignment Signal (FAS), is used to maintain H.221 frame and multiframe alignment, and channel numbering for multichannel synchronization. Another portion, the Bit rate Allocation Signal (BAS), is used to exchange terminal capabilities, issue frame synchronous commands that dynamically change the bit rate allocations for the media, and issue control and indication commands for coordinating the behavior of terminals in point-to-point and multipoint configurations. The bit-level encoding details for the frame structure, FAS, and BAS are described in H.221 and H.230. Procedures for their use in point-to-point communication are described in H.242.

This specification addresses interactions between the MCU and an H.320 terminal at the FAS/BAS signaling level in a multipoint configuration. It emphasizes the multipoint BAS codes defined in H.230 and the related procedures described in H.243. As background information, the next section describes the architecture of a generic MCU as defined in H.231. The concepts introduced are used in “Section 6 : H.320 Procedures,” and “Section 7 : Illustrative Scenarios.”

2.2 Overview of a Generic Endpoint

The ITU-T H.320 endpoint is a multimedia terminal conforming to ITU-T Recommendations H.221, H.230, H.242, and H.243. The endpoint acts as a user interface, converting analog audio and video signals into compressed digital signals for transport over digital carrier facilities. Conversely, the endpoint converts compressed digital signals into analog audio and video appropriate for the user.

The generic H.320 endpoint contains a single port to a Network Interface Unit (NIU) capable of supporting a full duplex H.221 bit stream. The H.221 bit stream is transported over the NIU by one or more bidirectional channels of equal capacity (i.e., 1B, 2B, 6B, H0, 2H0, H11, etc.). The endpoint must provide call control for the port and the H.221 bit stream. The endpoint may also run data applications, such as those described by the ITU-T T.120 Recommendations.

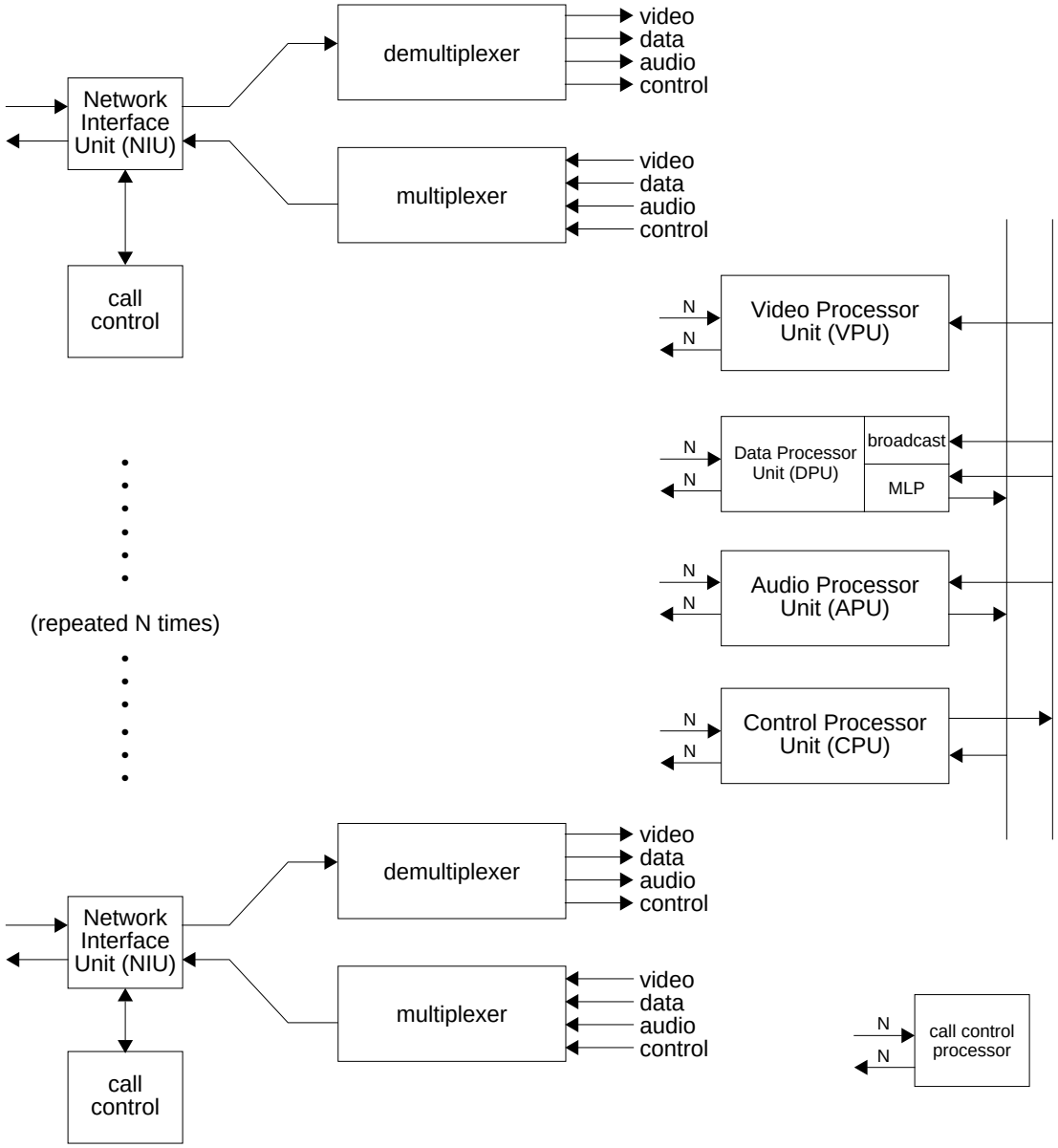
2.3 Overview of a Generic MCU

The ITU-T H.231 MCU is a multi-port device that allows two or more multimedia terminals conforming to ITU-T Recommendations H.221, H.230, H.242, and H.243 to communicate simultaneously over constant bit-rate digital connections. For each port of an MCU, a NIU with associated call control provides the conversion between the line signal coding (e.g., T1) and the H.221 digital bit stream. This bit stream is contained in one or more bi-directional channels of equal capacity (i.e., 1B, 2B, 6B, H0, 2H0, H11, etc.).

The incoming bit stream is sent to a demultiplexer which extracts the different types of information (i.e., audio, video, data, and control) and passes them to their respective processors. The processors are controlled in such a way as to produce an appropriate output for every terminal (i.e., conferenced audio, broadcast video/data, etc.). For each terminal, a multiplexer combines the processor outputs into that port‘s outgoing channels for transmission by the NIU.

The following sections describe the major components of an MCU. These components are illustrated in Figure 2-1.

Figure 2-1 Generic MCU Functional Block Diagram



2.3.1 Network Interface Unit

The Network Interface Unit (NIU) provides the conversion function between the line signal coding and the H.221 signal. The H.221 signal is actually a multiplex of several different types of information (audio, video, data, control); therefore, the NIU must send the incoming MCU H.221 stream to a demultiplexer which separates the individual signals for processing. Likewise, the NIU receives the outgoing MCU H.221 bit stream from a multiplexer which combines the individual processed signals for a particular terminal.

2.3.2 Multiplexer

The multiplexer combines the various processed bit streams and outputs them through a Network Interface Unit to an H.221 terminal. The multiplexer operation is therefore analogous to the transmit side of an H.221 terminal. The following operations are performed by the multiplexer:

1. Generation of frame and multiframe alignment signals.
2. Insertion of control codes, some of them from the control processor.
3. Insertion of audio from the audio processor.
4. Insertion of video from the video processor.
5. Insertion of data from the data processor.
6. Encryption and insertion of encryption vectors, if relevant.

2.3.3 Demultiplexer

The signal entering the demultiplexer from the NIU was originally transmitted by a terminal that conforms to H.221. The demultiplexer is therefore analogous to the receiving side of an H.221 terminal. The following operations are performed by the demultiplexer:

1. Recovery of H.221 frame and multiframe alignment.
2. Buffering, synchronization, and ordering of multiple channels, if relevant.
3. Extraction of control codes and forwarding some of them to the control processor.
4. Extraction of encryption vectors and decryption, if relevant.
5. Extraction of audio and forwarding to the audio processor unit.
6. Extraction of video and forwarding to the video processor unit.
7. Extraction of data and forwarding to the data processor unit.

2.3.4 Audio Processor Unit

For each conference of size N, the Audio Processor Unit (APU) receives N audio signals from the demultiplexers and prepares N audio outputs for the multiplexers. The audio processing may take the form of switching the audio, mixing the audio, or both.

Audio-mixing requires the addition of linear signals obtained by decoding the inputs (from G.711 μ- or A-law PCM, or G.728) and then re-encoding the linear sum appropriately for each terminal. The summation may be limited in numerous ways:

- The output sum for a given terminal may exclude that terminal's input.
- The sum may include inputs whose present or recent past values exceed(ed) a certain threshold.
- Or, the sum may be controlled by one person using some method of chair-control.

Audio-switching requires one APU input to be broadcast to all other APU outputs, either automatically or under manual control. For automatic switching, the APU may be required to cut a new speaker through within milliseconds of detecting speech to prevent clipping. The manually controlled audio-switched approach may be useful when encrypted audio cannot be decrypted and processed at the MCU.

Other APU conditioning functions may include echo cancellation and automatic gain control. The APU may also contain a voice synthesizer or a recorded message store to be connected into the mixing unit or separately to any terminal. Furthermore, if the delays introduced by the VPU and APU differ by a significant amount, a compensating delay may be inserted in one of the bit streams to retain lip synchronization.

2.3.5 Video Processor Unit

The Video Processor Unit (VPU) transmits a video signal from one terminal to some or all other terminals in the same conference. Video selection may be automatic or under manual control. For instance, the APU and the VPU may be automatically controlled such that the present speaker receives the picture of the previous speaker while all other terminals receive the picture of the present speaker. A time delay is incorporated into the switching to avoid excessively frequent image changes caused by spurious sounds such as coughing, knocking a microphone, etc. As with the audio, video switching may also be controlled directly by a person through chair-control. If the delay in the VPU and the delay in the APU differ by a significant amount, a compensating delay may be inserted in one of the bit streams to retain lip synchronization.

2.3.6 Data Processor Unit

The Data Processor Unit (DPU) contains one or both of the functions depicted as "broadcast" or "MLP". For either Low Speed Data (LSD) or High Speed Data (HSD) data broadcast, data input is accepted from only one terminal at any one time. However, a single terminal can simultaneously provide LSD and HSD data input. The accepted data is broadcast to the other terminals as determined by the control processor, according to the capability of the connected terminals to receive such data. For MLP, the data processor is able to process the Multi-Layer Protocol and support duplex data traffic for each terminal. The data processor may be required to process telematic information and conference control signals (i.e., request/grant floor, chairman token control, audio/video switching).

2.3.7 Control Processor Unit

The Control Processor Unit (CPU) is responsible for determining the correct routing, mixing, switching, encoding, and timing of the audio, video, data, and control signals throughout a conference. The capability codes from all N terminals are collected and stored in the MCU so the control processor can correctly manage the conference for all terminals. The MCU in turn sends the capability codes for the conference to each of the N ports so the terminals themselves act appropriately. The CPU coordinates mode switches on outgoing streams to accommodate combinations of audio, video, and data according to the declared capabilities of the connected terminals. MCU specific commands are transmitted to the terminals to force identical mode switches from the connected terminals.

The major inputs to the CPU are commands embedded in the H.221 BAS channel. Commands from the terminals are routed to the CPU to ensure that the bit streams are distributed correctly to the audio, video, and data processors, that the correct audio decoding algorithm is used at the inputs to the audio mixer, and that any incoming data is sent to the data broadcast unit or MLP processor. The CPU also directs the switching of the bit streams from the audio, video, and data processors to each multiplexer and specifies the audio encoding algorithm used in the audio mixer and at each output from the audio mixer.

Section 3 : *versit* -Compliant Endpoint and MCU

3.1 Endpoint

An endpoint operates in two modes, point-to-point and multipoint. In point-to-point mode, the endpoint interacts with another endpoint. In multipoint mode, an endpoint interacts with an MCU which can bridge additional endpoints into the call. The H.242 standard describes the interactions necessary for point-to-point calls; the H.243 standard describes the interactions necessary for multipoint calls. An endpoint must operate in both modes. An endpoint knows that the call is multipoint after receiving the BAS Multipoint Command Conference (MCC) Multipoint Command Conference command.

In a multipoint call, the MCU is responsible for opening and closing the various H.221 streams. In a point-to-point call, the endpoints are jointly responsible for opening and closing H.221 streams.

3.2 MCU

The MCU allows compliant H.320 terminals to participate in multipoint conferences. It supports multipoint conferencing features and capabilities defined in the ITU-T recommendations H.231 and H.243. In these conferences, the H.320 framing of the audio/video/data/control signal is de-multiplexed by the MCU, and each signal is processed separately. The H.261 encoded video is switched by the MCU without being terminated (decoded). The audio and control signals and the content of the data channel are decoded and processed by the MCU.

The MCU must determine and enforce a common, shared H.320 multiplex framing configuration among all terminals participating in a single conference. Participating terminals must be designed to reconfigure their framing based on commands received from the MCU.

The use made of the H.320 multiplex is dependent on the capabilities of the terminals participating in a conference. For example, a terminal could use only audio and video.

3.2.1 MCU Conference Modes

Amongst the different types of MCU conference modes, the following subsections describe:

- Audio conference modes
- Video conference modes
- Data conference modes

3.2.1.1 Audio Conference Modes

The MCU will support G.711 μ-law and A-law PCM[3], and 16 kbit/s G.728. The audio mode of a conference is determined based on the Selected Communication Mode (SCM) specified for the conference. The SCM is used to configure the conference as the terminals are connected to the conferences. Refer to section 6.4 for a more detailed description of SCM.

One possible SCM for audio is Highest Common (HC). In this mode, the MCU adapts and selects the audio mode and access bit rate to provide multimedia service to the maximum number of terminals. Terminals can best accommodate this service by including all possible capabilities of the terminal in the capability set provided to the MCU. The MCU can also fix SCM at a preferred audio mode for the conference, such as 16 Kbit/s LD-CELP. H.320 terminals joining the conference that do not support the preferred audio mode and access bit rate are restricted to PCM audio only, non-video service. Preferred audio modes such as LD-CELP can be used when video quality is paramount for the conference or when var-MLP is used.

To provide multipoint conference users with feedback during the set-up of multipoint conferences when a party joins or leaves a conference, the MCU will send BAS codes (e.g. **TIN/TID/AIM/MIV/VIS/MIS/MIZ/VIN**, described in section 4) to terminals, allowing them to display a status message.

3.2.1.2 Video Conference Modes

The typical video SCM is HC. In this mode, the MCU adapts and selects the video format and frame rate to provide multimedia service to the maximum number of terminals. Terminals can best accommodate this service by including all possible capabilities of the terminal in the capability set provided to the MCU.

3.2.1.3 Data Conference Modes

The MCU supports var-MLP at 46.4Kbps for 64K connections and 38.4Kbps for 56K connections.[4] Although the ITU-T standards allow var-MLP to coexist with any of several audio modes (e.g. G.711 and G.728), the MCU only supports var-MLP with G.728 LD-CELP because var-MLP with G.711 does not provide enough bandwidth for running some existing applications.

The SCM of a conference specifies whether the conference uses MLP. When the MLP option is not selected, regardless of whether the endpoints support MLP or not, no MLP data channels will be opened for the conference. When the MLP option is selected, a MLP channel will be opened to the endpoints that support both var-MLP and G.728 LD-CELP. Endpoints not declaring a suitable MLP capability will become audio-only secondary endpoints when joining the conference. Endpoints that declare a suitable MLP capability but do not declare G.728 LD-CELP will also become audio-only secondary endpoints.

These restrictions do not apply to point-to-point calls. An endpoint may open a var-MLP channel in the presence of any form of audio. Users should expect very low data performance.

3. Framed modes only; 56 kbit/s for 64 kbit/s bandwidth connections and 48 kbit/s for 56kbit/s connections.
4. Support of fixed data rates are not required, but will be considered in the future.

3.2.2 Video Switching Modes

The MCU must provide the following H.320 video switching modes, at least:

1. *Voice Activated Switching (VAS)* - The video image of the broadcaster is seen by all other conferees except the broadcaster who continues to see the previous broadcaster. The broadcaster is selected based on the voice energy detected from the conferees. This feature should include “ping-pong” suppression so that the broadcast source does not switch too rapidly during a conversation with frequent changes of speaker. Each conferee hears the summation of the audio from all other conferees.
2. *See-Me* - The MCU supports the See-Me mode as described in the H.320 standards. A terminal must send a particular BAS code (**MCV**) to the MCU to make itself the broadcaster. The terminal must send a cancellation BAS code when the broadcast is complete. Each conferee hears the summation of the audio from all other conferees. The MCV broadcaster sees video based on voice energy detection among other terminals. Any terminal may become a video broadcaster. Terminals may take advantage of this feature to send a high-resolution video still image as described in [H.261 Annex D]. This feature is permitted only if VAS is in effect and it overrides VAS. For more details of the mode, refer to section 6.13.

