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International Telegraph and Telephone Consultative Committee (CCITT)

COM XV-NO

Period 1981-1984

English only

Question: 4/XV

Date: November 1984

SOURCE : GEC UK

TITLE : PROPOSED RECOMMENDATION FOR A 1.544 Mbit/s DIGITAL FRAME STRUCTURE FOR VIDEO CONFERENCING

The attached proposal is a companion to the associated proposal from GEC McMichael for a recommendation for a codec operating at 1.544 Mbit/s.

The digital frame provides a multiplex of the video information, a sound channel, optional data channels for facsimile etc, codec-to-network and codec-to-codec signalling, together with the framing, signalling and alarm facilities which form part of the T1 digital frame as recommended in CCITT Recommendation G.733. The time slot and bit allocations within the digital frame are the same as those recommended in Part 2 of CCITT Recommendation H.130 and fully compatible with those in the frame of Part 1 of that Recommendation which apply to systems using 625 lines, 50 field/s and 2.048 Mbit/s digital transmission.

In one Time Slot (TS 2), half the capacity (32 kbit/s) is used for codec-to-codec and codec-to-network signalling. The other half may be used for coded video or as an optional additional data channel with a capacity of 32 kbit/s. In the other optional data channels available for sound, fascimile etc, all 8-bits-per-time-slot are available to the user, so that the available data rate in those channels is 64 kbit/s.

Since some T1 type transmission channels do not permit unrestricted runs of zeros and because the video data has no such constraints placed on it, a scrambling function is associated with the frame structure to ensure that the constraints on bit-pattern are met. The scrambler does not cause error extension.

The proposed frame structure meets all the requirements for transmission over 1.544 Mbit/s digital channels. It provides the capacity for video, sound, control and ancillary facilities required for videoconferencing using the 1.544 Mbit/s codecs in the associated proposal together with the capability of international interworking with countries using the CCITT recommendations in Parts 1 and 2 of CCITT Recommendations H.120 and H.130. In addition, it is capable of being extended to provide for additional facilities such as multipoint conferencing which are still under study.

PROPOSED RECOMMENDATION

CHARACTERISTICS OF A 1.544 Mbit/s FRAME STRUCTURE FOR VIDEOCONFERENCING

1. GENERAL CHARACTERISTICS

The multiplex structure described in this Recommendation 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 CCITT Recommendation G.733.

Some of the characteristics of this multiplex structure are identical to those in CCITT Recommendation G.733; these are covered by cross references to that Recommendation.

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.

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.

1.2 Bit Rate

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

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.

1.4 Interfaces

The interfaces should comply with CCITT 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.

1.5 Format Restrictions Enforced by the Network

As indicated in CCITT 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. FRAME STRUCTURE AND TIME SLOT ALLOCATIONS

The basic frame structure follows CCITT Recommendation G.733 with changes in the Time Slot (TS) allocations. The time slots are numbered from 1 to 24, with the 193rd bit positioned between TS24 and TS 1.

2.1 Frame Alignment

The basic frame alignment is obtained bit No. 193, as in Recommendation G.733. The pattern transmitted is as follows:

Frame Number	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

2.2 Speech

Speech is transmitted at 64 kbit/s in TS 1. The coding law is the A-law of CCITT 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 TS 17.

2.3 Codec-to-Codec Information

This information is transmitted in the 32 kbit/s channel corresponding to odd frames of TS 2 (frame parity is gained from the multiframe alignment in the eighth bit of alternate Time Slots 2; 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 192 bit frames. The multiframe is composed of eight octets numbered 1, 3, 5, ..., 15, each from TS 2 in an odd numbered 192 bit frame. The supermultiframe corresponds to eight consecutive multiframes which are numbered 0, 1, 2, ...7.

The multiframe of TS 2 for codec-to-codec signalling is quite independent of the basic 12-frame multiframe of CCITT Recommendation G.733.

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.

2.5 Facsimile, Data, etc

When required, this information will be transmitted in TS 16 and 17 and TS 2 (even).

2.6 Encoded Video

A minimum of 20 x 64 kbit/s capacity is reserved for encoded video in TS 3-15 and 18-24; depending on applications, TS 2 (even), TS 16 and 17 may also be used for video, providing a maximum of 22.5 X 64 kbit/s capacity. The available bit rate for video therefore lies between 1280 and 1440 kbit/s.

3. CODEC-TO-CODEC INFORMATION

The structure of the multiframe and supermultiframe has been described in 2.3, above.

The use of the bits in each octet in TS 2 of the odd frames is as follows:

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

- Bit 2 for buffer state.

- Bit 3 for coding mode identification; the eight consecutive 'bits 3' of TS 2 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** Spare (set to 0)

  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 Spare (set to 0)

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 x 384 kbit/s capability (set to 1)

Bit 3.1.3 Encryption (1 if provided)

Bit 3.1.4 System M (set to 1)

Bit 3.1.5) Reserved for possible (set to 0)

Bit 3.1.6) alternative graphics (set to 0)

modes

Bit 3.1.7 Spare (set to 0)

- Bit 4 to identify the use of time slots; the 8 consecutive bits 4 of TS 2 in a multiframe will carry the following information:

Bit 4.1 TS 2 (even) is used for video (0) or other (1)

Bit 4.3 TS 16 is used for video (0) or other (1)

Bit 4.5 TS 17 is used for video (0) or other (1)

* The notation used here should be interpreted as in the following examples: Bit 3.1 means Bit 3 (in TS 2) of frame No. 1 in each multiframe: Bit 3.1.0 means Bit 3 (in TS 2) of frame No.1 in multiframe No. 0 of each supermultiframe.

