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**Terminal Equipment (TE);
Integrated Services Digital Network (ISDN);
B-Channel Aggregation Unit (CAU);
Procedures and terminal requirements**



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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Terminal Equipment (TE).

National transposition dates	
Date of adoption of this EN:	5 December 1997
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1 Scope

The present document defines protocols for the synchronization and aggregation of multiple Integrated Services Digital Network (ISDN) channels at 64 kbit/s, these channels having a differential delay in the range of one second and with or without octet integrity structure. It also addresses the case of interworking with a digital network restricted to a rate of 56 kbit/s. It is applicable to a wide range of user data transport up to 63 channels using ISO/IEC 13871 [1], but special provision is made for audiovisual systems according to ETS 300 144 [2], up to 24 channels; the aggregation may be network-based or associated with Customer Premises Equipment. The available operating modes (B1, B2, B3, H2) provide options with/without transmission-management overhead and user-data rates at or less than the exact multiples of 64/56 kbit/s.

The number of aggregated channels may be varied dynamically during a session. Procedures are given for dealing with faults, including loss of channels and slip.

Call control is outside the scope of the present document.

2 Normative references

References may be made to:

- a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or
- b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or
- c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or
- d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] ISO/IEC 13871: "Information Technology - Telecommunications and information exchange between systems - Private telecommunications networks - Digital channel aggregation".
- [2] ETS 300 144: "Integrated Services Digital Network (ISDN); Audiovisual services; Frame structure for a 64 kbit/s to 1 920 kbit/s channel and associated syntax for inband signalling".
- [3] ETS 300 143: "Integrated Services Digital Network (ISDN); Audiovisual services; Inband signalling procedures for audiovisual terminals using digital channels up to 2 048 kbit/s".
- [4] ITU-T Recommendation H.320 (1993): "Narrow-band visual telephone systems and terminal equipment".
- [5] ETS 300 145: "Integrated Services Digital Network (ISDN); Audiovisual services; Videotelephone systems and terminal equipment operating on one or two 64 kbit/s channels".
- [6] ITU-T Recommendation H.242 (1993): "System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s".
- [7] ITU-T Recommendation H.221 (1993): "Frame structure for a 64 to 1 920 kbit/s channel in audiovisual teleservices".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

called end: The Channel Aggregation Unit (CAU) or Multiple Channel Equipment (MCE) which accepts the first 64/56 kbit/s channel connection request of the whole session, resulting in the establishment of the "initial channel". If during fault-recovery procedures the initial channel is transferred to another connection, this does not affect the definition (see note 1).

calling end: The CAU or MCE which requests the first 64/56 kbit/s channel connection of the whole session, resulting in the establishment of the "initial channel". If during fault-recovery procedures the initial channel is transferred to another connection, this does not affect the definition (see note 1).

Channel Aggregation Unit (CAU): A device having both multiple 64 kbit/s accesses and a single access at a higher bitrate. Reference in the present document to "CAU" or "aggregator" means equipment conforming to the present document.

compatibility bits: Bit 8 of the first sixteen octets in every time slot of a single channel except time slot 1.

external setting: Term used to express operations outside the scope of the present document which determine the behaviour of a CAU as to choice of option or timing of its action.

H.221: See subclause 3.1, H.221 frame structure, H.221 framing

H.221 frame structure, H.221 framing: Frame structure according to ITU-T Recommendation H.221 [7], as set out in ETS 300 144 [2].

H.244 aggregation: Terminal-Aggregator Communication

H.320 terminal: A terminal that conforms to ITU-T Recommendation H.320 [4] (see note 2).

ISO aggregation: No Terminal-Aggregator Communication

mode H2: Modes of aggregation by the method given in clauses 7 and 8 of the present document.

modes B1, B2, B3: Modes of aggregation by the method of ISO/IEC 13871 [1], see subclause 4.2.

Multiple Channel Equipment (MCE): A terminal or other unit (such as a Local Area Network (LAN) gateway) directly attached to an ISDN (through one or more ISDN accesses, whether basic accesses or primary rate access(es)).

No Terminal-Aggregator Communication Case (ISO Aggregation Case): No in-band management communication between Single Channel Equipment (SCE) and CAU takes place - the single channel is only a clear path for the data which will be wholly transmitted to the remote party; any communication between the terminal and the CAU is by means not specified in the present document (see clause 8).

redundant command: A Bit Allocation Signal (BAS) command which repeats, unchanged, a previously transmitted mode value which is still in force.

Single Channel Equipment (SCE): A terminal or other unit (such as a LAN interface) having a single serial bi-directional digital interface.

H.244 aggregation case: In-band communication between SCE and CAU takes place using ITU-T Recommendation H.221 BAS codes (see clauses 7 and 8 of the present document).

user information: The application data streams passing (in both directions) between CAU and SCE (see note 3).

NOTE 1: The significance of "calling" and "called" end-points is mentioned in subclause 7.1.3.

NOTE 2: ETS 300 145 [5] is the ETSI equivalent to ITU-T Recommendation H. 320 [4]. The scope of ETS 300 145 [5] is, however, restricted to systems supporting 1B or 2B access.

NOTE 3: In the audiovisual cases, the application data stream includes the ITU-T Recommendation H.221 [7] frame structure.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

NOTE: For readability, the capability and command values listed in ETS 300 144 [2] are referred to in the present document by their names rather than codepoint byte values; the use of {*name*} for capabilities and [*name*] for commands serves to distinguish between these.

N	an integer, applied to 64/56 kbit/s channels to define a parallel (un-aggregated) bitstream of rate $N \times 64$ kbit/s.
n	an integer, applied to 64 kbit/s to define a serial (or otherwise aggregated) bitstream of rate $n \times 64$ kbit/s.
N_a	the number of active 64/56 kbit/s channels between CAU and MCE or between two CAUs.
N_m	the maximum number of 64/56 kbit/s channels which can be accepted by a CAU transmitting the value $\{N_m \times B\}$.
N'_m	used to denote the incoming value of N_m from the remote CAU, or equivalent from an MCE.
N_d	the number of connections requested by the calling end, the lower of N_m and N'_m .
$\{N \times 64k\}$	capabilities in the series $\{1B\}, \{2B\}, \{3B\}, \dots$ corresponding to $N=1, 2, 3, \dots$, (applies to Mode H2 only).
$\{n \times 64k\}$	capabilities in the series $\{64k\}, \{128k\}, \{192k\}, \dots$ corresponding to $n=1, 2, 3, \dots$.
n_m	such that $\{n_m \times 64k\}$ is the highest transfer-rate capability incoming from the SCE for which the continuous series of rate capabilities $\{(n_m-1) \times 64k\}, \{(n_m-2) \times 64k\}, \dots, \{2 \times 64k\}$ is also present in the capability set (capset).
$[N \times 64]$	Multiple-channel commands (as defined in ETS 300 144 [2]).
$[n \times 64k]$	Single channel commands (as defined in ETS 300 144 [2]).
[capex]	command issued by a CAU (see subclause 6.3.6.3) to an SCE to stimulate a capability exchange.
[AggIN]*	a double Single Byte Extension (SBE) symbol indicating the number n as determined by the process of subclause 6.3.4.2; see the procedure described in clause 7 (see ETS 300 144 [2]).
{null}	capability having no significance other than as a filler; only ever transmitted by a CAU, and therefore it identifies the capset as having last come from, or been forwarded by, a CAU; SCE ignores any number of these in an incoming capset (see ETS 300 144 [2]).
{SM-comp}	capability to transmit and receive user information without using any compatibility bits, setting these to 1 (see ETS 300 144 [2]).
[SM-comp]	user information is not contained in the compatibility bits (and is not sent in the compatibility bits in the reverse direction either). See ETS 300 144 [2].
Σ	Audible signal (to be defined), which would be recognized by a human user as a call progress tone (he would not hang up).

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AV	Audiovisual
BAS	Bit Allocation Signal
capex	capability exchange
capset	Capability set
CAU	Channel Aggregation Unit
FAS	Frame Alignment Signal
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MBE	Multi Byte Extension
MC (side)	Multiple Channel (side, of a CAU)
MC	Multiple Channel
MCE	Multiple Channel Equipment
NII	Network Indicate Incompatible - aggregators
SBE	Single Byte Extension
SC (side)	Single Channel (side, of a CAU)

SCE	Single Channel Equipment
SM-comp	Single Multiple compatibility
UD	Unspecified Data

4 General

4.1 Application of the present document

On the single channel connections, which may be very short if the terminal and Channel Aggregation Unit (CAU) are co-located, or much longer if a telecommunications link is involved, two options are covered by the present document:

- no in-band management communication on the single channel, this being only a clear path for the data which will be wholly transmitted to the remote party; any communication between the terminal and the CAU is by means not specified in the present document; this is referred to as the "ISO Aggregation" case - No Terminal-Aggregator Communication;
- in-band communication as specified in the present document, using the Bit Allocation Signal (BAS) codes defined in ETS 300 144 [2] and the procedures of ETS 300 143 [3]; this is referred to as the "H.244 Aggregation" case - Terminal-Aggregator Communication. This corresponds to the use of Mode H2 (see subclause 4.2, figure 8 and associated text).

4.1.1 Intercommunication of audiovisual equipments

For audiovisual terminals conforming to ETS 300 144 [2] and ETS 300 143 [3], the present document provides for synchronization and aggregation of up to 24 channels of 64/56 kbit/s, each being with or without octet integrity and relative transmission delay in the range ± 1 second.

Provision is made for the following intercommunication Cases A to C.

