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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Communication
procedures

**Procedures for establishing communication
between three or more audiovisual terminals
using digital channels up to 1920 kbit/s**

ITU-T Recommendation H.243



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ITU-T Recommendation H.243

Procedures for establishing communication between three or more audiovisual terminals using digital channels up to 1920 kbit/s

Summary

This Recommendation concerns the system operation for a conference call between three or more audiovisual terminals conforming to ITU-T Rec. H.320.

This revised version of ITU-T Rec. H.243 introduces a number of enhancements and clarifications to the previous version, primarily the description on the usage of Unicode characters in H.320 systems.

Source

ITU-T Recommendation H.243 was approved on 7 October 2005 by ITU-T Study Group 16 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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

NOTE

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

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ITU-T Recommendation H.243

Procedures for establishing communication between three or more audiovisual terminals using digital channels up to 1920 kbit/s

1 Scope

This Recommendation concerns the system operation for a conference call between three or more audiovisual terminals. It is applicable to a single MCU containing an audio mixer and a video switch according to the provisions of ITU-T Rec. H.231, to calls involving two such MCUs, and to calls involving three or more MCUs in a star configuration. It is also applicable to MCUs containing a video mixer. ITU-T Recs H.233 and H.234 address issues concerning the use of the Encryption Control Signal (ECS). ITU-T Rec. H.242 provides for communication between two audiovisual terminals connected point to point, using the frame structure defined in ITU-T Rec. H.221. ITU-T Rec. H.230 defines a number of Control and Indication signals, including those used in the multipoint communication procedures described in this Recommendation.

Three or more audiovisual terminals may be put into communication to form a conference call, by means of one or more Multipoint Control Units (MCU). The general principles of multipoint communication are described in ITU-T Rec. H.231. The means by which digital channels are established between terminals and MCUs, and between MCUs, is outside the scope of this Recommendation (see ITU-T Rec. H.200/AV.420).

It should be noted that the physical realization of an MCU may be such that two or more independent conferences may be set up within the same unit; logically, however, there is no relationship between these conferences; the text herein refers to an MCU only as a logical entity pertinent to the particular call of concern.

This Recommendation concerns only the flow of signals along the fixed digital paths, which may be at 64 kbit/s (56 kbit/s in certain networks) or multiples thereof up to 1920 kbit/s. The flow consists of a multiplex of audio, video, control and indication signals, and optional user data as defined in ITU-T Rec. H.221 which must be handled by the MCU in a way which is satisfactory to the users.

The signal multiplex on each path is fully in accordance with ITU-T Rec. H.221: the BAS commands define explicitly how the demultiplexer at the end of each link shall operate. Likewise, the basic procedures for initialization and mode switching are fully in accordance with those defined in ITU-T Rec. H.242 for point-to-point working. However, the composition of the multiplexed signal transmitted by each terminal and by the MCU is determined by terminal procedures and multipoint system procedures, as follows:

- a) Terminal procedures are defined in service-specific system Recommendations, such as ITU-T Rec. H.320 for visual telephony.
- b) Multipoint system procedures are defined in this Recommendation and are not of themselves service-specific.
- c) ITU-T Rec. T.120: by making use of the T series, MCU and terminal procedures may be greatly enhanced, offering far more sophisticated specific applications to the user. Such enhancement is outside the scope of this Recommendation, although interactions with specific T.120 methods are described here.

For definitions of terms used in this Recommendation, see ITU-T Rec. H.231; for definitions of SBE and MBE symbols, see ITU-T Rec. H.230.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-T Recommendation G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.
- ITU-T Recommendation G.722 (1988), *7 kHz audio-coding within 64 kbit/s*.
- ITU-T Recommendation G.728 (1992), *Coding of speech at 16 kbit/s using low-delay code excited linear prediction*.
- ITU-T Recommendation H.221 (2004), *Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices*.
- ITU-T Recommendation H.224 (2005), *A real time control protocol for simplex applications using the H.221 LSD/HSD/MLP channels*.
- ITU-T Recommendation H.230 (2004), *Frame-synchronous control and indication signals for audiovisual systems*.
- ITU-T Recommendation H.231 (1997), *Multipoint control units for audiovisual systems using digital channels up to 1920 kbit/s*.
- ITU-T Recommendation H.233 (2002), *Confidentiality system for audiovisual services*.
- ITU-T Recommendation H.242 (2004), *System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s*.
- ITU-T Recommendation H.261 (1993), *Video codec for audiovisual systems at $p \times 64$ kbit/s*.
- ITU-T Recommendation H.262 (2000) | ISO/IEC 13818-2:2000, *Information technology – Generic coding of moving pictures and associated audio information: Video*.
- ITU-T Recommendation H.263 (2005), *Video coding for low bit rate communication*.
- ITU-T Recommendation H.320 (2004), *Narrow-band visual telephone systems and terminal equipment*.
- ITU-T Recommendation H.321 (1998), *Adaptation of H.320 visual telephone terminals to B-ISDN environments*.
- ITU-T Recommendation Q.931 (1998), *ISDN user-network interface layer 3 specification for basic call control*.
- ITU-T Recommendation T.120 (1996), *Data protocols for multimedia conferencing*.
- ITU-T Recommendation T.122 (1998), *Multipoint communication service – Service definition*.
- ITU-T Recommendation T.123 (1999), *Network-specific data protocol stacks for multimedia conferencing*.
- ITU-T Recommendation T.124 (1998), *Generic Conference Control*.
- ITU-T Recommendation T.125 (1998), *Multipoint communication service protocol specification*.