Section 4 : BAS Codes

The BAS capability, command, and control and indication (C & I) codes required by *versit* are summarized in Tables 4-1 through 4-6. In each case, a complete table of BAS codes taken from the H.221 or H.230 standards is presented. Entries marked with "•" are required for support by the terminal offering basic or enhanced level *versit* service (i.e., transmitted/received in accordance with procedures described in the H-series recommendations). Entries marked with "◊" are required for support by the terminal offering enhanced level *versit* service. Both groups of code are required for support by the MCU and will be used in the description of H.320 procedures in section 6. Entries without "•" or "◊" marks are not required to be supported. Section 4.4 summarizes the octet level formats for the supported and required BAS codes listed in the tables.

4.1 H.221 Capabilities and Commands

Table 4-1 through Table 4-3 summarize the BAS command and capability attributes described in H.221 that are required by *versit* . Definitions of these BAS codes are provided in [H.221 Annex A].

4.2 H.230 Capabilities

Table 4-4, "H.230 BAS Capabilities," on page 17 summarizes the *versit* required capabilities described in H.230. All the capabilities listed are for multipoint operation only.

4.3 Control and Indication Codes

Table 4-5, "BAS Control and Indication Codes," on page 18 summarize the BAS control and indication (C & I) codes, their definition, the direction in which they are sent, and whether or not they are required by *versit* . These codes are defined in [H.230, section 3], and must be preceded by the **H.230** BAS code. Among these codes, **AIA, AIM, VIA, VIA2, VIA3, VIR,** and **VIS** apply to both point-to-point and multipoint operations. All others apply only to multipoint operations.

versit does not require Low Speed Data and High Speed Data, therefore [H.243, Table 2] is not included in this specification.

The symbols T_{CC}, T_H, and T_L represent the Chair Control, HSD, and LSD tokens respectively.

Table 4-1 BAS Numerical Values [H.221, Annex A, Table A-1]

b_3-b_7	(000) Audio Command	(001) Transfer Rate Command	(010) Other Command	(011) LSD/MLP Command	(100) Audio/Transfer Rate Capability	(101) Data/Video Capability	(110) Unused	(111) Escape
[0]	neutral †	64 •	video-off •	LSD-off ∇	neutral	var-LSD		set-class 0
[1]		2 x 64 •	H.261 •	300	A-law •	300		set-class 1
[2]		3 x 64	vid-imp (R)	1200	μ-law •	1200		set-class 2
[3]		4 x 64	video-ISO	4800	G.722-64	4800		set-class 3
[4]	A-law, 0U	5 x 64	AV-ISO	6400	G.722-48	6400		set-class 4
[5]	μ-law, 0U	6 x 64		8000	G.728 •	8000		set-class 5
[6]	G.722, ml †	384	encryp-on	9600	Au-ISO	9600		set-class 6
[7]	Au-off, U †	2 x 384	encryp-off ∇	14 400		14 400		set-class 7
[8]	Note 2	3 x 384		16k	128	16k		set-family 0
[9]	Note 3	4 x 384		24k	192	24k		set-family 1
[10]		5 x 384		32k	256	32k		set-family 2
[11]		1536		40k	320	40k		set-family 3
[12]		1920		48k	512	48k		set-family 4
[13]	Au-ISO-64	128		56k	768	56k		set-family 5
[14]	Au-ISO-128	192		62.4k		62.4k		set-family 6
[15]	Au-ISO-192	256		64k		64k		set-family 7
[16]	Au-ISO-256	320	VCF •	MLP-off •		MLP-4k		HSD ∇
[17]	Au-ISO-384	loss-i.c.	VCU •	MLP-4k		MLP-6.4k		H.230 •
[18]	A-law, 0F •	channel No. 2 •	LCA	MLP-6.4k	3B	var-MLP •		Data-apps. •
[19]	μ-law, 0F •	channel No. 3	LCV	var-MLP •	4B			SBE-num •
[20]	A-law, F6 † •	channel No. 4	LCD		5B	QCIF •		SBE-char
[21]	μ-law, F6 † •	channel No. 5	LCO ∇	dti-1(R)	6B	CIF ◊		(R-SBE)

Table 4-1 BAS Numerical Values [H.221, Annex A, Table A-1] (continued)

b_3-b_7	(000) Audio Command	(001) Transfer Rate Command	(010) Other Command	(011) LSD/MLP Command	(100) Audio/Transfer Rate Capability	(101) Data/Video Capability	(110) Unused	(111) Escape
[22]		channel No. 6		dti-2 (R)	restrict •	1/29.97 ◊		(R-SBE)
[23]		512		dti-3 (R)	6B-H_0-comp	2/29.97 ◊		(R-SBE)
[24]	G.722, m2 (Note 3) †	768			H_0	3/29.97 ◊		cap-mark •
[25]	G.722, m3 (Note 3) †		6B-H_0-comp		$2H_0$	4/29.97 •		start-MBE •
[26]	(Au-40k)	1152	Not-comp 6B-H_0 ∇		$3H_0$	vid-imp (R)		(R-MBE)
[27]	(Au-32k)		restrict •		$4H_0$	video-ISO		(R-MBE)
[28]	(Au-24k)		derestrict •		$5H_0$	AV-ISO		(R-MBE)
[29]	G.728 † •	1472			1472	esc-CF (R)		(R-MBE)
[30]	(Au-<16k)				H_{11}	encryp.		ns-cap
[31]	Au-off, F † •			var-LSD	H_{12}	MBE-cap •		ns-com

Note 1 - The column header gives the attribute designation as bits (b_0, b_1, b_2); the left-hand column gives the decimal value of [bits b_3, b_4, b_5, b_6, and b_7]; for example, “channel No. 6” has value (001) [10110]. All unassigned values are reserved, as are the values marked (R).

Note 2 - These codes are listed in Recommendation G.725 with reference to an “application channel”; such a channel has not been defined, the concept having been superseded by that of LSD/MLP; therefore these codes are not used.

Note 3 - These codes are listed in Recommendation G.725 with reference to “data”; however, the nature of such data (video, LSD, MLP, ECS) must be specified by further commands (001), (010), (011).

• Terminals that offer the basic or enhanced level *versit* service are required to support these codes.

† Use of these codes in a 56 Kbps environment is defined in ANNEX B of H.221.

∇ The corresponding mode is not required. However this command is transmitted in the repeating command set to maintain the mode in the “off” state, for robustness reasons.

◊ Terminals that offer the enhanced level *versit* service are required to support these codes.

Table 4-2 HSD/H-MLP Numerical Values [H.221, Annex A, Table A-2]

b_3 - b_7	Commands (011)	Capabilities (101)
[0]	HSD-off ∇	
[1]	var-HSD (R)	var-HSD (R)
[2]	H-MLP-62.4	H-MLP-62.4
[3]	H-MLP-64	H-MLP-64
[4]	H-MLP-128	H-MLP-128
[5]	H-MLP-192	H-MLP-192
[6]	H-MLP-256	H-MLP-256
[7]	H-MLP-320	H-MLP-320
[8]	H-MLP-384	H-MLP-384
[9]		
[10]		
[11]		
[12]		
[13]	var-H-MLP (R)	var-H-MLP (R)
[14]	H-MLP-off ∇	
[15]		
[16]		
[17]	64k	64k
[18]	128k	128k
[19]	192k	192k
[20]	256k	256k
[21]	320k	320k
[22]	384k	384k
[23]	512k (R)	512k (R)
[24]	768k (R)	768k (R)
[25]	1152k (R)	1152k (R)
[26]	1536k (R)	1536k (R)
[27]		
[28]		
[29]		
[30]		
[31]		

Note 1 - The column header gives the attribute designation as bits (b_0, b_1, b_2); the left hand column gives the decimal value of bits [b_3, b_4, b_5, b_6, b_7]. All assigned values are reserved, as are values marked (R).

Note 2 - Escape table reached by BAS (111) [16].

∇ The corresponding mode is not required. However, this command is transmitted in the repeating command set to maintain the mode in the “off” state for robustness reasons.

Table 4-3 Numeric Values for Applications in LSD/HSD Channels [H.22, Annex A, Table A-3]

b3-b7	Commands (010)	Commands (011)	Capabilities (101)
[0]		ISO-SP on in LSD	ISO-SP baseline on LSD
[1]		ISO-SP on in HSD	ISO-SP baseline on HSD
[2]			ISO-SP special
[3]			ISO-SP progressive
[4]			ISO-SP algorithmic
[5]			
[6]			
[7]			
[8]			
[9]			Still image (Rec. H.261)
[10]		Cursor data on in LSD	Graphics cursor
[11]			
[12]			
[13]			
[14]			
[15]			
[16]		Fax on in LSD	Group 3 Fax
[17]		Fax on in HSD	Group 4 Fax
[18]			
[19]			
[20]		V.120 LSD	V.120 LSD
[21]		V.120 HSD	V.120 HSD
[22]			
[23]			
[24]			
[25]			
[26]			
[27]			
[28]	T.120-off ‡ •	T.120-on ‡ •	T.120-cap ‡ •
[29]			
[30]			
[31]			

Note 1 - The column header gives the attribute designation as bits (b_0, b_1, b_2); the left hand column gives the decimal value of bits [b_3, b_4, b_5, b_6, b_7]. All assigned values are reserved, as are values marked (R).

Note 2 - Escape table reached by BAS (111) [18].

‡ Documented in H.221 revision, February 1995.

• Terminals that offer the basic or enhanced level *versit* service are required to support these codes.

Table 4-4 H.230 BAS Capabilities

BAS Cap.	Code (*Note 1*)	Direction	Command Name	Comments
CIC *	(010)[0]	MCU —> term	Chair Indicate Capability	*versit* -compliant MCU can handle CCA, CCD, CCK, CCR, CIR, CIS, CIT, TIA, TID, TIF, TIL, TIN, TCU, VCB, cancel-VCB, VCR, VIN. (*Note 2*)
TIC	(001)[7]	MCU <—> term	Terminal Indicate Capability	Term/MCU supports call association via TIA/ TIX.

Note 1 - The bit coding for each BAS code is represented as (b_0, b_1, b_2)[$d_{3\text{-}7}$], where $d_{3\text{-}7}$ is the decimal value of b_3, b_4, b_5, b_6, b_7.

Note 2 - Handling of **TIA, TIN, TID, TIL, and TCU** are not controlled by **CIC**. Handling of the other codes in the list are controlled by **CIC**.

* **CIC** will be included in the cap-set of the MCU if the reservation agent specifies chair control for the conference.

Table 4-5 BAS Control and Indication Codes

BAS C&I	Code (*Note 1*)	Direction	Notes (*Note 2*)	*versit* req'd?	Command Name	Comments
AIM	(000)[2]	MCU/term <—> term	r	•	Audio Indicate Muted	No audio generated.
AIA	(000)[3]	MCU/term <—> term	r	•	Audio Indicate Active	Complementary to AIM.
CCA	(010)[4]	MCU <— term	n		Chair Command Acquire	Request T_{CC}.
CCD	(010)[1]	MCU <— Chair	n, E_s		Chair Command Disconnect	Drop terminal SBE-num.
CCK	(010)[3]	MCU <— Chair	n		Chair Command Kill	Drop all terminals from the conference.
CCR	(010)[6]	MCU —> term	n		Chair Command Release/Refuse	Withdraw T_{CC}.
CIR	(010)[2]	MCU —> Chair	n		Chair Indicate Release/Refuse	Used by MCU to refuse CCD.
CIS	(010)[7]	MCU <— term	n		Chair Indicate Stopped-using-token	Chair frees T_{CC}.
CIT	(010)[5]	MCU —> term	n		Chair Indicate Token	Assign T_{CC}.
DCA-H	(010)[24]	MCU <— term	n, E_s		Data Command Acquire HSD	Request T_H.
DCC-H	(010)[28]	MCU <— term	n		Data Command Close	Free T_H and close channel.
DCR-H	(010)[26]	MCU —> term	n		Data Command Release/Refuse	Withdraw/refuse assignment of T_H.
DCR-H	(010)[26]	MCU <— Chair	n		Data Command Release	Sent by chair to cause withdrawal of T_H.
DIS-H	(010)[27]	MCU <— term	n		Data Indicate Stopped-using-token	Free T_H.
DIT-H	(010)[25]	MCU —> term	n		Data Indicate Token	Give T_H.
DCA-L	(010)[16]	MCU <— term	n, E_s		Data Command Acquire LSD	Request T_L.
DCC-L	(010)[20]	MCU <— term	n		Data Command Close	Free T_L and close channel.
DCR-L	(010)[18]	MCU —> term	n		Data Command Release/Refuse LSD	Withdraw/refuse assignment of T_L.
DCR-L	(010)[18]	MCU <— Chair	n		Data Command Release	Sent by chair to cause withdrawal of T_L.
DIS-L	(010)[19]	MCU <— term	n		Data Indicate Stopped-using-token	Free T_L.
DIT-L	(010)[17]	MCU —> term	n		Data Indicate Token	Give T_L.
MCC	(001)[0]	MCU —> term	r	•	Multipoint Command Conference	Term must slave to MCU.
cancel-MCC	(001)[1]	MCU —> term	n		Cancel Multipoint Command Conference	Term may initiate mode changes, etc.

Table 4-5 BAS Control and Indication Codes (continued)

BAS C&I	Code (*Note 1*)	Direction	Notes (*Note 2*)	*versit* req'd?	Command Name	Comments
MCN	(001)[21]	MCU —> term	n		Multipoint Command Negating	Undo MCS.
MCS	(001)[20]	MCU —> term	r	•	Multipoint Command Symmetrical	Request Symmetrical-Data-Transmission.
MCV	(001)[16]	MCU <— term	n	◊	Multipoint Command Visualize	Forces broadcast of terminals video.
cancel-MCV	(001)[17]	MCU <— term	n	◊	Cancel Multipoint Command Visualize	Revert to voice activated video switching.
MIL	(001)[31]	MCU —> any	n, E_s		Multipoint Indicate Loop	For loopback detection by MCU.
MIM	(001)[6]	MCU —> MCU	r	•	Multipoint Indicate Master	Sent by MCU claiming master role.
MIS	(001)[4]	MCU —> term	r	•	Multipoint Indication Secondary-status	Term is secondary.
cancel-MIS	(001)[5]	MCU —> term	r	•	cancel Multipoint Indicate Secondary-status	Term is primary.
MIV	(001)[18]	MCU —> term	r	•	Multipoint Indicate Visualize	On-air.
cancel-MIV	(001)[19]	MCU —> term	r	•	cancel Multipoint Indicate Visualize	Not on-air.
MIZ	(001)[2]	MCU —> term	r	•	Multipoint Indicate Zero	First/last terminal in conference.
cancel-MIZ	(001)[3]	MCU —> term	r	•	cancel Multipoint Indicate Zero	Cancel MIZ indication.
RAN	(001)[9]	MCU —> any	E_s		Random number	Master/slave contention resolution.
TCA	(001)[15]	MCU <— term	n		Token Command Association	Request list of token owners.
TCI	(000)[8]	MCU —> term	n		Terminal Command Identify	Request TII+SBE-NUM+TIS information.
TCP	(011)[4]	MCU <— term	‡, n, E_s	•	Terminal Command Personal-identifier	Request ID of another terminal.
TCS-1	(001)[1]	MCU —> term	n	•	Terminal Command String-One	Request IIS MBE containing password.
TCS-2	(001)[2]	MCU —> term	n	•	Terminal Command String-Two	Request IIS MBE containing term ID.
TCS-3	(001)[3]	MCU —> term	n		Terminal Command String-Three	Request IIS MBE containing conference ID.
TCU	(001)[14]	MCU <— term	n	•	Terminal Command Update	Term requests assigned terminal numbers.