4.1.1.1 Case A

For interconnection of a Single Channel Equipment (SCE) and a Multiple Channel Equipment (MCE) audiovisual end-point, both conforming to ETS 300 144 [2] and ETS 300 143 [3], only the H.244 Aggregation approach can be followed (see figure 1); this involves only one CAU, which may be within the network or close to the single channel end-point.

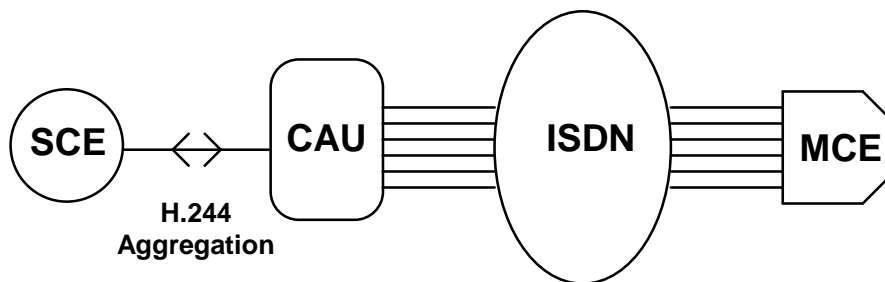


Figure 1: Case A

4.1.1.2 Case B

This case provides for interconnection between two single channel audiovisual end-points which see the aggregated link purely as a clear data channel; each has a CAU associated with it, but there is no in-band control communication between the end-point and its associated CAU (see figure 2); this is the ISO Aggregation approach. The system is exactly the same as for unspecified data applications (see subclause 4.1.2); the CAU-ISDN-CAU combination provides a clear channel at one of the transfer rates specified in ETS 300 144 [2], and, therefore, shall use Mode B1 or B3 (see subclause 4.2).

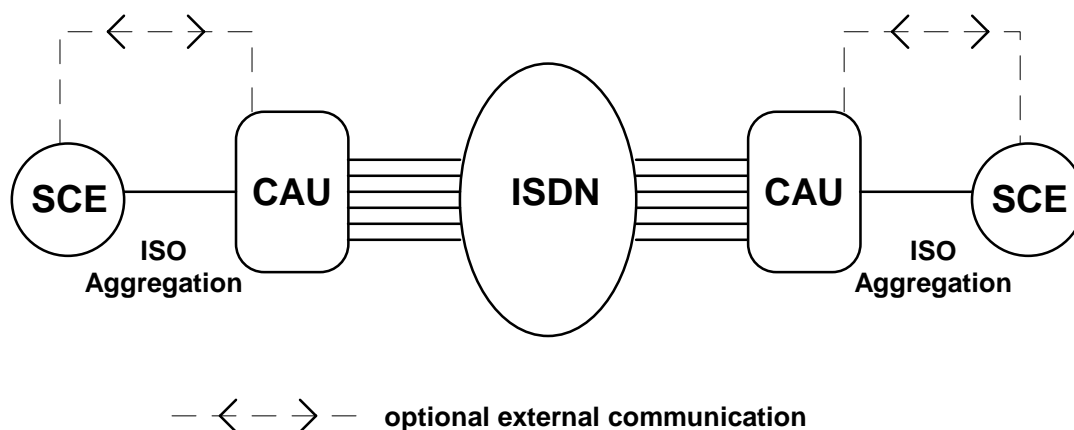


Figure 2: Cases B and D

4.1.1.3 Case C

This provides for the interconnection of two single channel end-points both conforming to ETS 300 144 [2] and ETS 300 143 [3] and capable of the operation described in clauses 7 to 8, the H.244 Aggregation approach (see figure 3); this involves two CAUs, which may be within the network or close to the single-channel end-points.

NOTE: H.244 Aggregation cannot be used at one end and ISO Aggregation at the other, see clause 5.

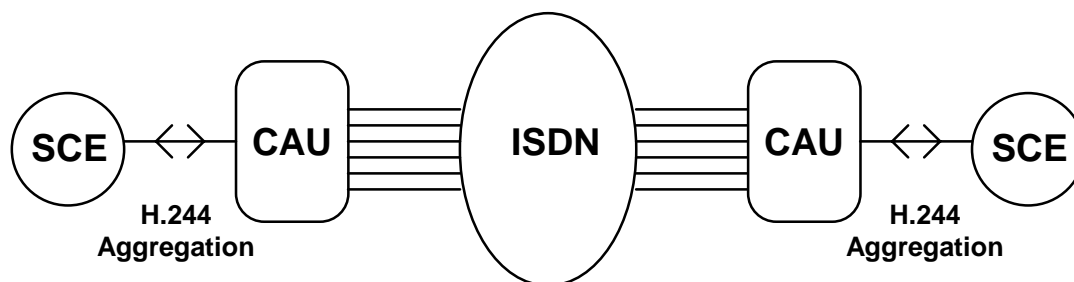


Figure 3: Case C

4.1.2 Intercommunication of non-audiovisual equipments - Case D

The present document provides for synchronization and aggregation of up to 63 channels of 64/56 kbit/s, each being with or without octet integrity and relative transmission delay in the range \pm one second. It is applicable to a wide range of user information transport, including LAN-LAN interconnect, private circuit back-up, and other "unspecified data" applications. No in-band control communication takes place on the single channel side. The equipment sees the aggregated link purely as a clear data channel, and the structure or content of the data streams is of no concern to the aggregating equipment.

The ISO Aggregation approach is appropriate (see figure 2); the CAU-ISDN-CAU combination provides a clear channel at one of the transfer rates specified in ISO/IEC 13871 [1] using Mode B1, B2 or B3 (see subclause 4.2).

4.2 Definition of the modes of transmission on the Multiple Channel (MC) side

The four modes of transmission are defined below, the accompanying figures being given by way of example for the case of about 192 kbit/s on the Single Channel (SC) side.

Mode B1: the user information occupies an integral number of 64/56 kbit/s channels (usually the N available and aligned channels); only unframed signals are transmitted (see figure 4), alignment of the channels has previously been

achieved using a framed mode, and it is assumed that no slip or other network fault has occurred since then. There are no management bits multiplexed into the stream on either Multiple Channel (MC) or SC sides, and the total bitrates are equal; the mode is therefore confined to ISO Aggregation cases, and rate change cannot occur.

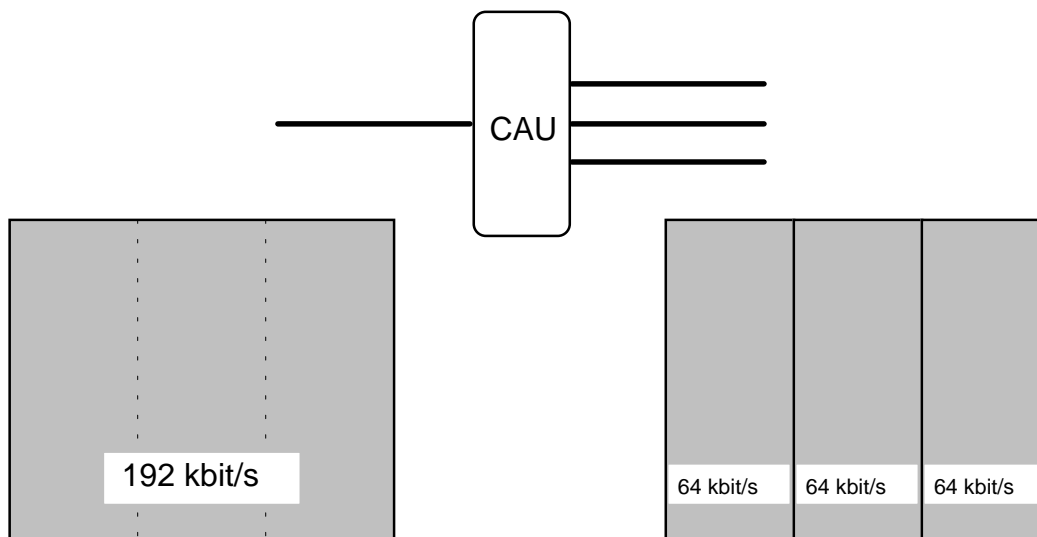


Figure 4: Mode B1 - applicable to the ISO Aggregation case only

Audiovisual signals according to ETS 300 144 [2] can be transmitted, but the ITU-T Recommendation H.221 [7] framing plays no part in the aggregation process, and shall appear at a random position within one of the B-channels as shown in black in figure 5.

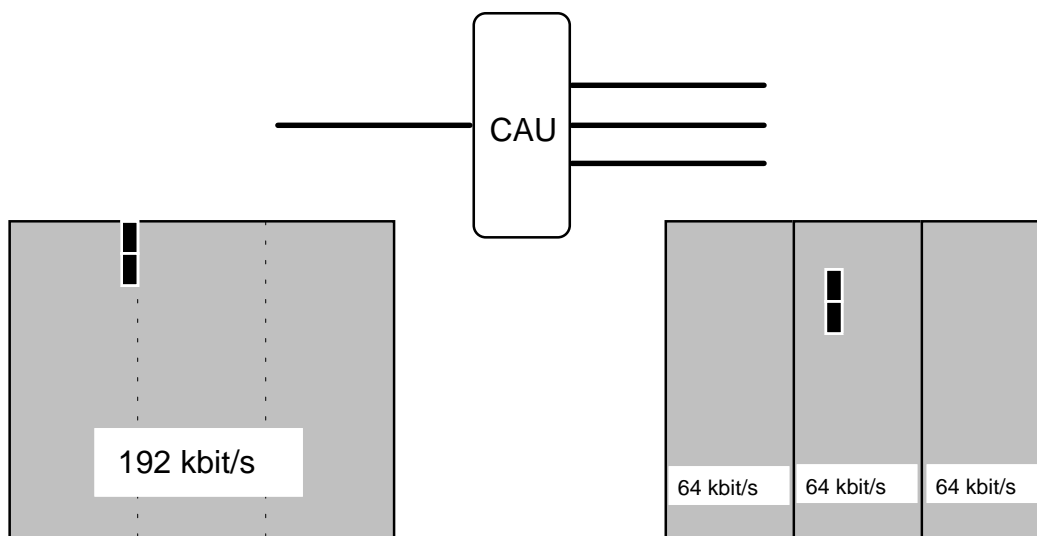


Figure 5: Mode B1 - framed audiovisual signal carried as Unspecified Data (UD)

Mode B2: signals are transmitted with framing according to ISO/IEC 13871 [1] (depicted as white in figure 6), the user information rate being about 1,5 % less than an integral multiple of 64/56 kbit/s due to the overhead of the frame structure. There is no provision for management bits on the SC side, so the use of this mode is confined to the ISO Aggregation case.

