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PROCEDURES FOR ESTABLISHING COMMUNICATION BETWEEN THREE OR MORE AUDIOVISUAL TERMINALS USING DIGITAL CHANNELS UP TO 2 Mbit/s

ITU-T Recommendation H.243

(Previously "CCITT Recommendation")

FOREWORD

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

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

ITU-T Recommendation H.243 was prepared by the ITU-T Study Group XV (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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PROCEDURES FOR ESTABLISHING COMMUNICATION BETWEEN THREE OR MORE AUDIOVISUAL TERMINALS USING DIGITAL CHANNELS UP TO 2 Mbit/s

(Helsinki, 1993)

1 Introduction and 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 Recommendation H.231; to calls involving two such MCUs; and to calls involving three or more MCUs in a star configuration. It may also be applicable in part to other circumstances (for example, MCUs containing a video mixer) but this aspect is left for further study.

Recommendation H.242 provides for communication between two audiovisual terminals connected point-to-point, using the frame structure defined in Recommendation H.221. Recommendation 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 Recommendation 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 Recommendation 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, 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 Recommendation 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 Recommendation 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 Recommendation H.320 for visual telephony;

b) multipoint system procedures are defined in this Recommendation, and are not of themselves service-specific;

c) multi-layer protocol (MLP): by making use of the MLP defined in the H.200/AV.270-Series Recommendations, 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.

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

2 Capabilities and "selected" communication modes

The MCU must 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. Within that table there is some scope for procedural freedom, but for the purposes of this Recommendation it is necessary to define the operation more closely.

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 (Recommendation H.242) has been applied (see 11.1), 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 Recommendation H.231. The SCM may include one or more data channels.

The following methods may be used to determine the SCM:

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 (see Note): 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 the MLP.

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 must have at least one of them, and it must be clear to the user and service provider what method is in force.

NOTE – Where there are several modes common to the connected terminals (e.g. both 16 kbit/s and wideband audio), implementers should indicate what method is used to determine which one is selected – for example, that adopted by the chair-control terminal, if any.

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 (and does not need to) set the video mode CIF or QCIF, nor the audio mode where there is a choice at one bit rate (Recommendation G.711 or G.722 at 56 kbit/s).

At the start of a call, the cap-set 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 cap-set, not to be capable of transmitting the SCM will be connected in the conference at the audio mixer only – see 11.1. 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 will support them. The connection of single- and multiple-channel (e.g. 2B and 128 kbit/s) terminals into the same multipoint call is for further study.

3 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 Recommendation H.242.

Synchronization: all terminals must synchronize their outgoing transmissions to the bit rate incoming from the local MCU.

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 Recommendation H.221; it sends its capabilities and is waiting to receive frame structure and capabilities, as described in Recommendation H.242, with transmission in mode OF only. There may then be additional procedures, such as identity checking, to be carried out before the terminal is added to the conference (see definition in 4.4 d)/H.231).

3.1 First terminal added to conference

The MCU transmits its SCM-cap with PCM-audio in mode OF, with an optional audio-message and the C&I symbols MCC and MIZ (see Recommendation 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. 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 11.1).

3.2 Second terminal added to conference

The MCU transmits its SCM-cap with PCM-audio in mode OF, and MCC, with an optional audio-message indicating that a conference call is being set up.

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 11.1). 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 (Recommendation H.242) and a fast update request VCU (see Recommendation H.230) is sent towards the transmitter(s) of those signals;

– if VIR (see Recommendation H.230) is received from either or both terminals this is forwarded.

3.3 Third terminal added to conference

The MCU transmits its SCM-cap with PCM-audio in mode OF, with an optional audio-message indicating that a conference call is being set up.

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 11.1).

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 (Recommendation H.242) and a fast update request VCU (see Recommendation 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.

3.4 Fourth and subsequent calls added to conference

The procedure followed is essentially that of 3.3.

3.5 Extension of 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 Recommendation H.200/AV.420 or in subclause 5.2.

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 two terminals have all the requested additional channels available; the MCU itself adopts the higher rate and the terminals must follow suit. In the event that some connections do not reach the desired number of additional channels, the MCU may downrate those to secondary status and proceed normally with the rest.

3.6 MCU-MCU interconnections

3.6.1 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 3.1. 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 does not then transmit any audio message as in 3.1, but the symbol MIZ (see Recommendation 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 3.2 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 as though it were a terminal, taking decisions as to transmitted mode and BAS values according to the incoming capabilities, and switching video on an audio-power basis. 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 has been designated master (see 3/H.231), the slave must 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 5, 6, 7), the following are mandatory:

a) if both MCUs have declared G.722-48, the transmission of audio shall be G.722 at 56 kbit/s only (48 kbit/s in the restricted-network situation);

b) if both MCUs have declared G.728 audio and G.722-48, 56 kbit/s G.722 shall be used (if this choice is found unsatisfactory at one MCU it may send a capset omitting the G.722 value 48 kbit/s in the restricted-network situation);

c) if both MCUs have declared G.728 (but not G.722) audio, this shall be used.

An MCU M1 receiving VCU from another MCU M2 must 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 must forward this symbol to those terminals and/or MCUs (if any) to which it is sending the video signal received from M2. An MCU may respond to VCU and VCF from terminals in the same way as it responds to those symbols from MCU.

3.6.2 Designation of master MCU

It may be required that one of the MCUs take on the master role, for various reasons as will be seen in 5, 6, 7 and 11.2. It is essential that for a star configuration of 3 or more MCUs (see 3/H.231) the master be that at the centre, and therefore must be designated before the call (outside the scope of this Recommendation) but for the dumb-bell case (2 MCUs only) procedure of 3.6.2.2 could be used by a suitably equipped MCU.

3.6.2.1 Master designated prior to the call: when this MCU 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 3.6.2.2.

3.6.2.2 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 11.2; 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.

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

For further study.

3.7 Closure of conference

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

4 Video switching

4.1 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.

4.1.1 No video processing

When it is decided within the MCU that terminal A, currently receiving the video signal from terminal B, should instead be sent that from terminal C, the following procedure is used (codes VCF, VCU are specified in Recommendation 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;

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) together with the freeze picture release command;

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.

