Recommendation T/TR 01-03 (Odense 1986)

FRAME STRUCTURE AT 64 KBIT/S FOR MULTIMEDIA APPLICATIONS

Recommendation proposed by Working Group T/WG 12 "Transmission" (TR)

Text of the Recommendation revised adopted by Commission "Telecommunications":

"The European Conference of Posts and Telecommunications Administrations,

Considering

— that digital networks are now available which provide for the transparent transmission of 64 kbit/s from user to user,

— that there is a need for new services making extensive use of those networks and that multimedia services may be important for their development,

Recognising

— the need to multiplex on the same 64 kbit/s channel several flows of information relevant to a multimedia service and to control these flows in a robust way even in a multipoint configuration and using transmission media (such as satellites) having considerable delay,

— that a procedure which does not require a return link is preferable, e.g. for broadcasting applications,

— that the ISDN does not prevent the use of a single 64 kbit/s channel for multimedia end-to-end services and that in the future it might provide supplementary means to transmit different flows of information in switched point-of-point calls *(Note 1)*,

— that the network does not provide any means of interworking of a part of the information flows relevant to a multimedia application with telecommunication services using the total channel capacity,

— that the subdivision of a 64 kbit/s channel is not recognised by the network and hence is a terminal matter,

Recommends

the use of the frame structure described hereafter for multimedia services in a single 64 kbit/s channel."

Note 1: The relevant protocols are for further study.

1. BASIC PRINCIPLE

The 64 kbit/s channel is structured into 8-bit octets transmitted at 8 kHz. The least significant bit (bit 8) *(Note 1)* of each octet conveys a sub-channel of 8 kbit/s . This sub-channel, called Service Channel (SC), provides end-to-end signalling and consists of three parts (see Figure 1 (T/TR 01-03)):

— *Frame Alignment Signal* (FAS). This signal allows to structure the 64 kbit/s channel into frames of 80 bytes each and multiframes (MF) of 16 frames each. Each multiframe is divided into two 8-frame submultiframes (SMF). In addition to framing and multiframing information, control and alarm information may be inserted, as well as error check information to control end-to-end error performance and to check frame alignment validity (this last point is still under study). FAS can be used to derive octet timing when it is not provided by the network.

— *Bitrate Allocation Signal* (BAS). This signal allows the transmission of Codewords to describe the structure of the residual 56 kbit/s channel, as well as, if necessary, the structure of the primary rate multiplex in which the basic 64 kbit/s channel is inserted, in the case of $n \times 64$ kbit/s multimedia service as videoconference or videophony. Other possibilities are under study, like describing sub-multiplexing, rate adaption and low-layer protocols of the data channels.

— *Application Channel* (AC) or Service Dedicated Information. This channel allows transmission of binary information or the insertion of message-type data channel(s) (such as telematic information) up to 6,400 bit/s.

The remaining 56 kbit/s channel, carried in bits 1-7 of each byte, may convey a variety of signals in the framework of a multimedia service, under the control of the BAS and possibly the AC. These signals are carried as flows at $n \times 8$ kbit/s. Some examples follow:

— Sound, coded at 56 kbit/s using truncated PCM (A-law or mu-law of CCITT Recommendation G.711[1]).

— Sound, coded at 32 kbit/s (ADPCM according to CCITT Recommendation G.721 [2]) and data at 24 kbit/s or less.

— Sound, coded at 56 kbit/s with a bandwith 50-7,000 Hz (sub-band ADPCM according to CCITT Draft Recommendation G.72X). The coding algorithm is also capable to work at 48 kbit/s (bitrates of 40 or 32 kbit/s with a reduced quality are under study). Data can then be dynamically inserted at 8, 16 or 24 kbit/s.

— Still pictures coded at 56 kbit/s.

— Data at 56 kbit/s (e.g. file transfer for communicating personal computers).

2. FRAME ALIGNMENT

2.1. General

An 80-byte frame length produces an 80-bit word in the Service Channel. Those 80 bits are numbered 1-80. Bits 2-8 of the Service Channel in every other frame contain 0011011 and are the Frame Alignment Word (FAW). Those bits are completed by bit 2 in every alternate frame (those not containing the FAW) to form the complete Frame Alignment Signal. So a pattern similar to the one in CCITT Recommendation G.704 [3] is used (see Figure 2 (T/TR 01-03)).

2.2 Description of the CRC procedure

Depending on service and network requirements which are not yet defined, there may be a need to evaluate end-to-end quality by the means of a CRC code similar to the one used in CCITT Recommendation G.704 [3]. The use of bits E and C1-C4 for computing parity bits on blocks of information for this purpose is under study. The CRC may also be used to validate or invalidate frame alignment.