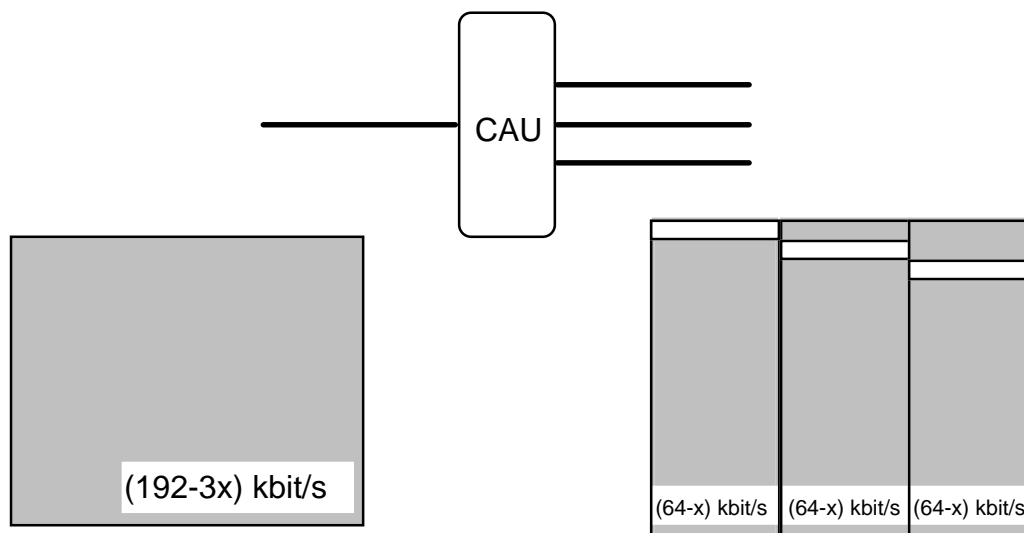


Figure 6: Mode B2 - applicable to the ISO Aggregation case only

Mode B3: signals are transmitted with framing in all N channels according to ISO/IEC 13871 [1], the user information rate being an integral multiple (such as N-1) of 64/56 kbit/s; thus there is a management overhead of about 1,5 % and generally some unused capacity, as illustrated in figure 7. The exact bit positions occupied by user information are defined in ISO/IEC 13871 [1].

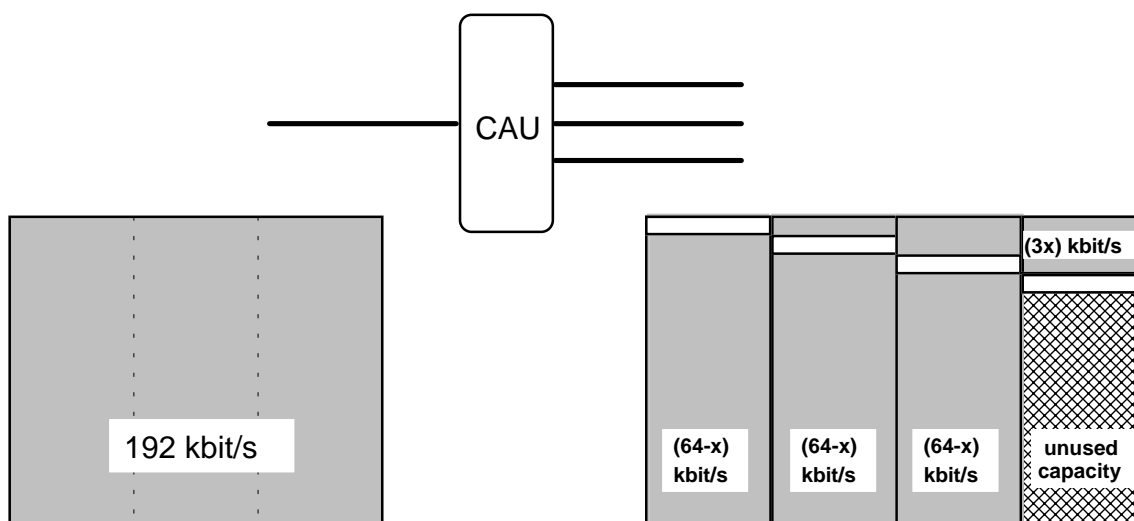


Figure 7: Mode B3 - applicable to the ISO Aggregation case only

Mode H2: only ITU-T Recommendation H.221-framed signals are transmitted (framing is shown as white in figure 8), the user information rate being an integral number of 64/56 kbit/s channels (usually the N available and aligned channels), including the Frame Alignment Signal (FAS) and BAS within this rate. On the MC side all channels are framed; on the SC side only the I-channel (Time-Slot 1) carries H.221 framing, but the corresponding bits (shown with dashed outline) in the other time-slots shall be vacated, so that framing can be inserted at the CAU in the SC to MC direction (and removed in the other): this is done under the Single Multiple compatibility ([SM-comp]) command.

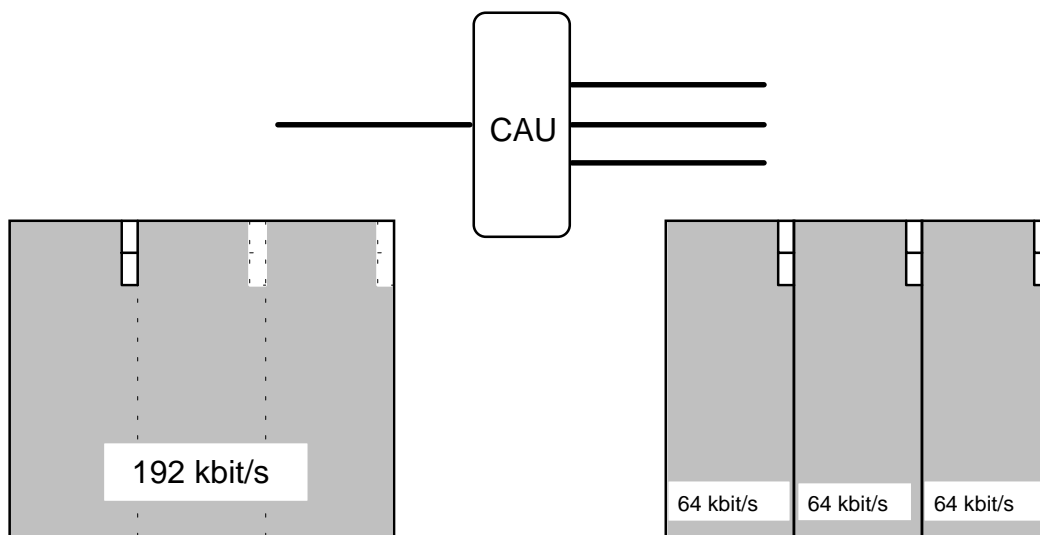


Figure 8: Mode H2 - applicable to the H.244 Aggregation case only

Mode properties

The properties of the four modes are summarized in table 1. "Dynamic rate change" refers to dynamic variation of the number N of aggregated channels during a session: rate changes within available connection capacity can normally be made in less than 40 ms for Modes H2 and B3; when new connections need to be added, the response depends on call set-up time; for Mode B1, interruption of the application is inevitable.

Table 1: Mode properties

	Mode B1	Mode H2	Mode B2	Mode B3
Aggregation overhead	None	2,5 % in the additional channels	1,5 %	64/56 kbit/s
Dynamic rate changes	No	Yes	Yes	Yes
Exact multiples of 64/56 kbit/s	Yes	Yes (H.221 - framed only)	No	Yes
Interworking with MCE (audiovisual)	No	Yes	not applicable	No

The applicability of the Modes is summarized in table 2.

Table 2: Mode applicability

Mode	AV/non-AV	Mode applicable when.....
B1	Audiovisual	the remote end is not an MCE, and the remote CAU does not support Mode H2, and Mode B3 is considered too inefficient or is not available; bitstream treated as UD only; ISO Aggregation case, so external means shall be used to set bitrate.
	Non-audiovisual	exact multiple of 64/56 kbit/s required, absence of dynamic rate change tolerable, B3 considered too inefficient.
B2	Audiovisual	not applicable - B2 does not provide suitable bitrates.
	Non-audiovisual	exact multiple of 64/56 kbit/s not essential, dynamic rate change desired.
B3	Audiovisual	the remote end is not an MCE, and the remote CAU does not support Mode H2; dynamic rate change more important than efficiency; bitstream treated as UD only; ISO Aggregation case, so external means shall be used to set bitrate.
	Non-audiovisual	exact multiple of 64/56 kbit/s required, dynamic rate change more important than efficiency.
H2	Audiovisual	remote end is an MCE, or a CAU supporting Mode H2; H.244 Aggregation case, so no external control needed.
	Non-audiovisual	not applicable (unless conformant to ETS 300 144 [2]).