4.1.2 Video processed to eliminate error-correction framing changes

For further study.

4.2 Automatic switching and visualization-forcing

All video switching actions in this section conform to the procedure of 4.1.

The automatic switching of video signals is governed by the audio power transmitted from the terminals, as described in 2.2.4/H.231. This voice-activated video switching is effective from the start of the video transmissions, unless and until overridden by one of three commands, VCB, MCV, and VCS.

If terminal numbers have been assigned (see 5), in each outgoing signal the MCU transmits periodically (with each BAS command cycle) the terminal number of the video it is transmitting, using the symbol {VIN, num}. All terminals having suitable capabilities may thus display an identity (number or locally-generated name) with the video.

4.2.1 Video command broadcast (VCB)

See 7.4.1.

4.2.2 Multipoint command visualization (MCV)

By transmitting the symbol MCV (see Recommendation H.230), a terminal can try to force its MCU to broadcast its video signal to all other ports, overriding the voice-activation mechanism. On receipt of MCV from a directly-connected terminal or from another MCU, the MCU switches the video from that port through to all other ports, including directly-connected terminals and inter-MCU links; it also forwards MCV to any other MCUs. Having done this, it transmits MIV to the terminal being broadcast. When the said terminal no longer requires this broadcasting, it transmits the symbol Cancel-MCV. The MCU reverts to voice-activation and sends Cancel-MIV to the terminal; it also forwards Cancel-MCV to any other MCU. No provision is made for selection of the video to be transmitted to the terminal which is the source of the distributed video. It is local MCU may forward the previous video signal or that from the T_M, if available, or other available signals on a rotating basis (e.g. 20 s at a time), or another basis at the discretion of the implementer.

If an MCU receives MCV at one port while a visualization phase resulting from receipt of MCV at another port is effective, it does not act on MCV, instead returning VCR. The action of MCV overrides any VCS commands the MCU may have received before receipt of MCV and until receipt of Cancel-MCV.

Once an MCU has assigned its chair-control token by transmitting CIT (see 7), or during a chair-control session using MLP, it does not act on MCV, instead returning VCR.

4.2.3 Video command select (VCS)

By transmitting the symbol {VCS, <M>, <T>} a suitably-equipped terminal can determine which video signal shall be transmitted to itself. If the local MCU has this (non-mandatory) capability, and if it also has the requested video signal available, it transmits the requested video to this terminal. In the case of contention with a VCB or VCS request from the chair-control terminal T_M, the chair-control request shall take precedence. If the MCU cannot comply, it returns VCR.

To return to the automatic selection of video (see 4.2), the terminal transmits Cancel-VCS.

NOTES

1 This procedure can only be used when numbering of terminals has taken place.

2 It is highly desirable that a terminal equipped to transmit VCS present to the user continuously an indication (reminder) while this facility is activated, as the service to the users at other terminals is affected.

3 Transmission of VCS from a terminal may not secure the desired result, for various reasons: due to the single link between MCUs, conflicting demands may not be met; the MCU may not provide for many VCS from different terminals simultaneously; other reasons.

4 VCS is not propagated to other MCUs, and all other terminals connected to the local MCU continue to receive video as determined by voice-activation.

In summary, the MCU uses the following rules of precedence for visualization operation:

– when chair-control token has been assigned:

  a) if VCB is in force, refuse all conflicting VCS requests, and override all voice-switching;

  b) if VCB has not been received or Cancel-VCB is in force, accede to VCS from any local terminal requesting to see other local terminal's video;

– when chair-control token has not been assigned:

  a) if MCV is in force, refuse all conflicting VCS requests, and override all voice–switching;

  b) if MCV has not been received or Cancel-MCV is in force, accede to VCS from any local terminal requesting to see other local terminal's video.

5 Numbering of terminals

All the provisions of this clause are optional, but it should be noted that they are required for most of the functions available under the chair-control provisions of 7.

The assignment of numbers to each terminal can serve the following purposes:

– association of additional channels with the correct initial channel, when single-number conference service is offered (see Recommendation H.200/AV.420, or subclause 5.2);

– management of chair-control functions (see 7).

The following terms are used in this clause:

1) NAN: network address number (similar to telephone number) – to avoid confusion with numbers assigned within the MCU system;

2) per-MCU meet-me NAN: all terminals dial a single NAN to reach a conference on an MCU. This requires the terminals to identify the conference they wish to join once connected to the MCU. This may be done by means such as described in 5.4;

3) per-conference meet-me NAN: all terminals in a conference dial a single NAN to reach that conference. Terminals in other conferences dial a different NAN;

4) per-endpoint meet-me NAN: each terminal dials a different NAN. Particular NANs are associated with particular conferences at reservation time.

5.1 Numbering method

All terminals are given a unique number <M> <T> in the range <1 to 191> <1 to 191> (192-223 reserved in both cases), where the <M> is an 8-bit number allocated to the local MCU (see 1/H.231) and <T> is an 8-bit number allocated by the local MCU to the terminal. Both 8-bit numbers are encoded using one of the set of SBE symbols "NUM" – (see Recommendation H.230). However, it should be noted that the pair must always be preceded by another symbol conveying the control or indication concerning the terminal of that number.

The value <M = 0> is not assigned. If only one MCU is involved in the call the value of <M> may be set to any value, default <1>. If 2 or more MCUs are involved in the call they may be given any unique value in the decimal range <1 to 191>; they may for example be assigned sequentially or reserved in advance (192-223 reserved; for further study, as is the question of exhaustion of MCU numbers).

The terminals attached to one MCU may be given any unique value in the decimal range <1 to 191>; they may for example be assigned sequentially or reserved in advance (192-223 reserved; for further study, as is the question of exhaustion of terminal numbers).

If two or more MCUs are connected in the call, it may be necessary to set up a master-slave relationship between them, at least for the generation of a unique set of terminal numbers. One of the MCUs may be designated master prior to the call, or by the in-band procedure of 3.6.2.2. Other MCUs must be connected directly to the master, which will treat them as slaves. No provision is made in this Recommendation for any case in which a further MCU, other than the master, is connected to a slave, and service providers are alerted to the possibility of malfunction (of the procedures of 6 and 7) which may result from such configurations.

