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1. INTRODUCTION

At the recent meeting of WP XV/1, concern was expressed that the number of 8-bit BAS values would soon be exhausted by the need to indicate numerous combinations of data, application channel, command and indication (C&I) channel, voice, graphics and video rates. Thus, a method was proposed whereby the rate and content of each class of channel would be indicated by a separate BAS, and where the bit-layout of a submultiframe would be calculated from a sequence of such "orthogonal" BAS codes.

At the same meeting, a method of sending BAS with error correction was adopted provisionally. This allows 2-frame submultiframes, and leads to the possibility that the various demands for data and application channels can be satisfied by statistical multiplexing. In the following, principles regarding the needs of audio visual services are set forth, statistical multiplexing is applied to address the needs, and new BAS code assignments are proposed.

It appears that the original plan of having a single BAS specify the succeeding submultiframe is still practical.

2. DEFINITIONS, PRINCIPLES AND ASSUMPTIONS

2.1 Terminals

For convenience of discussion, the following terminals are defined:

T — Telephone, PCM only, G.72Y Type 0.

AT — 7 kHz audio telephone, G.72Y Type 1.

AV — Audio/visual terminal, G.72Y Type 2.

VP1 — Video telephone for 1 B-channel.

VP2S — Video telephone for 2 B-channel operation with video on one channel and audio on the other (separate).

VP2C — Video telephone with video on both B-channels (combined).

In view of the fact that the operation of the application channel, possibly including a C&I channel, will not be defined this study period, it may be that an AD terminal having only audio and audio/data modes should be defined in Blue Book G.72Y. This point is for suggested for further study.

2.2 Signals to be Transmitted

Several different signals must be communicated as part of audio visual services. When there is no information to be transmitted we have:

N — Neutral: the bit position is assigned to carry no information.

Several signals are carried at relatively high bit rates and are mutually exclusive. Only one of the following can be carried in a 64 kb/s channel at a given time:

P — PCM voice encoded according to A or mu-law G.711.

H.L — High and low band parts of 7 kHz audio encoded per G.722.

D — Data at 56 or 64 kbit/s.

V — Video.

G — Graphics or other high speed audio/visual application data.

Signals which are compatible with, and can be transmitted at the same time as the "exclusive" signals are:

c — Command and indication information.

a — Application channel data carried between AV or VP terminals according to standard protocols and recommendations to be defined.

d — Low speed data carried between Data Terminal Equipment (DTE) attached to the AV or VP terminals, without necessarily having any standard structure or protocol.

s — Low rate encoded speech at 8, 16, or 32 kb/s.

2.3 Speech

Speech at 40 kb/s is not required. The 40 kb/s variant of G.721, as specified in draft G.72Z is intended to provide transparency for voiceband data modems. Although preliminary subjective testing indicated that it also provides performance equivalent to PCM for speech, it is not a useful rate for VP applications, since G.722 at 48 kb/s provides greatly superior performance while using only 8 kb/s more capacity.

Speech at 32 kb/s is useful primarily for VP2C. In the VP1 case, too little capacity ($\leqslant$30.4 kb/s) is left over for video during talk spurts, considering that signals a and c may also be sent at the same time.

Speech at 24 kb/s is not useful. Preliminary subjective tests indicated that G.72Z at 24 kb/s scores about 0.7 MOS poorer than G.711 PCM for 1 transcoding. Considering that conferencing bridges may result in multiple transcodings, the performance will not be satisfactory.

The speech coding algorithm and maximum instantaneous rate can be negotiated at call setup. At call set up, one of 8, 16, or 32 (G.721 or G.722 variant) kb/s can be specified by the exchange of capability BAS. Since all coding methods are required to achieve "7-bit PCM" quality, the lowest common rate will always be used.

Silence elimination and/or variable rate coding can be implemented by sending speech in a fraction of submultiframes. In a given submultiframe signal, **s** is either not sent, or sent in 1, 2, or 4 octet bit positions, depending on whether the peak speech rate is 8, 16, or 32 kb/s as negotiated. Variable rate coding, (e.g. an algorithm which operates at 8, 10, 12, 14, 16 kb/s adaptively) can be implemented by buffering signal **s**, and sending 160, 320, or 640 bits when available. The actual instantaneous variable speech coding rate would be indicated in signal **s** itself, not by BAS, since times at which the speech coding rate changes should not be forced to be aligned with the AV.221 frame structure.