- ISO 639-1: 2002, *Codes for the representation of names of languages – Part 1: Alpha-2 code*.
- ISO/IEC 10646 (2003), *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*.

3 Conventions

In this Recommendation, the word "shall" is used to indicate a mandatory requirement, while the word "should" is used to indicate an option or a suggestion.

4 Capabilities and "selected" communication modes

The MCU shall send appropriate capabilities, according to the type of communication intended. Table 2/H.231 lists the MCU types classified as "Listed", showing the capabilities which each will be able to declare if the terminals connected have appropriate capabilities and the modes it will be able to transmit.

For each conference call, a "Selected Communication Mode (SCM)" is identified in the MCU. During the call, the MCU strives to maintain this SCM as that transmitted bidirectionally between itself and all terminals, and between itself and other MCUs. The exceptions are those channels where mode-0 forcing (ITU-T Rec. H.242) has been applied or, in some cases, where data is temporarily being transmitted. Table 1 gives some examples of SCM which could be specified for the listed MCUs of ITU-T Rec. H.231. The SCM may include one or more data channels.

Table 1/H.243 – Examples of selected communication modes

Transfer rate	MCU Type (according to Table 2/H.231)						Code	
	A	B(d)	C	C(d)	D	D(d)		
64/56 kbit/s	a8+v	a6+d6400 a7+d8000					a1	A-law,0U
							a2	μ-law,0U
							a3	A-law,0F
2 × 64/56 kbit/s			a3/4+v a7+v	a8+v+d6400 a7+v+d8000			a4	μ-law,0F
							a5	Rec. G.722, m1
							a6	Rec. G.722, m2
128 kbit/s					a8+v a7+v		a7	Rec. G.722, m3
							a8	Rec. G.728
							v	H.261-ON
384 kbit/s					a6+v	a6+v a6+v+d64k	d6400	LSD
							d8000	LSD
							d64k	HSD
							r	restrict

The following sample methods may be used to determine the SCM; other methods are feasible:

- 1) The SCM may be fixed as a permanent feature of the MCU as manufactured.
- 2) The MCU may provide for several possible values of SCM, and one of these is specified by the service provider or at the time of booking the call.
- 3) The SCM is selected automatically within the MCU according to the capabilities of the terminals connected.

NOTE 1 – The algorithm for this selection is outside the scope of this Recommendation; for example, the SCM is set at the value transmitted by the first terminal to access the MCU; or the highest common mode of all primary terminals is selected; or the SCM is set at the value transmitted by the chair-control terminal, if any.

- 4) The SCM is set by utilizing procedures effectuated using T.120-series protocols.

In the cases 2, 3 and 4 it is also possible that the SCM may change during the course of the call. It is not mandatory that the MCU have all of these methods available but it should be clear to the user and service provider what method is in force.

NOTE 2 – Where there are several modes common to the connected terminals (e.g., both 16 kbit/s and wideband audio), implementers should document what method is used to determine which one is selected. It should be noted that the power of the MCU to control the mode transmitted by a terminal is limited to a determination of the rates of audio, video and any data paths; it cannot set the video mode CIF or QCIF except by limiting the SCM to QCIF via capability changes, nor the audio mode where there is a choice at one bit rate (for example: ITU-T Recs G.711 or G.722 at 56 kbit/s). Specifically, if the MCU sends the BAS command for ITU-T Rec. G.711 at 56 kbit/s, the terminal may respond with either ITU-T Rec. G.711 at 56 kbit/s or with ITU-T Rec. G.722 at 56 kbit/s without this being considered a violation of MCC. In the situation just described, a terminal that responded with ITU-T Rec. G.728 at 16 kbit/s would be in violation of MCC since G.728 and G.711-56 use different bit rates within the H.221 multiplex.

When advanced video modes such as H.262/H.263 are used, the MCU may make use of Multipoint Mode Symmetrize (MMS), which is supported by all terminals with such advanced video capabilities to require video mode symmetry, including CIF/QCIF symmetry, for all modes. When in receipt of MMS, terminals shall respond to the MCU with whatever video, audio, and/or data modes they receive. If the MCU does not make use of MMS, terminals are free to follow the mode asymmetry allowed by MCC, e.g., to send H.263 while receiving H.261.

The MCU is bound by the hierarchy of advanced video modes as described in Figure A.1/H.320 such that an MCU with H.263 capability shall have H.261 capability, and an MCU with H.262 capability shall have H.263 and H.261 capability. The MCU may choose to exclude a video capability for the purpose of maintaining a particular SCM, during which the hierarchy would be violated, e.g., the MCU might have only H.262 in the capability set. However, MMS/H.230 should be used for maintaining control over video modes. Note that MMS support is required for all terminals that support advanced video modes such as H.262 and H.263.