5.2 Terminal-MCU interconnection

Two cases are considered: with and without call association. If "per-MCU or per conference meet-me NANs" are in use (see above) and multiple-channel calls are involved, call association is necessary.

In the following cases there is no need for the MCU to associate incoming calls into a single multiplex and the procedures of this subclause apply:

1) when only a single channel is needed for all multiplexes accessed through the same meet-me NAN, e.g. H0, 1B, etc.;

2) when per-endpoint meet-me NANs are used;

3) when MCU dial-out operation is in use;

4) others.

5.2.1 Terminal/MCU interactions without call association

When a terminal is first added to the conference and initialization has been completed according to Recommendation H.242, the MCU may transmit to it the symbol {TIA, <M>, <T>}, where <M> is the MCU number and <T> the number assigned by the MCU.

NOTE – Terminals not equipped to receive such symbols ignore them, as only SBE are used.

If the MCU is not, or not yet, connected to a master value of <M> it is locally assigned (default <1>). If the MCU is subsequently connected to a master and receives a value of <M> from it, {TIA, <M>, <T>} is retransmitted as the new value.

If a terminal leaves the conference or is dropped for any reason, the corresponding value of <T> may or may not be reassigned; a terminal re-added into the conference may or may not be given the same number as before – this is a matter for implementation.

If the MCU sends a new {TIA, <M>, <T>} at a later time, this value replaces the previous value.

5.2.2 Terminal/MCU interactions with call association

In the case where the MCU is operated in a meet-me mode using per-conference or per-MCU meet-me NANs, initial and additional channels for each multiplex may be associated using the following in-band signalling procedure.

Terminals and MCUs with BAS-cap TIC are capable of these call association procedures. In the event that a terminal without TIC-cap attempts to join a conference under these circumstances, it may be reduced to secondary status, suffer repeated call failures, or be delayed in joining the conference.

Whenever the MCU has accepted an initial-channel call and carried out the initial capability exchange, it looks for incoming BAS-cap TIC (see Recommendation H.230); if it finds this, the MCU must send a TIA value on the I-channel

as described in 5.3.1. This TIA value consists of <M> (MCU number) and <T> (terminal number), and uniquely identifies the terminal. When the additional-channel calls are made, the terminal sends in the additional channels:

– in FAS the channel number according to Recommendation H.221;

– in BAS position alternately the channel number according to Recommendation H.221 and the symbol {<TIX>, <M>, <T>}. The MCU is then able to associate the additional channels with the correct initial channels. Note that there is no capability exchange on additional channels and the above values are sent by a terminal upon connection, without waiting for $A_n = 0$ framing response from the MCU.

As calls (channels) arrive at the MCU, it must begin to send H.221-framed signals towards the terminals. Within this FAS channel numbering information must be carried (see 2.2/H.221). Therefore, the MCU transmits the values L1 = L2 = L3 = 0 until it has made the correct associations, and then supplies FAS with the correct channel number. Terminals having TIC-cap must be able to accept this condition.

If the MCU sends a new {TIA, <M>, <T>} at a later time, this value replaces the previous value.

If the MCU, while using per-conference or per-MCU meet-me NANs, finds a terminal with no BAS-cap TIC, it may do one of the following:

1) maintain a reduced transfer-rate cap, thus keeping the offending terminal in secondary status;

2) drop any additional channels; or

3) send the higher transfer-rate cap only to one terminal at a time, until that connection has been brought up to the desired rate, before proceeding to another terminal. This may greatly lengthen conference setup time.

5.3 MCU interconnection

5.3.1 Master MCU has been designated

The actions described in this subclause are taken after transmission of MIM by the master and receipt thereof by the slave in question.

5.3.1.1 Assignment of MCU numbers

The master transmits the symbol {TIA, <M>, <0>}. The slave recognizes this as coming from the master, registers <M> as its own assigned MCU number, and then transmits to the master the list TIL.

5.3.1.2 Forwarding of numbers for terminals added or dropped

If a new terminal is connected subsequently to any MCU, the local MCU sends {TIN, <M>, <T>} to all its ports. If a terminal is dropped, the local MCU sends {TID, <M>, <T>} to all its ports. If an MCU receives TIN and/or TID values from another MCU, it forwards these to all its ports. Thus information about terminals added or dropped is rapidly disseminated to all parties.

5.3.1.3 Storage and dissemination of terminal numbers

All numbers of terminals added and dropped are stored in the master MCU and optionally at any other. The symbol TCU may be used at any time and by any terminal to elicit a list of the terminal numbers currently participating in the conference. TCU may be transmitted from any terminal or MCU to any MCU. If that MCU holds the list it responds with TIL; if not, it forwards TCU to the master, which itself responds.

5.3.2 No master MCU has been designated

For further study.

5.4 Identity information

Provision is made for the transmission of personal- or terminal-identity numbers, names, or other information between a terminal and its local MCU, if both entities are suitably-equipped. This procedure applies only to directly-connected terminals.

One entity transmits the symbol TCI or TCS-*n*, where *n* has one of several values as listed in Recommendation H.230.

An entity which receives TCI responds with a sequence of symbols {TII, A-N} (see Note), where A-N represents one of a set of values defined for alphanumeric SBE characters in Recommendation H.230. The sequence must be terminated by the end-marker TIS.

An entity which receives values of TCS-*n* responds with the MBE message IIS. Values for the IIS message can be found in Recommendation H.230.

TCS-*n* is ignored by a terminal not having this capability.

NOTE – The TII sequence used to send the string "XYZ" is {<TII> <X>}, {<TII> <Y>}, {<TII> <Z>}, {<TIS>}. Other BAS codes may be interspersed within this sequence, not between <TII> and the following symbol.

6 Mode switching and data broadcast procedures

6.1 General mode switching

The provisions of this subclause are mandatory for all MCUs.

6.1.1 Bit-rate symmetry

In a point-to-point call, a terminal is free to change modes at any time, within the constraint of the capabilities it has received from the other end. However, in a multipoint call, there are additional, temporal constraints:

i) because the output frames from the MCU cannot be synchronous with all input frames, there will usually be at least a partial-submultiframe delay in transmitting a necessary BAS code; in a more extreme case the MCU may already be engaged in a capability exchange with another terminal, and so be unable itself to mode switch for some time;

ii) time is needed for the MCU to process BAS capabilities and commands to ensure that the resulting modes are acceptable to all primary terminals (see Recommendation H.231) and are imposed in coordination, without corruption of any video being transmitted.