2.3 Multiframe structure

Each multiframe contains 16 consecutive frames numbered 0 to 15 thus making 2 submultiframes of 8 frames each. The multiframe alignment signal is located in bit 1 of frames 1-3-5-7-9-11 and contains 001011. Bits 1 of frames 0-2-4-6-8-10-12-13-14-15 are reserved. Their value is provisionally fixed to 0 (Figure 3 (T/TR 01-03)).

Note 1: For networks where this bit 8 is needed for network purposes and therefore is not available, the second least significant bit (bit 7) might be used.

2.4. Loss and recovery of frame alignment

Frame alignment will be assumed to have been lost when three consecutive frame alignment signals have been received with an error.

Frame alignment will be assumed to have been recovered when the following sequence is detected:
— for the first time, the presence of the correct frame alignment word;
— the absence of the frame alignment word in the following frame detected by verifying that bit 2 is a 1;
— for the second time, the presence of the correct frame alignment word in the next frame.

When frame alignment is lost, bit 3 (A) of the next odd frame is set to 1 in the transmit direction.

2.5. Loss and recovery of multiframe alignment

Multiframe Alignment is used to validate teh Bitrate Allocation Signal (see paragraph 3.). The criteria for loss and recovery of multiframe alignment described underneath are provisional and have to be confirmed by experimentation.

As the search of the Multiframe Alignment Word is located on bit 1 of each odd frame, multiframe alignment is easier. Multiframe alignment will be assumed to have been lost when three consecutive multiframe alignment signals have been received with an error. It will be assumed to have been recovered when the multiframe alignment signal has been received with no error in the next multiframe.

3. BITRATE ALLOCATION SIGNAL (BAS)

The Bitrate Allocation Signal (BAS) occupies bits 9-16 of the Service Channel in every frame. It is repeated 8 times along the same submultiframe. A majority decision (5 out of 8) allows the validation of BAS. The validated value of BAS applies to the next submultiframe. A change in configuration can then occur at submultiframe rate, i.e. every 80 ms. In case of loss of frame or multiframe alignment, the BAS should keep the same value as the previously validated one, until frame and multiframe alignment are recovered.

The encoding of BAS is made in accordance with the attribute method:

The three first bits (bits 9-10-11) represent the attribute number relevant to the description of the configuration. Up to now, two attributes are defined: the Audio Coding (attribute 000) and the Transfer Rate (attribute 001). Other attributes are under study.

Bits 12-16 of each frame represent the values of the attributes and describe the used configuration.

Figure 4 (T/TR 01-03) gives the coding of BAS for attribute 000.

Figure 5 (T/TR 01-03) gives a possible assignment of codes for attribute 001 and requires further study.

4. APPLICATION CHANNEL (AC)

It occupies bits 17-80 of the Service Channel in each frame, making a user-available bitrate of 6.4 kbit/s. According to the application, different kinds of information may be inserted herein. In particular, information concerning forward error correction or end-to-end encryption which both depend on the application, could take place in the Application Channel.

4.1. Binary information

Each bit of the Application Channel may represent a binary digit, repeated 100 times per second. If odd and even frames are identified, each bit may represent two digits, transmitted at 50 Hz each. If multiframing is used, each bit may represent 16 binary digits, transmitted at 6.25 Hz.

An example of this kind of information is in teleconference the use of a bit to synchronise the encoder clock on the receive clock, or to indicate the microphone number, or to signal the use of the graphics mode, etc.

4.2. Synchronous message-type channel

As each bit of the Application Channel represents a bitrate of 100 bit/s, any synchronous channel working at n × 100 bit/s may be inserted in the Application Channel. An example is, in videoconference, the Message Channel at 4 kbit/s which is used for multipoint management.

Another possibility is the insertion of data channels at a bitrate of the hierarchy defined in CCITT Recommendation X.1 [4], according to CCITT Recommendation X.30 [5]/I.461 [6]: "Support of X.21 [7] and X.21*bis* [8] based DTEs by an ISDN". The present frame structure is coherent with the X.30/I.461 frame structure in a double way:

— It has the same length (80 bits by bearer channel at 8 kbit/s).
— It needs 63 bits per frame (17 bits are used for framing information not to be transmitted), which fits into the 64 bits available in this frame structure.

4.3. Asynchronous message-type channel

In case of asynchronous terminals, X.1 [4] hierarchy is relevant. The existing European standard is the ECMA standard ECMA-TAxx "Bitrate adaptation for the support of synchronous and asynchronous terminal equipment using the V-series interfaces on a PSTN". This standard also uses the same 80-bit frame structure as X.30 [5]/I.461 [6] presented above. The Application Channel will therefore allow adoption of this ECMA standard if needed.

4.4. Error correction and encryption

When needed, forward error correction and encryption information may take place in the Application Channel. The bitrate and the protocol to be used will depend of the application.