4.3 General description of the aggregation process

CAU is a device having, on the one side, a single channel port and on the other side a multiplicity of 64/56 kbit/s channel ports. The present document defines the behaviour of the CAU in respect of the input and output signals at the two sides.

When new multiple channels are active, the CAU buffers the incoming signals in order to synchronize them, and then reads the user information to the SC side. In the reverse direction, the CAU takes the serial input into the SC side and loads it into those parallel channels which it knows to be in synchronism at the remote end. However, according to the two quite different conditions described at the beginning of subclause 4.1, the CAU has two different processes, that is, depending on whether or not it is communicating in-band with the single channel terminal; selection of the correct process is described in clause 5.

When there is such communication (this applies only to audiovisual terminals), effectively it is the terminal which is communicating with the other terminal at the remote end of the connection, by capability sets and commands; the CAU merely moderates this communication in order to assure satisfactory conditions on the multiple 64/56 kbit/s channel subclause. The CAU informs the terminal about the upper limit of transmission rate, which depends on the number of channels available, or what the other end can accept, whichever is the lower; it does this by suitably modifying the capability sets exchanged. The synchronization process is based on ETS 300 144 [2], which also provides for numbering of the channels. Negotiation of appropriate conditions is based on ETS 300 143 [3]; the capability sets emanating from the CAU define the range of signals that could be sent to it, while commands define the actual signal structure being transmitted from the CAU. See clauses 7 to 8 of the present document.

When there is no in-band communication between the CAU and SCE, the CAU is totally responsible for its communication with the remote CAU, presenting on its SC side a clear digital channel at a specified bit rate, which can be used for any purpose whatsoever (including audiovisual systems). Here again the CAU needs to control the transmission rate from the terminal - this can be done by clocking if the application rate can be varied in this way (and this does not apply to terminals conforming to ETS 300 145 [5]), or by other external signalling. In this ("ISO Aggregation") case, the synchronization and communication processes are fully described in ISO/IEC 13871 [1] - see clause 8 of the present document.

4.4 CAU functionality

The CAU functionality can be summarized as follows:

1) all modes

MC-to-SC direction: synchronization and aggregation of N incoming 64/56 kbit/s channels into one outgoing single channel; SC-to-MC direction: partition of incoming user information onto N outgoing 64/56 kbit/s channels, with framing as appropriate.

H2 mode

Ignore the compatibility bits incoming on the SC side, putting FAS/BAS into the corresponding outgoing bits on the MC side; remove FAS/BAS in additional channels incoming on the MC side, putting "ones" into the corresponding outgoing bits on the SC side.

2) all modes

Control the aggregated bitrate according to application requirements and the available MC capacity.

H2 mode

Modify capability sets and commands to ensure correct operation of the system; detect changes to capacity requirements from incoming capability sets.

3) all modes

Detect fault conditions and take appropriate action.

4) all modes

(Optionally) transfer the call-control signalling between the ISDN and single channel networks.

The action of the CAU is not completely specified, some matters being left to the choice of the implementer or service provider. For example, requests for channels will not all mature simultaneously, and it is a matter of choice whether each should be added in to the communication as soon as available (increasing the bit rate in a series of many steps), or alternatively held back until all or most are available (increasing the bit rate in one single step).

5 Choice of ISO Aggregation or H.244 Aggregation procedure

The procedure at the start of the call is as depicted in figure 9 and described as follows. It is mandatory that all CAUs intended for use with audiovisual terminals conforming to ETS 300 144 [2] shall be able to operate in Mode H2.

There are two alternatives for the choice between ISO Aggregation and H.244 Aggregation processes at each CAU:

- 1) the CAU may be pre-set to operate in the ISO Aggregation procedure or the H.244 Aggregation procedure only, according to the environment for which the CAU is intended;
- 2) if 1) has not been applied, a decision shall be taken on the basis of incoming signals on both SC and MC sides, as described below.

Reference is made to figure 9. The CAU operation is essentially the same whether it is the originating (calling) end or the destination (called) end (the setting of Flag1 is for possible later use when the additional channels are to be requested).

First, three local conditions need to be tested, and if any of the three are not met then ISO Aggregation (clause 8) shall be used. These conditions are:

- a) there has been no pre-set to specify ISO Aggregation only; note that if the connected SCE is an ITU-T Recommendation H.320 [4] terminal, then specifying ISO Aggregation means that only modes B1 or B3 may be used - B2 does not provide valid bitrates;
- b) H.221 framing is detected, coming from the SCE; note that a time-out is involved here;
- c) the capability set (capset) in that H.221 frame contains the value {SM-comp} and/or {6B-H0-comp}.

Only under these three conditions is the H.221-framed signal forwarded from the SCE on the initial channel, otherwise the CAU generates the signal defined in section 7.1 of ISO/IEC 13871 [1].

Second, the incoming signal is searched for H.221 framing and ISO/IEC 13871 [1] signal. If ISO/IEC 13871 [1] signal is detected, then ISO Aggregation procedure of clause 8 shall be used - if previously following clauses 7 to 8 because the above three conditions were met, this means switching to ISO/IEC 13871 [1] signal on the outgoing transmission. A time-out of 10 seconds is applied to the detection of the ISO/IEC 13871 [1] signal to allow for the possibility that clauses 7 to 8 is initially being followed at the remote end. **Only if the transmissions in both directions are H.221-framed with {SM-comp} or {6B-H0-comp} the procedures of clauses 7 to 8 apply.**

Failure states

If no incoming framing, either of ITU-T Recommendation H.221 [7] or ISO/IEC 13871 [1] type, **Failure State 1** is reached, it shall be presumed that the remote end-point is neither a CAU nor an audiovisual MCE (in some applications, speech communication using PCM according to CCITT Recommendation G.711 may still be possible).

If one end is transmitting according to ISO Aggregation operation (clause 8), one of the above three conditions not having been fulfilled, and the remote end is sending H.221 framing but without {SM-comp} or {6B-H0-comp}, **Failure State 2** shall be reached, reflecting the technical impossibility of interconnecting to an MCE at the remote end.

Failure State 3 shall be reached if the CAU is set to operate in the H2 mode but the connected SCE is not sending H.221 framing.

The action to be taken on reaching any of the failure states shall be an implementation matter. The Single Byte Extension (SBE) symbol NII (Network Indicate Incompatible-aggregators), indicating incompatible aggregators, may be used in appropriate fault conditions.

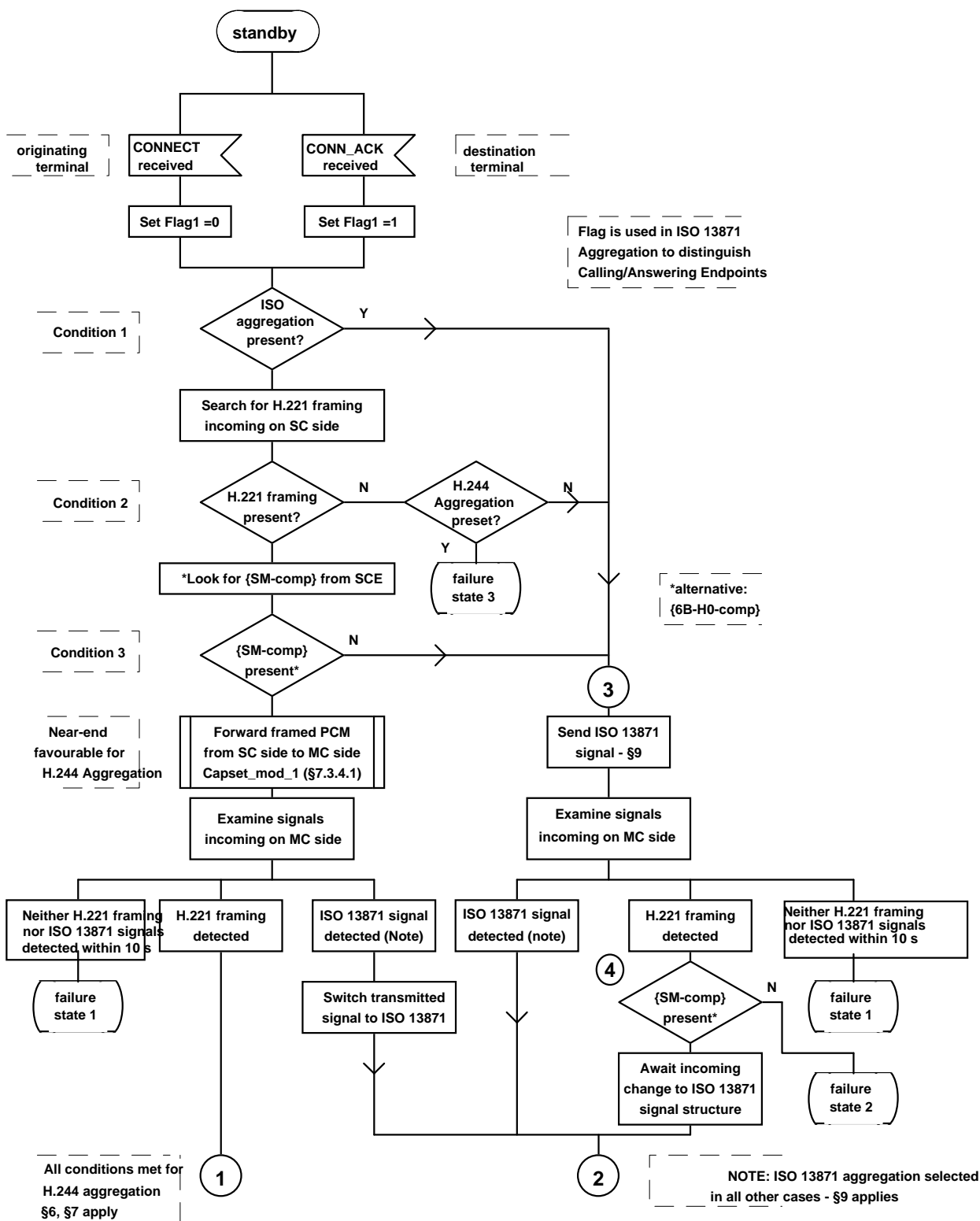


Figure 9: Procedure for selection between H.244 Aggregation and ISO Aggregation processes

6 H.244 Aggregation procedure

6.1 Call control

The signalling for call control is outside the scope of the present document. It is assumed that external signalling is available to set up the appropriate paths between the equipments - for example, the "D-channel" in the case of ISDN. Means are described in subclause 7.1.3 for the in-band transfer of network address information where this is needed for call control.