To ensure that an MCU has adequate control, and in particular that it can drive video signal transmission to a common rate (noting that in the case treated here the MCU has no power to transcode the video), bit-rate changes are initiated solely from the MCU. Terminals, after having received MCC and MCS from the MCU, may not change bit-rates except in response to such a change incoming from the MCU, so as to maintain the symmetry commanded by MCC and, if relevant, MCS for each component signal. This applies to bit-rates for audio, data (LSD, HSD, MLP, H-MLP), video, encryption control signal (ECS) channel and the transfer rate; audio and video mode changes not involving bit-rate changes may still be initiated by terminals. When the bit rate incoming from the MCU changes, the terminal must follow suit as promptly as other procedures allow, as any delay may preclude the terminal's transmission from being received by the other parties in a conference.

6.1.2 Changing the video bit rate

As a consequence of changing the bit rate of other signals, the video rate will also change, since it occupies all bits not designated for other signals. The procedure to be used is similar to that for video switching:

a) the MCU transmits VCF and Video-Off to all terminals before transmitting the BAS commands that establish a new rate for video;

b) until a terminal that is a video source has responded by symmetrizing transmission, its outgoing video will be at the wrong rate and can no longer be forwarded to other terminals which may previously have been receiving it; if the terminal does not adjust its rate promptly, the MCU may switch to distribution of another video source pending restoration of the proper symmetrical condition;

c) when the new bit rates have been established for the other signals, video is again switched ON, forwarding from the same sources as before unless b) applies or there is another overriding change;

d) after a time sufficient for video receivers to recover error-correction-frame alignment, the MCU transmits VCU to all video source(s).

6.1.3 Mode changes in multi-MCU calls

6.1.3.1 Master/slave working

On master-slave interconnections, mode changes may only be initiated by the master; the slave must respect the MCS command in the same way as a terminal would do.

6.1.3.2 No master MCU has been designated

In this case all MCUs may reject the literal interpretation of MCC and MCS if relevant, and seek only to coordinate mode changes with their peers, by "dynamic compliance": on each interconnecting link, each MCU adopts a mode change initiated by the other unless it is in the process of carrying out a contrary change. In the case of contention, the contention resolution principle (see 11.2) should be applied.

6.2 Mode switching for data distribution in multipoint conferences

The provisions of this subclause are mandatory for those MCUs that support data distribution by the BAS code method. The MLP of Recommendation H.200/AV.270 provides a more powerful set of facilities for data handling: the procedures given here may be applicable to the opening of MLP channels but require further study.

6.2.1 General

6.2.1.1 Range of data channel provisions

In this subclause the term "data" is used generically to refer to either of two types of data channel permitted by Recommendation H.221 and designated there as LSD and HSD. These are managed independently, and may be effective simultaneously: LSD may be sent by one terminal while HSD is sent by the same or a different terminal.

LSD and/or HSD may be sent by one terminal to its MCU, whence it is broadcast to all other terminals and MCUs in the call. Selectivity of destinations and multiple simultaneous transmissions of either LSD or HSD are for further study.

The following procedure must be followed when the MCU has declared a suitable data capability: this can only occur if the MCU includes the requisite data distribution unit(s), if the service provider has previously agreed to its use, and if at least two terminals have declared the same capability.

Having received MCS from an MCU, a terminal must not open a data channel of its own volition, but may make a request to the local MCU and await the outcome, as described below.

Multi-point operation of FAX is for further study.

6.2.1.2 Idle bits

After a data channel is opened and before the data token is assigned, idle bits are broadcast by the MCU. For a period of time after the data token is assigned, the contents of the data channel may be undefined (i.e. consists of whatever a terminal stuffs in the channel before sending real-data). Users of the data channel should keep this fact in mind. The only transmitter of real-data of each of the two types is the one terminal which has been assigned the requisite data token. An idle bit is a binary one – this is both a stop bit for asynchronous serial transmission and a permitted inter-frame time fill for HDLC-based protocols.

6.2.1.3 Terminals without data capability

Some of the terminals connected may not have the data capabilities to be used (but see Note 2), and therefore no data channel will be opened to them; the audio may not be affected. The following options are available to deal with this situation:

a) if they are not transmitting or receiving video, there is no change of service to the user;

b) if they are transmitting a video signal this will no longer be at the same rate as those terminals to which the data channel has been opened; therefore their video cannot be forwarded to those terminals, neither can they receive video from them, during data transmission; they may, however, continue to exchange video with other non-data-capable terminals if the MCU provides for this;

c) the MCU may choose not to open any data channel.

NOTES

1 Since only SBE codes are used in this procedure, such terminals may ignore these symbols without misoperation.

2 It is permissible for a terminal to declare an LSD or HSD capability and have such a channel opened to it, even though it may have no actual data equipment attached, provided only that its video rate conforms to the MCC and MCS condition. It is advisable to include such capabilities in terminals which may be used in multipoint calls involving LSD or HSD. The extension to MLP is for further study.

6.2.2 Data tokens

The control of data distribution is governed by means of data tokens, one for each type of data; all tokens are assigned independently. Tokens may optionally be reserved in advance, or otherwise assigned by an out-of-band method. Tokens for LSD and HSD may be assigned to two different terminals.

Possession of a data token confers the right to transmit data for distribution to all other terminals having sufficient data capability; however the token can be released by one terminal and taken up by another without the MCU closing the data channel or changing its rate.

This subclause is couched in terms of the management of LSD. Exactly the same process applies to the management of HSD, using the codes DCA-H, etc. (see Recommendation H.230). The data paths may be managed independently, and more than one may be effective simultaneously. An MCU may contain the data transmissions to one type if appropriate, by withholding/withdrawing the other token and declaring a new capability set with omission of that type.

6.2.2.1 Assignment of the token

6.2.2.1.1 A terminal T_D wishing to transmit LSD may proceed to claim the requisite token if its currently-registered capset from the MCU includes the appropriate LSD value.