At the start of a call, the capset transmitted by the MCU shall be that which corresponds to SCM; for brevity this is referred to below as "SCM-cap". Any terminal which is found, from its declared capset, not to be capable of transmitting the SCM will be given secondary treatment (see 13.1). Secondary status may be audio-only, or audio/data only, or some other status as determined by the MCU manufacturer. Later on in the call the MCU must transmit such capabilities as meet its immediate needs with respect to controlling the information transmitted to it; this may still be SCM-cap, or indeed there may be a change of SCM itself during the call.

The conference participants may initiate out-of-band changes if the network and MCU support them. The connection of single- and multiple-channel (e.g., 2B and 128 kbit/s or 6B and 384 kbit/s) terminals into the same multipoint call is provided by SM-comp and 6B-H0-comp as defined in ITU-T Rec. H.221.

The **only** condition that removes a capability from a terminal's capability set is the transmission of a new capability set lacking the capability being removed. Other events, such as a brief loss of framing, initiation of loopbacks, movement to secondary status, etc. shall not be assumed by the MCU to have resulted in a change to a terminal's capability set. See ITU-T Rec. H.242 for a detailed discussion of capability exchanges.

The MCU should not assume that because a terminal supports MBEs that it is capable of supporting all or any particular sub-set of standard MBE messages except as is indicated by its capability set.

Terminals should, to allow the MCU to function more effectively, declare their full capability set and keep that set in effect without unnecessary changes that may result in an oscillating SCM.

A terminal may use the procedure of 9.5/H.242 to request that a particular mode or allocation of bit rate (e.g., ITU-T Rec. G.728) be used in the SCM. The MCU should attempt to meet this request, but is not obligated to do so. A slave MCU shall pass such requests to the master MCU for action. MCUs are not required to provide exactly what the terminal has requested; a "best effort" may be attempted. The method by which an MCU determines such a "best effort" is left to the manufacturer.

5 Initialization procedures for establishing communication between standard terminals and an MCU

The initialization procedure is very similar to that between two terminals, as specified in ITU-T Rec. H.242.

All terminals shall synchronize their outgoing transmissions to the bit rate incoming from the local MCU when they receive MCC from the MCU. Terminals should avoid mode 0 forcing when in receipt of MCC from an MCU unless justified for communication reasons. The following description of the procedure assumes that video and data are included in the communication; however, for conference calls not including video, or data, or both, essentially the same applies.

When the connection has been established, each terminal transmits a signal according to ITU-T Rec. H.221; it sends its capabilities and is waiting to receive frame structure and capabilities, as described in ITU-T Rec. H.242, with transmission in mode 0F only. There may then be additional procedures, such as identity checking, to be carried out before the terminal is added to the conference but after the MCU sends MCC to the terminals.

5.1 First terminal added to conference

The MCU transmits its SCM-cap and the C&I symbols MCC and MIZ (see ITU-T Rec. H.230) immediately after the final cap-mark and command (see Table 2/H.242), indicating that a conference call is being set up, that no other terminals are yet connected and the user should wait.

Until the audio coding law for the terminal is determined and if necessary, set properly, the MCU should not add the terminal's audio signal to the audio mix. At the discretion of the manufacturer, the MCU should also do one of the following:

- 1) Send the audio-off command to the terminal.
- 2) Send silence or an optional audio-message to the terminal.
- 3) Send audio and rely on the terminal to mute the output.

In the above list, 1 and 2 are to be preferred over 3 since not all terminals will reliably mute the output in this circumstance. However, 3 has been included for reasons of backward compatibility with earlier versions of this Recommendation.

The MCU finds incoming frame alignment and registers the capability of this first terminal, which it designates T_A ; if the terminal is not capable of transmitting the SCM, a different procedure is followed (see 13.1).

The video seen by the first terminal is up to the discretion of the MCU manufacturer. VIR can be ignored without any ill effect.

Data

- If the terminal has requested that an LSD or HSD channel be opened, the MCU may open the channel at this time at the discretion of the manufacturer. The MCU should provide idle bits to non-H.224-capable terminals and it should connect H.224-capable terminals to the data mixer in loopback mode.
- If the terminal is T.120 or H.224-MLP¹-capable, the MCU may open the MLP channel to the terminal and connect it to a data conferencing unit.

The MCU may defer opening of MLP data channels to a later time, such as when a predetermined number of terminals is present.

5.2 Second terminal added to conference

The MCU transmits its SCM-cap followed by MCC indicating that a conference call is being set up.

Until the audio coding law for the terminal is determined and if necessary, set properly, the MCU should not add the terminal's audio signal to the audio mix. At the discretion of the manufacturer, the MCU should also do one of the following:

- 1) Send the audio-off command to the terminal.
- 2) Send silence or an optional audio message to the terminal.
- 3) Send audio and rely on the terminal to mute the output.

In the above list, 1 and 2 are to be preferred over 3 since not all terminals will reliably mute the output in this circumstance. However, 3 has been included for reasons of backward compatibility with earlier versions of this Recommendation.