Table 4-5 BAS Control and Indication Codes (continued)

BAS C&I	Code (*Note 1*)	Direction	Notes (*Note 2*)	*versit* req'd?	Command Name	Comments
TIA	(001)[11]	MCU—> term	n, E_s	•	Terminal Indicate Assign	Assign term number to a new terminal.
TID	(001)[13]	MCU—> term	n, E_s	•	Terminal Indicate Dropped	Terminal dropped out.
TIF	(010)[8]	MCU <— term	n, E_s		Terminal Indicate Floor	Terminal requests floor from chair.
TIF	(010)[8]	MCU—> Chair	n, E_s		Terminal Indicate Floor	MCU forwards request for floor to chair.
TII	(000)[9]	MCU <— term	n, E_s		Terminal Indicate Identity	Precedes each terminal ID string SBE.
TIN	(001)[12]	MCU—> term	n, E_s	•	Terminal Indicate Number	MCU informs existing terminals of new term no.
TIS	(000)[10]	MCU <— term	n		Terminal Indicate identity-Stop	End of TII coded terminal id string.
TIX	(001)[8]	MCU <— term	n, E_s		Terminal Indicate additional-channel-X	Associate additional channel with term's TIA.
VCB	(001)[23]	MCU <— Chair	n, E_s		Video Command Broadcast	Chair forces broadcaster.
cancel-VCB	(001)[24]	MCU <— Chair	n		cancel Video Command Broadcast	Revert to Voice Activated Switching.
VCR	(001)[27]	MCU—> term	n	◊	Video Command Reject	Reject terminal command.
VCS	(001)[25]	MCU <— term	n		Video Command Select	Select viewed party.
cancel-VCS	(001)[26]	MCU <— term	n		cancel Video Command Select	Undo select viewed party, revert to VAS.
VIA	(000)[17]	MCU/term <—> term	r	•	Video Indicate Active	Video Source "One" is active.
VIA2	(000)[18]	MCU/term <— term	n	◊	Video Indicate Active	Video Source "Two" is active.
VIA3	(000)[19]	MCU/term <— term	n	◊	Video Indicate Active	Video Source "Three" is active.
VIN	(001)[22]	MCU—> term	r, E_s	•	Video Indicate Number	Identifies video source.
VIR	(000)[31]	MCU/term <— term	n		Video Indicate Ready-to-activate	Will do video if far end does.
VIS	(000)[16]	MCU/term <—> term	r	•	Video Indicate Suppressed	No video input available. Complementary to VIA.

Note 1 - The bit coding for each BAS code is represented as $(b_0, b_1, b_2)[d_{3\text{-}7}]$, where $d_{3\text{-}7}$ is the decimal value of b_3, b_4, b_5, b_6, b_7.

Note 2 - The letters or symbols in this column have the following meanings:

- Terminals that offer the basic or enhanced level *versit* service are required to support these codes.

◊ Terminals that offer the enhanced level *versit* service are required to support these codes.

∇ The corresponding mode is not required. However, this command is transmitted in the repeating command set to maintain the mode in the “off” state, for robustness reasons.

r Included in repeating command set by MCU.

n Not included in repeating command set by MCU.

E_S One or more SBE codes follow this BAS code as defined in H.230, section 3.

‡ Documented in the H.230 revision, February 1995.

Table 4-6 BAS MBE Codes

BAS C&I	Code (*Note 1*)	Direction	Notes (*Note 2*)	*versit* req'd?	Command Name	Comments
IIS	0000 0011	MCU <— term	n, E_M	•	Information Indicate String	Sent in response to TCS-n.
TIL	0000 0010	MCU —> term	n, E_M	•	Terminal Indicate List	Transmit list of terminal numbers.
TIP	0000 0101	MCU —> term	‡, n, E_M	•	Terminal Indicate Personal-identifier	Response to TCP.
TIR	0000 0101	MCU —> term	n, E_M		Token Indicate Response	Response to TCA.

Note 1 - This column specifies the MBE type identification byte.The bit coding for each BAS code is represented as (b_0, b_1, b_2)[$d_{3\text{-}7}$], where $d_{3\text{-}7}$ is the decimal value of b_3, b_4, b_5, b_6, b_7.

Note 2 - The letters or symbols in this column have the following meanings:

- Terminals that offer the basic or enhanced level *versit* service are required to support these codes.

n Not included in repeating command set by MCU.

‡ Documented in the H.230 revision, February 1995.

4.4 BAS Code Formats

This section summarizes the octet level formats for the required BAS codes listed in the tables. With the exception of some H.221 BAS codes with the *Escape* attribute (111), all other BAS codes are a single octet in length (the BAS code itself). The octet level formatting for multi-octet escape BAS codes is described in the following sections.

4.4.1 H.230 Codes

All H.230 codes are preceded by the **H.230** escape code. Formats for the H.230 codes required by the MCU fall into three categories:

1. Single octet (H.230 followed by the single BAS C&I code).
2. Fixed length with single byte extension (SBE) codes.
3. Variable length with multiple byte extension (MBE).

The format for single octet codes is:

{H.230 code}

All codes not defined in the following sections are single octet codes.

4.4.2 SBE Based Codes

Formats for the fixed length H.230 codes are shown in Table 4-7. Columns *data1* through *data4* each represent a single octet. The value shown in the first column is the number of octets that follow the BAS C&I code.

Table 4-7 SBE Based H.230 C&I

# octets	H.230	C&I	data1	data2	data3	data4
4	H230	CCD	SBE-num	M	SBE-num	T
4	H230	TCP	SBE-num	M	SBE-num	T
4	H230	TIA	SBE-num	M	SBE-num	T
4	H230	TID	SBE-num	M	SBE-num	T
4	H230	TIF	SBE-num	M	SBE-num	T
4	H230	TIN	SBE-num	M	SBE-num	T
4	H230	VCB	SBE-num	M	SBE-num	T
4	H230	VIN	SBE-num	M	SBE-num	T

M MCU number in binary

T Terminal number in binary

4.4.3 MBE Based Codes

The formats for the MBE based H.230 Control and Indication (C&I) codes are shown in Table 4-8. Columns *data1*, *data2*, *data3*, etc. each represent a single octet.

Table 4-8 MBE Based H.230 C&I Codes

MBE Cmd	Length	Type Code	data1	data2	data3	• • •			
start-MBE	N	IIS	n	S_1	•	•	•	S_{N-2}	
start-MBE	N	TIL	M	T_1	•	•	•	T_{N-2}	
start-MBE	N	TIP	M	T	S_1	•	•	•	S_{N-3}

N Length.

M_X MCU number for a connected terminal (in binary).

T_X Terminal number for a connected terminal (in binary).

S_M The Mth character in a data string, coded in T.61 format with the MSB set to 0. The maximum size of the data string supported by the MCU for **IIS** and **TIP** is 15 bytes for outgoing direction and 225 bytes for incoming direction. However, for the incoming direction, the data string is truncated to 15 bytes before it is processed.

n Binary number indicating this **IIS** is in response to **TCS-n**. For n=1,2,and 3 the data string corresponds to a password, terminal id, and conference id respectively.

4.4.4 Capability BAS Code

The format for using the **CAP-MARK** code is described in section 6.6.1.

4.5 Repeating Commands

When there is no other immediate use for the BAS channel, the MCU transmits the current set of valid commands to all terminals. Table 4-9 shows the values for the repeated command set. One of the BAS codes shown in “{ }” is included in the repeating command set.

Table 4-9 MCU—Repeated Command Set Values

Command Type	Commands in Initial Channel	Commands in Additional Channels
H.221 Audio Commands (000)	{Au-off F, A-law 0F, μ-law 0F, A-law F6, μ-law F6, G.728}	
H.221 Transfer Rate Commands (001)	{64, 2x64}	{channel No. 2}
H.221 Other Commands (010)	{video-off, H.261}, {restrict, derestrict}, {LCO}, {not-comp 6B-H_0}, {encryp-off}	
H.221 LSD/L-MLP Commands (011)	{LSD-off}, {MLP-off, var-MLP}	
H.221 HSD/H-MLP Escape Commands (HSD-011)	{HSD-off} {H-MLP-off}	

Table 4-9 MCU—Repeated Command Set Values (continued)

Command Type	Commands in Initial Channel	Commands in Additional Channels
H.221 LSD/HSD/MLP application commands	{T.120-on, T.120-off}	
H.230 C&I	{AIA, AIM}, {MCC}, {MCS}, {MIS, cancel-MIS}, {MIV, cancel-MIV}, {MIZ, cancel-MIZ}, {MCV, cancel-MCV, absent}, {MIM, absent}, {VIA, VIA2, VIA3, VIS}	

Section 5 : Terminal Support for Point-to-Point and Multipoint Operations

5.1 Recommended Terminal Behavior for Point-to-Point Operations

H.242 and H.230 describes how H.320 terminals interact in point-to-point operations. In addition, adherence to the following terminal implementation notes assures further interoperation between two endpoints.

1. Terminals should provide their full set of capabilities during the initial capability exchange so that the two endpoints can select the best operating mode.
2. During initialization of the initial channel call, it is recommended that the terminal not decode the incoming audio stream until it receives a supported audio command. This eliminates initial “noises” heard by terminal users operating with A-law PCM that dial into a μ-law PCM terminal installed in the U.S.A.
3. After exchanging BAS capabilities, the calling terminal should automatically open compatible audio and video streams. If possible, G.728 audio should be opened in order leave as much bandwidth as possible for other services. After the initial automatic opening of audio and video, either terminal may request changes, including the opening of data channels and the termination of video.

5.2 Mapping BAS C&I Codes to Multipoint Features

The BAS codes described in “Section 4 : BAS Codes” are designed to support a full range of multipoint multimedia conferencing features. An H.320 terminal implementation supports various subsets of these codes, depending on which multipoint features is offered to the terminal user. Table 5-1 illustrates the multipoint features that terminals and MCUs are required to support and the BAS codes required for implementing such features. To support a given feature, the terminal must transmit/receive the indicated BAS codes according to the procedures described in H.243.

Feature 1 refers to the fact that H.230 and H.320 specify mandatory codes for multipoint operation with an MCU. These are considered to be the minimum set required for correct operation of the terminal in a multipoint conference. Feature 2 lists additional required BAS codes that would permit a terminal to provide its user with information regarding their status in the multipoint conference. Features 3 and beyond are self-explanatory, and are covered in more detail in section 6.

Table 5-1 Terminal Support of Multipoint Features

Feature	Terminal Support of Associated BAS Codes	
	Transmit	Receive
1. H.series mandatory BAS codes for multipoint operation.		MCC, VCF, VCU
2. Additional BAS codes for multipoint operation.	AIA, AIM, VIA, VIS	AIA, AIM, LCO, MCS, MIS, cancel-MIS, MIV, cancel-MIV, MIZ, cancel-MIZ, VIA, VIS
3. Password access to conferences.	IIS	MBE-cap, TCS-1
4. Terminal Number and Terminal ID (name).	MBE-cap, IIS, TCP, TCU	MBE-cap, TCS-2, TIA, TID, TIL, TIN, TIP, VIN
5. 56K/64K Rate Adaptation on 2 channels.	restrict, derestrict	restrict, derestrict
6. See-Me video mode. (Note 1)	MCV, cancel-MCV	VCR

Note 1 - Features required only for terminals supporting the enhanced level *versit* service.

5.3 Recommended Terminal Behavior for Multipoint Operations

Full exploitation of MCU features by terminals requires conformance to particular aspects of the H.320 specifications. Adherence to the following terminal implementation notes ensures operability with the MCU and provide better multipoint service for the terminal user. Some of these are mentioned in the context of the H.320 procedures described in “Section 6 : H.320 Procedures.” They are summarized here for easier reference.

1. Terminals must accept mode change forcing commands so the MCU can maintain a common, shared H.320 framing configuration among all terminals participating in a single conference. This is the expected behavior of a terminal that supports receipt of MCC and **MCS**. If the terminal receives a mode change command for a mode that it does not support (i.e., due to corrupted BAS), it should not echo the command, but maintain a mode consistent with its capability set.
2. Terminals should provide their full set of capabilities during the initial capability exchange so that the MCU can make the best selection of a common operating mode. The only exception to this would be the withholding of non-standard capabilities until the terminal receives **MBE-cap**.
3. During initialization of the initial channel call, it is recommended that the terminal not decode the incoming audio stream until it receives a supported audio command. This eliminates initial “noises” heard by terminal users operating with A-law PCM that dial into a μ-law PCM MCU installed in the U.S.A.

4. During the initial cap exchange, since an audio command cannot be sent and the capability of the far end equipment are not known, it is recommended that the MCU transmits all binary 1s as the indication of silence in the audio and video channels. Once the initial cap exchange completes and commands from the terminal have been received, **Au-off F** may be sent to indicate that there is no audio channel present until the audio encoder is configured based upon the far end capabilities and command received.
5. Audio muting by the terminal user should result in the transmission of encoded silence in the appropriate audio mode. **Au-off F** should not be transmitted, as this would disrupt the video bit rate allocation.
6. Video muting by the terminal user should result in transmission of **VIS** or transmission of an electronically generated image.
7. The MCU turns on video regardless of the available video bandwidth. It is the responsibility of the terminal to determine if video at the current bandwidth should be displayed to the terminal user.
8. When a graphic screen (e.g. high-resolution video) is sent, the terminal must send the BAS code **MCV** (Multipoint Command Visualize) to the MCU so that the terminal is made the broadcaster. At the end of the broadcast, **cancel-MCV** must be sent to the MCU. If this is not done, the terminal that sent MCV continues to be the video broadcaster after completion of the video transmission. Terminals may extend to the user control of the BAS code **MCV** so that a “see-me” feature may be implemented. Both graphic send and “see-me” features appear the same to the MCU.
9. When a **MCV** request is rejected by the MCU (e.g. because another terminal has requested first), the request is remembered by the MCU. When the rejection condition goes away, the request is granted at that time. If the terminal does not want the rejected request to stay active, an explicit **cancel-MCV** has to be issued.
10. On-screen status is viewed as a terminal function. The MCU provides BAS codes (e.g., **AIA**, **AIM**, **MIS**, **MIV**, **MIZ**, **TID**, **TIN**, **VIA**, **VIN**, **VIS**, etc.) that may be used to inform the user of warning conditions or changes in terminal/conference status. The MCU may also add audio tones to the conferenced audio to announce the entry or exit of a conferee, or as a warning of impending conference tear-down. Therefore, the terminal should not turn off a speakerphone when the **AIM** code is received. Otherwise, the user would not be able to hear the tones provided by the MCU.
11. It is highly desirable that terminals without any auxiliary data equipment still be able to open an MLP channel at a rate required by *versit* so that they can participate in multipoint communications without losing video [H.320, section 4.5].
12. The minimum interval between repeated transmissions of request BAS codes, such as **CCA**, should be 3 to 5 seconds. Since request BAS codes such as **MCV**, **TIF**, and **VCB** have no corresponding acknowledgment BAS codes, it is recommended that they be transmitted once per terminal user request. The terminal user can determine if the desired effect was achieved and retry the request if necessary.

13. A terminal should be able to handle receipt of any BAS capabilities supported by the H.320 standards from the MCU without error, even if the terminal does not support them.
14. A terminal should be able to receive any BAS command supported by the H.320 standards from the MCU without error, even if the terminal does not use them.
15. It is recommended that the terminal supports sending a full range of repeated command sets for robustness.

Section 6 : H.320 Procedures

This section applies to multipoint operations only. Terminals and MCUs are required by *versit* to support the procedures in this section. To maintain the flow of event sequences so the procedures are more easily understood, requirements for terminal and MCUs are combined instead of specified separately.

6.1 Organization

This section describes the procedures required by *versit* to support multipoint multimedia conferenced communication services among H.320 terminals. Where appropriate, the description of a procedure uses the following organization:

- *Preconditions* - What requirements must be met before this procedure can be executed.
- *Procedure* - A description of the details of the procedure, including BAS code sequences.
- *Exception Conditions* - A list of possible exception conditions and the procedures followed. These can be network related errors, procedural errors on the part of the terminal, or exceptions to the general procedure described.

The descriptions in this section assume familiarity with H.221, H.230, H.231, H.242, H.243, and H.320.

6.2 Notation

The following notations are used in describing BAS code level interactions between the MCU and a terminal:

- Multiple octet commands, capabilities, and BAS C&I codes are enclosed in braces { }.
- While not explicitly shown, it is understood that all BAS codes defined in H.230 are to be preceded by the **H.230** BAS code.
- The notation (b) indicates a single octet containing a decimal number *b* (e.g. (3)) or the value of the MBE message type *b* (e.g. (IIS), (TIL), and (TIP)).
- The notation <b> indicates that the octet containing the decimal number *b* should be preceded by the **SBE-num** BAS code.
- The notation “cc...c” indicates one or more octets containing characters coded according to T.61 with the MSB set to zero.
- The notation [bb...b] indicates one octet containing a binary number *bb...b*.

More detailed information on BAS code formats is given in section 4.4.