T_D requests assignment of the LSD broadcast token by sending {DCA-L, <B>}, where <B> represents the desired data rate according to the values in Table 2. If it does not receive a response (see below) from the MCU it may repeat the request in a reasonable time.

6.2.2.1.2 On receipt of {DCA-L, <B>} from terminal T_D, the local MCU acts as follows:

a) IF {OR [it has already assigned the token to a terminal or MCU other than T_D, (having transmitted DIT-L and not received DIS-L)]. OR.(received another request to do so from a directly-connected terminal or MCU).OR.(is in the process of closing a data channel, or making a mode change). OR.(if the requested data rate is not in the current common capset).OR.(if the MCU is in a state of resource exhaustion)} THEN the MCU must respond with DCR-L;

b) if the MCU has previously assigned the token to T_D, two cases exist:

   i) if the data channel is already open at the requested rate the MCU must respond with DIT-L, and T_D retains the token;

   ii) if this is as a result of T_D requesting a different rate, the MCU responds with DCR-L and T_D no longer holds the token. T_D should send another DCA-L to request the token at the new rate. (The preferred method of requesting a new data rate is for T_D to release the token by sending DIS-L and then ask for the new rate.) Since the MCU now holds the token, it responds as in c) i) and ii);

c) IF {it has neither assigned the token nor received another request to do so, nor have any of the other refusal conditions of a) occurred} THEN:

i) if it is the only MCU, it proceeds to perform any needed mode changes according to the procedures of 6.1. After the channel has been assigned and any appropriate mode change has taken place, the MCU sends DIT-L to T_D. At this point the terminal may begin to transmit data;

ii) if it is one of two or more interconnected MCUs, three cases must be considered, keeping in mind that only a single LSD token exists in a master/slave network, and that the master controls that token:

1) a master has been assigned, and the local MCU is a slave. The slave MCU forwards {DCA-L, <B>} to its master and awaits DIT-L. When the slave MCU receives DIT-L or DCR-L, it forwards the code to T_D;

2) a master has been assigned, and the local MCU is the master. The master MCU acts on {DCA-L, <B>} by treating its subordinate MCUs like terminals;

3) if no master has been assigned, the operation is left for further study.

6.2.2.2 Release and reassignment of data token

A change of data control should be negotiated between conference participants; the terminal holding the token, and having ceased to transmit real-data, may release the token by sending DIS-L or DCC-L. This allows the endpoint to request either that the channel be left open for future use (DIS), or that it be closed (DCC) to maximize video bandwidth. Several cases exist:

a) if the MCU is singular, it sends DCR-L to T_D and in the case of DCC-L closes the channel;

b) if the MCU is a slave, it forwards DIS-L or DCC-L to the master MCU, and awaits DCR-L. On receipt of DCR-L from the master, the slave forwards DCR-L to T_D and in the case of DCC-L closes the channel;

c) if the MCU is a master, it acts on DIS-L or DCC-L itself while treating its slaves as terminals;

d) if no master has been selected, operation is left for further study.

After the receipt of DCR-L or DCC-L, T_D is free to request the token again, perhaps at a different data rate.

An MCU receiving DIS-L or DCC-L from any directly connected terminal other than the one to which it previously assigned the token must respond with DCR-L. In this case, if the data channel is open, it should not be closed in response to DCC-L.

After receiving DIS-L or DCC-L from T_D, the MCU must revert to transmitting idle bits if the channel is left open. Terminals receiving data will experience a brief period during which the state of data in the channel is undefined (between when DIS-L is received at the MCU and when the MCU begins sending idle bits. After sending DIS-L or DCC-L, a terminal may not resume sending real-data without again claiming and receiving DIT-L.

6.2.2.3 Withdrawal of data token

The withdrawal of the data token may be invoked using the chair-control facility (see 7.6). In case of necessity (e.g. to resolve a fault condition), any MCU may itself withdraw the data token. In both cases, the withdrawal should be understood as the correction of an error condition, not a request to the token holder. Generally, terminals should hold the token only as long as needed to transmit their data.

An MCU making the withdrawal transmits DCR-L on the path on which it had sent DIT-L during the assignment of the token. An MCU receiving DCR-L must forward this on the path on which it had sent DIT-L during the assignment of the token, and the MCU itself must send DIS-L or DCC-L on the path from which it received DCR-L. This description applies to both master-slave and MCU-terminal paths.

A terminal receiving DCR-L while possessing the token must cease data transmission within the LSD path as soon as possible consistent with proper operation of protocols within the real-data; it must then transmit DIS-L or DCC-L to the MCU. The MCU may close the data channel at this time, or leave it open for future use.

If T_D does not return DIS-L or DCC-L within a reasonable time the MCU to which it is connected may force the token release according to the above procedures. It is understood that this procedure may cause some loss of data. For good operation, the master timeout should be greater than the slave timeout.

6.2.3 Opening/closing/rate changing the data channel

Opening a channel refers to moving from a mode where no data channel exists to a mode where one does exist. Closing the channel refers to the reverse operation. Rate change refers to moving from one rate to another in an already open channel (e.g. from LSD-300 to LSD-9000). All of these operations are mode changes, and are done according to the procedures of 6.1.

6.2.3.1 Master/slave or single MCU

The data channel may only be opened, closed, or its rate changed when the master MCU or single MCU possesses the relevant data token. If any T_D is broadcasting when this necessity arises the token must either be released voluntarily by T_D when it completes its broadcast or peremptorily withdrawn from T_D.

The MCU with the token changes the modes of all its ports according to the procedures of 6.1.

Receiving the mode change from the MCU while the MCC and MCS are in effect, each terminal must respond by symmetrizing its transmission; that is, it must open an identical data channel in the direction of the MCU, using the mode switching procedure (see 6.1) with the requisite BAS command(s). The terminal must be prepared to receive data from the time of the mode change; there is no warning of a transition from idle to undefined data to real-data, except perhaps asynchronously by a preceding data application BAS command. Use of the data channel must take this into account, recognizing that different terminals may send different fill when they are not sending real-data.

The MCU awaits symmetrization of the changed channels; if any terminal is tardy in symmetrizing, the MCU may relegate this terminal to secondary status after a time-out of 5 seconds.