The MCU finds incoming frame alignment and registers the capability of the second terminal T_B ; if the terminal is not capable of transmitting the SCM, a different procedure is followed (see clause 13). When the MCU is receiving $A = 0$ from both terminals, the audio and video paths are set up as follows.

Audio

- Both the (decoded) audio signals are connected to the audio mixer; the symbol Cancel-MIZ is sent to terminal T_A .
- The normal working audio command is transmitted and the appropriate mixer outputs are connected at the next submultiframe.

Video

- If video signals are being received from either or both terminals, they are forwarded via the video switch using the proper mode switching procedure (see ITU-T Rec. H.242) and a fast update request VCU (see ITU-T Rec. H.230) is sent towards the transmitter(s) of those signals.
- If VIR (see ITU-T Rec. H.230) is received from either or both terminals, this is forwarded.

Data

- If one of the terminals has requested that an LSD or HSD channel be opened, the MCU may open the channel at this time.
- If both terminals are T.120 or H.224-MLP-capable, the MCU may open the MLP channel to the second terminal, and connect both to a data conferencing unit.

¹ Note that H.224-capable terminals are required to be able to make use of both the LSD and the MLP channels.

The MCU may defer opening of data channels to a later time, such as when a predetermined number of terminals is present.

5.3 Third terminal added to conference

The MCU transmits its SCM-cap followed by MCC indicating that a conference call is being set up.

Until the audio coding law for the terminal is determined and if necessary, set properly, the MCU should not add the terminal's audio signal to the audio mix. At the discretion of the manufacturer, the MCU should also do one of the following:

- 1) Send the audio-off command to the terminal.
- 2) Send silence or an optional audio-message to the terminal.
- 3) Send audio and rely on the terminal to mute the output.

In the above list, 1 and 2 are to be preferred over 3 since not all terminals will reliably mute the output in this circumstance. However, 3 has been included for reasons of backward compatibility with earlier versions of this Recommendation.

The MCU finds incoming frame alignment and registers the capability of the third terminal T_C ; if the terminal is not capable of transmitting the SCM, a different procedure is followed (see 13.1). When the MCU is receiving $A = 0$ from T_C , the audio and video paths are set up as follows.

Audio

- The (decoded) audio signal is connected to the audio mixer.
- The normal working audio command is transmitted and the appropriate mixer output is connected at the next submultiframe.

Video

- If video signals are being received from either or both terminals T_A , T_B , one of them (default T_A) is transmitted to T_C via the video switch using the proper mode switching procedure (ITU-T Rec. H.242) and a fast update request VCU (see ITU-T Rec. H.230) is sent towards the transmitter(s) of that signal; when video is received from T_C , it may optionally be transmitted to both T_A and T_B , in which case VCU is sent to T_C .
- If VIR is received at the MCU, it may be ignored without ill effect.

Data

- If an LSD or HSD channel is open in the conference, the channel should be opened to the new terminal.
- If the new terminal is T.120 or H.224-capable, the MCU may open the MLP channel to the third terminal, and connect it to the data conferencing unit.

5.4 Fourth and subsequent calls added to conference

The procedure followed is essentially that of 5.3 above.

5.5 Extension to multiple channels

If the intended SCM of the conference communication involves multiple channels, then the transmitted MCU transfer-rate capability reflects the appropriate rate to all terminals, and the additional channels are set up according to the procedures defined in ITU-T Recs H.242, H.221, and Q.931 and/or 7.2 as appropriate.

Having received MCC, the terminals cannot transmit at the higher transfer rate until the MCU does so, which could be when the other terminals are all ready, or after a time-out, or when at least one terminal has all the requested additional channels available; the MCU itself adopts the higher rate

and the terminals shall follow suit. In the event that some connections do not reach the desired number of additional channels, the MCU may downrate the corresponding terminals to secondary status by sending them MIS, or dropping them or by following some other procedure as determined by the manufacturer, and proceed normally with the rest.

5.6 Other standard terminals

The support of non-H.320 terminals by an H.243 MCU is optional.

Ordinary PSTN terminals that do not support ITU-T Rec. H.221 may optionally be supported by the MCU. Such calls may make use of the same network addresses as the H.320 terminals, or different network addresses as determined by the manufacturer. As each call arrives, it is added to the audio mixer. The manufacturer may optionally require a DTMF password prior to attachment to the audio mixer. The manufacturer may optionally transcode to the current audio coding, or change the SCM to include the appropriate G.711 coding. If the PSTN call is first in the conference, treatment is determined by the manufacturer (either loop-back or no connection to the audio mixer).

T.120 terminals that do not support ITU-T Rec. H.221 may optionally be supported by the MCU. Such connections may make use of the same network addresses as the H.320 terminals, or different network addresses as determined by the manufacturer. As each call arrives, it is added to the T.120 data conference. It is the responsibility of the MCU data conferencing module to use T.123 flow control to ensure that the data rate in the non-H.221 connections matches the current T.120 data rate which is less than or equal to the MLP channel rate specified by the conference SCM. Examples of non-H.221 connections include PSTN calls using the PSTN stack of T.123 or LAN connections using one of the various LAN stacks of ITU-T Rec. T.123.

