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FRAME STRUCTURES FOR USE IN THE INTERNATIONAL INTERCONNECTION OF DIGITAL CODECS

FOR VIDEOCONFERENCING OR VISUAL TELEPHONY

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988)

Recommendation H.130

Introduction

Videoconferencing and visual telephony are new services which require greater bit rates than telephony. In the studies in CCITT on the ISDN and on international interworking, 384 kbit/s is emerging as an important channel capacity for wideband services. On this basis it is recommended that the videoconferencing and visual telephone services should be based on multiples of 384 kbit/s.

It is noted that both the 2048 kbit/s and 1544 kbit/s primary digital levels can be expressed by the formula $y + (n \times 384)$ kbit/s, where $n = 5$ or 4 and $y = 128$ or 8 kbit/s, respectively.

While this Recommendation covers only frame structures for transmission at the primary digital rates, it is not intended to suggest that transmissions using other frame structures or formats at primary rates or lower are precluded. In the future, frame structures based on other multiples and/or sub-multiples of 384 kbit/s may also be considered.

1 Characteristics of a 2048 kbit/s (n = 5) frame structure for use in codecs described in § 1 of Recommendation H.120

1.1 *General characteristics*

The multiplex structure described under § 1 is suitable for use on digital paths and connections which interconnect video codecs for videoconferencing or visual telephony using 2048 kbit/s transmission. The connections may either be direct or via higher-order digital multiplex equipment compatible with the primary PCM multiplex equipment defined in Recommendation G.732.

Some of the characteristics of this multiplex structure are identical to those in Recommendation G.704 and are covered by cross-references to that Recommendation.

The main features of the multiplex structure are that it provides:

— one 64 kbit/s channel for frame alignment, alarm signals and other signals as required;

— one 64 kbit/s channel reserved for the transmission of the sound signal;

— one 32 kbit/s channel for codec-to-codec information;

— the option of one or two 64 kbit/s channels and/or one 32 kbit/s channel for stereophonic sound, facsimile, data, etc.;

— the possibility of end-to-end and subscriber-to-network signalling;

— the remaining capacity (between 1664 and 1888 kbit/s) is used for the encoded video signal.

1.1.1 *Fundamental characteristics*

The multiplex structure contains 32 time slots, each of 64 kbit/s.

1.1.2 *Bit rate*

The nominal bit rate is 2048 kbit/s. The tolerance on this rate is ± 50 parts per million (ppm).

1.1.3 *Timing signal*

The timing signal is a 2048-kHz signal from which the bit rate is derived. It should be possible to derive the timing signal from an internal source or from the network.

1.1.4 *Interfaces*

The interfaces should comply with Recommendation G.703.

1.2 *Frame structure and time slot allocations*

The frame structure is in accordance with Recommendation G.704, § 3.3. The time slot (TS) allocations within the frame are given in Table 1/H.130, two options are shown according to whether or not the network is switched (under control of signals within the frame structure).

1.3 *Codec-to-codec information*

This information is transmitted in the 32 kbit/s channel corresponding to odd frames of TS2 (frame parity is gained from the multiframe alignment in the 8th bit of alternate TS2, the frames are consecutively numbered 0 to 15, forming a multiframe).

The 32 kbit/s channel is structured in a multiframe and supermultiframe derived from 128 consecutive 256 bit frames. The multiframe is composed of 8 octets numbered 1, 3, 5, . | | , 15, each from TS2 in an odd numbered 256 bit frame. The supermultiframe corresponds to 8 consecutive multiframes which are numbered 0, 1, 2, . | | , 7.

The use of the bits in each octet in the odd frames is as follows:

— Bit 1 for clock justification ,

— Bit 2 for buffer state ,

— Bit 3 for coding mode identification; the 8 consecutive bits 3 of TS2 in a multiframe will carry the following information:

Bit 3.1 Codec facilities (see below)

Bit 3.3 Colour transmission (1 if provided)

Bit 3.5 split-screen indicator (if required)

The notation used here should be interpreted as in the following examples: Bit 3.1 means Bit 3 (in TS2) of frame No. 1 in each multiframe: Bit 3.1.0 means Bit 3 (in TS2) of frame No. 1 in multiframe No. 0 of each supermultiframe.

Bit 3.7 Fast update request (1 if required)

Bit 3.9 Advance warning of interruption (1 if required)

Bit 3.11 Sound power signal, for use with encrypted multipoint (under study)

Bit 3.13 Data distribution (1 if required)

Bit 3.15 Detection of looped ports (set to 1)

Bit 3.1 is used to signal the availability of certain facilities in the decoder at supermultiframe rate, as follows:

Bit 3.1.0 Graphics (mode 1) (1 if provided)

Bit 3.1.1 High-quality speech (1 if provided)

Bit 3.1.2 4×384 kbit/s capability (see Note 1) (1 if provided)

Bit 3.1.3 Encryption (1 if provided)

Bit 3.1.4 System M (1 if 525-line signal being coded)

Bit 3.1.5 Graphics (mode 2) (1 if provided)

Bit 3.1.6 Spare (set to 0)

Bit 3.1.7 2×384 kbit/s capability (see Note 1) (1 if provided)

H.T. [T1.130]

TABLE 1/H.130

Timeslot allocation in 32 Timeslot frame structure of Recommendation G.704

	{ Timeslot allocation (within the 256-bit frame) } Bit rate (kbit/s)	Non switched (i)	Switched (ii)
{ Frame alignment, network alarms, etc. }	as in G.704	0	0
Speech information	64	1	1
{ Codec-to-codec information }	32	2	2
{ Signalling information (subscriber-network) }	64	—	16
Fax, data, etc. (optional)	up to 2 × 64	17 and/or 18	17 and/or 18
{ Encoded video information (minimum) }	{		
(i) 27 × 64 (ii) 26 × 64 }	{		
3 to 16 + 19 to 31 }	{		
3 to 15 + 19 to 31 }			

Tableau 1/H.130 [T1.130], p.