If the master/slave arrangement, mode changes originate with the master and rate symmetrization radiates outward from the master.

When all primary terminals have symmetrized, the MCU sends DIT-L to T_D, and begins broadcasting the data from T_D to all other connections.

T_D may now begin real-data transmission. If after receipt of DIT-L, T_D sends a data application BAS command (Table A.3/H.221), the MCU will forward this on to all other ports, and after doing so will echo the same back to T_D. The forwarded commands cannot be synchronous to the broadcast data stream, nor can the echoed command be taken as a guarantee that all terminals have received it; the commencement of real-data broadcast should take these limitations into account.

After a period of disuse, during which no data token has been claimed, an MCU may close the data channel. Until a channel is closed, the MCU must transmit idle bits when it holds the token.

6.2.3.2 No master

For further study.

7 Chair-control procedure using BAS codes

The provisions of this clause, except those of 7.4.2 are mandatory if the MCU supports chair-control.

7.1 General

NOTE – Chair-control may also be assigned using MLP – see AV.270/Rec. T.120; when terminal numbers and chair-control token have been assigned using the MLP, those assignments take precedence and the procedures of this subclause must not be invoked. When an MLP channel is open between a terminal and its local MCU, then the BAS codes referenced in the definition of CIC (see Recommendation H.230) must not be transmitted.

This option requires the MCU to have certain software and hardware provisions, and at least one terminal must be suitably enhanced, as detailed below.

The MCU must have the capability "multipoint chair-control" (CIC); it can:

- assign a number to each terminal;
- assign a chair-control token;
- disconnect a terminal from the conference on command from the token-holder;
- switch video signals according to commands from the token-holder;
- stop data transmission by all other terminals;
- drop the entire conference.

If two or more MCUs are to be involved in the conference, all must declare CIC-cap to support cascaded chair-control. Note that it is possible for an MCU to have CIC-cap, and not support cascaded chair-control, since cascading is an optional feature separate from chair-control.

The terminal to be used for chair-control should have means to:

- send the BAS values CIC, CCA, CIS, CCD, CCK, VCB, cancel-VCB, and SBE numbers;
- display terminal numbers or other identifiers with associated video (or audio);
- accept user input regarding video switching and terminal disconnection, etc.

It is not essential that other connected terminals have any special capabilities. Since only SBE codes are used in this procedure, such terminals may ignore these symbols without misoperation.

The facilities provided by CIC-cap may be presented to a single user, or the capabilities may be split at the terminal level to provide for two persons to act respectively as controller and chairman as specified in Recommendation F.730.

7.2 Assignment, release and withdrawal of chair-control token

NOTE – The text of this subclause is derived from 6.2.2, so the process is identical.

7.2.1 Assignment

7.2.1.1 A terminal T_M wishing to assume chair-control may proceed to claim the requisite token if its currently-registered capset from the MCU includes CIC.

T_M requests assignment of the chair-control token by sending CCA. If it does not receive a response (see below) from the MCU in a reasonable time it may repeat the request. The MCU may optionally provide a mode in which the chair token is pre-allocated at reservation time. In this case, the MCU refuses all requests for the token unless they come from the pre-allocated chair.

7.2.1.2 On receipt of CCA from terminal T_M, the local MCU acts as follows:

a) if it has already assigned its token to a terminal or MCU other than T_M, (having transmitted CIT and not received CIS) or received another request to do so from a directly-connected terminal or MCU, the MCU must respond with CCR;

b) if the MCU has previously assigned its token to T_M, the MCU must respond with CIT and T_M retains the token;

c) if it has neither assigned its token nor received another request to do so nor have any of the other refusal conditions of a) occurred then:

   i) if it is the only MCU, the MCU sends CIT to T_M. At this point the terminal may begin to issue chair-control commands. The chair terminal may give some indication to the user that the chair token has been received;

ii) if it is one of two or more interconnected MCUs, three cases must be considered, keeping in mind that only a single chair token exists in a master/slave network, and that the master controls that token:

1) a master has been assigned, and the local MCU is a slave. The slave MCU forwards CCA to its master and awaits CIT. When the slave MCU receives CIT or CCR, it forwards the code to T_M. If the master receives two or more CCAs at the same time, one is picked at random and the rest receive CCR;

2) a master has been assigned, and the local MCU is the master. The master MCU acts on CCA by treating its subordinate MCUs like terminals;

3) if no master has been assigned, the operation is left for further study.

7.2.2 Release of chair token

A change of chair-control should be negotiated between conference participants; the terminal holding the token may release it by sending CIS to the MCU.

Several cases exist:

a) if the MCU is singular, it sends CCR to T_M as a confirmation of the withdrawal of the token;

b) if the MCU is a slave, it forwards CIS to the master MCU, and awaits CCR. On receipt of CCR from the master, the slave forwards CCR to T_M;

c) if the MCU is a master, it acts on CIS by itself while treating its slaves as terminals;

d) if no master has been selected, operation is left for further study.

After the receipt of CCR, T_M is free to request the token again, or another terminal may request the token.

An MCU receiving CIS from any directly connected terminal other than the one to which it previously assigned, the token must respond with CCR.

7.2.3 Withdrawal of chair-control token

The chair-control token may be withdrawn by the MCU. One possible example of this procedure is that two MCUs which have both assigned chair tokens are subsequently connected and one becomes a slave MCU. The slave chair token must be withdrawn.

An MCU making the withdrawal transmits CCR on the path on which it had sent CIT during the assignment of the token; this will therefore propagate through to T_M. This description applies to both master-slave and MCU-terminal paths. If the MCU making the token withdrawal is a slave MCU, it must inform the master of the release with CIS after sending CCR to T_M. The master confirms the CIS from the slave with CCR.

A terminal receiving CCR while possessing the token must cease chair operations immediately; it must then transmit CIS to the MCU, subsequent operation being as for token release above.

If T_M does not return CIS within a reasonable time the MCU to which it is connected may act on its behalf in effecting token release according to the above procedures. For the best operation, the master timeout should be longer than the slave timeout.

When the chair-control token has been released or withdrawn the control of video switching reverts to voice-activation (see 4.2). Whether this reversal affects an operative VCS is left to the manufacturer.