6.3 Connection Establishment

The standard data call procedures used for establishing the network connection for each channel of the H.320 multiplex are the same for multipoint as for point-to-point terminal operation. This specification does not address terminal or MCU interactions with the network.

6.4 Selected Communication Mode

The MCU uses its Selected Communication Mode (SCM) [H.243, section 2] to determine the capabilities advertised to a terminal during the capability exchange phase of H.320 mode initialization. SCM represents the current common communication mode in effect for each of the following communication services: audio, video, data, transfer rate, and bandwidth. Depending on the service, SCM for that service can be:

- Fixed for the duration of the conference, either according to internal MCU capabilities, or as specified by the reservation agent at the time the conference is booked.
- Selected automatically by the MCU, based on the capabilities of the connected terminals

Table 6-1 summarizes the methods used in the MCU to determine SCM for each of the offered services.

Newly connected terminals that do not meet SCM for the fixed modes are provided secondary, audio-only service. Automatically selected modes are determined based on the capabilities common to connected primary terminals (see section 6.5 for more details on primary and secondary status). If a new terminal is connected that does not meet SCM, the MCU may change SCM to permit it to join the conference. This is done by transmitting a new cap set and mode switch commands to the existing and the new terminals.

Table 6-1 Methods Used in Establishing SCM

Method	Communication Services				
	Audio	Video	Data	Transfer Rate	Per Channel Bandwidth (56K/64K)
Fixed	✓		✓	✓	✓
Automatic	✓	✓			✓

6.5 Terminal Status

Terminal status, as viewed by the MCU, depends on three major factors:

1. The capabilities announced by the terminal.
2. Which valid media (audio, video, and data) are being received from the terminal.
3. The transfer rate and per channel bandwidth of the terminal.

If terminal capabilities match SCM, the terminal is said to be *primary*, or have *primary status*. The MCU transmits to it the media streams within the current bit rate allocations associated with SCM.[1]

If terminal capabilities do not match SCM and the MCU cannot change SCM to accommodate the terminal, the terminal is said to be *secondary*, or have *secondary status*. In this case, the MCU only transmits PCM audio to the terminal.[2]

In addition, terminal status is also described by whether the MCU allows the media transmitted by the terminal to be used in the conference. If no error conditions exist and the terminal is transmitting the same media and bit rate allocations as the MCU, then the terminal's audio is summed into the conference audio, its video may be broadcast, and its data stream is multicast, if appropriate. However, certain error conditions and terminal behavior may cause the MCU to *mute* one or more media from the terminal, preventing the media from being used in the conference. For example,

- A *primary* terminal that has turned off or suppressed its video is *video-muted* by the MCU. It is not considered as a video source during Voice Activated Switching.
- If the number of channels established by the terminal is less than the number indicated by SCM (e.g., 2B), the MCU will *video-* and *data-mute* the terminal.
- If a terminal transmits an unsupported audio command, it is *audio-muted*. Its audio is not included in the conferenced audio transmitted to other terminals. In addition, it is also *video-* and *data-muted*.
- If the terminal is asked to adapt the transfer rate from 2x64 to 2x56 and the terminal does not follow, the MCU will *video-* and *data-mute* the terminal.

A summary of possible error conditions and muting actions taken by the MCU is given in section 6.16.

6.6 Mode Initialization

The mode initialization procedures address the establishment of the initial mode of communication between the MCU and a newly connected terminal. They include attaining H.221 framing, exchanging capability information, optionally verifying a password, and switching to a compatible communication mode. For 2B terminals, the mode initialization process is not completed until both channels are connected to achieve the transfer rate.

6.6.1 Initial Channel Procedures—Capability Exchange

6.6.1.1 Preconditions

The MCU has received an indication from the network that the connection for the initial channel has been established.

1. Some media may not be transmitted if the terminal is not operating at the transfer rate indicated by SCM, either because an additional channel has not been connected or due to error conditions.
2. These definitions of primary and secondary status are consistent with the H-series Recommendations.

6.6.1.2 Procedure

The MCU executes *Sequence A* in H.242, section 5.1.[3] While searching for frame alignment, multiframe alignment, and a capability set (hereafter referred to as “cap-set”), the MCU:

- Transmits all binary 1s as the content of the audio and video channels.
- Transmits the multiframe alignment word (MFA) and multiframe numbering in the FAS.
- Repetitively sends its cap-set based on the current SCM settings.

The general layout of the cap-set output by the MCU (*cap-set 1*) is as follows:

{cap-mark cap ... cap MBE-cap cap-mark}

As indicated, the MCU includes **MBE-cap** as one of the capabilities. At this point, the terminal has not yet been connected to the APU, and is receiving all binary 1s.

When the MCU has (1) found and maintained frame and multiframe alignment throughout the sequence, (2) received a complete cap-set, and (3) transmitted one complete cap-set since receiving A=0, the MCU begins sending the commands specified in the repeating command set (see Table 4-9).

The MCU checks the terminal cap-set for the presence of **MBE-cap**. If **MBE-cap** is present, a second cap-set exchange using *Sequence A* takes place to identify non-standard capabilities. The cap-set output by the MCU (*cap-set 2*) would be:

{cap-mark cap ... cap MBE-cap {ns-cap (n)...} cap-mark}

In the above example, **{ns-cap (n)...}** denotes one full non-standard capability set. When the terminal receives *cap-set 2*, it should also respond with its *cap-set 2*, including supported non-standard capabilities.[4] If the terminal does not support **ns-cap**, then it should transmit its original cap-set.

The following subsections describe how the capabilities transmitted by the MCU are determined. After the above cap-set exchanges are completed, the MCU proceeds with the appropriate mode switches (see section 6.6.7) and connection of terminal audio to the APU.

6.6.1.2.1 Bandwidth Capabilities

Bandwidth of channel is specified by the reservation agent at booking time based upon the access bandwidth of the facilities to be used. If it is specified at a multiple of 64 kbit/s, the **restrict** capability is not sent by the MCU, implying the default of 64 kbit/s. If a value of a multiple of 56 kbit/s has been specified by the reservation agent at booking time, the MCU transmits **restrict** capability. If the conference bandwidth is specified at 2x64K and the Rate Adaptation option is *on*, the MCU accepts a 2x56K terminal and sends the **restrict** capability to it.

3. Refer to Tables B-1 and B-2 in “Appendix B : H.221 BAS Message Exchange” for details on the BAS message sequencing for Sequence A and capability exchanges with the MCU.
4. Per H.series standards, none of the octets within the **ns-cap** sequence should be coded to the value [11111000], which is **cap-mark**, or to a value greater than or equal to [11100000]. Doing so may lead to non-operation of the MCU and the terminal if such an **ns-cap** sequence were received while searching for framing and the first **cap-mark** BAS code.

6.6.1.2.2 Transfer Rate Capabilities

A transfer rate of **2x64K** is specified by the reservation agent at booking time.

6.6.1.2.3 Audio Capabilities

The audio capabilities advertised by the MCU depend on the current SCM setting for audio. If SCM is PCM, then both μ-**law** and **A-law** capabilities are transmitted. If SCM for audio is G.728, then μ-**law**, **A-law**, and **G.728** capabilities are transmitted. Note the following with respect to the audio capabilities of the MCU:

- Support of unframed audio modes are not required.
- The MCU interworks mixtures of A-law and μ-law PCM audio-only terminals and LD-CELP terminals in a conference. If a terminal that supports both laws of PCM elects to return A-law when the MCU is sending μ-law, then the MCU provides the incoming transcoding. If a terminal does not support the preferred PCM mode (μ-law), the MCU provides transcoding to A-law for that terminal.

6.6.1.2.4 Data Capabilities

The MCU transmits var-MLP and T.120-cap capabilities.

6.6.1.2.5 Video Capabilities

The first terminal connected to the MCU receives **CIF** with minimum picture intervals (MPI) of **1/29.97** and **1/29.97** for QCIF and CIF, respectively. If a terminal announces capabilities of less, the SCM is lowered to the capabilities of that terminal, and these capabilities are transmitted to all currently and subsequently connected terminals. If a terminal announces no video capability, it receives secondary status.

6.6.1.2.6 Other Capabilities

The MCU transmits MBE-cap since support of multiple byte extension (MBE) codes are required.

6.6.1.2.7 Non-Standard Capabilities

Non-standard capabilities are used to implement features not supported by the ITU-T H.320 standards, or for standards which have not yet been defined. *versit* does not require terminals and MCUs to support **ns-cap**.

6.6.1.3 Exception Conditions

The following exception conditions apply to the capability exchange phase of mode initialization.

1. The following error conditions result when disconnecting the terminal from the MCU:
   - Frame and multiframe alignment is not found by the MCU within t_{INIT} seconds of connection establishment (the MCU will not switch to unframed mode OU, since it is not supported).
   - A complete cap-set is not received from the terminal within the same t_{INIT} interval.
   - Channel number encoded in FAS is not ‘1’ for the initial channel.

2. The following conditions result in putting the terminal to secondary status by the MCU:
    - A terminal that is connected to a 64K bandwidth conference via 64K facilities transmits **restrict** capability or commands.
    - A terminal that is connected to a 56K bandwidth conference via 56K facilities transmits neither the **restrict** capability or command, nor transmits the **derestrict** command.
    - A terminal does not announce video capability.
    - If a terminal does not include any audio capabilities in its cap-set, MCU assumes the terminal supports G.711 μ-law and A-law PCM and makes the terminal secondary status.
3. If the cap-set contains any errors (e.g., only one MPI is supplied for **CIF**, uncorrectable bit errors, etc.), the MCU may impose secondary status.
4. Additional cap-sets received by the MCU during or after initialization are processed and responded to with the current MCU cap-set. The last cap-set received is then in effect for the terminal.

6.6.1.4 Post-Initialization Capability Exchanges

6.6.1.4.1 Procedure

Either the terminal or MCU may use *Sequence A* to initiate a cap-set exchange any time after mode initialization has been completed. The MCU does this to communicate a lowered video capability to terminals as a result of adjusting SCM for video (refer to section 6.6.1.2.5) to communicate a lowered audio capability to terminals as a result of adjusting SCM for audio, or to exchange non-standard capabilities after receiving **MBE-cap** from the terminal during the initial cap-set exchange. The receiver of a cap-set should reciprocate by transmitting its cap-set (*cap-set 2* if non-standard capabilities are being exchanged, *cap-set 1* if not). If the cap-exchange is to downgrade the terminal to a lower level functionality, the cap-exchange is not be initiated unless sufficient channels have been connected, the transfer rate has met the SCM, and some level of video is supported by the terminal.

6.6.2 Initial Channel Procedures—Password Validation

The support of this procedure is required. However, in an actual conference, this phase in the mode initialization process is optional based on the conference information entered by the MCU reservation agent.

6.6.2.1 Preconditions

1. The password validation option has been selected and a password have been specified by the MCU reservation agent at booking time. If this is not the case, the MCU proceeds to the next phase of mode initialization (refer to section 6.6.6).
2. The capability exchange procedure has been successfully completed (refer to section 6.6.1).

6.6.2.2 Procedure

The MCU transmits **TCS-1** to the terminal and sets timer t_{PW}.. If the terminal responds with **{start-MBE (N) (IIS) (1) "...N - 2 T.61 encoded character password..."}** within the timeout period, the MCU validates the password against what was specified by the reservation agent at booking time. If there is a match, the MCU begins the mode switch procedure (refer to section 6.6.7). If not, the above procedure is repeated, allowing a total of three attempts.

A '1' in the start-MBE message indicates that the **IIS** is in response to **TCS-1**. The MCU accepts a maximum of 15 characters for the password string. A string longer than the maximum is treated as an invalid string.

6.6.2.3 Exception Conditions

The following conditions result in a failure of the password validation:

- **IIS** is not received by the MCU within t_{PW} of transmission of **TCS-1** in three attempts.
- The incorrect password has been received in three attempts.

☞ **Implementation Recommendation**

On reception of the second and third TCS-1, the terminal should inform the user that the previously inputted password was incorrect. It should then prompt for the password again.

After the third failure, the MCU disconnects the terminal immediately.

6.6.3 Initial Channel Procedures—Assignment of Terminal Number

After the first channel is established, the MCU transmits **MIZ** if this is the only terminal connected to the conference. It also transmits **{TIA <M> <T>}** to the terminal, assigning it a unique terminal number that can be used by the MCU or other terminals when referring to this terminal in BAS C&I commands. <M> and <T> are in the range of <1 to 191>. When the MCU is used in a non-cascading environment, the MCU number defaults to M=1. If the MCU were connected in a cascaded configuration, each MCU in the cascade is assigned a unique number. The unique terminal number is announced to other terminals via a **{TIN <M> <T>}**.

6.6.4 Turning On Audio for 2B Terminals

This section only applies to 2B terminals.

6.6.4.1 Preconditions

The initial channel procedures in section 6.6 have been successfully completed, and both the MCU and the terminal have indicated a transfer rate of 2B during the capability exchange.

6.6.4.2 Procedure

For 2B conferences, the terminal receives SCM at audio. If the terminal does not support SCM audio, it receives PCM audio. The audio is connected to the APU only when 1B is connected.

The following commands are sent by the MCU to turn on audio to a 2B terminal for a G.728 conference:

{cancel-MIV, video-off, G.728, 64, MLP-off, cancel-MIS}

6.6.5 Additional Channel Procedures for Mode Initialization

This section only applies to 2B terminals.

6.6.5.1 Preconditions

1. The initial channel procedures in section 6.6 have been successfully completed, and both the MCU and the terminal have indicated a transfer rate of **2B** during the capability exchange.
2. The MCU has received an indication from the network that the second call has been established.

6.6.5.2 Procedure

The MCU follows the synchronization procedure described in [H.221, section 2.7] for the synchronization of multiple B channels. This procedure requires both the MCU and the terminal to repeatedly transmit the channel number in both FAS (bits L3, L2, L1 as per [H.221 Figure 4/H.221]) and BAS (.i.e, **channel no.2**) in the additional channel. To support calculation of transmission delay between channels, they must also transmit the multiframe alignment word and multiframe numbering within the FAS of both channels. When each achieves multiframe alignment (MFA) and synchronization of the additional channel with the initial channel, they transmit A=0 on the additional channel.[5]

6.6.5.3 Exception Conditions

The following error conditions result in disconnection of the additional channel, leaving the terminal in secondary status:

1. The MCU does not achieve MFA and multi-channel synchronization, and has not received A=0 and the BAS and FAS channel numbers on the additional channel within t_{INIT} of connection establishment.
2. The channel numbers received in FAS and BAS of the additional channel do not agree, or do not equal “2”.

6.6.6 Modification of SCM

As mentioned in section 6.4, the MCU may downgrade SCM to permit a terminal to enter the conference as primary.[6] The MCU modifies the SCM at this point in the mode initialization process. As mentioned in section 6.6.1.2.5, the MCU downgrades SCM for video if a terminal

5. Refer to Table 7-7, “BAS Messaging for Including Additional Channel,” on page 78 for examples on the BAS message sequencing for including the additional channel.
6. This may also occur any time during a conference if a terminal changes its cap-set.

announces less capability than the current SCM. For audio, the MCU downgrades SCM from G.728 if:

- The reservation agent specifies automatic SCM selection using the Highest Common algorithm for audio, and
- The terminal has transmitted proper video caps and transfer rate caps, and
- The current SCM for audio is G.728 and the terminal has not transmitted **G.728** in its cap-set.

If SCM for audio is fixed by the reservation agent at G.728, it is not modified regardless of terminal capabilities.

6.6.7 Mode Switching

6.6.7.1 Preconditions

The mode initialization sub-procedures in sections 6.6.1 through 6.6.6 have been successfully executed (password validation procedure is optional).

6.6.7.2 Procedure

The MCU uses the current SCM (possibly modified, as in section 6.6.6) and the announced capabilities of the terminal to determine the proper communication mode. If the terminal does not meet SCM for audio, data, bandwidth, or transfer rate, it receives secondary status (refer to section 6.9). The MCU then performs the necessary mode switching to provide primary or secondary service.

6.6.7.3 Exception Conditions

Refer to the exception conditions described for the primary status procedure in section 6.8.

6.6.8 Terminal Identification

6.6.8.1 Preconditions

1. The terminal must support transmission of the multiple byte extension BAS code **start-MBE**.
2. The terminal has passed the password validation procedure if password entry is required.