— Bit 4 to identify the use of time slots; the 8 consecutive bits 4 of TS2 in a multiframe will carry the following information:

Bit 4.1 TS2 (even) is used for video (0) or other (1)

Bit 4.3 TS16 is used for video (0) or other (1)

Bit 4.5 TS17 is used for video (0) or other (1)

Bit 4.7 TS18 is used for video (0) or other (1)

Bit 4.9 TS16, 26 to 31 are not used for video (see Note 2)

Bit 4.11 Graphics transmission (1 if required)

Bit 4.13 Error correction (1 if required)

(see Note 3)

Bit 4.15 Use of time slots for video in conjuction with bit 4.9 (see Note 2)

— Bit 5 for multipoint conferencing; provides a 4 kbit/s message channel (transparent through the codec) from customer to multipoint control unit, between control units and from customer to customer. (The message format and protocols are under study.)

When the codec is not equipped with a message channel, bit 5 is used to signal split-screen: 1 = split-screen active, 0 = split-screen inactive.

— Bit 6 free (for possible national use) (set to 0)

— Bit 7 free (for possible national use)

— Bit 8 for multiframe and supermultiframe alignment; the values of bit 8 in each frame of the multiframe (multiframe and supermultiframe alignment patterns) should be as detailed in Table 2/H.130.

Note 1 — Bits 3.1.2 and 3.1.7, taken together, signal the capability of the codec to operate at various bit rates, as follows:

Bit 3.1.2 Bit 3.1.7 0 0 2 Mbit/s only 1 0 2 Mbit/s and 4 × 384 kbit/s operation 0 1 2 Mbit/s and 2 × 384 kbit/s operation 1 1 2 Mbit/s and 4, 3, and 2 × 384 kbit/s operation

Note 2 — Bits 4.9 and 4.15, taken together, signal the time slots available (subject to the settings of bits 4.1, 4.3, 4.5 and 4.7) for video at various bit rates. The use of TS0, TS1 and TS2 (odd) is unaffected by these bits.

Bit 4.9 Bit 4.15 Bit rate Time slot available for video 0 0 2 | 48 kbit/s TS2 (even), TS3-31 1 0 4 × 384 kbit/s TS2 (even), TS3-15 and 17-25

1 1 3 × 384 kbit/s TS2 (even), TS3-9 and 17-25 0 1 2 × 384 kbit/s TS2 (even), TS3-6 and 17-22

A 2 Mbit/s codec which allows $n \times 384$ kbit/s working, will set to zero time slots other than those mentioned above in its transmitter and ignore them in the receiver.

Note 3 — When set to 1, the last 64 bits of each multiframe contain the error corrector parity bits. The multiframe then appears as follows:

Diagramme, p.

The conditions signalled in bits 3 and 4 can only change at supermultiframe rate. The change at the decoder will take place at the start of the first supermultiframe following the one where the change in signalling has been detected. This procedure can be used to improve the resistance to transmission errors.

H.T. [T2.130]
TABLE 2/H.130
Multiframe and supermultiframe alignment on bit 8 of TS2 (odd)

		Multiframe alignment pattern							
Frame	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	5	1	1	1	1	1	1	1	1
	7	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0
	11	1	1	1	1	1	1	1	1
	13	0	0	0	0	0	0	0	0
	15	1	1	1	0	0	1	0	(Note)

Tableau 2/H.130 [T2.130], p.

2 Characteristics of a 1544 kbit/s (n = 4) frame structure for use with codecs described in § 2 of Recommendation H.120

2.1 *General characteristics*

The multiplex structure described under § 2 is suitable for use on digital paths and connections which interconnect video codecs for videoconferencing or visual telephony using 1544 kbit/s transmission. The connections may either be direct or via higher-order digital multiplex equipment compatible with the primary PCM multiplex equipment defined in Recommendation G.733.

Some of the characteristics of this multiplex structure are identical to those in Recommendation G.704 and/or in § 1 of this Recommendation; these are covered by cross-references to the appropriate documents.

The main features of the multiplex structure are that it provides:

— one 8 kbit/s channel for frame alignment, alarm signals and other signals as required;

— one 64 kbit/s channel for the sound signal;

— one 32 kbit/s channel for codec-to-codec information;

— the option of one or two 64 kbit/s channels and/or one 32 kbit/s channel for auxiliary data services;

— the remaining capacity (between 1280 and 1440 kbit/s) is used for the encoded video signal.

2.1.1 *Fundamental characteristics*

The multiplex structure contains 24 time slots per frame, each of 64 kbit/s, plus one bit per frame for frame alignment and signalling. The number of bits per frame is 193 and the nominal frame repetition rate is 8000 Hz.

2.1.2 *Bit rate*

The nominal bit rate is 1544 kbit/s. The tolerance on this rate is ± 50 parts per million (ppm).

2.1.3 *Timing signal*

The timing signal is a 1544 kHz signal from which the bit rate is derived. It should be possible to derive the timing signal from an internal source or from the network.

2.1.4 *Interfaces*

The interfaces should comply with Recommendation G.703; the option of AMI or B8ZS should be provided as the interface code. Which of the two codes is used should be determined by bilateral agreement.

2.1.5 *Format restrictions enforced by the network*

As indicated in Recommendation G.703, runs of more than 15 ‘‘zeros’’ are forbidden in some networks; also, there must be, on average, at least three ‘‘ones’’ in every 24 digits. Provision is made by means of a scrambling system to ensure that forbidden patterns cannot occur.