H.321 (H.320 on Broadband ISDN (B-ISDN)) terminals may also be optionally supported by the MCU. Since these terminals are H.320-compatible, the procedures for H.320 terminals shall be followed. The MCU shall support B-ISDN parameters as described in ITU-T Rec. H.321 if this optional feature is provided.

5.7 MCU-MCU interconnections

Cascading of MCUs is an optional feature. Also, master/slave operation is an optional mode of operation for cascaded MCUs which is required for many features, but not for simple cascading. Finally, the construction of a slave-only MCU that does not return MIM is allowed, but note that a cascade of slave-only MCUs is not possible except via simple cascading.

5.7.1 Initialization

The following applies to interconnection of two, three or more MCUs.

After each initial channel between MCUs has been established, each MCU sends its current capability set as it would to a terminal, following this up with MCC as in 5.1. Each becomes aware of the presence of the other MCU by virtue of receiving MCC from it.

During call set-up, the circumstance may arise that one MCU is connected only to another and not to any terminal: it should not then transmit an optional audio message as in 5.1, but the symbol MIZ (see ITU-T Rec. H.230) is included in the outgoing BAS codes. Then, when a terminal is first connected, Cancel-MIZ is transmitted to the other MCU, and the audio from that terminal is forwarded via the mixer.

When an MCU has established communication with a first terminal, and on a second port is receiving MIZ in conjunction with MCC, it does not proceed to 5.2 until either it receives Cancel-MIZ on the inter-MCU port or is itself connected to a second terminal.

In general, each MCU treats each other MCU as though it were a terminal, making decisions as to transmitted mode and BAS values according to the incoming capabilities, and switching video as appropriate. However, it is necessary to ensure that, where there is a choice of bit rate for video, the

same is chosen by both MCUs. When one MCU has been designated master, the slave shall symmetrize to the rates transmitted by the master.

In basic operation where no master is specified (that is, apart from the enhanced procedures described in clauses 7, 8 and 9) the following are mandatory for unrestricted operation:

- a) If both MCUs have declared G.722-48, the transmission of audio shall be G.722 at 56 kbit/s only.
- b) If both MCUs have declared G.728 audio and G.722-48, 56 kbit/s G.722 shall be used.
- c) If both MCUs have declared G.728 but not G.722 audio, G.728 shall be used.
- d) If the declared video modes are asymmetric, the highest common mode according to the video algorithm hierarchy of Figure A.1/H.320 and Annex A/H.320 shall be used by both MCUs.

For restricted operation, substitute G.722 at 48 kbit/s for G.722 at 56 kbit/s in the above cases.

An MCU M1 receiving VCU from another MCU M2 shall forward this symbol to the terminal or other MCU which is the current source of the video it is transmitting to M2; if M1 receives VCF from M2, it shall forward this symbol to those terminals and/or MCUs (if any) to which it is sending the video signal received from M2. An MCU should respond to VCU and VCF from terminals in the same way as it responds to those symbols from MCUs.

5.7.2 Designation of master MCU

In order for the procedures of clauses 7, 8 and 9 to operate properly in the cascaded case, one of the MCUs must take on the master role. If the procedures of clauses 7, 8 and 9 are not used, a master/slave relationship need not be established for simple operation as described in 5.7.1. It may be desired for operational reasons that for a star configuration of 3 or more MCUs (see clause 6/H.231) the master be that at the centre, but this is not required if all the MCUs are MIH-capable.

MCUs should designate a master in a cascade even if the procedures of clauses 7, 8 and 9 are not being used in order to avoid overuse of the contention resolution principle. MCUs should use the contention resolution principle once to establish mastership, and thus avoid additional use of the contention resolution principle.

5.7.2.1 Master designated prior to the call

When an MCU pre-administered to be master is connected to another (which it recognizes by receipt of MCC therefrom), it sends MIM, ignoring any MIM signal received as a result of procedure of 5.7.2.2. If a call involves two MCUs that have both been configured as master MCU prior to the call, a manual procedure may be followed to resolve the conflict, or the contention resolution principle of 13.2 may be followed as described in 5.7.2.4.

5.7.2.2 Automatic designation of master in the dumb-bell case

If an MCU receives the symbol MCC at one port, and has not also received MIM at that port, it carries out the contention resolution procedure of 13.2; if the result is that it sent a lower number than it received, it assumes the master role and transmits the symbol MIM to the other.

5.7.2.3 Automatic designation of the master when 3 or more MCUs are involved

This subclause is based on the assumption that a master has been established initially, either via pre-administration, or via the procedure of 5.7.2.2. For consideration of the case when two domains of MCUs, each with its own master, are merged, see 5.7.2.4.

In the dumb-bell or star configuration, where each slave is directly connected to the master, as each new MCU attaches to the master and receives MCC and MIM, it becomes a slave.