6.6.8.2 Procedure

After the **TIA** command is sent to a terminal, the MCU queries the terminal for an identification string by transmitting **TCS-2**. The terminal should respond with **{start-MBE (N) (IIS) (2) "...N - 2 T.61 encoded characters..."}** where (2) indicates that the **IIS** is in response to **TCS-2**. This string can be used by other terminals to inform their users about who is connected to the conference (refer to section 6.11). The maximum length of the character string should be 15; longer strings are truncated by the MCU.

6.6.8.3 Exception Conditions

1. The MCU truncates identification strings longer than 15 characters.
2. The **TCS-2** request is only made once during a conference. If the endpoint changes its identifier during the conference, it must drop itself from the conference and then rejoin for the change to be visible to others in the conference.

6.7 Dynamic Mode Switching, Bit Rate Changes and Rate Adaptation

6.7.1 Preconditions

Dynamic mode switching involves changing of audio, video, transfer rate, bandwidth, or data modes, and can occur at any time during the conference. The MCU initiates dynamic mode switching to accommodate new terminals being added to the conference, upgrade/downgrade terminal status to primary/secondary, and to open and close the MLP channel.

In the case of bandwidth changes (rate adaptation), the MCU supports dynamic changes from 64Kbs to 56Kbs. This bandwidth change only occurs at conferences operating at a transfer rate of 2x64K and administered to allow Rate Adaptation. The operating rate of the conference is downgraded to 56Kbs to accommodate a new terminal attempting to join a 64Kbs conference but would only be operating at 56Kbs.

6.7.2 Procedure

The MCU supports mode switching *Sequence B* between framed modes described in H.242, sections 5.2 and 6.2.1. This completes the mode switch for any of the following cases:

- No bit rate change is required (e.g., a change from μ-law to A-law PCM, turning video on/off).
- The terminal involved in the mode switch is secondary.

If the mode switch requires a bit rate change with a primary terminal that has video capability and is receiving video, the MCU implements the procedure in H.243, section 6.1.2 by transmitting the following:

- **VCF** - Freeze terminal video.
- **video-off** - Switch video mode off.
- **BAS command(s) -** One or more, indicating the new mode(s) (e.g. **restrict** for Rate Adaptation), each effective in the next sub-multiframe.

The terminal is expected to mirror all mode switch commands that change the bit rate allocation within t_{MS}. If the terminal is to receive video, it receives **H.261** as one of the commands. The MCU then waits for a time interval that guarantees that H.261 frame alignment has been achieved by the receiving terminal.

The value for this interval is:

- if the transfer rate is 2B, t_{261} = 625msec +/- 125msec
- if the transfer rate is >2B, t_{261} = 375msec +/- 125msec

The MCU then transmits **VCU** to the terminals serving as broadcast and return video sources.

6.7.3 Exception Conditions

If the terminal does not echo any mode switch within t_{MS}, it may be muted for certain media, as described in section 6.16.9.

6.8 Upgrade to Primary Status

A terminal is upgraded to primary status when it meets SCM for the conference. This can occur as part of mode initialization (section 6.6) or after a terminal has been operating in secondary status.

6.8.1 Mode Switching

The MCU uses the dynamic mode switching procedure described in section 6.7: transmitting commands to set one or more of the following modes to the current SCM values.

6.8.1.1 Transfer Rate

The MCU initiates a transfer rate mode switch by transmitting the appropriate transfer rate command (e.g., **2x64** for 2B) and waiting for the terminal to mirror the change.

6.8.1.2 Audio Mode

If SCM for audio is G.728, then the MCU initiates an audio mode switch by transmitting **G.728**, effective within the next sub-multiframe [H.242, *Sequence B*].

If SCM for audio is PCM and the terminal has μ-law PCM capability, no mode switch is performed. If the terminal has only A-law capability, then the MCU transmits **A-law**, followed by A-law coded conferenced audio in the next sub-multiframe.

6.8.1.3 Data Mode

If an MLP channel is open, the MCU transmits the appropriate BAS data command to the terminal. The terminal should mirror the command and the bit rate allocation to accommodate the open channel. The MCU then transmits the **T.120-on** BAS command to indicate the start of T.120 data conferencing. The terminal should then issue the **T.120-on** BAS command in response. The MCU uses the T.124 procedure to admit the terminal into the data portion of the conference.[7]

7. More details to be provided in the *versit* T.series specifications to be published later this year (1995).

Note

This may result in reception of an incomplete data transmission at the new terminal if one was in progress among existing primary terminals.

6.8.1.4 Video Mode

As part of the mode switching, the MCU sends **H.261** to the terminal, indicating that video bandwidth is available. The terminal should mirror the command and the bit rate allocation to accommodate the open video channel.

6.8.2 Video-Related BAS Indications from the MCU

As part of upgrading a terminal to primary status, the MCU transmits BAS codes that can be used by the terminal to interpret the status of the transmitted and received video, who the broadcaster is, and what the video switching mode is. These BAS codes are:

- **cancel-MIV** - If the terminal is not an “on-air” video source (broadcast or return).
- **MIV** - If the terminal is an “on-air” video source (broadcast or return).
- **VIA/VIA2/VIA3** - If received video corresponds to a normal camera image.
- **VIN** - Number of the terminal transmitting the received video.
- **VIS** - If received video does not represent a normal camera image.

After the above commands are sent, the MCU waits t_{261} to allow the terminal to recover the H.261 framing. The MCU then sends a fast update request (**VCU**) to the terminal transmitting the video received by the newly upgraded terminal.

6.8.3 Cancellation of Secondary Status

If the terminal was currently receiving secondary status (**MIS**), the MCU transmits **cancel-MIS** when the terminal’s cap-set indicates that it can support the SCM.

6.8.4 Exception Conditions

1. If the terminal does not echo any mode switch within t_{MS}, it may be muted for certain media, as described in section 6.16.9.
2. If voice activated switching is in effect and no other primary terminal is connected to the conference, the terminal’s transmitted video is returned (i.e., the terminal receives its own terminal number in **VIN**).
3. If the video to be received by the terminal is not available from the transmitting terminal, the MCU transmits **VIS**.[8] This can occur if the current transmitter sends **VIS**, is downgraded to secondary status, is disconnected, or fails to qualify as a video source. If another video source is selected or if the terminal sends **VIA**, the MCU transmits **VIA** to the receiving terminals.

8. When a terminal receives **VIS**, it is recommended that the terminal continue look for framing in the video channel and freeze until **VIA** is received.

4. The MCU forwards **AIM** to a terminal if all other terminals providing audio to the conference send **AIM**. If the terminal sends **AIA**, or if an audio source is provided by another terminal, the MCU transmits **AIA** to the receiving terminals.[9]

6.9 Secondary Status

6.9.1 Preconditions

A terminal is given secondary status if, after a cap-set exchange, its cap-set does not meet SCM for the conference.

6.9.2 Procedure

Secondary status can be assigned during mode initialization or at any time during the conference. The assignment of secondary status during mode initialization is described in section 6.6. The following procedure is used by the MCU to downgrade a primary terminal to secondary status.

When a terminal is downgraded to secondary status, the MCU uses BAS commands to dynamically switch modes with the terminal. This method is a modified form of the *Mode 0 Forcing* procedure [H.242, section 6.3] in that a cap-set exchange is not initiated by the MCU. This allows endpoints that have been made temporarily secondary to be quickly upgraded to primary status. The terminal receives the following BAS commands:

- **cancel-MIV** - If the terminal was a broadcast or return video source.
- **VCF** - If the terminal currently has video channel, freeze the video.
- **video-off**[10] - Received video turned off.
- **T.120-off** - Turn off T.120 protocol in the MLP channel, if appropriate.
- **MLP-off** - Close MLP channel (if appropriate).
- μ/**A-law** - Change audio mode to μ-law PCM (A-law if the terminal only supports A-law).
- **64** - Indicates that only the initial channel is being used. This command is sent when the transfer rate of the terminal is 2B but no additional channel is connected, or when the terminal capability indicates that the terminal does not support the transfer rate of the conference.
- **MIS** -Indicates secondary status.

☞ **Implementation Recommendation**

When the terminal receives MIS, this should be announced to the user as a forcing to secondary status.

9. The MCU will not send **AIA** or **AIM** to a terminal as a result of audio-muting of an audio source by the MCU. These codes are only received by the MCU from a terminal and forwarded on to other terminals in the conference.
10. Note that if the terminal was transmitting broadcast video, **VCF** is sent to the other terminals first. If it was transmitting return video, **VCF** is sent to the broadcast terminal first.

If the terminal being downgraded was a video source, then the MCU follows the procedure described in section 6.16.3 for selecting a new source.

6.9.3 Procedure for Return to Primary Status

In some cases, the condition(s) that warranted reduction of a terminal to secondary status may be corrected at a later time. An example is a terminal transmitting a cap-set that matches SCM. In these cases, the MCU upgrades the terminal to primary status when the correcting event occurs, as described in section 6.8.

6.10 Terminal Entry and Exit—Effects on Existing Terminals

As terminals enter and exit the conference, the MCU provides commands, controls and indications to other connected terminals. The following sections describe the most common situations and the signals transmitted to existing terminals.

6.10.1 Connection of Second Terminal

When the second terminal is added to a conference, the *first* terminal receives the following BAS codes after the initial channel is connected:

- **cancel-MIZ** - It is no longer the only terminal connected to the conference.
- **TIN** - Announcing the number of the second terminal.

When all the channels are connected and the terminal reaches the primary status, the *first* terminal receives the following BAS codes:

- **VIA/VIA2/VIA3**[11] - If received video corresponds to a normal camera image.
- **VIN**[11] - Terminal sees video of second terminal
- **VIS** - If received video does not represent a normal camera image.

If SCM is automatically controlled by the MCU for audio, it may perform a mode switch to a compatible audio mode (e.g., from G.7.28 to PCM). In this case, the procedure in section 6.7 is followed, and includes sequencing of a bit rate change.

At the end of the sequence, **VCU** is transmitted to the first terminal as the video broadcaster and to the second terminal as the returned video source.

6.10.2 Connection of Subsequent Terminals

When the third and subsequent terminals are added to the conference, the following takes place with respect to the *previously connected* terminals:

- If a bit rate change is required (e.g., rate adaptation), it is performed with each terminal according to section 6.7. Otherwise, the MCU transmits **VCU** to the terminal transmitting broadcast video.

11. These BAS codes received by primary terminals only.

- Each terminal receives **TIN**, identifying the number of the newly added terminal.
- If the newly added terminal is the designated broadcaster, each terminal receives **VIA** (**VIS** was in effect prior to this).[11]

6.10.3 Disconnection of a Terminal

If a terminal is disconnected from the conference either by its own action or by the MCU, the following signals are received by the *remaining* terminals:

- **TID** - Specifying the number of the disconnected terminal.
- **MIZ** - If this terminal is the only remaining terminal.
- **VIS** - If the disconnected terminal was a broadcast or return video source. (Note that the MCU then transmits **VIA** if the video source is restored or another source is selected.)

6.11 Identification of Terminals

6.11.1 Preconditions

The terminal must support reception of the multiple byte extension BAS code **start-MBE**, and must have announced **MBE-cap** in its cap-set.

6.11.2 Procedure

To provide the terminal user information about the video being displayed, the terminal may use several information sources provided by the MCU. As described in section 6.10, **TIN** and **TID** reports when another terminal enters or leaves the conference. The terminal may also obtain a list of the terminals currently connected to the conference by transmitting **TCU**. The MCU responds with **{start-MBE (N) (TIL) (M) (T) ... (TN-2)}** where (M) is the MCU number and (T) ... (T_{N-2}) are the terminal numbers.

The terminal can also request the personal identification string of another terminal by transmitting **{TCP <M> <T>}**. The MCU responds with either the terminal identification (if it has been received), or a NULL response using the following command:

{start-MBE (N) (TIP) (M) (T) “...N - 3 characters...”}

where the maximum number of characters in the string is 15.

In order to take care of the race condition where a terminal identification is queried before it is received by the MCU, every time the MCU receives a terminal identification, it sends a **TIN** to reannounce the existence of the terminal.

The above information can be used in conjunction with **VIN** as reported by the MCU to indicate to the terminal user the identity of the currently displayed video. For the audio add-on port, the terminal identification is defaulted to “Audio-Only.”

6.11.3 Exception Conditions

1. If the terminal number requested in TCP is unknown to the MCU, or if the corresponding terminal did not respond to TCS-2 during mode initialization, the MCU transmits **{start-MBE (N=3) (TIP) (M) (T)}** to the requesting terminal.
2. If the same terminal identification is used by multiple participants of a conference, it is up to the receiving terminals to distinguish the participants based upon the participants' terminal numbers.

6.12 Video Switching

The MCU supports two fundamental classes of control over the broadcast video source:

- Voice activated
- Terminal controlled (e.g., See-Me)

These classes are differentiated not only by the point of control of the broadcast video, but also by the source for the return video (i.e., that seen by the broadcast terminal).

All classes require terminal support for the basic video switching procedure described in section 6.12.2. Terminal control of video switching requires that the controlling terminal support the appropriate BAS codes, as summarized in Table 5-1, "Terminal Support of Multipoint Features," on page 26.

6.12.1 Basic Video Switch

The *versit* -compliant MCU supports the video switching procedure described in H.243, section 4.1. The sequence shown in Table 6-1 occurs when the *versit* -compliant MCU switches the video viewed by one or more terminals to a new video source.

Table 6-1 Basic Video Switch Procedure

New Video Source	*versit* -Compliant MCU	Viewing Terminal(s)
	VCF ———>	
	Send every t_{VCF}	
		Freeze picture
	Switch to new video source	
	cancel-MIV ———>	—>*To old video source only*
	<——— **MIV**	
	New video source "on the air"	
	VIA ———>	
	{VIN <M> <T>} ———>	
	Viewing new video source	

Table 6-1 Basic Video Switch Procedure (continued)

New Video Source	*versit* -Compliant MCU	Viewing Terminal(s)
	• • Wait t261 to recover H.261 framing • • <——— **VCU**	
Starts fast update mode Send Freeze Picture Release (H.261) —>	—> —> —> —> —> —> —>	Resume video decode/display

6.12.2 Voice Activated Switching

Voice Activated Switching (VAS) is the default video switching mode of the MCU. The VAS algorithm chooses the broadcast video source based on audio information received from each terminal.

When a terminal user is speaking, the VAS algorithm attempts to use that terminal's video stream as the broadcast video source. If another video terminal user is already speaking, the new speaker is queued until the broadcaster stops. If **AIM** has been received from a terminal, the MCU will not video switch to that terminal until **AIA** and speech are received from it.

6.12.2.1 Preconditions

During VAS, terminals are eligible to be video sources if they are primary, not video-muted by the MCU, and have sent **VIA** to the MCU (see section 6.16.9).

6.12.2.2 Procedure

When the broadcaster stops speaking or is silent while another terminal is speaking, the MCU uses the basic video switch procedure (section 6.12.1) to broadcast the video of the new speaker (the broadcast video) to all other terminals. The same procedure is used to transmit the video of the previous speaker (return video) to the new speaker's terminal.

6.12.2.3 Exception Conditions

If the terminal providing broadcast or return video is disconnected or video-muted, the procedure described in section 6.16.3, "Loss of Video Source," on page 48 is followed.

6.13 See-Me

The See-Me procedure is required to be supported by terminals offering enhanced *versit* service and MCUs. When the voice activated switching mode is in effect, this procedure allows an H.320 endpoint to make itself as the video broadcaster. Only one endpoint can be a broadcaster at a time. Other endpoints cannot claim the broadcast token until the current

broadcaster release the token. Endpoints may use this procedure to send a high-resolution video via the video channel.

6.13.1 Preconditions

The terminal must:

- Be primary and not video-muted by the MCU.
- Be capable of transmitting **MCV** and **cancel-MCV**.
- Be capable of receiving **VCR**.

6.13.2 Procedure

The MCU follows the procedure described in H.243, section 4.2.2. In response to a user action, the terminal transmits **MCV** to the MCU. The MCU uses the basic video switch procedure (section 6.12.1) to make the current broadcast terminal the return video source, and to transmit the new broadcast terminal's video to all other terminals. Thereafter, the return video source is selected based on the voice energy detection algorithm described in section 6.12.2. When the broadcast terminal user no longer needs broadcast control, the terminal should send **cancel-MCV** to the MCU, which from that point on uses VAS to select the broadcast and return video.

6.13.3 Exception Conditions

The following conditions result in the MCU rejecting the terminal's **MCV** request by transmitting **VCR**:

- The terminal is secondary, or it is primary and video-muted.
- In VAS mode, when MCV is in effect for another terminal.[12]

A rejected **MCV** request is remembered by the MCU and is kept in a pool of outstanding MCV requests. When the current MCV broadcaster relinquishes control by sending a **cancel-MCV**, the *versit* -compliant MCU searches the pool and selects a new MCV broadcaster from the pool. If no outstanding request exists, or existing outstanding requests do not qualify (e.g. still muted), the conference reverts to VAS.