2.2 *Frame structure and time slot allocations*

The basic frame structure follows Recommendation G.704. The time slots are numbered from 1 to 24, with the 1st bit positioned between TS24 and TS1.

2.2.1 *Frame alignment*

The basic frame alignment is obtained at bit No. 1, as in Recommendation G.704, Method 2 (see § 2.1.3.2). The pattern transmitted is as shown in Table 3/H.130.

H.T. [T3.130]
TABLE 3/H.130

Frame No.	Frame alignment signal	S-bit	Signalling bit
1	1	—	
2	—	0	
3	0	—	
4	—	0	
5	1	—	
6	—	1	A
7	0	—	
8	—	1	
9	1	—	
10	—	1	
11	0	—	
12	—	0	B

Tableau 3/H.130 [T3.130], p.

2.2.2 *Speech*

Speech is transmitted at 64 kbit/s in TS1. The coding law is the A-law of Recommendation G.711 or, for future applications, the law that will be recommended by CCITT for higher-quality speech. In the case of stereophonic transmission, the second speech channel will be transmitted in TS17.

2.2.3 *Codec-to-codec information*

This information is transmitted in the 32-kbit/s channel corresponding to the odd frames of TS2. The channel is structured in multiframes of 16 frames and supermultiframes of 8 multiframes in exactly the same way as in the 2-Mbit/s version in § 1. Multiframe and supermultiframe alignment are obtained from bit 8 of TS2 (odd) in the same way as in § 1.

The multiframe of TS2 for codec-to-codec signalling is quite independent of the basic 12-frame multiframe of Recommendation G.704.

2.2.4 *Signalling*

In the future, some 1.5 Mbit/s networks will allow the use of bits A and B for signalling. This facility is not available on all networks.

2.2.5 *Facsimile, data, etc.*

When required, this information will be transmitted in TS16 and TS17 and TS2 (even).

2.2.6 *Encoded video*

A minimum of 20 × 64 kbit/s capacity is reserved for encoded video in TS3-15 and 18-24; depending on applications, TS2 (even), TS16 and 17 may also be used for video, providing a maximum of 22.5 × 64 kbit/s capacity. The available bit rate for video therefore lies between 1280 and 1440 kbit/s.

2.3 *Codec-to-codec information*

The structure of the multiframe and supermultiframe are exactly the same as in § 1, except that each frame contains only 24 time slots as compared with 32 in the frames in § 1.

The bit allocations [in TS2 (odd)] are identical with § 1, with the following exceptions:

— Bit 1 for clock justification; required for interworking with 625-line codecs; disregarded in 525-line decoders.

— Bit 3.1.2 is permanently set to 1 (see Note 1)

— Bit 4.9 time slots are used for video (see Note 2)

— Bit 6 is reserved for the transmission of encryption data (see Annex D Recommendation H.120).

— Bit 7 is used for scrambler control (see § 2.4).

Note 1 — Bits 3.1.2 and 3.1.7, taken together, signal the capability of the codec to operate at various bit rates, as follows:

Bit 3.1.2 Bit 3.1.7 0 0 Not used in 525-line codecs 1 0 4 × 384 kbit/s 0 1 2 × 384 kbit/s operation 1 1 4, 3, and 2 × 384 kbit/s operation

Note 2 — Bits 4.9 and 4.15, taken together, signal the time slots available (subject to the settings of bits 4.1, 4.3, 4.5 and 4.7) for video at various bit rates. The use of TS1 and TS2 (odd) is not affected by these bits.

Bit 4.9 Bit 4.15 Bit rate Time slots available for video 0 0 This combinaison is not used in 525-line codecs

1 0 4 × 384 kbit/s TS2 (even), TS3-24 1 1 3 × 384 kbit/s TS2 (even), TS3-9 and 16-24 0 1 2 × 384 kbit/s TS2 (even), TS3-6 and 16-21

2.4 *Scrambling*

2.4.1 *General*

The bit sequence produced by a videoconference codec is not subject to any limitation on the bit patterns that are generated. Therefore, reversible processing has to be carried out at the output and input ports to ensure that the format restrictions specified for some 1544 kbit/s networks are not violated.

There are two typical constraints on the format:

1) There must not be runs of more than 15 consecutive ‘‘zeros’’.

2) The average density of ‘‘ones’’ must be at least 12.5%.

A classical self-synchronizing or reset scrambler, based on a maximum-length pseudo-random sequence, is incapable of guaranteeing that such a bit-sequence never occurs. It is however possible, by judicious choice of scrambler design, to minimize the number of violations of the above rules to such an extent that the residual violations can be removed by forcibly inserting ‘‘ones’’. The effect of this is to introduce transmission errors giving a residual bit-error-ratio of approximately 1×10^{D}lF261^{7}, which is imperceptible as far as the picture quality is concerned.

2.4.2 *Details of scrambling — first stage*

The scrambling sequence is applied to all 24 time slots but not to bit 193 nor to bit 7 of TS2 (odd).

Note — If data are inserted and/or extracted from TS2 (even), 16 or 17 within the network, the insertion/extraction equipments must ensure that the network constraints are not violated.

The 1544 kbit/s serial data from the codec are first applied to the following scrambling sequence:

I N I N N I,

where

I = inverted and

N = do not invert.

This sequence starts from the bit following bit 193, and is restarted every frame. Bit 193 and bit 7 of TS2 (odd) are not scrambled but the scrambling sequence is continuous through bit 7 of TS2 (odd).

2.4.3 *Details of scrambling — second stage*

Data scrambled by the above sequence are then checked for runs of more than 15 zeros. For signalling purposes, these data are considered to be in blocks of 385 bits. Each block starts with bit 8 of TS2 (odd) and ends with bit 6 of TS2 (odd). If a block of data preceding bit 7 of TS2 (odd) is found *not* to contain the string of data, 1 00000000 00000000 (i.e. no runs of 16 or more zeros), bit 7 of TS2 (odd) is set to one.