For situations where MCUs are not connected directly to the master, the procedures are the same, with an MCU that is already a slave sending MIM to an MCU as it connects to the hierarchy. From the viewpoint of the new MCU, the "slave" is its master, but the "slave" MCU merely passes commands up the hierarchy and awaits the true master's response. No more than one MIM shall be processed at the same time by a given slave to avoid confusion.

Note that slave MCUs that are not connected directly to the master must have the Multipoint Indicate Hierarchy (MIH) capability in their capset. This capability allows an MCU to distinguish between an MCU that cannot support multi-level hierarchies and one that can. Since multi-level hierarchies involve additional operations on both the master and each level of slave, all MCUs in a hierarchy of three levels or more must have MIH capability.

Such master/slave networks need not have the master MCU in the centre; the master may be at the "root" of a tree of slave MCUs. This procedure should not be used without the use of ITU-T Rec. T.120 for control for more than a total of 3 layers of MCUs due to the BAS processing delays that accumulate as the hierarchy grows.

5.7.2.4 Domain mergers for master/slave domains

Whenever a group of MCUs with a designated master (perhaps a single MCU pre-administered as being a master) is joined to another such group, the conflict may be removed via administration. However, the conflict may automatically be removed via the use of the contention resolution principle. The following cases exist:

- a) The masters are directly connected: Each receives MIM, and the contention is resolved via the use of the contention resolution principle. One MCU and its entire sub-tree of slaves becomes a slave of the winning MCU.
- b) The masters are connected via one or more slave MCUs.

NOTE – These procedures are supported by MCUs with MIH capability.

When the slave receives a second MIM, it forwards it up the tree to the master, which responds by making use of the contention resolution principle. A slave shall store the path by which MIM came to that slave so that it will be able to conduct the contention resolution principle with the correct port. No more than one application of the contention resolution principle can be under way at a given point in time on a particular MCU. The timers described in the contention resolution principle should be extended by an amount determined by the manufacturer. The amount the timers are extended should be a function of the number of MCUs in the conference.

MCU re-numbering during domain merger is described in 7.3.1.1.

5.8 Closure of conference

If the conference is closed by sequentially dropping terminals, then when only one remains connected it should be sent MIZ to allow the user to understand explicitly the reason for loss of video from the dropped terminal, etc.

5.9 User-initiated connection establishment

Terminals may dial in to an MCU that is appropriately configured for a dial-in conference. The MCU may also be constructed to support dynamic dial-out as well as pre-set dial-out to establish connections. Dynamic dial-out operations may be controlled, for example, either via the use of T.124 operations for T.120-equipped terminals, or via the use of so-called "BAS DTMF" commands using the numerics described in ITU-T Rec. H.230 for non-T.120-equipped terminals, or via some other method. The sequence of numerics used to initiate dial-out during an ongoing conference is beyond the scope of this Recommendation. Methods for dealing with the capacity

exhaustion in the MCU that may result from user-initiated dial-out are also beyond the scope of this Recommendation.

6 Video switching and mixing

6.1 Video switching procedure

There are two cases to be considered: in some MCUs the video signal is switched without any processing, whereas in others the video may be processed such that when the switching is carried out there is no discontinuity in the error-correction framing in the outgoing signals.

6.1.1 No video mixing

When it is decided within the MCU that terminal A, currently receiving the video signal from terminal B, should instead be sent from terminal C, the following procedure is used (codes VCF, VCU are specified in ITU-T Rec. H.230).

- a) The MCU transmits VCF to terminal A at an appropriate moment, and then switches video such that the picture from C is transmitted towards A.
- b) Terminal A receives VCF, and freezes its currently displayed picture; it ignores subsequent decoded video information, but continues to track the error-correction framing, and to monitor Picture Headers for the Freeze Picture Release command.
- c) When incoming video to A changes from B-picture to C-picture, error-correction frame alignment is lost, and will take a time T to recover, dependent on the video bit rate and other factors (refer to ITU-T Rec. H.242).
- d) After a time greater than T, the MCU transmits VCU to terminal C.
- e) On receipt of VCU, terminal C sends its next video frame in "fast-update" mode (see 4.3.2/H.261, H.262 and H.263), together with the Freeze Picture Release command².
- f) On receipt of the Freeze Picture Release command, terminal A reverts to displaying the incoming decoded picture.

NOTE – Users at other terminals which have been receiving picture C continuously during the above procedure will nevertheless be aware of the switching action because of the use of the fast-update mode: this is the transmission of a single new picture over a period inversely proportional to video bit rate – at 320 kbit/s this period is likely to be about 0.5 seconds.

An MCU capable of video mixing may also be able to speed up video switching by eliminating error-correction framing changes, thereby eliminating the need for resynchronization in the terminal; this requires no additional standardization and is left to the discretion of the manufacturer.

6.1.2 With video mixing

The method of switching for a video mixing MCU is as follows.

When it is decided within the MCU that terminal A, currently receiving the video signal from terminal B via the video mixer, should be sent from terminal C instead of terminal B, the following procedure is used (codes VCF, VCU are specified in ITU-T Rec. H.230):

- a) The MCU informs the video mixer that the signal from terminal B is being switched away at an appropriate moment, and then switches video such that the picture from C is transmitted towards the video mixer.