5. ACCESS TO DATA IN THE 56 KBIT/S CHANNEL

The 56 kbit/s channel, when used with sound coded according to CCITT Recommendation G.721 [2] or Draft Recommendation G.72X, allows the static or dynamic allocation of data channels at $n \times 8$ kbit/s. The access to those channels could be done according to standardised procedures (e.g. I.461 [6], I.462 [9], I.463 [10] or ECMA-TAxx...).

The 56 kbit/s channel may also be used to transmit data only.

In some applications, it may be desirable to merge the Application Channel with the data channel in order to have a single user-data path.

6. CONCLUSION

A frame structure for multimedia applications in a single 64 kbit/s channel has been defined which makes the best use of the characteristics and properties of the audio compression algorithm, of the transmission framing structure and of the existing CCITT Recommendations. It offers several advantages:

— It takes into acount CCITT Recommendations as G.704 [3], X.30 [5]/I.461 [6], etc., and may make use of existing hardware or software.

— It is simple, economic and flexible. It may be implemented on a simple microprocessor with very well known hardware principles.

— It is a synchronous procedure. The exact time of a configuration change is the same in the transmitter and the receiver. Configurations can be changed at 80 ms intervals.

— It needs no return link, since a configuration is signalled by a continuously transmitted codeword.

— It is very secure in case of transmission errors, since the BAS is repeated 8 times with a majority logic decision.

— It allows the control of a higher multiplex configuration, into which the basic 64 kbit/s channel is inserted (case of $n \times 64$ kbit/s multimedia services as videoconference).

— It can be used to derive byte sync in IDN's when it is not available.

— It can be used in multipoint, where no dialogue is needed to negotiate the use of a data channel.

— It provides a variety of data bitrates (from 6.25 bit/s up to 64 kbit/s) to the user.

Bit number								Octet number
1	2	3	4	5	6	7	8	
S u b – C h a n n e l # 1	S u b – C h a n n e l # 2	S u b – C h a n n e l # 3	S u b – C h a n n e l # 4	S u b – C h a n n e l # 5	S u b – C h a n n e l # 6	S u b – C h a n n e l # 7	FAS BAS AC	1 • 8 9 • 16 17 • • • • • • • • 80

Figure 1 (T/TR 01-03). Frame structure.

FAS: Frame Alignment Signal *(Note 1)*.
BAS: Bitrate Allocation Signal.
AC: Application Channel.

Note 1: The block termed as FAS contains also other information than for frame alignment purposes.

Successive frames	Bit #							
	1	2	3	4	5	6	7	8
Even frames (those containing FAW)	Mi *Note 1*	0	0	1	1	0	1	1
		Frame Alignment Word						
Odd frames	Mi *Note 1*	1 *Note 2*	A *Note 3*	E	C1	C2	C3	C4
				Note 4				

Figure 2 (T/TR 01-03). Assignment of bits 1-8 of the Service Channel in each frame.

Note 1: Mi — Bits reserved for multiframing.
Note 2: Bit used to avoid simulation of FAW by a frame-repetitive pattern.
Note 3: A — Remote Alarm Indication. This bit is set to 1 to signal the following fault conditions:
— Failure of power supply.
— Failure of equipment (to be further studied).
— Loss of frame alignment.
Note 4: The use of bits E and C1-C4 is under study (see 2.2.).

	Sub-Multiframe (SMF)	Frame	Bits 1 to 8 of the Service Channel in every frame							
			1	2	3	4	5	6	7	8
Multiframe	SMF 1	0	R1	0	0	1	1	0	1	1
		1	0	1	A	E	C1	C2	C3	C4
		2	R2	0	0	1	1	0	1	1
		3	0	1	A	E	C1	C2	C3	C4
		4	R3	0	0	1	1	0	1	1
		5	1	1	A	E	C1	C2	C3	C4
		6	R4	0	0	1	1	0	1	1
		7	0	1	A	E	C1	C2	C3	C4
	SMF 2	8	R5	0	0	1	1	0	1	1
		9	1	1	A	E	C1	C2	C3	C4
		10	R6	0	0	1	1	0	1	1
		11	1	1	A	E	C1	C2	C3	C4
		12	R7	0	0	1	1	0	1	1
		13	R9	1	A	E	C1	C2	C3	C4
		14	R8	0	0	1	1	0	1	1
		15	R10	1	A	E	C1	C2	C3	C4

Figure 3 (T/TR 01-03). Assignment of bits 1-8 of the Service Channel in each frame in a multiframe.

R1-R10: Reserved (provisionnally set to 0).
A, E, C1-C4: As in Figure 2 (T/TR 01-03).