If a block of data preceding bit 7 of TS2 (odd) is found to contain the string of data, 1 00000000 00000001 (i.e. a run of 15 zeros), bit 7 of TS2 (odd) remains set to one, even if one or more subsequent runs of zeros within the same block reaches or exceeds 16. However, in such a case, the 16th zero(s) of the run(s) are set to one. As this is not signalled to the descrambler, it causes (a) single-bit transmission error(s).

Bit 7 of TS2 (odd) is set to zero only if the preceding block of data is found to contain the string, 1 00000000 00000000 (i.e. a run of 16 zeros or more), in which case the 16th zero is inverted to one and all subsequent strings of the form 1 00000000 0000000B within the same block have bit B inverted, except in the case where bit B =1 before inversion, in which case it remains unchanged.

2.4.4 *Details of descrambler*

When bit 7 of TS2 (odd) is one, the preceding block of scrambled data is left unchanged. When bit 7 of TS2 (odd) is zero, the descrambler must detect all occurrences of the string 1 00000000 0000000B in the preceding block and invert the bit B. This can introduce transmission errors if the second or subsequent runs of zeros within the block (at the scrambler) contain 15 zeros.

The repetitive scrambling sequence, I N I N N I, is then applied to the data.

For the purpose of counting runs of zeros, at both the scrambler and descrambler, bit 7 of TS2 (odd) and bit 193 are both assumed to be zero. In the case where bit B would be on bit 193 or bit 7 of TS2 (odd), the string 1 00000000 000000B is used instead of 1 00000000 0000000B. Only bit B has to be within the block of data being considered. The preceding zeros may lie partially or completely within the preceding block.

When bit B is inverted, the ‘‘zeros’’ counter is reset to zero.

3 Characteristics of a 1544 kbit/s (n = 4) frame structure for use with codecs described in § 3 of Recommendation H.120

3.1 *General characteristics*

The multiplex structure describes under § 3 is suitable for use on digital paths and connections which interconnect video codecs for videoconferencing or visual telephony using 1544 kbit/s transmission. The connection may either be directly via the ISDN defined in Recommendation I.431 or via higher order digital multiplex equipment compatible with the primary PCM multiplex equipment defined in Recommendation G.733.

The main features of the multiplex structure are that it provides:

— one 8 kbit/s channel for frame alignment, alarm signals and other signals as required,

— one 64 kbit/s channel for the audio signal,

— one 32 kbit/s channel for codec-to-codec information,

— one optional 64 kbit/s for auxiliary data service, and

— the use of the remaining capacity (between 1376 and 1440 kbit/s) for the encoded video signal.

3.1.1 *Fundamental characteristics*

The multiplex structure contains 192 bits per frame plus one bit per frame for frame alignment and other purposes. The nominal frame repetition rate is 8000 Hz.

3.1.2 *Bit rate*

The nominal bit rate is 1544 kbit/s with a tolerance of ± | 0 parts per million (ppm).

3.1.3 *Timing signal*

The timing signal is a 1544 kHz signal from which the bit rate is derived. It should be possible to derive the timing signal either from an internal source or from the network.

3.1.4 *Interfaces*

The interfaces should comply with Recommendation G.703. The interface code should be either of AMI/B8ZS described in Recommendation G.703, in addition to which CMI (Coded Mark Inversion) code is also applicable when the codec is installed as a part of terminal equipment. Which of the three codes is used should be determined by bilateral agreement.

3.1.5 *Format restrictions enforced by the network*

As indicated in Recommendation G.703, runs of more than 15 ‘‘zeros’’ are forbidden in some networks. Additionally, on the average, there must be at least three ‘‘ones’’ in every 24 digits. Provision is made by means of a stuffing system to ensure that forbidden patterns do not occur.

3.2 *Frame structure and bit allocation*

The basic frame structure follows Recommendation G.704 with changes in bit allocations. The bits in a frame are numbered from 1 to 193 with a transmission frame bit as numbered one. Remained 192 bits are divided into 24 time slots (TS) in which each time slot has 64 kbit/s rate. Time slot number is assigned to each TS in the way that the first slot is TS1 and the last slot is TS24. Bit allocation in a frame is shown in Figure 1/H.130.

3.2.1 *Frame alignment*

The basic frame alignment is obtained at bit No. 1 as in Recommendation G.704, Method 1 (§ 2.1.3.1).

3.2.2 *Audio signal*

The audio signal is transmitted at 64 kbit/s in TS1.

Figure 1/H.130, p.

3.2.3 *Codec-to-codec information*

This information is transmitted in odd numbered time slots 2 the 32 kbit/s channel. Identification of codec-to-codec information is made by detecting multiframe alignment which is inserted in the eighth bit of the odd numbered TS2.

The channel is structured in multiframes of 16 frames each (numbered from 1 to 16) and supermultiframes of 8 multiframes each (numbered from 1 to 8). Multiframe and supermultiframe alignment is obtained from bit No. 8 in TS2.

The multiframe of the codec-to-codec information channel is independent of the multiframe of the transmission frame generated by bit No. 0.

3.2.4 *Auxiliary data information*

When required, this information is transmitted basically in TS16 which is used for the encoded video signal when no optional auxiliary equipment is connected. If stuffing is performed due to some channel restrictions, data alignment is as given in § 3.4.2.

3.2.5 *Encoded video*

A minimum of 64×21.5 kbit/s capacity is primarily reserved for encoded video in even numbered TS2, TS3 through TS15 and TS17 through TS24. When the auxiliary data information channel is not set up, the capacity is increased to 64×22.5 kbit/s with TS16 added. The available bit rate for the encoded video signal therefore lies between 1376 and 1440 kbit/s. If stuffing is performed, data alignment is as given in § 3.4.2.