6.1.1 Initial channel

The initial 64/56 kbit/s channel is requested when communication has been established between the calling-end SCE and its CAU and any necessary checking has been carried out (for example, presence of {SM-comp} if required; presence of {n*64k} with $n > 1$...). During establishment of the initial channel, the value of N_m shall be calculated from the SCE capset (see subclause 6.3.2).

SCE terminals conforming to ETS 300 145 [5] should include the 6B-H0 compatibility mode; if this capability and {SM-comp} are both absent, the CAU shall adopt ISO Aggregation working - see clause 5.

6.1.2 Additional channels

Additional-channel requests are made by a CAU when:

- the total of channels already requested is less than the lower of N_m and N'_m , and (in dial-up cases) the CAU is the calling end.

Additional channels may be dropped by a CAU when the total of channels already requested exceeds the lower of N_m and N'_m .

6.2 Channel synchronization

On the multiple-channel side, CAUs shall always synchronize all connected channels (in the ISDN case, those for which CONNECT has been sent or received). The value of N_a shall be determined according to the channels for which:

- the incoming A-bit is set to zero;
- the channel numbers in BAS position (see annex A) form a continuous series from 1 to N_a .

6.3 In-band procedure using ITU-T Recommendation H.221 BAS codes

In-band signalling shall follow ETS 300 143 [3] to ensure correct operation between the equipments. H.221 framing shall be used on all the multiple channels, and also on the single channel side. All BAS commands shall be considered effective from the start of the following submultiframe, and shall remain in force until countermanded, see ETS 300 143 [3].

CAUs shall remain responsive to incoming H.221 framing throughout the call, on the MC side on all channels, and on the SC side. This means that when no framing is detected, the equipment will nevertheless respond rapidly when the incoming signal is switched to a framed mode, and will also respond quickly (if required) to fault conditions.

6.3.1 Control of transfer rate

The main function of the CAU is to match the effective transfer rates on its two sides. To do this it shall be able to control the user information which is sent to it: it does this in-band on the MC side, and in the H.244 Aggregation case also on the SC side. The in-band method is by means of the capability set (see ETS 300 143 [3]) which it transmits or

forwards; this shall always contain transfer-rate capability values no higher than the available rate on the other side of the CAU.

NOTE: There can be other in-band signalling between SCE and CAU, however, this is outside the scope of the present document, and should be treated in the same way as "out-of-band" signalling - see ISO Aggregation case.

6.3.2 Determination of the transfer-rate capabilities to be transmitted on the MC side

Reference is made to the in-band streams (1) and (2) in figure 10.

Transfer-rate capabilities transmitted on the MC side (2) are decided on the basis of the capset received from the SCE (1).

If $n_m > 1$, an $\{N \times 64k\}$ type value, with $N = n_m$ shall be sent - this is required for communication with an MCE, and also provides for communication with an SCE with fallback to all lesser multiples of 64/56 kbit/s.

If an SCE-transmitted capset contains values of $\{n \times 64k\}$ for which n is higher than n_m , these also shall be included (see subclause 6.3.4.2) for potential communication with another SCE, though fallback to lesser rates shall be limited.

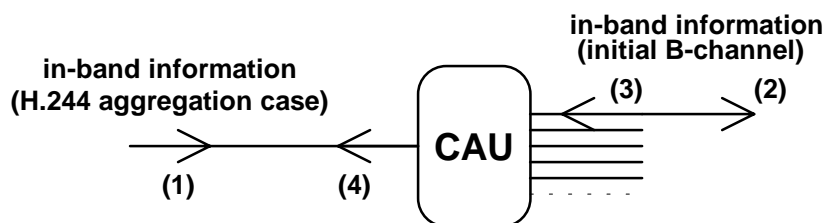


Figure 10

6.3.3 Determination of the transfer-rate capabilities to be transmitted on the SC side

Reference is made to the in-band streams (3) and (4) in figure 10.

Transfer-rate capabilities transmitted on the SC side (4) are decided on the basis of the capset received from the MC side (3) and the number of channels currently available, N_a .

The incoming capability set on the MC side contains a single transfer-rate value of $\{N'_m \times 64k\}$ type: this value shall be replaced by a $\{n \times 64k\}$ -type transfer-rate value, corresponding either to the incoming value (i.e. such that $n = N'_m$), or to the available number of channels (i.e. such that $n = N_a$), whichever is the lesser. In general, the highest $\{n \times 64k\}$ -type transfer-rate capability value transmitted from CAU on the SC side (4) is that which indicates the maximum bitrate that can be accepted, including both user information and management.

6.3.4 Capability sets transmitted from a CAU

Capsets are not generated by the CAU itself; they are generated only in the terminals, and shall be forwarded, in both SC and MC directions, by the CAUs with modifications as described in subclauses 6.3.4.1 and 6.3.4.2. No changes in the length of a capset are made by a CAU, the value $\{\text{null}\}$ being used to fill any unused positions.

The capsets outgoing from CAUs shall not violate the rules set out in ETS 300 143 [3]; in particular, all capsets which follow one another in succession without intervening commands shall be identical. Thus when circumstances require that a new modification be made, this shall always be done on a new capset, which shall be stimulated by the procedure of subclause 6.3.5.

6.3.4.1 Modification of SCE capset for forwarding towards MC side

The CAU modifies the SCE capset changing the lowest transfer-rate capability value to $\{N_m \times 64k\}$; here N_m is determined from subclause 6.3.2, except that if the SCE capset has only one transfer-rate capability value $\{n \times 64k\}$ then this is sent unchanged.

This may be understood with reference to the following examples:

Table 3

Original transfer rate capabilities	External setting	Modified transfer rate capabilities
512, 384, 320, 256, 192, 128, 64	none	512, 384, 320, 256, 192, 128, 6B
384, 256, 192, 128, 64	6B	384, 256, 192, 128, 4B (see note 1)
384, 320, 256, 192, 128	none	384, 320, 256, 192, 6B
384, 320, 256, 192, 128	4B	384, 320, 256, 192, 4B
384	none	384 (see note 2)
NOTE 1: 6B cannot be used here since the rate 320 is absent from the list of original capabilities.		
NOTE 2: See annex C for further information.		

Modification of the lowest transfer-rate capability guarantees that the transfer-rate capability for just 64 kbit/s, which is the same as 1B, shall never be present in the same set as a higher rate $\{N \times B\}$ -type. The remaining transfer rate and all other Capability codes are left unchanged. A remote MCE shall receive the $\{N \times B\}$ -type and ignore the $\{n \times 64k\}$ -type values. The MCE shall use the received A bits to determine the rate at which it can transmit data.

The CAU shall conform to ITU-T Recommendation H.242 [6] at all times: in particular, it shall not cause a change (in content or even order) in forwarded capsets without the insertion of a command - this may require the omission of a complete capset.

6.3.4.2 Modification of capset incoming from MC side for forwarding towards SCE

The CAU modifies the capset incoming from the MC side according to subclause 6.3.3. All values of transfer rate exceeding the capacity actually available on the multiple-channel link shall be replaced by the $\{\text{null}\}$ value; $\{\text{null}\}$ shall also be used to avoid any repetitions. If only five channels are active, and even though information (3) from the equipment connected at the MC side up to 6B (for example) would be acceptable, then the capset transmitted by the CAU in direction (4) shall contain the transfer rate values no higher than $\{320k\}$.

This is best understood with reference to the following examples:

Table 4

Original transfer rate capabilities	Available channels	Modified transfer rate capabilities
512, 384, 320, 256, 192, 128, 6B	6	null , 384, 320, 256, 192, 128, 6B
384, 256, 192, 128, 4B	3	null , null , 192, 128, null
384, 256, 192, 128, 5B	5	null , 256, 192, 128, 320

6.3.5 Notification of change of N_a

When the number of available channels has been changed, this shall be made known to the SCE by sending a new value of $\{n \times 64k\}$ capability, using the modification of subclause 6.3.4.2. If a sequence of (identical) capsets is already being received on the MC side, then two steps shall be taken:

- one complete set shall be replaced by redundant commands (since to comply with ETS 300 143 [3] a capset change may not be made without interposing at least one command);
- the next capset shall be modified according to subclause 6.3.4.2, using the new value of N_a .

If there are no capsets incoming on the MC side, it shall be necessary to stimulate a capability exchange.

This procedure shall be initiated by the CAU by sending [capex] to the SCE (subclause 6.3.6.3).

NOTE: A terminal which has sent {6B-H0-comp} rather than {SM-comp} is unlikely to respond to [capex]; in this case the CAU may trigger the capability exchange by repeating the last capset it sent to the SCE.

The SCE shall respond with a new capset, which shall be passed by the CAU towards the distant terminal with modification according to subclause 6.3.4.1.

If the distant terminal is an MCE, it shall respond with a new capset, which shall be conveyed to the SCE with modification by the CAU according to subclause 6.3.4.2, reflecting the new value of N_a .