² In both ITU-T Recs H.261 and H.263, the Freeze Picture Release is contained in the PTTYPE field. In ITU-T Rec. H.262, the Freeze Picture Release is sent as described in Annex A/H.320. In all three cases, the Freeze Picture Release is contained in the video stream.

- b) Terminal A continues to receive video framing, and notices no discontinuity from this switch. However, the video mixer may insert FEC fill blocks, or a blank screen or other image (e.g., a loop repeating the previous complete image) while it is finding error-correction frame alignment from terminal C. This recovery will take a time T to occur, dependent on the video bit rate and other factors (see ITU-T Rec. H.242).
- c) After a time greater than T or when framing is recovered, the MCU transmits VCU to terminal C.
- d) On receipt of VCU, terminal C sends its next video frame in "fast-update" mode (see 4.3.2/H.261, H.262 and H.263), together with the Freeze Picture Release command. The video mixer is responsible for removing the Freeze Picture Release command from the H.261, H.262, or H.263 stream. When freeze picture release arrives from terminal C, the video mixer stops transmitting whatever image it has been sending toward terminal A and sends the image from terminal C.

Note that in the above procedure, switches occur on picture boundaries. More than one sub-part of the mixed image, up to and including the total number of images being mixed, may be switched at the same time. This is accomplished by repeating the above steps in parallel for each terminal being switched.

6.2 Video mixing

A generally desirable feature of audiovisual conferencing is the ability to simultaneously view more than one site other than the viewer's site, optionally including the viewer's site as well. The MCU can provide this feature which will be referred to as video mixing without regard to how many sites are visible at a time. The architecture of this subclause places video mixing at the MCU. While the terminals are in receipt of a mixed video image, they may send a mixed image (e.g., split screen) but note that two levels of video mixing may result in an image of little usefulness.

Figure 1 shows four independent H.221 multimedia multiplexes entering an MCU, being demultiplexed into their composite media streams, and the video streams being mixed by a video mixer to produce a single composite image. There are two general ways the video processor can operate:

- by implementing a full video decode/encode cycle with picture composition in the pel domain;
- by implementing a partial or zero decode combined with picture composition with the intent to lower delay, possibly making use of a modified H.320 terminal.

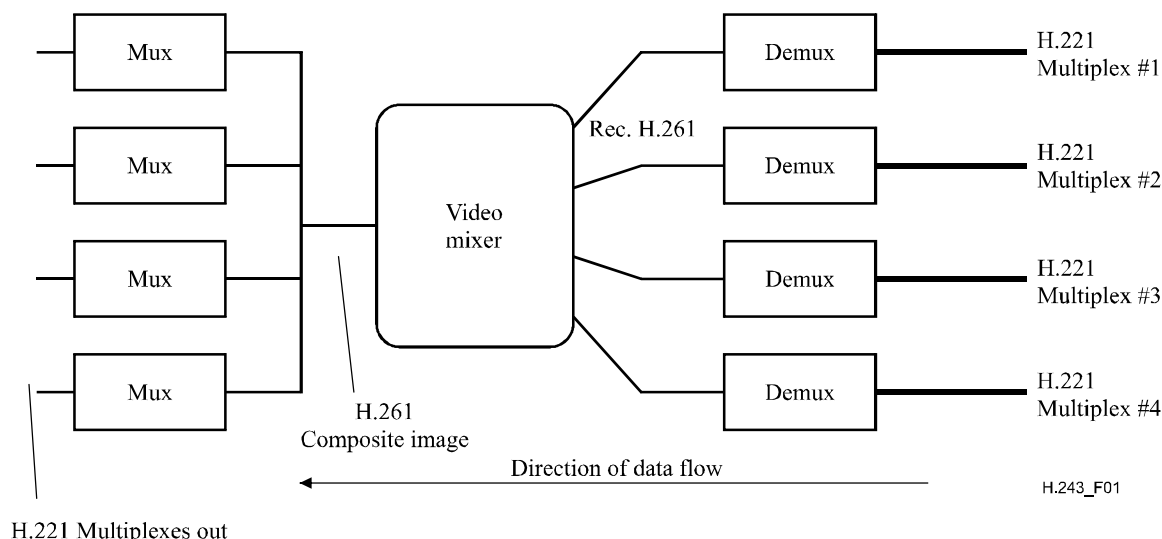


Figure 1/H.243 – Video mixing example: Quadrature

In either case, some MCUs may make use of the asymmetric nature of ITU-T Rec. H.221 to mix incoming QCIF images into an outgoing CIF image. In both cases, a video mixing MCU should operate properly with terminals conforming to the 1990, 1993 and 1996 versions of ITU-T Rec. H.320, and also supporting CIF. QCIF only terminals may not be suitable for video mixing since QCIF image resolution may not be appropriate for the display of a mixed image. Note that standardized mixed picture layouts are only defined for CIF images.

Systems involving modifications (relative to the 1990/1993/1996 versions of ITU-T Rec. H.320) to H.320 terminals are for future study, as are systems based on video mixing in terminals. The mixing procedures described here apply to ITU-T Recs H.261, H.262 and H.263 for any input image format, but only a CIF output format is specified. Mixing procedures for output formats other than CIF are for further study.