3.3 *Codec-to-codec information channel*

The use of the bits in the codec-to-codec information channel is as follows (see Table 4/H.130). In the following Sections, the notation, ‘‘m.n.l’’, is used for a bit position expressing the *n* th multiframe and the *l* th supermultiframe of bit No. m.

3.3.1 *C*

Bits 1.1, 1.5, 1.9, 1.13 Permanently set to 1 Bits 1.3, 1.7, 1.11 FC (sampling frequency control)

The lower 8 bits of the binary count for the two supermultiframe periods, i.e. 32 ms, are measured with the video sampling frequency clock, the MSB first. These same 8-bit words are transmitted in the three bits (1.3, 1.7 and 1.11) as well as in the two consecutive multiframes.

Bit 1.15 Spare (Note) *Note* — Spare bits are set to 1.

3.3.2 *C*

Bits 2.1-2.15 (odd number) 0 if not stuffed

The stuffing flag consists of four bits including C_2 and C_7 in each violation detection block (four frame length) which is defined in § 3.4.2. The first three bits are used for majority decision logic at the decoder. When the result indicates ‘‘stuffing’’, the decoder undergoes destuffing.

H.T. [T4.130]

TABLE 4/H.130 { **Codec-to-codec information** }

Multiframe frame number	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8

Unable to convert rest of table.

Tableau 4/H.130 [T4.130], p.

3.3.3 *C*

Bit 3.1 Codec facilities Bit 3.1.1 Graphics mode 1 (high resolution) (0 if provided)

Bit 3.1.2 Bit sequence independence (0 if secured) Bit 3.1.3 Monochrome mode (0 if provided) Bit 3.1.4 Video encryption (0 if provided) Bit 3.1.5 Audio encryption (0 if provided)

Bit 3.1.6 Pointing function (0 if provided) Bit 3.1.7 Graphics (mode 2, standard resolution) (0 if provided) Bit 3.1.8 Spare (Note 1)

Bit 3.3 Spare (Note) Bit 3.5 Spare (Note) Bit 3.7 Spare (Note)

Bit 3.9 Spare (Note) Bit 3.11 Spare (Note) Bit 3.13 Spare (Note) Bit 3.15 Coding mode

Bit 3.15.1 Video encryption (0 if used) Bit 3.15.2 Audio encryption (0 if used) Bit 3.15.3 Frame memory refresh request (0 if requested)

Bit 3.15.4 Backward path (0 if available) Bit 3.15.5-3.15.8 Spare (Note) *Note* — Spare bits are set to 1.

3.3.4 *C*

Bits 4.1, 4.3, 4.5, 4.7 Auxiliary data channel flag (0 if used) Bits 4.9, 4.11, 4.13, 4.15 Graphics mode flag (0 if used)

In graphics mode, video data are inhibited and their bit positions are used for graphics data transmission. These two flags consist of four bits as stuffing flag. Both auxiliary data and graphics data can be inserted or removed in a unit of multiframe (16 frames). Flags should precede the data by a multiframe.

3.3.5 *C*

Bits 5.1-5.15 (odd number) Message channel 1 (Note) *Note* — Protocols for these message channels are under study.

3.3.6 *C*

Bits 6.1-6.15 (odd number) Message channel 2 (Note) *Note* — Protocols for these message channels are under study.

3.3.7 *C*

Bit 7.1-7.15 (odd number) 0 if stuffed

3.3.8 *C*

Bits 8.1, 8.3, 8.7, 8.9, 8.11. 8.13 Multiframe alignment signal (1110010) Bit 8.15 Supermultiframe alignment signal (1110010*) (see Note) *Note* — The bit * is used for future higher order multiframing.

3.4 *Stuffing*

3.4.1 *General*

The bit sequence produced by a videoconferencing codec is not subject to any limitation on the bit patterns that are generated. Therefore, reversible processing has to be carried out at the output and input ports to ensure that the format restrictions specified for some 1544 kbit/s networks (described in § 3.1.5 above) are not violated.

To ensure this, the stuffing method shuld be employed in which necessary ‘‘ones’’ are inserted, or stuffed, if any violations are found in a block of bit streams to be transmitted. A flag is attached to the block to identify whether or not the block is stuffed.

3.4.2 *Details of stuffing*

Each block, which consists of four transmission frame lengths, i.e. $4 \times 193 = 772$ bits starting from the C_1bit of the codec-to-codec information in the (4*n* —3)th frame, is checked. If any violations occur with respect to the rules:

— no more than 15 consecutive zeros, and

— at least 3 ones in any 24 bits,

ones are stuffed as follows:

TS1 not stuffed,

TS2 not stuffed in odd numbered frames, stuffed at the top bit of TS in even numbered frames,

TS3-23 stuffed at the top bit of each time slot,

TS24 stuffed at the top bit and bottom bit of the time slot.

The stuffing position is shown in Figure 1/H.130.

Note — When stuffing pulses are inserted, the transmisison bit rate for encoded video is reduced to 1252 kbit/s without auxiliary data transmission and to 1188 kbit/s with auxiliary data transmission.

In order to ease processing at block boundaries, the C_1bit at the start of any block is assigned to be always as described in § 3.3.1 above as shown in Table 4/H.130.

To prevent 8 consecutive zeros in the codec-to-codec information when stuffing is carried out, the stuffing flag transmitted in the (C_2, C_7) bits are assigned as (1,0) for stuffing and (0,1) for no stuffing.

Violations are checked assuming that all transmission framing bits in bit No. 0 and stuffing flag bits in C_2 and C_7 are zero.

Note — If audio data are processed in the network, corresponding bits should also be assumed as zero for violation checking. However, as this may increase the probability of stuffing, measures are necessary to prevent such stuffing from becoming excessive.