If the distant terminal is a CAU2 and SCE2, then the capset reaching SCE shall have been modified by CAU2 according to subclause 6.3.4.2, reflecting the new value of N_a .

SCE2 shall likewise respond with a new capset, which shall be conveyed to SCE1 with modification by CAU2 according to subclause 6.3.4.1 and by CAU1 according to subclause 6.3.4.2, also reflecting the new value of N_a .

6.3.6 Commands transmitted from a CAU

In the H.244 Aggregation case, commands are not usually generated by the CAU itself, other than that certain substitutions shall be made, as detailed below; the remainder are generated only in the terminals.

6.3.6.1 Substitution of transfer rate commands

When [n*64k] from SCE is detected at the CAU, it shall be replaced by [N×64k] with $N=n$ for forwarding on MC side.

When [N×64k] from the MC side is detected at the CAU, it shall be replaced by [n*64k] with $N=n$ for forwarding to SCE.

6.3.6.2 Insertion and removal of [SM-comp] and [6B-H0-comp]

When [SM-comp] or [6B-H0-comp] from SCE is detected at the CAU, it shall be replaced by repeating the latest command received from SCE, for forwarding on MC side.

A redundant command from the MC side shall be replaced by the same value, [SM-comp] or [6B-H0-comp], for forwarding to SCE. For security, this process should be repeated from time to time during the communication, when convenient.

6.3.6.3 Insertion of [capex]

When it is necessary to stimulate a capability exchange between two terminals, a redundant command from the MC side shall be replaced by [capex] for forwarding to SCE; on receipt, a terminal which is able to recognize [capex] shall:

- a) if it is transmitting a capset, complete that capset, followed by cap-mark and a valid command (see ETS 300 143 [3]);
- b) start a new capability exchange according to ETS 300 143 [3].

6.3.6.4 Insertion of [AggIN]*

When it is necessary to notify rapidly the SCE of an unexpected drop in available capacity, four successive commands from the MC side shall be replaced by [AggIN]* for forwarding to SCE. A terminal which is able to recognize [AggIN]* shall make a mode switch to a lower transfer rate, consistent with the available multiple channels. (See note in subclause 7.3).

6.4 Transmission of user information by a CAU

Transmissions in both directions are governed by commands generated by the two terminals, except that on the MC side of a CAU the outgoing transfer rate shall be modified from the incoming value on the SC side according to subclause 6.3.6, and on the SC side of a CAU the outgoing transfer rate shall be modified from the incoming value on the MC side, also according to subclause 6.3.6.

While a CAU has no connection made on one side, it transmits its locally generated frame structure on the other side, in Mode 0F with audio Σ and any relevant command (such as [CCITT Recommendation G.711 A-law]) in the BAS position.

As soon as both sides are connected, the signal from each side shall be routed directly through to the other with two modifications:

- BAS values are modified according to subclauses 6.3.4 and 6.3.6;
- (optional) a fractional-frame buffer may be inserted to avoid the discontinuity arising when the locally-generated frame structure is replaced by that coming in on the other side.

NOTE: Because of the dependent H.221 framing on the two sides of the CAU, there may be a need to interrupt the framing while doing the synchronization of an additional channel.

7 Initialization, mode/rate changing and fault recovery

7.1 Initialization

The in-band procedures are the same for any CAU, whether it originates the request for the initial channel (calling end-point) or is the destination (called end-point). An additional example description of initialization, with SDL figure, is given in annex B.

Table 5: Summary

Step	
1.	SCE connected to CAU: CAU detects framing and {SM-comp} or {6B-H0-comp}, determines desired rate from transfer-rate capabilities from SCE.
2.	CAU makes/receives initial connection (which can be to/from another CAU or an MCE).
3.	Seeks and finds H.221 framing on connected initial channel.
4.	Capability exchange takes place between the SCE and the remote equipment, the transfer rate values being modified by the CAU in both directions; audio from SCE is sent; audio incoming from MC side is passed on.
5.	Requests additional network addresses if necessary; then requests additional connections (see note 1 to subclause 7.1.3).
6.	Synchronizes additional channels when connected.
7.	The command [SM-comp] is sent to the SCE, to ensure voiding of "compatibility bits" later.
8.	The command [capex] is sent to the SCE, to stimulate another capability exchange.
9.	New cap-exchange, CAU now modifies to reflect the available multi channel capacity.
10.	SCE performs a mode switch to the desired higher rate.
NOTE:	Also see examples in annex A.

7.1.1 Single channel side

7.1.1.1 Incoming signal

The CAU shall search the incoming signal from the SCE for frame and multiframe alignment. If H.221 framing is absent, it shall be presumed that a non-audiovisual equipment is connected, and transmission of Mode 0F be discontinued (see clause 5). In the case of Outcome I (see ETS 300 143 [3]), the incoming capset shall be examined. The CAU shall derive the target number of B-channels N_m from n_m . If the capset does not also contain {SM-comp} or {6B-H0-comp}, then the call cannot proceed as a H.244 Aggregation case, but shall be treated as ISO Aggregation (see clause 5).

7.1.1.2 Outgoing signal

Until a suitable signal is available incoming on the MC side, the CAU may optionally transmit towards SCE an audible signal Σ in Mode 0F (local audio coding law) and any relevant command (such as [CCITT Recommendation G.711 A-law]) in the BAS position. When H.221-framed signals are received on the MC side, the whole signal from the MC

side shall be forwarded towards SCE, the capsets being modified according to subclause 6.3.4.2. At this stage the transfer rate is just 64 kbit/s.

7.1.2 Multi channel side, initial channel

The following process begins when the CAU is notified, by external signalling, that the first connection on the MC side is completed.

7.1.2.1 Incoming signal

The incoming signal shall be searched for H.221 framing; if H.221 framing is not found, the process continues as in clause 5.

7.1.2.2 Outgoing signal

Transmission shall be in H.221-framed Mode 0F with the signal from SCE, as follows.

Receiving an H.221-framed signal from the SC side, the CAU shall forward this same signal outwards from the MC side. If the signal contains (repeated) capsets, it shall modify these according to subclause 6.3.4.1; if it does not, then it shall send [capex] towards the SCE to stimulate a capability exchange initiated by the SCE.

Transmission continues to follow the initialization procedure according to ETS 300 143 [3]. When Outcome I is reached, mode switching may take place, if desired, before the establishment of additional channels; however such action shall be the responsibility of the terminals alone - the CAU merely modifies the commands according to subclause 6.3.6.

7.1.3 Multi channel side, additional channels

A CAU (see note 1) may dial more channels after having detected framing on the initial channel and an capset incoming on the MC side. The total number N_d of connections to be dialled shall be selected as follows.

The capset incoming on the MC side contains a single value of type $\{N \times 64k\}$, where $N = N'_m$; there may also be values of type $\{n \times 64k\}$ (indicating the presence of another CAU - such values are not transmitted by an MCE), the maximum value being $n = n'_{max}$.

The capset incoming on the SC side contains values of type $\{n \times 64k\}$, the maximum value being $n = n_{max}$; the value of N_m shall also be calculated (see subclause 6.3.2).

N_d is the greater of $\{(the\ lesser\ of\ N_m, N'_m), (the\ lesser\ of\ n_{max}, n'_{max})\}$.

NOTE 1: It is assumed in the present document that additional connections may only be requested by the same unit that has obtained the initial connection; likewise the dropping of unwanted connections; however, since the in-band behaviour is not affected, there is no problem if some or all calls are made/dropped from the other endpoint.

NOTE 2: According to the properties of the network accessed, it may be necessary to insert a delay of up to 1 second between successive additional connection requests.

Methods of obtaining network address information for additional channels are described in ETS 300 143 [3].

NOTE 3: The use of SBE rather than Multi Byte Extension (MBE) messages is preferred here, since the substitution of a MBE message into the BAS command stream from a terminal is much more difficult than substitution of a SBE. **In general, the use of same or consecutive network addresses is strongly recommended.**

When the CAU is notified, by external signalling, that an additional connection is completed, it carries out framing and synchronization according to ETS 300 144 [2], and assigns the channel a number (see annex A). Transmission of user information may be expanded onto the additional channels either:

- a) one by one as they become synchronized and numbered;
- b) the target number of channels is reached (as determined from the incoming capset or external control); or

c) an allowed time limit for reaching this target has expired.

NOTE 4: The choice of time limit is an implementation matter.

At this point the CAU shall notify the SCE of the increased available capacity on the MC side; this shall be done following the procedure of subclause 6.3.5. Subsequent mode switching is a matter for the terminals alone - the CAU merely modifies the commands according to subclause 6.3.6.

7.2 Change of transmission rate during a session

Either terminal may switch its transmission to another mode within the ranges declared by the capability set received from the CAU, which is itself dependent on N_a . If having made such a mode change, one or more channels are no longer required, the calling CAU may release them.

An increase of N_a may be necessary to accommodate the desired transmission; if the called CAU is not permitted to request additional channels, and so shall await that action by the calling CAU (see note 1 to subclause 7.1.3), this need shall first be communicated to the calling CAU in the same way as for the initial session set-up (see subclause 6.3.2), and the calling CAU then requests the additional channels. The change of available capacity shall be notified to both terminals by the procedure given in subclause 6.3.5, and then they make the desired mode change(s).

7.3 Recovery from fault conditions

The onset of a fault may be recognized in a number of ways, for example:

- by loss of frame synchronization on an incoming channel;
- by an incoming A-bit set to 1;
- by errored connections from CRC4 check;
- by a high number of temporary loss of synchronization events.

The currently effective value of N_a is determined from the incoming A-bits and channel numbers according to subclause 6.2 (this may be delayed a short time to allow for the possibility of rapid restoration of normal conditions).