7.3 Information available to the chair-control terminal

The following information is available to a chair-control terminal T_M, provided that the facilities indicated are present in the MCU to which it is connected. Here <M>, <T> is abbreviated to "num" – Ed.

a) the assigned numbers of terminals and MCUs that have been connected – {TIN, num};

b) the numbers of any terminals which have been dropped from the call – {TID, num};

c) the terminal number associated with the incoming video – {VIN, num}; {a) to c) are also available to the other terminals – see below};

d) requests from the floor {TIF, num}.

The values of {TIN, num} and {TID, num} are forwarded by the master as they are received, after this information has been collected from all MCUs (see 5.3.1.2); alternatively T_M may extract this information by transmitting {TCU} to the master. The MCU procedures for this operation are described in 5.3.1.3.

7.4 Video selection

7.4.1 Chair-control of broadcast video

The terminal numbers <M>, <T> can be acquired at the chair-control terminal T_M by the transmission of TCU or conversationally (bringing each video source up using the voice switching action of the MCU), or by using VCB. By transmitting the symbol {VCB, num} the chair-control terminal determines which video signal shall be transmitted to all parties except the source of that video. On receipt of this symbol, an MCU first inspects the <M> part of the number; if this is not its own value it sends the video from the master or relevant connected slave to all its ports; if <M> is its own value it sends the video signal from the relevant local terminal to all its ports. In addition, it forwards the VCB value to any connected MCU, except that if it received that value from another MCU it does not reflect the value back there.

NOTE – This process results in the correct selection even if the token has been assigned to a terminal connected to a slave MCU.

T_M may order a return to automatic video switching (see 4.2) by transmitting VCE (forwarded to other MCUs). No provision is made for selection of the video to be transmitted to the terminal which is the source of the distributed video. Its local MCU may forward the previous video signal or that from the T_M, if available, or other available signals on a rotating basis (e.g. 20 s at a time), or another basis at the discretion of the implementer.

7.4.2 Chair-control of video received at T_M

By transmitting the symbol {VCS, num} T_M determines which video signal shall be transmitted to itself (see 4.2.3). If the local MCU has this (non-mandatory) capability, and if it also has the requested video signal available, it transmits the requested video to the T_M. If the MCU cannot comply, it returns VCR. To return to the automatic selection of video (see 4.2), the terminal transmits Cancel-VCS.

7.5 Terminal dropping by chair-control

The terminal numbers <M>, <T> can be acquired as described in 7.4.1. If it is then desired to disconnect a terminal from the conference, the symbol {CCD, <M>, <T>} is transmitted to the MCU.

NOTE – It has become common practice for a computer to seek the user's confirmation before doing a requested unrecoverable action, such as deleting a file; it is suggested that this precaution be included in the software of the chair-control terminal.

On receipt of this symbol, an MCU first inspects the <M> part of the number and acts thus:

– if <M> is its own value (the terminal is directly connected to it), it disconnects that terminal and transmits the symbol {TID, num} in the direction whence it received CCD;

– if the terminal is connected to another MCU, it repeats the symbol on the inter-MCU link.

On receipt of {TID, <M>, <T>} at one port of an MCU, it repeats this to all other connected MCUs and terminals, and to T_M if directly connected.

This process results in the correct terminal being dropped even if the token has been assigned to a terminal connected to a slave MCU.

If an MCU receives a command to disconnect a terminal which does not exist or which has already been disconnected, it shall send {CIR} in the direction whence the command came.

7.6 Withdrawal of data tokens by chair-control

The chair-control terminal may transmit the code DCR-L and/or DCR-H, causing the local MCU to broadcast the codes DCR-L/H; the effect of this is to cause the cessation of all data transmission. Subsequent closure of the data channels is according to 6.2.3.

7.7 Request for floor

Any suitably equipped terminal may input a “request for the floor”, using the symbol TIF.

An MCU receiving TIF forward it to the chair-control terminal if this is directly connected, otherwise to the other MCU(s) to forward it to the chair-control terminal.

7.8 Dropping the entire conference

When an MCU receives the BAS code CCK from the chair-control terminal it drops the connections at all its ports, releasing all associated conference resources. CCK in the cascaded case is for further study.

7.9 Dial-out facility (optional)

For further study.

7.10 Identification of token assignment

Any suitably equipped terminal may request information on which endpoints have been assigned the data and chair-control tokens by using the symbol TCA (Token Comm. and Association). If the connected MCU knows the terminal numbers of the assigned tokens, it responds with the MBE symbol TIR (Token Indicate Response), which includes the terminal numbers {<M>, <T>} of the current holders of LSD, HSD, and chair tokens in this order. The terminal number used when a token is unassigned or when a capability is not supported is a terminal number of {<M> = 0, <T> = 0}.

If the MCU to which the requesting terminal is connected is a slave supporting this feature and does not know the address of the terminals possessing the tokens, the TCA symbol is forwarded by the slave to the master MCU. The master MCU may need to query slave MCU to find the terminal numbers associated with particular tokens. The TIR from the master is forwarded by the slave to the requesting terminal.

8 BAS sequencing

The principles of 12/H.242 should be followed, with the additions described below.

The MCU transmits the C&I symbol MCC and MCS if relevant to all terminals along with the normal repetitions of BAS commands, to ensure that they remain aware of participation in the multipoint call.

9 Capability exchange during a call

Capability exchanges may be initiated by terminals in the same way as for point-to-point calls (see Recommendation H.242), and by an MCU when necessary to accommodate the different capabilities declared by the terminals connected (see clauses 2 and 3).

10 Procedure for loop detection at an MCU

This clause is optional.

NOTE – This clause is not concerned with digital loopback within connected terminals (this is a maintenance function and should not normally occur in conferences, but the MCU may periodically transmit LCO to be sure).

When a loop is placed on a line connected to an MCU (be this within a terminal or elsewhere in the network, the MCU is effectively communicating with itself: an indication of a looped port can be obtained by transmitting a symbol sequence which is sufficiently unique that emulation is very improbable, and looking for that same sequence to appear within a reasonable time in the received signal at that port. Such a test can be made at any or all ports as required according to circumstances (for example, normally every few seconds) provided that the port is not involved in a dynamic mode switch or in a capability exchange.