** The use of this bit for split-screen indication is under study.

Bit 4.7 TS 18 is used for video (0) or (1)

Bit 4.9 4 x 384 kbit/s working. Set to 1. (Note 1)

Bit 4.11 Graphics transmission (1 if required)

Bit 4.13 Error correction (1 if required)

Bit 4.15 Spare (set to 0)

- 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 for transmission of encryption data (see Annex 2 of standard for codecs)

- Bit 7 is used for scrambler control (see Section 4)

- 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 1.

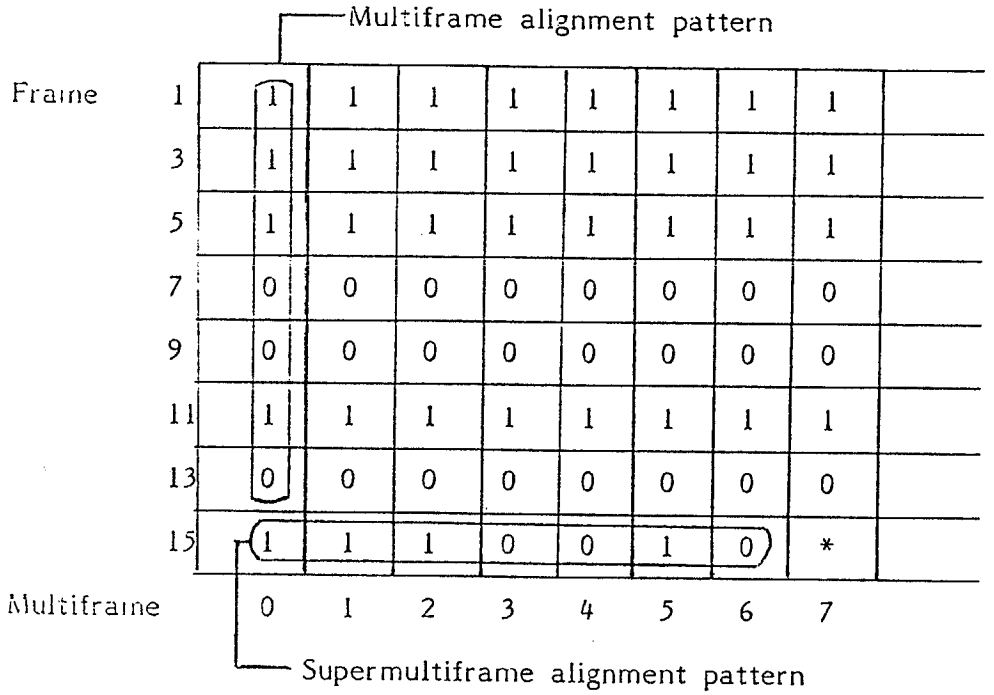
Notes

1. 2 Mbit/s codecs will set Bit 4.9 permanently to 0. On receipt of Bit 4.9 set to 1, a 2 Mbit/s codec which allows 4 x 384 kbit/s working (ie Bit 3.1.2 set to 1) will vacate Time Slots 16, 26, 27, 28, 29, 30 and 31 in its transmitter and ignore them in the receiver.

2. 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.

TABLE 1

Multiframe and supermultiframe alignment
on bit 8 of TS 2 (odd)



* Undefined (reserved for possible future use in a higher level framing structure).

4. SCRAMBLING

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-synchronising 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 minimise 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 x 10^{-7}, which is imperceptible as far as the picture quality is concerned.

4.2 Details of Scrambling - First Stage

The scrambling sequence is applied to all 24 time slots but not to bit 193 not to bit 7 of TS 2 (odd).

Note: If data are inserted and/or extracted from TS 2(even), 16 or 17 within the network, the insertion/extraction equipments must ensure that the network constraints are not violated.

The 1.544 Mbit/s serial data from the codec are first applied to the following scrambling sequence:

I N I N N I, where I = invert 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 TS 2 (odd) are not scrambled but the scrambling sequence is continuous through bit 7 of TS 2(odd).

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 TS 2(odd) and ends with bit 6 of TS 2(odd). If a block of data preceding bit 7 of TS 2 (odd) is found not to contain the string of data, 1 00000000 00000000 (ie no runs of 16 or more zeros), bit 7 of TS 2(odd) is set to one.

If a block of data preceding bit 7 of TS 2(odd) is found to contain the string of data, 1 00000000 00000001 (ie a run of 15 zeros), bit 7 of TS 2(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 TS 2(odd) is set to zero only if the preceding block of data is found to contain the string, 1 00000000 00000000 (ie 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.

4.4 Details of Descrambler

When bit 7 of TS 2(odd) is one, the preceding block of scrambled data is left unchanged. When bit 7 of TS 2(odd) is zero, the descrambler must detect all occurrences of the string 1 00000000 000000B 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 TS 2(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 TS 2(odd), the string 1 00000000 0000000B 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.