Without regard to how the video mixing is done by the MCU, a set of controls are needed analogous to VCB, MCV, and VCS that allow the user control over the images presented by the MCU. These control signals are the same for all methods of picture composition. Since these commands can become complex, they are standardized as part of the T.120 series of Recommendations using the MLP channel. See clause 15 for a discussion of the interactions between H.243 commands and T.120 commands with regard to video mixing.

The MCU may provide only a single mixed image per conference, or it may provide a larger number such as, for example, a different mix for each terminal. Control over multiple mixed images is left for further study as part of the T.120 series of Recommendations.

Terminals not capable of issuing picture composition commands using T.120 will receive a picture mixed according to rules established by the manufacturer. Examples of such rules are:

- a) include in the mixed picture the loudest N speakers;
- b) include in the mixed picture the first N parties in the conference;
- c) include in the mixed picture the most recent N speakers; and
- d) include in the mixed picture a pre-determined list of sites.

The details of this mechanism are beyond the scope of this Recommendation, but the MCU with video mixing capability shall provide some method by which spatial arrangement of images is accomplished in the absence of directives from enhanced terminals. Whether the viewing party is included in the composition is left to the discretion of the manufacturer.

6.2.1 Methods of image arrangement

There are eight defined image arrangements described in Figures 2 to 4 and in Tables 2 and 3. Table 2 shows the numbering of LSD commands in Table A.1/H.221 and Table 3 shows the numbering of HSD commands in Table A.2/H.221. An MCU may support all or any subset of the defined methods.

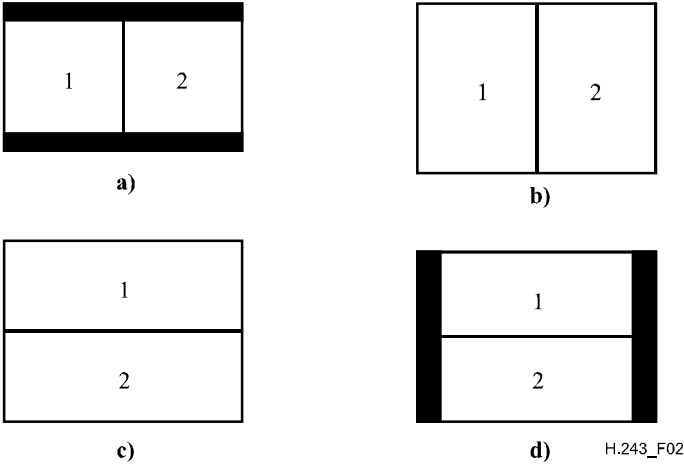


Figure 2/H.243 – Sub-picture location numbering for dual-view

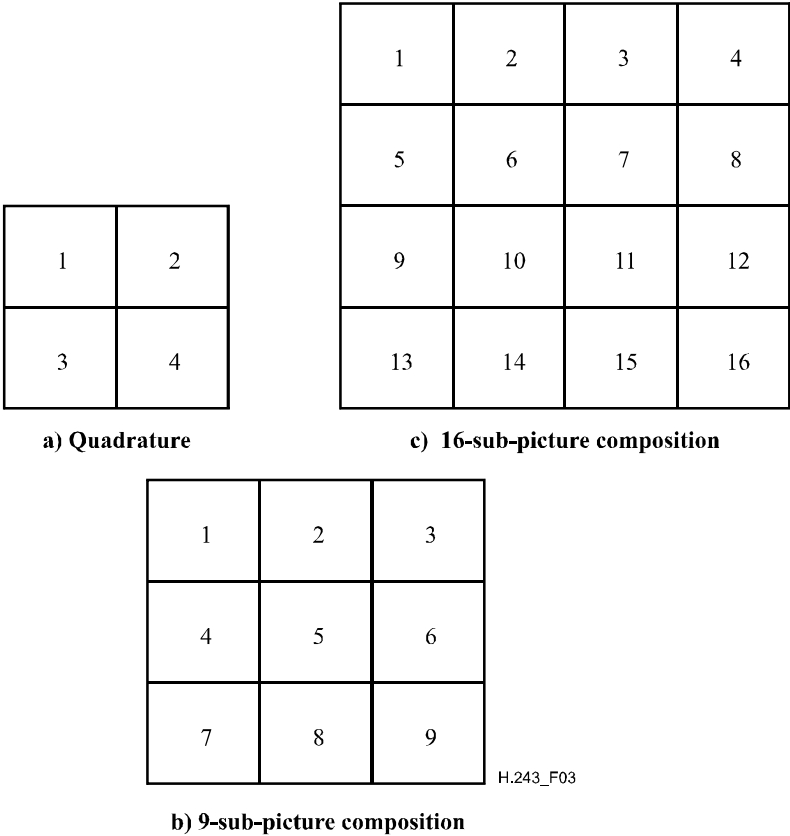


Figure 3/H.243 – Sub-picture location numbering for quadrature, 9-sub-picture composition, and 16 sub-picture composition