2.4 Commands and Indications

The rate of **c** *is* $\leqslant$ *6.4 kb/s.* No greater rates have ever been mentioned. This assumption allows **c** to always be in bit 8.

Provision should be made so that **c** *can be carried in every submultiframe.* The C&I are real-time critical. Hence, if **c** is required to be sent at its maximum rate, 50C b/s, then C bits shall be sent in every submultiframe, with C/2 in each frame.

Optionally, **c** *may be turned off.* This is needed so that synchronous data at the standard rate of 14.4 kb/s can be carried in bits 7 and 8 of the octet.

It may be useful to send **c** *at* $<$ *50C.* This can be accomplished, if needed, by sending C bits every other submultiframe, or in some other proportion of submultiframes.

2.5 Data and Applications Channel

The rate of **d** *is* $\leqslant$ *14.4 kb/s.* The only standard rates > 14.4 kb/s are 19.2 and 38.4 kb/s. 19.2 kb/s represents only a 33% speed increase, and it would use 3 bit-slots inefficiently. 38.2 kb/s would be a "mutually exclusive" signal, as are 56 and 64 kb/s.

The rate of **a** $\leqslant$ *14.4 kb/s.* If a higher rate is needed, then it can be carred in signal G.

The sum of the rates for **c**, **d**, *and* **a** *is* $\leqslant$ *14.4 kb/s.* In AV and VP2S terminals, the use of G.722 coding imposes this constraint. In a VP1 terminal, assuming 8 kb/s speech, this constraint guarantees $\geqslant$ 40 kb/s for the video signal. While it would not be necessary in VP2C terminals, observing the constraint in those terminals will simplify interworking with the other terminal types.

Signals **d** *and* **a** *may be buffered and transmitted proportionately to achieve lower data rates.* Consider signal **d**. If a data rate of 2400 b/s is required, **d** can be buffered and 288, 144, 288-C, or 144-C bits can be sent in a submultiframe, depending on buffer fill and whether **c** is also to be sent. If neither **a** or **c** is being sent simultaneously, then 2400/144 submultiframes/s will contain **d** (1/3 of the total submultiframes). This method is more efficient than I.46X rate adaptation, since the other 2/3 of the submultiframes can carry video, voice, or graphics, instead of fill.

The same statistical multiplexing method automatically allocates the 14.4 kb/s capacity between **a**, **d** *and* **c**. For example, and in the case where **c** is not active, **a** and **d** can both be transmitted at 7.2 kb/s by sending 288 bits of **a** and **d** in alternate submultiframes. Furthermore, since **a** originates internal to the terminal, **a** may be variable rate with flow control applied by the terminal. Since **d** originates externally, it is up to the user to resolve contention between **d** and **a** or **c**.

No more than one data channel and one application channel needs to be made available by the BAS technique. Multiple data channels and multiple application channels, if needed for some applications, can be derived from the single channels using standard data transmission techniques. The simpler terminals should not be burdened by the cost of novel multiplexing techniques to derive multiple channels for possible future services.

2.6 Other

Framed data at 62.4 kb/s is not required. This is not a standard data rate for DTE. Variable rate data originated within the terminal can be sent as G.

PCM can be temporarily overlaid with framing for the purpose of sending capability BAS, but there is no requirement to send PCM along with d, a, *or* c. PCM is included only for backwards compatibility with terminals T. AV or VP terminals always incorporate G.722 codecs, and no PCM-only AV terminal should be specified.

Graphics versus video operation can be controlled by C&I. Thus, the same BAS attribute and value can be used to indicate either video or graphics. Otherwise, different BAS attributes can be assigned to video and graphics, or video versus graphics can be indicated in the video/graphics channel.

The video coding algorithm is negotiated at call setup, by C&I, or within signal V. There is no requirement to send video coding algorithm designation on a submultiframe basis by BAS.