Attribute Bits 9-11	Attribute value Bits 12-16	Meaning
000	00000	"Neutralised channel" (the 62.4 kbit/s user data are unused)
Audio coding	S001	PCM G.711 (truncated to 7 bits) *(Note 1)* *(Note 2)*
	0	A law
	1	mu law
	S0001	32 kbit/s ADPCM G.721 *(Note 3)*
	001	64 kbit/s unframed mode *(Note 4)*
	00	PCM A law Mode 0
	01	PCM mu law Mode 0
	10	SB-ADPCM G.72X Mode 1 *(Note 5)*
	11	0 kbit/s; data at 64 kbit/s Mode 10
	S1	Variable bitrate audio coding
	000	G.72X 56 kbit/s; data at 0 kbit/s Mode 2
	001	G.72X 48 kbit/s; data at 8 kbit/s Mode 3
	010	40 kbit/s; data at 16 kbit/s Mode 4 *(Note 6)*
	011	32 kbit/s; data at 24 kbit/s Mode 5
	100	24 kbit/s; data at 32 kbit/s Mode 6
	101	16 kbit/s; data at 40 kbit/s Mode 7
	110	8 kbit/s; data at 48 kbit/s Mode 8
	111	0 kbit/s; data at 56 kbit/s Mode 9 *(Note 7)*
	10000	free
	10xxx	free

Figure 4 (T/TR 01-03). Attribute 000 used for BAS encoding.

Note 1: The 8th bit is fixed to 0 in the audio PCM decoder.

Note 2: The S bit set to 1 indicates that the Application Channel is merged with the data channel to form a single user-data path.

Note 3: The respective place of data and audio in each byte of the 64 kbit/s channel is under study.

Note 4: Attribute values 001xx imply the switching to an unframed mode. In the receive direction, reverting to a framed mode can only be achieved by recovering frame and multiframe alignment, which might take up to 2 multiframes (i.e. 320 ms).

Note 5: The allocation of bits in each byte of the 64 kbit/s channel is as follows:

Audio bitrate	1	2	3	4	5	6	7	8
64 kbit/s	H	H	L	L	L	L	L	L
56 kbit/s	H	H	L	L	L	L	L	S
48 kbit/s	H	H	L	L	L	L	D	S
40 kbit/s	D	D	L	L	L	L	L	S
32 kbit/s	D	D	L	L	L	L	D	S

S = Service channel
H = High band audio
L = Low band audio
D = Data channel

Bitrates of 56 and 48 kbit/s are respectively modes 2 and 3 of Draft Recommendation G.72X.
Bitrates of 40 and 32 kbit/s are not taken into account by Draft Recommendation G.72X.

Note 6: Audio coding bitrates of 40-32-24-16-8 kbit/s require further study.

Note 7: The whole of the channel 56 (or 62.4) kbit/s is used for data and the audio channel is muted.

Attribute Bits 9-11	Attribute value Bits 12-16	Meaning
001	00000	64 kbit/s
Transfer Rate	00001	64 kbit/s (audio) + 64 kbit/s (data/video)
	00010	384 kbit/s: 64 (audio) + 320 (video)
	00011	64 (audio) + 256 (video) + 64 (data)
	00100	768 kbit/s: 64 (audio) + 704 (video)
	00101	64 (audio) + 640 (video) + 64 (data)
	00110	1152 kbit/s: 64 (audio) + 1088 (video)
	00111	64 (audio) + 1024 (video) + 64 (data)
	01000	1536 kbit/s: 64 (audio) + 1472 (video)
	01001	64 (audio) + 1408 (video) + 64 (data)
	01010	1920 kbit/s: 64 (audio) + 1856 (video)
	01011	64 (audio) + 1792 (video) + 64 (data)

Figure 5 (T/TR 01-03). Attribute 001 used for BAS encoding (provisional values).

REFERENCES

[1] CCITT Recommendation G.711. *Pulse code modulation (PCM) of voice frequencies.*

[2] CCITT Recommendation G.721. *32 kbit/s adaptive differential pulse code modulation (ADPCM).*

[3] CCITT Recommendation G.704. *Functional characteristics of interfaces associated with network nodes.*

[4] CCITT Recommendation X.1. *International user classes of service in public data networks and integrated services digital networks (ISDNs).*

[5] CCITT Recommendation X.30. *Support of X.21 and X.21*bis *based data terminal equipments (DTEs) by an integrated services digital network (ISDN).*

[6] CCITT Recommendation I.461. *Support of X.21 and X.21*bis *based Data Terminal Equipments (DTEs) by an Integrated Services Digital Network (ISDN).*

[7] CCITT Recommendation X.21. *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks.*

[8] CCITT Recommendation X.21*bis. Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-series modems.*

[9] CCITT Recommendation 1.462. *Support of Packet Terminal equipement by an ISDN.*

[10] CCITT Recommendation 1.463. *Support of Data Terminal Equipments (DTEs) with V-series type interfaces by an Integrated Services Digital Network (ISDN).*