It is recommended that the terminal keeps its user informed of an outstanding MCV request. In order to get rid of an outstanding request, an explicit **cancel-MCV** command has to be sent by the terminal.

If the broadcast terminal is made secondary or video-muted after MCV is in effect, the terminal loses the broadcaster token but still has the **MCV** request outstanding. Once the terminal is unnoted, if the request still exists, the terminal can be selected by the MCU as the next MCV broadcaster.

12. If the requesting terminal has already been designated broadcaster by the chair, then the request is made as an outstanding request.
If the requesting terminal has already been designated broadcaster via MCV, then the request is ignored.

6.14 Terminal Disconnection by MCU

6.14.1 Preconditions

The MCU disconnects a specified terminal from the conference when the reservation agent manually removes the terminal from the conference. It disconnects all terminals from the conference when the reserved time period for the conference set by the reservation agent has expired, or when the reservation agent manually tears down the conference.

6.14.2 Procedure

The MCU drops the network connection for the additional channel, if any, followed by dropping the network connection for the initial channel. See section 6.10.3 for the effects of terminal disconnection on other terminals in the conference.

6.15 Cascading

A MCU is required to support a dumbbell cascade configuration (two MCUs connected to each other). For a terminal interface point of view, many procedures described in this specification for a single MCU environment remain the same for a cascaded MCU environment. This section only covers the terminal interface procedures that operate differently in a cascade environment.

6.15.1 Preconditions

In a dumbbell configuration, one MCU has to be designated as the master and another as the slave.

6.15.2 Procedure

6.15.2.1 Terminal Number

When two MCUs are connected to each other, the master MCU sends a **{TIA, <M>, <0>}** to the slave MCU. This triggers the slave MCU to send a **TIL** listing to all of the endpoints in the conference. The master MCU uses this **TIL** to notify its local endpoints about the endpoints on another MCU. This is done by sending the local endpoints a **{TIN, <M>, <T>}** for each endpoint in the **TIL**. Meanwhile, the slave MCU requests the list of terminal numbers on the master MCU by explicitly sending a **TCU** to the master MCU. Upon receiving a **TIL** back, the slave MCU sends the local endpoints a **{TIN, <M>, <T>}** for each endpoint in the **TIL**.

In a cascade conference, when an endpoint transmits a **TCU** to the local MCU, it receives two **TIL** in response. Each **TIL** corresponds to one of the two MCUs.

6.16 Miscellaneous Error Conditions

The following procedures describe how the MCU reacts to various error conditions that may arise during the course of a conference. See section 6.16.9 for the effects on the terminal as a source of audio, video, and data media.

6.16.1 Loss of Framing

If the MCU loses FAS, it ignores any incomplete BAS code sequence and initiates a capability exchange using *Sequence A* (see section 6.6.1). At the end of *Sequence A*, it resumes normal processing of received BAS codes. If the terminal loses FAS, it should react the same way. If the terminal subsequently transmits **VCU** to affect a video image update, the MCU forwards **VCU** to the appropriate video source.

Loss of frame alignment in a channel for greater than t_{FA} causes the MCU to disconnect the channel. If loss of framing occurrs in the initial channel, additional channel connections are also dropped.

6.16.2 Loss of Channel Connections

If the MCU is notified by the network that the additional channel connection has been dropped, then it will cease transmitting SCM to the terminal, transmitting PCM audio only instead. Also, it mutes all media received from the terminal except audio. If it is notified by the network that the initial channel connection has been dropped, it drops the initial and additional channel connections.

6.16.3 Loss of Video Source

If a terminal that is the broadcast or return video source is video-muted, sends **VIS**, or is disconnected, then the MCU transmits **VIS** to all primary terminals receiving video from that source. If the video source is restored or another source is selected, the MCU transmits **VIA** to the receiving terminals.

Another video source may be selected by the MCU, depending on the video switching mode in effect at the time of the video loss. Table 6-2 summarizes how another broadcast or return video source is selected, depending on the video switching mode. When the video switching mode is VAS, a change in the current speaker causes the selection of a new video source via VAS.

Table 6-2 Alternate Video Source Selection

Video Switching Mode	Alternate Video Source	
	Broadcast	Return
Terminal Activated (**MCV**)	Terminal with outstanding MCV request, otherwise VAS.	VAS
Voice Activated Switching (VAS)	VAS	VAS

6.16.4 Bandwidth Incompatibility

The following description assumes that the 56K/64K rate adaptation feature is turned off.

If the MCU receives a **restrict** command or cap from a terminal for a 64Kbps bandwidth conference and the access pipe of the terminal is 64Kbps, it will video- and MLP-mute all channel connections to that terminal.

If a terminal attempts to join a 64Kbps bandwidth conference and the access pipe of the terminal is a 56Kbps bandwidth, the MCU will not connect that terminal to the conference.

If the MCU does not receive a **restrict** command or cap from a terminal for a 56Kbps bandwidth conference and the access pipe of the terminal is of 56Kbps bandwidth, it will video- and MLP-mute all channel connections to that terminal.

If a terminal attempts to join a 56Kbps bandwidth conference and the access pipe of the terminal is of 64Kbps bandwidth, the MCU will not connect that terminal to the conference.

6.16.5 BAS Coding Errors

The MCU ignores any recognized BAS command sequences that have not been formatted according to the definitions described in this specification.

6.16.6 Unsupported BAS Codes

Recognized but unsupported BAS code sequences are ignored by the MCU. If an unsupported BAS command changes the bit rate allocation, the MCU reacts as indicated in item 6 of Table 6-3.

6.16.7 Unrecognized BAS Codes

Unrecognized BAS codes may be received as a result of uncorrectable bit errors or brief losses of framing. The MCU ignores all unrecognized BAS codes.

6.16.8 Internal Resource Failure

An internal resource failure may result in disconnection of the additional channel of a terminal, a terminal, or a whole conference by the MCU.

6.16.9 Muting of Terminal Media

As a result of terminal behavior or error conditions affecting the terminal during the conference, the MCU may mute one or more media (audio, video, MLP, etc.). Muting means that the MCU will not use the media that the terminal transmits. Table 6-3 describes which media is muted for the listed conditions. The terminal continues to have primary status in that the MCU continues to transmit all media to the terminal according to the current bit rate allocations. When the

condition that affects the terminal is corrected, the terminal will be unmuted for the corresponding media.

Table 6-3 Muting of Terminal's Transmitted Media

Condition	Muted Media
1. Terminal fails to echo audio, MLP, and transfer rate mode switch within t_{MS}. (*Note 2*)	video, MLP
2. MCU loses FAS in additional channel.	video, MLP
3. MCU loses FAS in initial channel.	audio, video, MLP
4. MCU loses MFA or multi-channel synchronization in either channel or a 2B terminal does not have the additional channel	video, MLP
5. Terminal transmits **video-off** and **VIS.**	video
6. Terminal-initiated mode switch. (*Note 1 and 2*)	<audio>, video, MLP
7. Terminal transmits more than 20 cap-set changes or mode switching BAS commands per second.(*Note 1*)	<audio>, video, MLP
8. Terminal transmits **MLP-off.**	video, MLP
9. 2B Terminal interworking with higher speed terminals.	video, MLP

Note 1 - <audio> indicates that depending on the nature of the error condition, the MCU may also mute the terminal's audio.

Note 2 - The mode switch must make the terminal's bit rate allocation inconsistent with SCM.

6.17 Time Interval Values

Table 6-4 defines and gives nominal values for the time variables used by the MCU in the above H.320 procedures. The values are subject to change based on human factors and field testing.

Table 6-4 MCU Time Variable Definitions and Values

Name	Value (sec.)	Definition
t_{261}	*(Note 1)*	Time required to recover H.261 framing.
t_{FA}	40	Frame alignment timeout which causes MCU to disconnect channel.
t_{INIT}	50	Timeout for channel initialization [H.242, sections 5.1 and 6.1.2].
t_{MS}	0.625 +/- 0.125	Timeout for terminal to echo mode switch from MCU.
t_{PW}	30-300	Password timeout interval.
t_{VCF}	5	Repeat interval between **VCF** transmissions [H.230, section 3.1].
t_{SCAN}	*(Note 2)*	Scan interval.

Note 1 - The value for this interval is:
if the transfer rate is 2B, t_{261} = 625msec +/- 125msec
if the transfer rate is >2B, t_{261} = 375msec +/- 125msec

Note 2 - This interval is relevant only in Broadcast video conference mode. It is administered for the conference by the MCU reservation agent and varies from 10-240 seconds.

Section 7 : Illustrative Scenarios

This section applies to multipoint operations only.

This section contains a set of multimedia conferencing scenarios that describe the BAS code level interactions between terminals and the MCU. Each scenario highlights some of the features and concepts described in the procedural descriptions.

Note that although the repeating command set is not illustrated in these scenarios, it is transmitted any time the BAS is not in use, and reflects the current commands in effect at the time of transmission.

7.1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS

This scenario demonstrates mode initialization for a 2B terminal, password validation, procedures for adding the first, second and third terminals, and voice activated switching (VAS) of video.

Three terminals, Term1, Term2, and Term3 join the conference in succession (S1-A through S1-E, S1-F, S1-G). As Term3 joins the conference, Term1 and Term2 stop talking, and Term3 begins talking (S1-H), causing the MCU to switch from Term1 to Term3 as the broadcast video source.

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS

Seq. Mark	Term1	MCU	Other Terminals
S1-A		The initial B-channel has been established. <——— Repeat following while searching for **FAS** and **MFA-FAS, MFA, MF numbering A=1** The var-MLP cap will be sent regardless of whether the MLP option of the conference is on or off. **{cap-mark, 2B, G.728, A-law, μ-law, CIF, 1/29.92, 1/29.92, var-MLP, T.120-cap, MBE-cap, cap-mark}**	

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
	———>		
	Repeat following while searching for **FAS** and **MFA-FAS, MFA, MF numbering A=1 {cap-mark, 2B, G.728, QCIF, 2/29.97, var-MLP, T.120-cap, MBE-cap, cap-mark}**		
		<——— **A=0** Found FAS and MFA Received complete cap-set	
	A=0 ———> Found FAS and MFA		
		<——— Repeat cap-set once more— **{cap-mark, 2B, G.728, A-law, μ-law, CIF, 1/29.92, 1/29.92, var-MLP, T.120-cap, MBE-cap, cap-mark}**	
		<——— Start repeating command set— **{MCC, MCS, Au-off F, 64, video-off, encryp-off, LCO, not-comp 6B-H0, derestrict, LSD-off, MLP-off, HSD-off, H-MLP-off, T.120-off, VIA, cancel-MIV, AIA, MIS, MIZ}**	
	Received complete cap-set		
	———> Repeat cap-set once more— **{cap-mark, 2B, G.728, QCIF, 2/29.97, var-MLP, T.120-cap, MBE-cap, cap-mark}**		
	———> Start repeating command set— **{μ-law 0F, 64, video-off}**		

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
	———>		
	When Term1 receives the repeating command set from the MCU, it updates its repeating command set— **{audio-off, 64, video-off}**		
S1-B		If the password needs to be collected, MCU sends a TCS-1 command. <——— **TCS-1**	
	The endpoint prompts for the password.		
	User returns the password. ———> **{start-MBE (5) (IIS) (1) “TOM”}**		
		If the password fails validation, the MCU will try again. <——— **TCS-1**	
	The user returns the password. again. ———> **{start-MBE (8) (IIS) (1) “THOMAS”}**		
		The password has passed the validation.	
S1-C		The MCU assigns terminal number. <——— **{TIA <1> <1>}**	
		<——— **cancel-MIS**	
		Connect Term1 to APU. <——— **G.728**	
	G.728 ———>		
		<————**MIZ**	
		•	
		•	
S1-D		The second B-channel is established	

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
		<———	
		Repeat the following in additional channel while searching for FAS and **MFA-FAS, MFA, MF numbering A=1 (L1=0, L2=1, L3=0)** (in FAS) **Channel No.2** (in BAS)	
	———>		
	Repeat the following in additional channel while searching for FAS and **MFA-FAS, MFA, MF numbering A=1 (L1=0, L2=1, L3=0)** (in FAS) **Channel No.2** (in BAS)		
	A=0 ———> (additional channel) Found FAS, MFA, and multichannel sync.		
		<——— **A=0** (additional channel) Found FAS, MFA, and multichannel sync.	
S1-E		<——— **VCF**	
		<——— **video-off**	
	video-off ———>		
		The MCU opens the MLP channel.	
		<——— **var-MLP**	
	The terminal opens the MLP channel. **var-MLP** ———>		
		The MCU enables T.120.	
		<——— **T.120-on**	
	The terminal enables T.120 **T.120-on** ———>		
		The MCU initiates the T.124 procedures to admit the terminal to the data conference.	
		Connect Term1 to VPU Loop Term1 video back to itself	

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
		<——— 2 x 64 Transfer rate mode switch **<——— H.261** Turn video on	
	2 x 64 ———> **H.261 ———>**		
		• • Wait T_{MS} for the endpoint to echo mode switch	
		<——— Change video cap. Repeat until complete cap-set received (Sequence A)— **{cap-mark, 2B, G.728, A-law, μ-law, QCIF, 2/29.97, var-MLP, T.120-cap, MBE-cap, cap-mark}**	
	———> **{cap-mark, current_cap-set, cap-mark}**		
		• • **<——— MIV** **<——— VIA** **<——— {VIN <1><1>}** Term1 viewing self. • • Wait t_{261} to recover. H.261 framing • • **<——— VCU**	
S1-F			• • Repeat sequence S1-A and S1-B for Term2. The cap set sent by the MCU will reflect the current SCM. • •
		Momentarily connect entry tone to APU.	
	User hears entry tone.		

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
		{TIA<1><1>} ———>	—> *Term2*
		Assign term no.	
		<——— **{TIN<1><2>}**	
		Term2 has been added.	
		<——— **cancel-MIZ**	
		Connect Term2 to APU. (μ-law PCM)	
			Repeat sequence S1-D for Term2.
		<———**VCF**———>	
		video-off ———>	
			<——— **video-off**
		G.728 ———>	—>*Term2*
		Mode switch to G.728.	
			Term2
			<———**G.728**
		The MCU opens the MLP channel.	
		var-MLP———>	
			The endpoint opens the MLP channel.
			<———**var-MLP**
		The MCU enables T.120.	
		T.120-on ———>	
			The terminal enables T.120
			<——— **T.120-on**
		The MCU initiates the T.124 procedures to admit Term2 to the data conference.	
		Connect Term2 to VPU as return video source.	
		H.261———>	—>*Term2*
		Turn video on.	
			Term2
			<———**H.261**

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
		•	
		•	
		Wait T_{MS} for the endpoint to echo mode switch.	
		•	
		•	
		MIV ———>	—> *Term2*
		<——— VIA	
		<——— {VIN<1><2>}	
		Term1 viewing Term2.	
		<——— MIV	
		VIA ———>	—> *Term2*
		{VIN<1><1>} ———>	—> *Term2*
		Term2 viewing Term1.	
		•	
		•	
		Wait t_{261} to recover.	
		H.261 framing	
		•	
		•	
		<———VCU———>	—> *Term2*
			•
			•
S1-G			Repeat sequence S1-A and S1-B for Term3. The cap set sent by the MCU will reflect the current SCM.
			•
			•
		Momentarily connect entry tone to APU.	
	Term1 user hears entry tone.		Term2 user hears entry tone.
		{TIA<1><3>}———>	—> *Term3*
		Assign term no.	
		<———{TIN<1><3>}	
		Term3 has been added.	
		{TIN<1><3>}	—> *Term2*
		Connect Term3 to APU. (μ-law PCM)	
			Repeat sequence S1-D for Term3.