2.7 Octet Structure

c *is present in only bit 8.*

d *or* a *(not both at the same time) can occupy the remaining capacity of bit 8.*

If d *or* a *is present in bit 8 of the octet, it may also be present in bit 7.* If either the d or a buffer contains more than 288 or 288-C bits, then 288 or 288-C bits are sent in bit positions 7 and 8. Otherwise, 144 or 144-C bits are sent (if available) in bit position 8.

If a *or* d *are not sent, then bit positions 7 and 8 are filled out by N, P, L, V or G.* In the case of 64 kbit/s unframed data, bit 8 may also carry D.

s *is carried in bit positions 1, 1-2, or 1-4, depending on the negotiated rate.*

When s *is not present, the bit positions otherwise occupied by* s, *and the remainder of bits 1-6, are occupied by N, P, H&L, V or G.*

3. BAS ASSIGNMENTS

The principles and assumptions listed above lead to 20 BAS for Video/Speech (Table 1) and 22 BAS for Audio/Data (Table 2). The method for coding BAS values for Video/Speech is shown in Table 3. The encoding method of Table 3 leads to a straightforward design of the multiplexor, where simple logic can be used to determine which source is to be transmitted in each bit position, except for bit position 8. Bit position 8 already contains at least the FAS and BAS, so special logic which takes into account the position within the frame is already needed.

The layout for audio/data BAS in Table 2 is nearly as regular with respect to G.722 and 56 kbit/s data modes. However, the four unframed modes, and the neutral channel modes are placed in the group of 0x1xx codes, so that they may be detected easily, and then processed appropriately.

4. CONCLUSION

Given the principles and assumptions listed in section 2, a total of 42 BAS codes under 2 attribute values can satisfy the need to define the content of 64 kbit/s channels used for AV services. If another means for switching between graphics and video is not used, one additional attribute and

20 additional modes will be needed.

If another attribute is used to define groupings of 64 kbit/s channels, then the BAS needs can be satisfied within 4 attributes, leaving the other 4 available to convey capability information.

Thus, there is no impending proliferation of BAS codes which would necessitate a more complex solution of sending multiple BAS to independently indicate bits used for voice, video, data, applications channel, C&I, etc.

Attribute Value	Octet Layout								Bits per Submultiframe				
Bits 12-16	1	2	3	4	5	6	7	8	Video	Speech	Data	App.	C&I
00000	V	V	V	V	V	V	V	V	1248	0	0	0	0
00001	V	V	V	V	V	V	V	c/V	1248-C	0	0	0	C
00010	-	-	-	-	-	-	-	-	-	-	-	-	-
00011	-	-	-	-	-	-	-	-	-	-	-	-	-
00100	-	-	-	-	-	-	-	-	-	-	-	-	-
00101	-	-	-	-	-	-	-	-	-	-	-	-	-
00110	-	-	-	-	-	-	-	-	-	-	-	-	-
00111	-	-	-	-	-	-	-	-	-	-	-	-	-
01000	V	V	V	V	V	V	V	d	1120	0	128	0	0
01001	V	V	V	V	V	V	V	c/d	1120	0	128-C	0	C
01010	V	V	V	V	V	V	V	a	1120	0	0	128	0
01011	V	V	V	V	V	V	V	c/a	1120	0	0	128-C	C
01100	V	V	V	V	V	V	d	d	960	0	288	0	0
01101	V	V	V	V	V	V	d	c/d	960	0	288-C	0	C
01110	V	V	V	V	V	V	a	a	960	0	0	288	0
01111	V	V	V	V	V	V	a	c/a	960	0	0	288-C	C
10000	s	s/V	s/V	s/V	V	V	V	V	928	320	0	0	0
10001	s	s/V	s/V	s/V	V	V	V	c/V	928-C	320	0	0	C
10010	-	-	-	-	-	-	-	-	-	-	-	-	-
10011	-	-	-	-	-	-	-	-	-	-	-	-	-
10100	-	-	-	-	-	-	-	-	-	-	-	-	-
10101	-	-	-	-	-	-	-	-	-	-	-	-	-
10110	-	-	-	-	-	-	-	-	-	-	-	-	-
10111	-	-	-	-	-	-	-	-	-	-	-	-	-
11000	s	s/V	s/V	s/V	V	V	V	d	800	320	128	0	0
11001	s	s/V	s/V	s/V	V	V	V	c/d	800	320	128-C	0	C
11010	s	s/V	s/V	s/V	V	V	V	a	800	320	0	128	0
11011	s	s/V	s/V	s/V	V	V	V	c/a	800	320	0	128-C	C
11100	s	s/V	s/V	s/V	V	V	d	d	640	320	288	0	0
11101	s	s/V	s/V	s/V	V	V	d	c/d	640	320	288-C	0	C
11110	s	s/V	s/V	s/V	V	V	a	a	640	320	0	288	0
11111	s	s/V	s/V	s/V	V	V	a	c/a	640	320	0	288-C	C