The change of available capacity shall be notified rapidly by each CAU to its local SCE by sending the double SBE symbol [AggIN]*, enabling them to switch immediately to a lower rate and enable the application to recover.

A terminal which has sent {6B-H0-comp} rather than {SM-comp} is unlikely to respond to [AggIN]*; in this case the CAU shall repeat the last capset it sent to the SCE, except that the modification according to subclause 6.3.4.2 now reflects the lower value of N_a .

7.4 Further mode changes

When it is desired to switch on video and/or data transmission, the procedures of ETS 300 143 [3] shall be followed. No action shall be required by the CAU as long as no change of transfer rate is involved. Symmetry of transmission is, as always, a matter for terminal procedures, neither terminal being obliged by in-band management signals to conform to a transmission mode adopted by the other. The transfer rate is essentially under the control of the calling party.

8 ISO Aggregation procedure

The ISO Aggregation procedure is described in ISO/IEC 13871 [1]. The frame structure is detailed in subclause 4.2 and the initialization in subclause 7.1 of ISO/IEC 13871 [1].

Annex A (informative): Examples

Case 1: Interconnection of two ITU-T Recommendation H.320 [4] SCE-type terminals via two CAUs using Mode H2; the last additional connection is tardy in maturing; during the call, a reduction of capacity is requested.

NOTE 1: The values 13, 9, 7, 3 in the following are purely for example.

SCE1 is the calling end, and the desired number of channels is specified as that giving the same capacity as the highest transfer rate in the SCE1 capset; the time limit for awaiting that number in the initial set-up phase is set at TIM. It is also specified that the SC side is to be active for user information as much as possible, including the period when only one channel is active.

- 1) CAU1 makes the initial channel request when the connection from SCE1 to CAU1 is complete and H.221 framing from SCE1 is detected, or upon an external stimulus which also resets the "Sequence A" timer in the SCE. It transmits tone Σ in Mode 0U towards SCE1. [NB: if CAU1 does not detect H.221 framing from SCE2 within {1s?}, then it sends ISO/IEC 13871 [1] framing to CAU2, and tone Σ is omitted.]
- 2) CAU2 receives SETUP from CAU1, and establishes contact with SCE2 (this may be a permanently active link, or require "waking up"); it then returns CONNECT to CAU1, and commences transmission of the framed signal from SCE2. It transmits tone Σ in Mode 0U towards SCE2. [NB: if CAU2 does not detect H.221 framing from SCE2 within {1s?}, then it sends ISO/IEC 13871 [1] framing to CAU1.]
- 3) On receipt of CONNECT, CAU1 sends towards MC side the incoming signal from SC side, including capsets (repeated continuously) from SCE with modification according to subclause 6.3.4.1 - in this case the {13*64k} is modified to {13B}.
- 4) CAU1 detects H.221 framing from CAU2; the incoming capset is that from SCE2, repeated; this contains {9B}, which is lower than the {13B}; passes the incoming signal from the MC side on towards the SCE1, modifying the {9B} to {1B}, since only one channel is yet available. Likewise CAU2 detects H.221 framing from CAU1; the incoming capset is that from SCE1, repeated; it passes the incoming signal from the MC side on towards the SCE1, modifying the {13B} to {1B}.
- 5) Comparing the incoming {13*64k} and {9B}, CAU1 calculates N_d as "9", and requests 8 additional connections, obtaining the remote addresses if necessary using the NCA-a procedure of ETS 300 143 [3].
- 6) By expiry of TIM, CONNECT has been received from CAU2 in respect of 7 more channels; CAU1 adds buffering and numbering to these to achieve synchronism and returns A=0 according to ITU-T Recommendation H.221 [7]. CAU2 does likewise. CAU1 and CAU2 both look for a redundant command, and replace this with [SM-comp].
- 7) When CAU1 receives A=0 on initial and the seven available additional channels, it needs to stimulate another capability exchange, in order to be able to indicate the increase channel availability; therefore it sends [capex] to SCE1, which returns one capset + cap-mark.

NOTE 2: An ITU-T Recommendation H.320 [4] terminal which transmits {6B-H0-comp} rather than {SM-comp} may not recognize [capex]; in this case the CAU may send the previously transmitted capset from CAU2, which it would have stored for the purpose; however, such situations would be better avoided.

- 8) CAU1 passes this on to CAU2 with usual modification (subclause 6.3.4.1), namely {13*64k} >> {13B}.
- 9) CAU2 passes the capset on to SCE2, modifying the capset again according to subclause 6.3.4.2, namely replacing one of the transfer-rate values with {512k}, the n*64k value corresponding to the multiple-channel capacity actually now available.
- 10) SCE2 itself responds with its normal capset + cap-mark; CAU2 passes this back with modification as in subclause 6.3.4.1.
- 11) CAU1 passes the capset on to SCE1, modifying the capset again according to subclause 6.3.4.2, namely replacing one of the transfer-rate values with {512k}, the n*64k value corresponding to the multiple-channel capacity actually now available.

- 12) Both SCEs are now in a position to mode switch to any framed rate up to [512k]. The CAUs must watch out for [SM-comp] coming from SCEs and replace it with a redundant command, and also for [n*64k] commands, replacing them with [N×64k].
- 13) CONNECT is belatedly received by CAU1 from CAU2 in respect of last requested channel; it adds buffering and numbering to this to achieve synchronism and returns A=0 according to ITU-T Recommendation H.221 [7].
- 14) Receives A=0 on this last channel; same process as in clauses 7-12, with 512k replaced by 576k.
- 15) At user request, SCE1 is instructed to drop three channels - namely down to 384k; SCE1 sends new capset containing {.....128k, 192k, 256k, 320k, 384k} + cap-mark; the process continues from line 3 of 8.

Case 2: Interconnection of two ITU-Recommendation H.320 [4] terminals, one an MCE type, the other SCE working via a CAU. The number of desired connections, etc., is as for Case 1. The SCE is the calling end.

The bold font conveys the effective differences from Case 1: it can be seen that they are minimal.

- 1) CAU makes the initial channel request when the connection from SCE to CAU is complete and H.221 framing from SCE is detected, or upon an external stimulus which also resets the "Sequence A" timer in the SCE. It transmits tone Σ in Mode 0U towards SCE. **[NB: if CAU does not detect H.221 framing from SCE2 within {1s?}, then it sends ISO/IEC 13871 [1] framing to MCE, and tone Σ is omitted; on later receipt of H.221 framing from MCE and this does not itself change to ISO/IEC 13871 [1] framing within 2s, a terminal-incompatibility fault condition is identified].**
- 2) **MCE** receives SETUP from CAU; it then returns CONNECT to CAU, and commences transmission of the framed signal.
- 3) On receipt of CONNECT, CAU sends towards MC side the incoming signal from SC side, including capsets (repeated continuously) from SCE with modification according to subclause 6.3.4.1 - in this case the {13*64k} is modified to {13B}.
- 4) CAU detects H.221 framing **and capset is that from MCE**, repeated; this contains {9B}, which is lower than the {13B}; passes the incoming signal from the MC side on towards the SCE, modifying the {9B} to {1B}, since only one channel is yet available. Likewise **MCE** detects H.221 framing from CAU; the incoming capset is that from SCE, repeated.
- 5) Comparing the incoming {13*64k} and {9B}, CAU calculates N_d as "9", and requests 8 additional connections, obtaining the remote addresses if necessary using the NCA-a procedure of ETS 300 143 [3].
- 6) By expiry of TIM, CONNECT has been received from CAU2 in respect of 7 more channels; CAU adds buffering and numbering to these to achieve synchronism and returns A=0 according to ITU-T Recommendation H.221 [7]. CAU2 does likewise. CAU looks for a redundant command, and replaces this with [SM-comp].
- 7) When CAU receives A=0 on initial and the seven available additional channels, it must stimulate another capability exchange, in order to be able to indicate the increase channel availability; therefore it sends [capex] to SCE, which returns one capset + cap-mark.

NOTE 3: An ITU-T Recommendation H.320 [4] terminal which transmits {6B-H0-comp} rather than {SM-comp} may not recognize [capex]; in this case the CAU may send the previously transmitted capset from CAU2, which it would have stored for the purpose; however, such situations would be better avoided.

- 8) CAU passes this on to MCE with usual modification (subclause 6.3.4.1), namely {13*64k} >> {13B}.
- 9) (No action in Case 2).
- 10) **MCE** itself responds with its normal capset + cap-mark.
- 11) CAU passes the capset on to SCE, modifying the capset again according to subclause 6.3.4.2, namely replacing one of the transfer-rate values with {512k}, the n*64k value corresponding to the multiple-channel capacity actually now available.

- 12) Both **SCE and MCE** are now in a position to mode switch to any framed rate up to [512k]. The CAUs need to watch out for [SM-comp] coming from SCEs and replace it with a redundant command, and also for [n*64k] commands, replacing them with [N×64k].
- 13) **CONNECT** is belatedly received by CAU from **MCE** in respect of last requested channel; it adds buffering and numbering to this to achieve synchronism and returns A=0 according to H.221.
- 14) Receives A=0 on this last channel; same process as in clauses 7 to 12, with 512k replaced by 576k.
- 15) At user request, SCE is instructed to drop three channels - namely down to 384k; SCE sends new capset containing {.....128k, 192k, 256k, 320k, 384k} + cap-mark; the process continues from line 3 of 8.

Case 3: Interconnection of two ITU-T Recommendation H.320 [4] terminals, one an MCE type, the other SCE working via a CAU. The number of desired connections, etc., is as for Case 1. MCE is the calling end.

The change marks convey the effective differences from Case 2: it can be seen that they are minimal.