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
		VCF ———>	—> *Term3*
		video-off ———>	
			<——— **video-off**
		G.728 ———>	
		Mode switch to G.728.	
			Term3
			<——— **G.728**
		The MCU opens the MLP channel.	
		var-MLP ———>	
			The endpoint opens the MLP channel.
			<——— **var-MLP**
		The MCU enables T.120.	
		T.120-on ———>	
			The terminal enables T.120
			<——— **T.120-on**
		The MCU initiates the T.124 procedures to admit Term3 to the data conference.	
		Connect Term3 to VPU.	
		H.261 ———>	—> *Term3*
		Turn video on.	
			Term3
			<——— **H.261**
		•	
		•	
		Wait t_{MS} for the endpoint to echo mode switch.	
		•	
		•	
		VIA ———>	—> *Term3*
		{VIN<1><1>}———>	—> *Term3*
		Term3 viewing Term1.	
		•	
		•	
		Wait t_{261} to recover. H.261 framing	
		•	
		•	
		<——— **VCU**	
S1-H	User stops speaking.		Term3 begins speaking.
		<——— **VCF** ———>	—>*Term2 & Term3*

Table 7-1 Scenario #1: 2B, 64kbps, G.728, var-MLP, Password, and VAS (continued)

Seq. Mark	Term1	MCU	Other Terminals
		Switch from Term1 to Term3 as broadcast video source.	
		<——— cancel-MIV	
		MIV ———>	—>*Term3*
		<——— VIA	
		<——— {VIN<1><3>}	
		Term1 viewing Term3.	
		VIA ———>	—>*Term2*
		{VIN<1><3>} ———>	—>*Term2*
		Term2 viewing Term3.	
		Switch from Term2 to Term1 as return video source †	
		cancel-MIV ———>	—>*Term2*
		<——— MIV	
		VIA ———>	—>*Term3*
		{VIN<1><1>} ———>	—>*Term3*
		Term3 viewing Term1.	
		•	
		•	
		Wait t_{261} to recover.	
		H.261 framing	
		•	
		•	
		<——— VCU ———>	—*Term3*

7.2 Scenario #2: See-Me

This scenario assumes Term1, Term2, and Term3 are connected to the conference (i.e., sequence mark S1-A through S1-G in Scenario #1 has been completed). The conference is running in VAS mode. It also assumes that the endpoints support the MBE cap.

Table 7-2 Scenario #2: See-Me

Seq. Mark	Term1	MCU	Other Terminals
S2-A	User requests to become the video broadcaster by clicking on a "see-me" button. **MCV** ———>		
		MCU makes Term1 the broadcaster. If Term1 was not the current speaker, the MCU will send BAS commands to all endpoints to change the broadcast video source and the return video source. The command sequence has been described in previous scenarios and is not shown here.	
S2-B			Term2 requests to become the video broadcaster <——— **MCV**
		MCU denies the request. However, the request will be "remembered" by the MCU. **{VCR}** ———>	
			Term2 cancels the request. Without explicitly canceling the request, Term2 will be made the broadcaster automatically by the MCU once Term1 does a **cancel-MCV**. <———
S2-C	User relinquishes the control. **cancel-MCV** ———>		
		MCU changes the video switching mode back to VAS.	
	The cancel-MCV message can actually be sent by any terminal at any time and will always be granted. **cancel-MCV** ———>		
		The MCU takes no action.	

7.3 Scenario #3: Password Validation Failure

The message sequences covered by this scenario include:

- No password entered.
- Password validation failure.

This scenario assumes that the endpoints support the MBE cap.

Table 7-3 Scenario #3: Password Validation Failure

Seq. Mark	Term1	*versit* -Compliant MCU	Other Terminals
	Repeat sequence S1-A for Term1.		
		The MCU collects the password. <——— **TCS-1**	
	The user is not there. The password is not entered.		
		After time-out, the MCU queries the password again. The time-out interval is a system level parameter. The range of the value is 30-300 seconds. <——— **TCS-1**	
	User returns password ———> **{start-MBE (5) (IIS) (1) “bad”}**		
		Bad password, try again <———**TCS-1**	
	User returns password ———> **{start-MBE (5) (IIS) (1) “bad”}**		
		The user only has three chances to enter the password (including time-out cases). After the third failure, the MCU tears down the connection.	

7.4 Scenario #4: Terminal Name Collection

The message sequences covered by this scenario include:

- Terminal name collection and query.
- Race condition for terminal name query.
- Terminal name for audio add-on port.

This scenario assumes that two terminals are already connected to the conference (i.e., sequence mark S1-A through S1-F in Scenario #1 has been completed). It also assumes that the endpoints support the MBE cap.

Table 7-4 Scenario #4: Terminal Name Collection

Seq. Mark	Term1	MCU	Other Terminals
S4-A		After **{TIA <1> <1>}** is sent to Term1, the MCU gets the terminal name from Term1. <——— **TCS-2**	
	User returns terminal name (Max 15 characters). ———> **{start-MBE (6) (IIS) (2) "Mike"}**		
		After **{TIA <1> <2>}** is sent to Term2, the MCU gets the terminal name from Term2. **TCS-2** ———>	
S4-B	At this time Term1 receives a **{TIN <1> <2>}** from the MCU. Term1 requests the name of Term2. **{TCP<1><2>}** ———>		
		MCU returns NULL terminal name because the name has not been returned. <——— **{start-MBE (3) (TIP) (1) (2)}**	
			User returns terminal name. <——— **{start-MBE (6) (IIS) (2) "Paul"}**

Table 7-4 Scenario #4: Terminal Name Collection (continued)

Seq. Mark	Term1	MCU	Other Terminals
		When a terminal returns its name, the MCU broadcasts the corresponding terminal number to everyone else. This will take care of the race condition where an endpoint queries a terminal name before the name is available (the endpoint now knows when to query again). **<——— {TIN<1><2>}**	
S4-C	Term1 requests the name of Term2. **{TCP <1> <2>} ———>**		
		MCU returns terminal name. **<———** **{start-MBE (7) (TIP) (1) (2) "Paul"}**	
S4-D			Term2 requests the list of Terminal numbers. **<——— TCU**
		MCU returns terminal number list. **———>** **{start-MBE (4) (TIL) (1) (1) (2)}**	
			Term2 requests the name of Term1. **<——— {TCP<1><1>}**
		MCU returns terminal name. **———>** **{start-MBE (7) (TIP) (1) (1) "Mike"}**	
S4-E			An audio add-on port joins the conference as Term3.
		MCU notifies Term1 and Term2 that Term3 has joined the conference. **<——— {TIN<1><3>} ———>**	
			Term2 requests the name of Term3. **<——— {TCP<1><3>}**
		MCU returns terminal name. **———>** **{start-MBE (13) (TIP) (1) (3) "Audio-Only"}**	

7.5 Scenario #5: 56K/64K Rate Adaptation for Dial-Out Conferences

The conference is administered as follows: 2x64, G.728, var-MLP, and with Rate Adaptation. The MCU dials a 64K endpoint first, and then dials a 56K endpoint.

Table 7-5 Scenario #5: 56K/64K Rate Adaptation for Dial-Out Conferences

Seq. Mark	64K Endpoint	MCU	56K Endpoint
		The MCU has dials an endpoint using 64K facilities. As part of the message exchange, the derestrict command is sent by the MCU to the endpoint. <——— **derestrict**	
	Optionally, the endpoint can respond with a derestrict command. **derestrict** ———>		
		Now the MCU dials the second endpoint. The second endpoint specifies a restrict cap in its cap set.	
			<——— **{cap-mark, restrict, other caps, cap-mark}**
		The MCU sends a **restrict** command to the endpoint. **restrict** ———>	
			The endpoint responds with a **restrict** command. <——— **restrict**
		• • Wait until the second B-channel is established.	
		The MCU sends the freeze picture command to the first endpoint. <——— **VCF**	
		The MCU stops video. <——— **v ideo-off**	
		The MCU sends restrict command <——— **restrict**	

Table 7-5 Scenario #5: 56K/64K Rate Adaptation for Dial-Out Conferences (continued)

Seq. Mark	64K Endpoint	MCU	56K Endpoint
		The MCU restarts video. <——— **H.261** • • Wait t_{MS} for the endpoint to echo mode switch. • •	
	video-off ———> **restrict** ———> **H.261** ———>	 • • Wait t_{261} for the endpoint to echo mode switch. • • The MCU fast updates broadcast video source. <——— **VCU** The MCU fast updates return video source. **VCU** ———>	

7.6 Scenario #6: Error Condition—Loss of Additional Channel

This scenario assumes that three terminals are already connected to the conference (i.e., sequence mark S1-A through S1-G in Scenario #1 has been completed).

Table 7-6 Scenario #6: Error Condition—Loss of Additional Channel

Seq Mark	Term1	MCU	Other Terminals
			Term2 is the video source and Term3 is the returned source.
		The additional channel from Term1 is lost.	
		The MCU freezes picture. <——— **VCF**	
		The MCU stops video. <——— **video-off**	
		The MCU disables T.120. <——— **T.120-off**	
		The MCU closes the MLP channel. <——— **MLP-off**	
		<——— **μ-law OF** <——— **64**	
	T.120-off ———> **MLP-off** ———> **μ-law OF** ———> **64** ———>		

Appendix A : Terminology and Acronyms

BAS: Bit rate Allocation Signal; 800 Bit/sec in the H.221 multiplex used for conveying control and indication (C&I) signals between terminals and between terminals and MCUs.

BRI: The ISDN Basic Rate Interface provides two 64 kb/s information channels (B channels) and one 16 kb/s signaling and packet switched data channel (the D channel): 2B+D.

Broadcast: The MCU is “broadcasting” when it sends the same video signal to two or more locations.

Broadcast Video: The video being broadcast from one terminal (the broadcaster) to all others. Also refer to *Return Video*.

Cap-Set: The H-series “Cap-Set” or “Capability Set” is the list of various media and bandwidths that a MCU or terminal can support. “Cap sets” are exchanged at the beginning of all H.320 calls.

Chair: An enhanced terminal possessing a token conveying a certain measure of authority over the operation of the MCU; the token is assigned by the MCU, and requested/released by enhanced terminals during the conference call. The person controlling the chair terminal need not be the actual chairperson of the meeting.

Codec: Coder/decoder; device that can encode/decode audio and/or video signals into/from digital form used for transmission.

Control and Indication: Sometimes abbreviated C&I; end-to-end signaling between terminals and MCUs consisting of control which causes a state change in the receiver, and indication which information regarding the functioning of the system. Also, refer to *H.230*.

Designated Broadcaster: A terminal that has been designated as the video broadcaster, overriding the default voice activated switching, the video switching mode. Designation can be performed by any MCV capable terminal in a VAS conference any time during the conference.

DS1: A 1.544 Mbits/sec North American standard digital interface or a 2.048 Mbits/sec international standard digital interface.

ECS: Encryption Control Signal. Also, refer to *H.221*.

FAS: Frame Alignment Signal. Also, refer to *H.221*.

FAW: Frame Alignment Word. Also, refer to *H.221*.

G.711: μ-law or A-law PCM audio at 48Kbps, 56Kbps, or 64Kbps.

G.722: 7kHz audio at 48Kbps, 56Kbps, or 64Kbps

G.728: LD-CELP Audio at 16Kbps.

H.221: Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices. Approved by the ITU-T during the Fall, 1990.

H.230: Frame synchronous control and indication signals for audiovisual systems. It also has a section on multipoint control signals. Approved by the ITU-T during the Fall, 1990.

H.231: Part of the proposed H.320 multipoint standard that includes: setting a framework for specifying MCUs, functional aspects, parameters (capability ranges) and any combinatorial constraints, definition of primary/secondary ports and the options for setting these, classification of MCUs, including those for which a specific need is already identified. Approved by the ITU-T in May 1992.

H.242: System for establishing communications between audiovisual terminals using digital channels up to 2 Mbit/s. Approved by the ITU-T during the Fall, 1990.

H.243: Basic MCU system for establishing communication between three or more audiovisual terminals using digital channels of up to 2 Mbits/sec. Approved by the ITU-T in May 1992.

H.261: Video codec for audiovisual services at Px64 kbit/s. Approved by the ITU-T during the Fall, 1990.

H.320: Narrow-band visual telephone systems and terminal equipment. Approved by the ITU-T during the Fall, 1990.

H.331: Broadcasting type audiovisual systems and equipment. It describes specialized call establishment, MCU and terminal capabilities, and procedures to support single sender/ multiple receiver multipoint broadcast configurations.

HC: Highest Common; refers to an algorithm used by the *versit* -compliant MCU for determining which audio or data rates to use as the default for a conference based on the highest capabilities common to all of the terminals. The intent of the algorithm is to provide multimedia service to the maximum number of terminals.

HSD: High Speed Data. Also, refer to *H.221*.

ISDN: Integrated Services Digital Network; an open standard switching interface.

LD-CELP: Low Delay-Codebook Excited Linear Prediction; an algorithm which is capable of achieving 64 kbit/sec PCM voice quality in 16 kbit/sec. Other “CELPs” exist at lower rates as well. The ITU-T standard for 16 kbit/sec CELP is G.728.

LSD: Low Speed Data. Also, refer to *H.221*.

MCU: Multipoint Control Unit; Video CODEC industry terminology for a unit that provides multipoint video/audio bridging. This terminology is also used by ITU-T standards committees to refer to a multipoint, multimedia bridge.

MLP: Multi-Layer Protocol; one of two data types bridged by an MCU. Described in AV.270.

MFA: Multi Frame Alignment

MSB: Most Significant Bit

Multimedia: Refers to the use of a variety of media, including audio, data, graphics, and full motion video.

Multipoint: A multipoint conference involves more than two terminals.

Narrowband: Refers to video channels at 64 Kbits/sec or less.

NUM: SBE with a value from 0 to 223.

Port: A port is the aggregate of network interfaces on the MCU associated with an H.320 terminal for conference with a given transfer rate. For a 2B conference, a port consists of two such interfaces. One interface is required for a 1B conference. A port servicing a 2B terminal consists of two network connections

PCM: Pulse Code Modulation; PCM is described in specification G.711. The encoding used in the domestic U.S. is called μ-law; for Europe, the encoding is called A-law.

Point-to-point: A point-to-point conference involves only two locations. Although it generally does not involve an MCU, a point-to-point call may or may not involve an MCU.

PRI: ISDN Primary Rate Interface; a trunk interface that provides one 64 kb/s channel for signaling (D-channel) and N 64 kb/s bearer channels (B-channel). N is equal to 23 for the North American standard and 30 for the international standard.

Primary: The classification of a terminal whose announced cap-set matches SCM is primary. This allows the terminal full access to the current audio, video and data operations.

Return Video: The video being sent to the broadcasting terminal.

SBE: BAS single byte extension commands such as H.230 and data-apps.

SCM: Selected Communications Model; the SCM is used to represent the currently active collection of audio, video, data, and transfer modes, and bit rate allocations provided to a conference. This collection may change over the course of a conference.

Secondary: The classification of a terminal whose cap-set does not conform to SCM. It receives PCM audio service only.

SMF: Sub-MultiFrame

T_{CC}: Chair Control Token

T_H: High Speed Data Token

T_L: Low Speed Data Token

Terminal: A video CODEC, camera, PC, speakers, or other equipment for multimedia conferencing. There are two types of terminals—the conference controller and the conference participants. The equipment at each type of terminal may or may not be identical.

VAS: Voice Activated Switching; the terminal whose video is to be broadcast is determined by voice energy in the audio stream detected by the MCU.

Appendix B : H.221 BAS Message Exchange

This appendix applies to multipoint operations only.

The following tables are modifications of the tables in H.242, Appendix A. They contain the messaging sent and received by the MCU as it connects with an endpoint. The endpoint joins into a 2B 56Kbs PCM conference.

The Boldface letters (**A, B, C,...**) refer to the fence post diagram in of H.242 Appendix I, Figure I-1/H.242 and H.242 Appendix II, Figure II-2/H.242.

Sequence A is viewed as being complete when the following events become true (the order of occurrence is not important).[13]

- A complete CAP has been received while outgoing (transmitted) A remained 0 (i.e. receive framing maintained through a complete capability set).
- The transmitter (MCU) has sent one complete cap sets *since* the incoming A bit became (and stayed) 0.[14]

The terminal then sends a BAS command to indicate that the end of *Sequence A* has been reached.

This terminal determines that the far end is through *Sequence A* by receiving a capability set followed by a BAS command (as described in H.242, ANNEX A). It is noted that this is not a trustworthy mechanism since the inclusion of “default” commands is allowed by H.242 section 12 (although it “might not be a good thing”).