Note: Video and speech bit rates are shown for 16 kb/s speech.

Table 1. Attribute Value Assignments for Video/Speech.

Attribute Value	Octet Layout								Bits per Submultiframe				
Bits 12-16	1	2	3	4	5	6	7	8	D Data	Speech	d Data	App.	C&I
00000	D	D	D	D	D	D	D	N	1120	0	0	0	0
00001	D	D	D	D	D	D	D	c/N	1120	0	0	0	C
00010	-	-	-	-	-	-	-	-	-	-	-	-	-
00011	-	-	-	-	-	-	-	-	-	-	-	-	-
00100	P	P	P	P	P	P	P	P	0	1280A	0	0	0
00101	P	P	P	P	P	P	P	P	0	1280mu	0	0	0
00110	H	H	L	L	L	L	L	L	0	1280	0	0	0
00111	D	D	D	D	D	D	D	D	1280	0	0	0	0
01000	D	D	D	D	D	D	D	d	1120	0	128	0	0
01001	D	D	D	D	D	D	D	c/d	1120	0	128-C	0	C
01010	D	D	D	D	D	D	D	a	1120	0	0	128	0
01011	D	D	D	D	D	D	D	c/a	1120	0	0	128-C	C
01100	-	-	-	-	-	-	-	-	-	-	-	-	-
01101	-	-	-	-	-	-	-	-	-	-	-	-	-
01110	N	N	N	N	N	N	N	N	0	0	0	0	0
01111	N	N	N	N	N	N	N	c/N	0	0	0	0	C
10000	H	H	L	L	L	L	L	L	0	1248	0	0	0
10001	H	H	L	L	L	L	L	c/L	0	1248-C	0	0	C
10010	-	-	-	-	-	-	-	-	-	-	-	-	-
10011	-	-	-	-	-	-	-	-	-	-	-	-	-
10100	-	-	-	-	-	-	-	-	-	-	-	-	-
10101	-	-	-	-	-	-	-	-	-	-	-	-	-
10110	-	-	-	-	-	-	-	-	-	-	-	-	-
10111	-	-	-	-	-	-	-	-	-	-	-	-	-
11000	H	H	L	L	L	L	L	d	0	1120	128	0	0
11001	H	H	L	L	L	L	L	c/d	0	1120	128-C	0	C
11010	H	H	L	L	L	L	L	a	0	1120	0	128	0
11011	H	H	L	L	L	L	L	c/a	0	1120	0	128-C	C
11100	H	H	L	L	L	L	d	d	0	960	288	0	0
11101	H	H	L	L	L	L	d	c/d	0	960	288-C	0	C
11110	H	H	L	L	L	L	a	a	0	960	0	288	0
11111	H	H	L	L	L	L	a	c/a	0	960	0	288-C	C

Note: 00100, 00101, 00110, and 00111 are unframed modes.

Table 2. Attribute Value Assignments for Audio/Data (000).

Attribute Value Bit N	Bit N = 0	Bit N = 1
N = 12	speech off	speech on
13	d and a off	d or a on
14	d or a in bit 8	d or a in bits 7 and 8
15	data channel on	application channel on
16	C&I off	C&I on

Table 3. Method of encoding the BAS Values for Video/Speech