3.4.3 *Stuffing mode operation*

Stuffing should be operated only when necessary. To identify the network restrictions , the bit sequence independence (BSI) in the codec-to-codec information channel is used. A coder usually operates without stuffing, but shifts to the stuffing mode if the received BSI is ‘‘one’’.

Recommendation H.140

A MULTIPOINT INTERNATIONAL VIDEOCONFERENCE SYSTEM

(Melbourne, 1988)

1 Scope

This Recommendation defines a multipoint videoconference system which enables three or more videoconference sites to intercommunicate simultaneously, provided that the codecs conform to Recommendations H.120 and H.130 (§ 1, Note).

Note — Codecs conforming to § 2 of Recommendations H.120 and H.130 are in principle also applicable.

2 General requirements

A multipoint control unit (MCU) is a piece of equipment located in a node of the network (terrestrial or satellite) which receives several (maximum seven) 2 Mbit/s channels from access ports (each access port corresponding either to a local or a remote codec, or to another MCU) and, according to a certain criterion, causes some of them called selected channels to be distributed towards the connected studios (see Figure 1/H.140).

Figure 1/H.140, p.

The basic functions of the MCU for a terrestrial or a satellite network are identical. The MCU shall have the capability:

— To synchronise the incoming streams to a single 2048 kHz pilot clock.

— To extract frame alignment from TS0 in order to synchronise the different streams to the frame clock, to extract frame parity, multiframe and supermultiframe alignment from TS2 in order to access in each incoming stream the codec-to-codec signalling channel.

— To process this signalling channel.

— To process the sound channels in order to create an open sound system, in the case of an unencrypted system.

— To decide image switching and dispatching according to a selection criterion (automatic or on request).

— To signal in advance the switching decisions to the codecs so that degradation during and after the switching can be avoided.

— To multiplex the selected video channels with the open sound channel and the effective data channels.

— To distribute the reconstructed streams to the corresponding access ports.

3 Synchronisation of bit streams

3.1 *Clock synchronisation*

All incoming bit streams to the MCU must be derived from the same basis 2048 kbit/s clock. If no codec involved in a multipoint conference resides in a synchronous network, i.e. no signal is received with bit 8 in TS0 of odd frames set to zero, then the MCU acts as a master clock source. Such an MCU should have a reference clock with a short term accuracy of 1 in 10^9, in order to avoid frame slips during a conference session. If one or more codecs are in synchronous networks (bit 8 = 0), then their clocks are taken as the master.

In both cases the MCU sets on all outgoing channels bit 8 in odd TS0's to zero.

3.2 *Frame synchronisation*

The MCU has the following functions:

i) Extract from TS0 frame alignment and generate the frame clock. Frame parity should not be extracted from TS0 as it is not transparently transmitted through some networks.

ii) Extract from TS2 multiframe and supermultiframe alignment and generate: frame parity, multiframe clock, supermultiframe clock.

iii) Synchronise the bit streams at the PCM frame rate, such that switching can be performed without interrupting the Recommendation G.704 frame structure.

4 MCU and codec use of TS2 odd for multipoint conference applications

The bits are encoded according to Recommendation H.130, (§ 1). A majority decision of 5 out of 8 is used to provide resilience to channel errors with respect to the signals in bits 3 and 4.

4.1 Bits 1, 2, 6, 7 are transparently transmitted by the MCU.

4.2 Bit 8 gives multiframe and supermultiframe alignment and recovery of frame parity.

4.3 Bit 3 is for coding mode identification.

Bit 3.1.c indicates the facilities offered by the codec (set to 1 if provided) and are fixed for each codec. The MCU should take account of these bits in order to set up a minimum operating mode for all the codecs involved in the conference. For each individual port on the MCU a logical AND is made between the incoming signals from all other ports. The resultant signal is then used as the outgoing signal for that specific port, the rule being that an individual ports facilities bits should not be echoed back.

Bit 3.1.0 Graphics (mode 1) Bit 3.1.1 High quality speech Bit 3.1.3 Encryption Bit 3.1.4 System M Bit 3.1.5 Graphics (mode 2) Bit 3.1.6 Spare — set to zero

Note 1 — MCUs not equipped to mix Recommendation G.722 audio will set bit 3.1.1 to zero.

Note 2 — The use of bit 3.1.3 for encryption is under study.

Bit 3.1.2 Bit 3.1.7 0 0 2 Mbit/s working only 1 0 2 Mbit/s and 4 × 384 kbit/s working only 0 1 2 Mbit/s and 2 × 384 kbit/s working only 1 1 2 Mbit/s and 4, 3, 2 × 384 kbit/s working

Note — If the bit rate signalled by bits 3.1.2 and 3.1.7 exceeds that available at the codec digital interface, then the meaning of the facilities bits is as follows:

— with codecs having a 1.5 Mbit/s serial interface

0 0 Never occurs 1 0 Means 4 × 384 kbit/s working only 0 1 Means 2 × 384 kbit/s working only 1 1 Means 4, 3, 2 × 384 kbit/s working only

— with codecs having a 2 Mbit/s serial interface, but effective rate of 768 kbit/s

0 0 Never occurs 1 0 Never occurs 0 1 Means 2 × 384 kbit/s working only 1 1 Means 2 × 384 kbit/s working only

Bits 3.3 (colour transmission) and 3.5 (split-screen display) are transparently transmitted by the MCU.

4.3.1 *Bit 3.7 — Fast update request (FUR)*

When set to 1, the transmitter buffer occupancy is forced to decrease and stabilise to a state of less than 6 K by preventing coded picture elements entering the buffer.