- 1) CAU **sends** the initial channel **CONNECT** when the connection from SCE to CAU is complete and H.221 framing from SCE is detected, or upon an external stimulus which also resets the "Sequence A" timer in the SCE. It transmits tone Σ in Mode 0U towards SCE. [NB: if CAU does not detect H.221 framing from SCE2 within {1s?}, then it sends ISO/IEC 13871 [1] framing to MCE, and tone Σ is omitted; on later receipt of H.221 framing from MCE and this does not itself change to ISO/IEC 13871 [1] framing within 2s, a terminal-incompatibility fault condition is identified.]
- 2) MCE **sends SETUP to CAU**; when it then **receives CONNECT from CAU**, and commences transmission of the framed signal.
- 3) **Having sent CONNECT**, CAU sends towards MC side the incoming signal from SC side, including capsets (repeated continuously) from SCE with modification according to subclause 6.3.4.1 - in this case the {13*64k} is modified to {13B}.
- 4) CAU detects H.221 framing and capset is that from MCE, repeated; this contains {9B}, which is lower than the {13B}; passes the incoming signal from the MC side on towards the SCE, modifying the {9B} to {1B}, since only one channel is yet available. Likewise MCE detects H.221 framing from CAU; the incoming capset is that from SCE, repeated.
- 5) Comparing the incoming {13B} and **its own** {9B}, **MCE** calculates N_d as "9", and requests 8 additional connections, obtaining the remote addresses if necessary using the NCA-a procedure of ETS 300 143 [3].
- 6) By expiry of TIM, **CONNECT** has been sent to MCE in respect of 7 more channels; CAU adds buffering and numbering to these to achieve synchronism and returns A=0 according to ITU-T Recommendation H.221 [7]. CAU2 does likewise. CAU looks for a redundant command, and replaces this with [SM-comp].
- 7) When CAU receives A=0 on initial and the seven available additional channels, it must stimulate another capability exchange, in order to be able to indicate the increase channel availability; therefore it sends [capex] to SCE, which returns one capset + cap-mark.

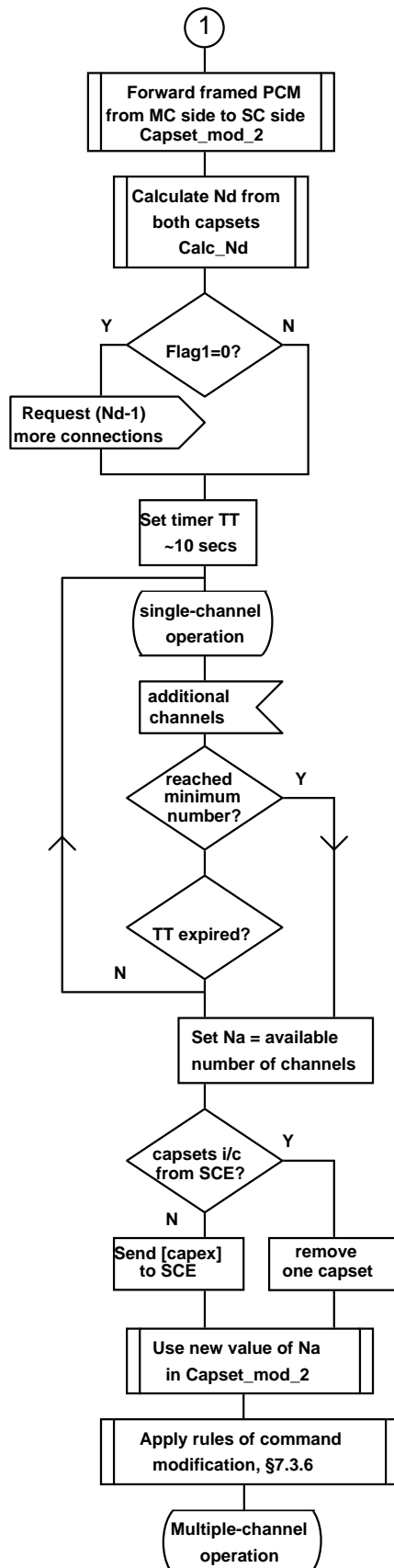
NOTE 4: An ITU-T Recommendation H.320 [4] terminal which transmits {6B-H0-comp} rather than {SM-comp} may not recognize [capex]; in this case the CAU may send the previously transmitted capset from CAU2, which it would have stored for the purpose; however, such situations would be better avoided.

- 8) CAU passes this on to MCE with usual modification (subclause 6.3.4.1), namely {13*64k} >> {13B}.
- 9) (No action in Case 3).
- 10) MCE itself responds with its normal capset + cap-mark.
- 11) CAU passes the capset on to SCE, modifying the capset again according to subclause 6.3.4.2, namely replacing one of the transfer-rate values with {512k}, the n*64k value corresponding to the multiple-channel capacity actually now available.
- 12) Both SCE and MCE are now in a position to mode switch to any framed rate up to [512k]. The CAUs must watch out for [SM-comp] coming from SCEs and replace it with a redundant command, and also for [n*64k] commands, replacing them with [N×64k].

- 13) CONNECT is belatedly received by CAU from MCE in respect of last requested channel; it adds buffering and numbering to this to achieve synchronism and returns A=0 according to ITU-T Recommendation H.221 [7].
- 14) Receives A=0 on this last channel; same process as in clauses 7 to 12, with 512k replaced by 576k.
- 15) At user request, SCE is instructed to drop three channels - namely down to 384k; SCE sends new capset containing {.....128k, 192k, 256k, 320k, 384k} + cap-mark; the process continues from line 3 of 8.

Annex B (informative):

Example of SDL diagram for H.244 Aggregation initialization



B.1 H.244 Aggregation operation selected

The incoming signal on the MC side is forwarded, with modification of its Capset according to the procedure Capset_mod_2 (see main text: N_a is set at 1). At this point, only one 64 kbit/s connection is available, so all higher incoming transfer-rate capabilities needs to be replaced by {null}.

If the CAU is sending a highest transfer-rate capability of $\{N_m \times B\}$, resulting from Capset_mod_1, and is receiving $\{N'_m \times B\}$ from the remote end, then calc_Nd gives the lower of N_m and N'_m .

In ITU-T Recommendation H.320 [4] all the connections are to be requested from the same end. If the network addresses are unknown, they may be obtained as described in the text (not shown here).

When the additional connections have been made, they are synchronized (ITU-T Recommendation H.221 [7] procedure) and when incoming A=0 on each it is made available to the process defined here.

However, it may not be desirable to increase the bitrate used for the ITU-T Recommendation H.320 [4] application in many steps of 64 kbit/s, but rather wait in single channel operation until a chosen minimum number of channels is available - for example, if 5 additional channels have been requested, it would be sensible to wait until at least 4 of these are available, but in any case not wait more than, say, 10 seconds. Such waiting is not mandatory - the "minimum" could be just 1.

From this point, N_a , hitherto set at 1, is increased to reflect the true number of available channels connected and synchronized. The rules for Capset_mod_2 still apply (see main text): essentially, the transfer rates passed to the SCE needs to be a continuous series 128, 192, 256... $n \times 64$, where $n=N_a$ is equal to the number of 64k connections available. Since the capset is not to be changed in length, the {null} value is used to fill gaps left by incoming values not passed on.

Of course Capset_mod_2 needs capsets to operate on. If there is already a stream of (identical) capsets coming in on the MC side, then a complete set need to be removed, replacing the BAS codes with valid commands (this is because, according to ETS 300 143 [3] concatenated capsets need to be identical); then the next capset is modified using the changed value of N_a . If there are currently no capsets, they are stimulated by sending [capex] to the SCE (replacing a redundant command). The SCE will then send a capset, and the remote end responds even if it is an MCE.

The actual increase in operating bitrate is carried out by the two terminals - the CAU need do nothing about this, though it applies the modification rules to the commands - see subclause 6.3.6 in the main text.

Annex C (informative): Comments on the modification of capsets and commands

Whereas the capset sent by a CAU on the MC side normally contains a single value from the series {1B, 2B, 3B...} and one or more from the {n*64k} series, in the case where only one transfer rate capability {n*64k} has been received from the SCE then this value alone is forwarded; this exception provides for the case that two similar SCEs be connected via two CAUs.

It should be noted that an SCE declaring only {384} will not interwork with a {6B} MCE via a CAU according to this standard; if the CAU were to forward {6B} towards the MCE, this would falsely imply that the SCE had declared {384, 320, 256, 192, 128, 64}. An SCE which is intended for interworking with an MCE should possess all the transfer-rate caps in the {n*64k} series up to the maximum intended operating rate, as well as {SM-comp} and the ability to recognize and act upon [capex] and [AggIN].

NOTE: If a CAU is provided in a situation where its **only** use is to interconnect a {384 only} SCE with {6B}-type MCEs, then it could be programmed to modify {384} to {6B}, and to deal appropriately with the situation when 5 or fewer channels are available. It is clear that connection to another CAU may cause misoperation if the CAU is programmed in this way.

There may be cases where the modification involves substitution by a two-byte capability or command. For example, the CAU modifies {512k, H0, 320k, 256k, 192k, 128k, 1B} from the SCE to include {8x64k}; this can be done by replacing the {512} value rather than the {1B}.

The {8x64k} is an example of a two-byte capability, whereas {512k} is only one.

Annex D (informative): Bibliography

The following documents are referenced informatively in the present document:

- CCITT Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies".
- ITU-T Recommendation Z.100 (1993): "CCITT specification and description language (SDL)".
- ITU-T Recommendation H.244: "Synchronized aggregation of multiple 64 or 56 kbit/s channels".

History

Document history		
Edition 1	July 1996	Publication as ETS 300 481
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