13. Framing and multiframing on the receive channel must be maintained throughout the sequence.

14. According to H.261 Recommendation, only one additional capability is necessary.

Table B-1 BAS Messaging for Sequence A

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
CAP-MARK	F,1	(111)	[24]	0	(off)	-	-	-	-	-	
2B Xfer Cap	F,1	(100)	[17]	0	(off)	-	-	-	-	-	
G.728 Audio Cap	F,1	(100)	[5]	0	(off)	-	-	-	-	-	
CIF Video Cap	F,1	(101)	[21]	0	(off)	-	-	-	-	-	
1/29.97 Video Cap	F,1	(101)	[22]	0	(off)	-	-	-	-	-	
1/29.97 Video Cap	F,1	(101)	[22]	0	(off)	-	-	-	-	-	
μ-law Cap	F,1	(100)	[2]	0	(off)	-	-	-	-	-	
A-law Cap	F,1	(100)	[1]	0	(off)	-	-	-	-	-	
restrict Cap	F,1	(100)	[22]	0	(off)	-	-	-	-	-	
MBE Cap	F,1	(101)	[31]	0	(off)	-	-	-	-	-	
CAP-MARK	F,1	(111)	[24]	0	(off)	-	-	-	-	-	
2B Xfer Cap	F,1	(100)	[17]	0	(off)	-	-	-	-	-	
time passes ...	(continue to cycle caps)					(search for fram alignment)					
G.728 Audio Cap	F,1	(100)	[5]	0	(off)	-	-	-	-	-	
CIF Video Cap	F,1	(101)	[21]	0	(off)	F,1	(111)	[24]	0	(off)	**B CAP-MARK**
1/29.97 Video Cap	F,1	(101)	[22]	0	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
1/29.97 Video Cap	F,1	(101)	[22]	0	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap
μ-law Cap	F,1	(100)	[2]	0	(off)	F,1	(101)	[20]	0	(off)	QCIF Video Cap
A-law Cap	F,1	(100)	[1]	0	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
restrict Cap	F,1	(100)	[22]	0	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
MBE Cap	F,1	(101)	[31]	0	(off)	F,1	(100)	[22]	0	(off)	restrict Cap

Table B-1 BAS Messaging for Sequence A (continued)

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
CAP-MARK	F,1	(111)	[24]	0	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
time passes ...						(searching for multiframe alignment) (Collect Cap Set from other terminal)					up to 320ms
CAP-MARK	F,0	(111)	[24]	0	(off)	F,1	(100)	[17]	0	(off)	**C** mfa achieved, A = 0
2B Xfer Cap	F,0	(100)	[17]	0	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
time passes ...						(waiting for incoming A = 0)					
µ-law Cap	F,0	(100)	[2]	0	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
A-law Cap	F,0	(100)	[1]	0	(off)	F,0	(100)	[5]	0	(off)	**D --* Receive A = 0 *--**
restrict Cap	F,0	(100)	[22]	0	(off)	F,0	(100)	[4]	0	(off)	G.722-T2 Audio Cap
MBE Cap	F,0	(101)	[31]	0	(off)	F,0	(101)	[20]	0	(off)	QCIF Video Cap
	(first cap set after A = 0)										
CAP-MARK	F,0	(111)	[24]	0	(off)	F,0	(101)	[24]	0	(off)	3/29.97 Video Cap
2B Xfer Cap	F,0	(100)	[17]	0	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
G.728 Audio Cap	F,0	(100)	[5]	0	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
CIF Video Cap	F,0	(101)	[21]	0	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
1/29.97 Video Cap	F,0	(101)	[22]	0	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
1/29.97 Video Cap	F,0	(101)	[22]	0	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
µ-law Cap	F,0	(100)	[2]	0	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap
A-law Cap	F,0	(100)	[1]	0	(off)	F,1	(101)	[20]	0	(off)	QCIF Video Cap
restrict Cap	F,0	(100)	[22]	0	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
MBE Cap	F,0	(101)	[31]	0	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
	(second cap set after A = 0)										

Table B-1 BAS Messaging for Sequence A (continued)

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
CAP-MARK	F,0	(111)	[24]	0	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
2B Xfer Cap	F,0	(100)	[17]	0	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
G.728 Audio Cap	F,0	(100)	[5]	0	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
CIF Video Cap	F,0	(101)	[21]	0	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
1/29.97 Video Cap	F,0	(101)	[22]	0	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap
1/29.97 Video Cap	F,0	(101)	[22]	0	(off)	F,1	(101)	[20]	0	(off)	QCIF Video Cap
µ-law Cap	F,0	(100)	[2]	0	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
A-law Cap	F,0	(100)	[1]	0	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
restrict Cap	F,0	(100)	[22]	0	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
MBE Cap	F,0	(101)	[31]	0	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
CAP-MARK	F,0	(111)	[24]	0	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
E	(start Mode Switch)										
CIF Video Cap	F,0	(101)	[21]	0	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
1/29.97 Video Cap	F,0	(101)	[22]	0	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap
1/29.97 Video Cap	F,0	(101)	[22]	0	(off)	F,1	(101)	[20]	0	(off)	QCIF Video Cap
µ-law Cap	F,0	(100)	[2]	0	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
A-law Cap	F,0	(100)	[1]	0	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
restrict Cap	F,0	(100)	[22]	0	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
MBE Cap	F,0	(101)	[31]	0	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
CAP-MARK	F,0	(111)	[24]	0	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
H.230 - SBE	F,0	(111)	[17]	0	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
MCC	F,0	(001)	[0]	0	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap

Table B-1 BAS Messaging for Sequence A (continued)

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
H.230 - SBE	F,0	(111)	[17]	0	(off)	F,1	(101)	[20]	0	(off)	QCIF Video Cap
MCS	F,0	(001)	[20]	0	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
restrict	F,0	(010)	[27]	0	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
64K Xfer	F,0	(001)	[0]	0	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
G.711 μ-law F6	F,0	(000)	[21]	0	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
vid-off	F,0	(010)	[0]	F6	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
LSD-off	F,0	(011)	[0]	F6	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
encrypt-off	F,0	(010)	[7]	F6	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap
LCO	F,0	(010)	[21]	F6	(off)	F,0	(010)	[26]	0	(off)	QCIF Video Cap
Not-Comp 6B-H0	F,1	(101)	[20]	F6	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
MLP-off	F,0	(011)	[16]	F6	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
HSD	F,0	(111)	[16]	F6	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
HSD-off	F,0	(011)	[0]	F6	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
HSD	F,0	(111)	[16]	F6	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**
H-MLP-off	F,0	(011)	[14]	F6	(off)	F,1	(100)	[5]	0	(off)	G.728 Audio Cap
H.230 - SBE	F,0	(111)	[17]	F6	(off)	F,1	(100)	[4]	0	(off)	G.722-T2 Audio Cap
MCC	F,0	(001)	[0]	F6	(off)	F,1	(101)	[20]	0	(off)	QCIF Video Cap
H.230 - SBE	F,0	(111)	[17]	F6	(off)	F,1	(101)	[24]	0	(off)	3/29.97 Video Cap
MCS	F,0	(001)	[20]	F6	(off)	F,1	(101)	[31]	0	(off)	MBE Cap
restrict	F,0	(010)	[27]	F6	(off)	F,1	(100)	[22]	0	(off)	restrict Cap
64K Xfer	F,0	(001)	[0]	F6	(off)	F,1	(100)	[17]	0	(off)	Xfer Cap 2B
G.711 μ-law F6	F,0	(000)	[21]	F6	(off)	F,1	(111)	[24]	0	(off)	**CAP-MARK**

Table B-1 BAS Messaging for Sequence A (continued)

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
time passes ...						(await incoming Mode Switch)					F (A=0 occurs in the reverse direction)
restrict	F,0	(010)	[27]	F6	(off)	F,0	(000)	[21]	0	(off)	G.711 µ-law F6
64K Xfer	F,0	(001)	[0]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
G.711 µ-law F6	F,0	(000)	[21]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
vid-off	F,0	(010)	[0]	F6	(off)	F,0	(000)	[21]	F6	(off)	G.711 µ-law F6
LSD-off	F,0	(011)	[0]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer

Table B-2 BAS Messaging for Capability Exchange

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
	(Cap Set with NS-Cap and video changes)										
CAP-MARK	F,0	(111)	[24]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
G.728 Audio Cap	F,0	(100)	[5]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711µ-law F6
QIF Video Cap	F,0	(101)	[20]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
3/29.97 Video Cap	F,0	(101)	[24]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
µ-law Cap	F,0	(100)	[2]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
A-law Cap	F,0	(100)	[1]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
restrict Cap	F,0	(100)	[22]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
2B Xfer Cap	F,0	(100)	[17]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6

Table B-2 BAS Messaging for Capability Exchange (continued)

Transmit Comments	Transmitted FAS, A-bit	Transmitted BAS Attr.	Transmitted Value	Transmitted Audio Mode	Transmitted Video Rate	Received FAS, A-bit	Received BAS Attr.	Received Value	Received Audio Mode	Received Video Rate	Receive Comments
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
MBE Cap	F,0	(101)	[31]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
NS Cap	F,0	(111)	[30]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
length	F,0	(000)	[6]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
Country Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
Country Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
Manufacturer Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
Manufacturer Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
NS-Cap One	F,0	(000)	[0]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
NS-Cap Two	F,0	(000)	[1]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
CAP-MARK	F,0	(111)	[24]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
G.728 Audio Cap	F,0	(100)	[5]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
QIF Video Cap	F,0	(101)	[20]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
1/29.97 Video Cap	F,0	(101)	[24]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
µ-law Cap	F,0	(100)	[2]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
A-law Cap	F,0	(100)	[1]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
restrict Cap	F,0	(100)	[22]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
2B Xfer Cap	F,0	(100)	[17]	F6	(off)	F,0	(111)	[24]	F6	(off)	**CAP-MARK**
MBE Cap	F,0	(101)	[31]	F6	(off)	F,0	(100)	[5]	F6	(off)	G.728 Audio Cap
NS Cap	F,0	(111)	[30]	F6	(off)	F,0	(100)	[4]	F6	(off)	G.722-T2 Audio Cap
length	F,0	(000)	[6]	F6	(off)	F,0	(101)	[20]	F6	(off)	QCIF Video Cap
Country Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(101)	[24]	F6	(off)	3/29.97 Video Cap
Country Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(100)	[17]	F6	(off)	Xfer Cap 2B

Table B-2 BAS Messaging for Capability Exchange (continued)

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
Manufacturer Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(101)	[31]	F6	(off)	MBE Cap
Manufacturer Code	F,0	(bbb)	[dd]	F6	(off)	F,0	(100)	[22]	F6	(off)	Restrict Cap
NS-Cap One	F,0	(000)	[0]	F6	(off)	F,0	(111)	[24]	F6	(off)	**CAP-MARK**
	(finish current cap)					(End of received caps) (Repeat current bit rate allocations)					
NS-Cap Two	F,0	(000)	[1]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
CAP-MARK	F,0	(111)	[24]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
	(Repeat current bit rate allocations)										
H.230 - SBE	F,0	(111)	[17]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
MCC	F,0	(000)	[19]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
H.230 - SBE	F,0	(111)	[17]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
MCS	F,0	(001)	[20]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
restrict	F,0	(010)	[27]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711µ-law F6
64K Xfer	F,0	(001)	[0]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
G.711µ-law F6	F,0	(000)	[19]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
vid-off	F,0	(010)	[0]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
LSD-off	F,0	(011)	[0]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
encrypt-off	F,0	(010)	[7]	F6	(off)	F,0	(001)	[0]	F6	(off)	64K Xfer
LCO	F,0	(010)	[21]	F6	(off)	F,0	(000)	[19]	F6	(off)	G.711 µ-law F6
Not-Comp 6B-H0	F,0	(010)	[26]	F6	(off)	F,0	(010)	[27]	F6	(off)	restrict
MLP-off	F,0	(011)	[16]	F6	(off)	F,0	(010)	[1]	F6	(off)	H.261 (video on)
HSD - SBE	F,0	(111)	[16]	F6	(off)	F,0	(001)	[0]	F6	6.4	64K Xfer

Table B-2 BAS Messaging for Capability Exchange (continued)

Transmit Comments	Transmitted					Received					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
HSD-off	F,0	(011)	[0]	F6	(off)	F,0	(000)	[19]	F6	6.4	G.711 µ-law F6
HSD - SBE	F,0	(111)	[16]	F6	(off)	F,0	(010)	[27]	F6	6.4	restrict
H-MLP-off	F,0	(011)	[14]	F6	(off)	F,0	(010)	[1]	F6	6.4	H.261 (video on)
H.230 - SBE	F,0	(111)	[17]	F6	6.4	F,0	(001)	[0]	F6	6.4	64K Xfer
MCC	F,0	(001)	[0]	F6	6.4	F,0	(000)	[19]	F6	6.4	G.711 µ-law F6

Table B-3 BAS Messaging for Including Additional Channel

Transmit Comments	Transmitted on I-Channel					Received on I-Channel					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
G 64K Xfer	FF,01	(001)	[0]	F6	(off)	F-,0-	(000)	[21]	F6	6.4	G.711µ-law
G.711 µ-law F6	FF,01	(000)	[21]	F6	(off)	F-,0-	(010)	[1]	F6	6.4	H.261 (video on)
						(searching for frame alignment in channel No. 2)					
video-off	FF,01	(010)	[0]	F6	(off)	F-,0-	(001)	[0]	F6	6.4	64K Xfer
LSD-off	FF,01	(011)	[0]	F6	(off)	F-,0-	(010)	[27]	F6	6.4	restrict
H.230 - SBE	FF,01	(111)	[17]	F6	(off)	**FF,01**	(000)	[21]	F6	6.4	G.711µ-law
H MCC	FF,01	(001)	[0]	F6	(off)	FF,01	(010)	[1]	F6	6.4	H.261 (video on)
time passes ...						(finding mfa and buffering to synchronize)					
I Send A = 0	FF,00	(111)	[17]	F6	(off)	FF,01	(001)	[0]	F6	6.4	64K Xfer
on channel No. 2.	FF,00	(001)	[20]	F6	(off)	FF,01	(010)	[27]	F6	6.4	restrict

Table B-3 BAS Messaging for Including Additional Channel (continued)

Transmit Comments	Transmitted on I-Channel					Received on I-Channel					Receive Comments
	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	FAS, A-bit	BAS Attr.	Value	Audio Mode	Video Rate	
	xx	bbb	dd	xx	xx	xx	bbb	dd	xx	xx	
restrict	FF,00	(010)	[27]	F6	(off)	FF,01	(000)	[21]	F6	6.4	G.711 µ-law F6
time passes ...						(Waiting for incoming $A_2 = 0$)					
J incoming A2 = 0	FF,00	(010)	[7]	F6	(off)	FF,00	(010)	[1]	F6	6.4	H.261 (video on)
start mode switch	FF,00	(010)	[21]	F6	(off)	FF,00	(001)	[0]	F6	6.4	64K Xfer
to expand video	FF,00	(010)	[26]	F6	(off)	FF,00	(010)	[27]	F6	6.4	restrict
Xfer Rate 2x64	FF,00	(001)	[1]	F6	(off)	FF,00	(000)	[21]	F6	6.4	G.711 µ-law F6
H.261 (video on)	FF,00	(010)	[1]	F6	(off)	FF,00	(010)	[1]	F6	6.4	H.261 (video on)
MLP-off	FF,00	(011)	[16]	F6	61.0	FF,00	(001)	[0]	F6	6.4	64K Xfer
HSD - SBE	FF,00	(111)	[16]	F6	61.0	FF,00	(010)	[27]	F6	6.4	restrict
HSD-off	FF,00	(011)	[0]	F6	61.0	FF,00	(000)	[21]	F6	6.4	G.711 µ-law F6
HSD - SBE	FF,00	(111)	[16]	F6	61.0	FF,00	(010)	[1]	F6	6.4	H.261 (video on)
H-MLP-off	FF,00	(011)	[14]	F6	61.0	FF,00	(001)	[0]	F6	6.4	64K Xfer
H.230 - SBE	FF,00	(111)	[17]	F6	61.0	FF,00	(010)	[27]	F6	6.4	restrict
MCC	FF,00	(001)	[0]	F6	61.0	FF,00	(000)	[21]	F6	6.4	G.711µ-law F6
H.230 - SBE	FF,00	(111)	[17]	F6	61.0	FF,00	(010)	[1]	F6	6.4	H.261 (video on)
MCS	FF,00	(001)	[20]	F6	61.0	FF,00	(001)	[0]	F6	6.4	64K Xfer
time passes ...	(continue to cycle BAS commands)					(waiting for incoming Mode Switch)					**K**
64K Xfer	FF,00	(001)	[0]	F6	61.0	FF,00	(010)	[0]	F6	6.4	Video off
G.711 µ-law F6	FF,00	(000)	[21]	F6	61.0	FF,00	(001)	[1]	F6	(off)	Xfer rate 2x64
H.261 (video on)	FF,00	(010)	[1]	F6	61.0	FF,00	(010)	[1]	F6	(off)	H.261 (video on)
LSD-off	FF,00	(011)	[3]	F6	61.0	FF,00	(000)	[21]	F6	61.0	G.711µ-law F6