4.3.2 *Bit 3.9 — Freeze frame request (FFR)*

Used to warn a decoder that its received signal may be interrupted after the start of the next supermultiframe for a period of no more than 2 s. On receipt of bit 3.9 set to 1 a decoder will normally ‘‘freeze’’ the contents of its frame store for 2 s or until a field start code is received with bit A set to 1 (see Recommendation H.120 § 1).

Both bits 3.7 and 3.9 should pass transparently across an MCU if set on an incoming signal: this is to allow for multipoint conferencing using distributed MCU’s.

Bit 3.11.c indicates the power of the sound channel, integrated during 16 ms (period of the supermultiframe) and encoded with 8 bits. It is only used with encrypted multipoint, otherwise it is set to zero. The MCU can use this bit to select the New and Previous Speaker’s channels (see § 6).

4.3.3 *Bit 3.13 — Data distribution*

When a codec received this bit set to one, it must vacate in its transmission channel the same time slots which are vacated with respect to the video signal in its receive channel and which are signalled by bits 4.1, 4.3, 4.5, 4.7.

The MCU uses this bit to ensure data continuity during a conference (see § 9).

4.3.4 *Bit 3.15 — Loop detection*

Bit 3.15 may be used by the MCU to detect whether one of its bidirectional 2 Mbit/s ports has been externally looped. It is necessary to monitor this condition since instability may result from such a configuration. The definition of bit 3.15 is as follows:

Codecs set bit 3.15 to 1 in their outgoing paths. MCUs use a number of consecutive bit 3.15s to transmit a serial random bit stream of length n, repeatedly. If the received bit sequence is the same as the transmitted random serial sequence then a loop has been detected. It should be noted that the received bit sequence may exhibit a phase delay compared with the transmitted sequence.

The details of the random sequence need not be rigidly specified as the sequence is only relevant when an individual MCU is in a looped configuration. However precautions must be taken to avoid false loop detection. This is likely to occur when two or more MCUs are connected together or when the transmission medium is subject to errors. A number of recommendations are given below.

The length of the transmitted random sequence n should be sufficiently large to avoid duplication when two or more MCUs are connected together. It is suggested that the total length be in excess of 15 bits, thus the possibility of duplication is less than 1 in 65536. The sequence transmission and detection mechanism should be sufficiently resilient to channel errors. This can be achieved in a number of ways, two simple methods are suggested here.

First, considering the sequence as a number of individual bits, each bit may be transmitted for 8 consecutive bit 3.15s. The receiver takes a majority 5 from 8 vote as the received sequence bit. Thus to transmit a single sequence takes $8 \times n$ bits. This is similar to the method adopted for bits $4 \times x$.

Alternatively, as the random sequence is transmitted repetitively, the decision as to whether the port is in the looped state or not is taken only when a number of sequences has been received.

4.4 Bit 4 is for time slot allocation.

If the following bits are set to 1:

Bit 4.1 TS2 even is not used for video Bit 4.3 TS16 is not used for video Bit 4.5 TS17 is not used for video Bit 4.7 TS18 is not used for video Bit 4.11 Graphics transmission Bit 4.13 Use of error correcting code

When a codec receives any of the bits 4.3/5/7 set to one, and bit 3.13 is set to 1 (see § 4.3), it also vacates the corresponding time slots in its transmitted stream and sets to one the corresponding bits 4.b in its transmission channel.

Bit 4.1 is transmitted transparently by the MCU as the MCU cannot switch half time slots, i.e. the MCU takes no action.

Bits 4.9 and 4.15 are used for bit rate signalling.

Bit 4.9 Bit 4.15 0 0 2 Mbit/s operation 1 0 4 × 384 kbit/s 1 1 3 × 384 kbit/s 0 1 2 × 384 kbit/s

At 5 × 384 kbit/s Time slots 1-15 and 17-31 active At 4 × 384 kbit/s Time slots 1-15 and 17-25 active At 3 × 384 kbit/s Time slots 1-9 and 17-25 active At 2 × 384 kbit/s Time slots 1-6 and 17-22 active

The MCU should take account of bits 4.9 and 4.15 in order to set up a minimum operating mode for all the codecs involved in the conference. For each individual port, bits 4.9 and 4.15 from every other port on the MCU are analysed to determine which is the lowest requested bit rate permitted by the facilities bits 3.1.2 and 3.1.7. The code for this bit rate is then used as the outgoing signal in bits 4.9 and 4.15 for that specific port. Again the rule is that an individual port’s bit rate facilities bits should not be echoed back.

To avoid a lock up situation, the codec should not return its received bits 4.9 and 4.15 in its transmit path, but should generate them independently.

4.5 Bit 5 carries a 4/kbits message channel

This bit is used to convey an asynchronous message channel at 4 kbit/s for signalling between the room and the MCU or between rooms or between MCUs.

The protocol of this message channel is under study.

5 Audio processing

Each terminal connected to an MCU must receive a mix of the audio from all other terminals. The audio signals should be summed at the MCU without normalisation, i.e. unity gain on each channel. The introduction of dynamic mixing for the suppression of ambient noise may be included but speakers would still enjoy unity gain.

Note — Not applicable with encrypted multipoint.

6 Switching decision criteria

The criteria for switching to some extent depends on the philosophy of the multiconference service in each Administration. Any solution, automatic or manual, can be implemented without altering the basic arrangement of the MCU.

The minimum working mode or ‘‘automatic’’ mode is as follows: the MCU, by comparison of the incoming sound channels or, in case of encrypted sound channels, by the means of the sound power bit (bit 3.11 in TS2 odd), selects the loudest speaker (called new speaker or NS). A second channel is selected by the MCU, being the previous loudest speaker (called previous speaker or PS). The NS is sent the PS channel and the other rooms are sent the NS channel. This mode is always used when the multiconference is established. Details of the switching criterion with respect to sound levels, hangover time, etc., are under study.