Either of two sequences may be used, according to circumstances:

1) if the MCU has been numbered, the sequence {MIL, <M>} may be used, since this cannot be generated by any other MCU;

2) alternatively the sequence may be as described below.

The sequence consists of {MIL, <N>} where <N> is a random SBE number between 0 and 223 (see Recommendation H.230). After transmission, the incoming BAS position is monitored for 2 seconds (for example): if the same sequence is returned within that time, the conclusion is reached that the port is indeed looped (but see Note), and further action depends on the internal software (e.g. disconnecting the port from a conference if one is in progress, perhaps timing the loop delay for diagnostic purposes). The test could also be repeated for greater confidence, using a different random number.

NOTE – Where there is a possibility that the test is being carried out simultaneously by another connected equipment (e.g. when MCUs are connected together), it needs to be established that the received sequence could not have been generated elsewhere; the test should be repeated twice with different random numbers – the probability of a false indication is then reduced to $1:224^3$.

11 Exceptional procedures

11.1 A terminal connected does not indicate capability for the SCM

The MCU transmits to this terminal a reduced capset, consisting of cap-mark and at least one audio capability code.

Communication proceeds as in clause 3, except that the transmission mode between this terminal and the MCU is in a lower mode. The MCU transmits MIS to this terminal, indicating that it has been accorded secondary status (see Recommendation H.231).

11.2 Contention resolution principle

In a master-slave situation, the slave must adopt the choice made by the master, and the master must ignore the action taken by the slave, expecting this to be corrected within a short time. This comment may not be necessary.

Where both MCUs on an inter-MCU link happen to transmit conflicting commands at about the same time, then instead of acting on the incoming value each transmits a random SBE number (see Recommendation H.230). The MCU which receives a higher number than it transmitted maintains the decision already taken, while the other must adopt the action chosen by the first. If both numbers happen to be the same, the process is repeated.

TABLE 1/H.243

Examples of selected communication modes

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

Table 2 should follow the numbering of LSD commands in Table A.1/H.221

TABLE 2/H.243

Encoding for <B> in {DCA-L, <B>} using SBE/num of Recommendation H.230

Value of <B>	Requested rate
0	Reserved
1	300 bit/s LSD
2	1200 bit/s LSD
3	4800 bit/s LSD
4	6400 bit/s LSD
5	8000 bit/s LSD
6	9600 bit/s LSD
7	14 400 bit/s LSD
8	16 kbit/s LSD
9	24 kbit/s LSD
10	32 kbit/s LSD
11	40 kbit/s LSD
12	48 kbit/s LSD
13	56 kbit/s LSD
14	62,4 kbit/s LSD
15	64 kbit/s LSD
16-30	Reserved
31	Var-LSD
32	MCU will pick highest common rate
33	MCU will pick lowest common rate
34	Use current channel rate
35-255	Reserved

Table 3 should follow the numbering used in Table A.2/H.221.

TABLE 3/H.243

Encoding for <B> in {DCA-, <B>} using SBE/num of Recommendation H.230

Value of <B>	Requested rate
0	Reserved
1	Var-HSD (R)
2-16	Reserved
17	64 kbit/s HSD
18	128 kbit/s HSD
19	192 kbit/s HSD
20	256 kbit/s HSD
21	320 kbit/s HSD
22	384 kbit/s HSD
23	768 kbit/s HSD
24	1152 kbit/s HSD
25	1536 kbit/s HSD
26	Var-HSD
29-31	Reserved
32	MCU will pick highest common rate
33	MCU will pick lowest common rate
34	Use current channel rate
35-255	Reserved

Appendix I

C&I signals defined in Recommendation H.230

(This appendix does not form an integral part of this Recommendation).

*	Followed by a SBE number or alphanumeric
#	Cancel signals are also defined
AIA	Audio indicate active
AIM	Audio indicate muted
CCA	Chair-control command acquire
CCD*	Chair-control command disconnect
CCK	Chair-control command kill
CCR	Chair-control command release/refuse
CIC	Chair-control indicate capability
CIR	Chair-control indicate release/refuse
CIS	Chair-control indicate stopped-using-token

CIT		Chair-control indicate token
DCA-L*		Data (LSD) command acquire
DCA-H*		Data (HSD) command acquire
DCC-L		Data (LSD) command close
DCC-H		Data (HSD) command close
DCR-L		Data (LSD) command release/refuse
DCR-H		Data (HSD) command release/refuse
DIS-L		Data (LSD) indicate stopped-using-token
DIS-H		Data (HSD) indicate stopped-using-token
DIT-L		Data (LSD) indicate token
DIT-H		Data (HSD) indicate token
IIS		Information indicate string
LCA		Loopback command, “audio loop request”
LCD		Loopback command, “digital loop request”
LCO		Loopback command off
LCV		Loopback command, “video loop request”
MCC	#	Multipoint command conference
MCN		Multipoint command negating MCS
MCS		Multipoint command symmetrical data-transmission
MCV	#	Multipoint command visualization-forcing
MIL*		Multipoint indication loop
MIM		Multipoint indicate master-MCU
MIS	#	Multipoint indication secondary-status
MIV	#	Multipoint indication visualization
MIZ	#	Multipoint indication zero-communication
RAN*		Random number
TCA		Token command association
TCI		Terminal command identity
TCP*		Terminal command personal identifier (reserved)
TCS-*n*		Terminal command string
TCU		Terminal command update
TIA*		Terminal indicate assignment
TIC		Terminal indicate capability
TID*		Terminal indicate dropped
TIF*		Terminal indicate floor-request
TII*		Terminal indicate identity
TIL		Terminal indicate list

TIN*		Terminal indicate number
TIP		Terminal indicate personal identifier (reserved)
TIR		Token indicate response
TIS		Terminal indicate identity-stop
TIX		Terminal indicate additional-channel-X
VCB*		Video command broadcast
VCE		Video command end-broadcasting
VCF		Video command “freeze-picture request”
VCR		Video command release/refuse
VCS*	#	Video command select
VCU		Video command “fast update request”
VIA		Video indicate active
VIA2		Video indicate active 2
VIA3		Video indicate active 3
VIN*		Video indicate number
VIR		Video indicate ready-to-activate
VIS		Video indicate suppressed