Five manual overrides are currently identified:

a) The system remains automatic but one location is considered to be the chairman of the conference. Participants are able to transmit a ‘‘request for the floor’’ to either the chairman or all rooms. At an appropriate time, the chairman orally gives the floor to the requesting conferee who, as he begins to speak, is automatically selected as the NS.

b) One location (e.g. NS or chairman or VIP) is able to choose the allocation of the second selected channel (normally the PS channel) by transmitting a request to the MCU.

c) Each location has the choice between the channels, which can be made available by the MCU connected to that location without affecting the displays of other locations.

d) Complete manual chairman control with no voice detection.

e) Manual forcing, where one location may force the MCU to regard his port as the NS.

This override is known as visualisation forcing. It may be used in one of two cases:

i) where a chairman or VIP wishes to be seen without interrruption,

ii) where a terminal is using a graphics camera, but is not equipped with a graphics capable codec.

Only the ‘‘automatic’’ mode does not require the use of the message channel in bit 5.

Modes a), b), c), d) imply the use of the message channel and extra control equipment (push-buttons, lights, signalling and data connections to the codec, etc.) at the conference room. Mode e) normally makes use of the message channel, but an interim solution is available on a National basis (see § 8.1).

7 MCU procedure for source switching

Once the switching decision is taken, (either by monitoring the audio levels or by the message channel, the MCU must prepare the connected codecs and operate as following:

i) it sends a FFR (bit 3.9) to all the codecs which will be affected by the switch, via the selected transmission channels connected to them.

ii) It performs image switching whilst maintaining the basic Recommendation G.704 frame structure continuity in the selected channel(s).

iii) It waits for at least 32 ms to allow sync recovery in all decoders.

iv) It sends a FUR (bit 3.7) to the codec(s) which are about to be used as a new picture source.

A FUR or a FFR must be set to one for at least one supermultiframe (SMF), or 256 frames in the case of non SMF-synchronous MCUs.

If the newly selected channels are connected to the MCU via a terrestrial link, the whole operation is likely to take no more than 100 ms. If it is via a satellite link, switch times of 500 ms are typical.

8 Protocols for ‘‘who is seen’’ in a multipoint conference

8.1 *Automatic mode*

This is described in § 6.

During automatic operation, it is convenient for the NS and PS to have some local indication that their picture is being transmitted. This facility is known as ‘‘visualisation status’’ or ‘‘on-air’’.

When defined, the message channel will have the capability of signalling such information together with many other useful facilities. In the short term, for existing codecs, an alternative means of signalling using TS2 odd bit 5 which is currently reserved for the message channel may be used for transmission of the visualisation and forcing bit by those countries who wish to implement such a simplified system. Under these circumstances, in a multiple MCU conference, the inter MCU link should be inhibited from sending the visualisation signal to avoid problems of contention. As a long term solution, the message channel is required to ensure compatibility with audioconferencing (this point is under study). In the mean time, the method of transmission should be bilateral agreement.

8.2 *Control using message channel*

Initialization and addressing procedure including the following items are under study;

— request for floor,

— local selection by request to view,

— chairman control.

9 Transmission of graphics during multipoint

This concerns the use of graphics modes 1 and 2 in the codec, not separate SPTV systems.

9.1 *Automatic mode*

The general principle is that all participants see the graphics information except the sender who sees the loudest speaker (other than himself).

The MCU first needs to establish whether all codecs in the conference have a graphics facility. If both the graphics facilities bits (bits 3.1.0 and 3.1.5) in any of the incoming channels to the MCU are set to zero, then the MCU sets both bits to zero in all its outgoing paths. This forces all codecs to use face-to-face type coding for graphics transmission.

When the MCU receives the graphics transmission bit set to 1 (bit 4.11), then the voice detector is overridden and the originating port (say port A) is made the new speaker, and hence transmitted to all other participants. Port A is sent the loudest speaker from the remaining ports (in the PS channel).

9.2 *Manual Mode*

Under study.

10 Transmission of data during multipoint

If a participant wishes to transmit data to all other terminals then data continuity must be ensured by the simultaneous vacation of the data channels by all codecs. This involves some delay (800 ms maximum if double satellite hops occur).

Time slot 2 even is not used for data distribution so it does not need to be separately switched by the MCU.

10.1 *Fully automatic mode* | i.e. no message channel)

The terminal ‘‘A’’ wishing to broadcast data sets to 1 the relevant bit 4 of TS2 for the data channel to be used. The MCU sets bit 3.13 to 1 in all outgoing streams except A and overrides the speaker detection procedure to make ‘‘A’’ the present speaker.

Other terminals on receipt of bit 3.13 and the relevant bit 4 in TS2 set to 1, vacate their outgoing equivalent data ports and set the corresponding bit 4’s to 1.

The MCU then allows voice switching by the other ports after 2 s. When A concludes the data transmission it sets its relevant outgoing bit 4 in TS2 to zero. The MCU in turn sets bit 3.13 to zero. Normal voice switched operation then continues.

10.2 *Operation with message channel*

Under study.

11 Outline of output from MCU

Each location is sent a 2 Mbit/s channel reconstructed from one of the selected video channels, the corresponding TS2 odd with the possible modifications issued from the MCU in bits 3 or 5, the sound channel resulting of the mixing of the other sound channels and the effective data channels.

12 Multipoint conference configurations

12.1 *Terrestrial configuration*

Figure 1/H.140 shows a terrestrial multiconference using multiple MCU's. Many multiconferences may need only one MCU in a star formation.

12.2 *Possible satellite configurations*

Figure 2/H.140 shows a multiconference where rooms are connected through the same earth station to a single MCU. This situation is similar to that of § 12.1 but with a double hop between the rooms X and Y.

Other possibilities for satellite working are currently under study.

Figure 2/H.140, p. 8

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