CCITT SGXV
Working Party XV/1
Specialists Group on Coding for Visual Telephony

Document #461
March 1989

Source: Japan

Title: Signaling coded sub-blocks
(cf. CBP on page 29 of the Annex 3 to Doc. #445R)

1. Introduction

Investigations have been carried out to decide the CBP (coded block pattern) specification. And the results and proposals of Japan have been delivered as a correspondence, which said that Method 4 in Doc. #357 (VLC coded 7 patterns) showed the best performance among three methods and the extra processing power to handle EOB-only sub-blocks was small (cf. Annex 2).

We newly studied the fourth method, **start of block trick**, which was suggested by a letter from Dr. Geoff Morrison dated on February the 1st. And it showed better performance than our previous proposals.

2. Signaling methods

The following four methods have been investigated.

Method (1): 7 patterns, VLC.
Method (2): 63 patterns, FLC.
Method (3): 63 patterns, VLC.
Method (4): 63 patterns, VLC, two code tables for TCOEFF.

Method (3) encodes possible 63 patterns. Therefore EOB-only sub-blocks never appear. In other words, the first event within a coded sub-block is always a run + quantized index (TCOEFF). So it becomes possible to **have two code tables [Start of block trick]**, Table-1 for the first event only, and Table-2 for the remaining events including EOB.

The data format is the same as Method (3).

3. Comparison

The four Methods have been compared from the viewpoints of processing power (cf. Annex 2) and code table capacity.

As for the comparison among Methods (1) through (3), refer to the Annex 2. The major difference between Methods (3) and (4) is the code table capacity. Taking note 2) below the comparison table and large memories currently available into account, this will not cause

remarkable problems in hardware complexity.

method	(a) pattern length	(b) coded sub-block	(c) EOB-only sub-block	(d) code table capacity (bits) (coder)	(decoder)	performance (bits) +:worse -:better
(1)	variable	0	0	400 k	14 M	0 (ave.)
(2)	fixed	0	-	400 k	14 M	+72 - +217 (+153)
(3)	variable	0	-	400 k	14 M	-15 - +61 (+32)
(4)	variable	0	-	800 k	28 M	-106 - -29 (-49)

0: necessary

Notes:

1) In the simulation, Table-2 is the same as RM7 and Table-1 is almost the same as RM7 except that two 3-bit codes is changed to 2-bit codes. So no optimization has been carried out.
2) Memory capacity for the decoder can easily be reduced by limiting the maximum length of the variable length part (cf. Doc. #462), but the ratio between Methods (1) through (3) and Method (4) is 1 : 2.
3) The details of the code table capacity and performance are shown in Annex 1.

4. Conclusion

We, Japan, have been proposing the method that has the best coding performance taking the hardware complexity into account. From this standpoint and to fix the FH specification as soon as possible, we support Method (4) since four methods have no large difference in the hardware complexity.

The important issue of this meeting concerning to the CBP should be:

1) to decide the contents of the code table(s) for 2-D TCOEFFs or alternatively
2) to decide the number of signals and their bits that go into the code table(s) for 2-D TCOEFFs to fix the capacity (and signal flow).

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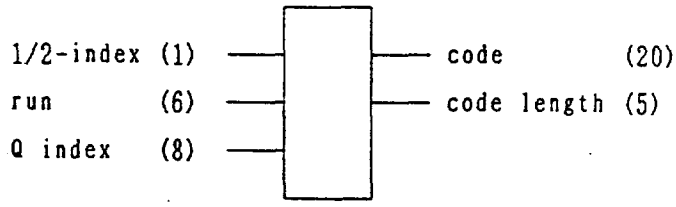
Annex 1 to Doc. #461

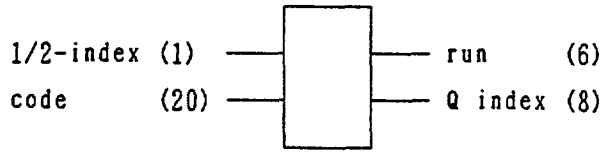
Code table capacity (based on RM7)

Coder:



$2^{1+6+8} \times (20+5) = 2^{15} \times 25 =$ 800 kbits

Decoder:



$2^{1+20} \times (6+8) = 2^{21} \times 14 =$ 28 Mbits

Performance

	Miss America	*Claire*	*Salesman*	*Swing*	*Weighted ave.*
No. of coded frames	49	164	149	124	*(Total)* 486
Method (1)	2,029	1,501	1,718	1,713	1,674.85
Method (2)	2,101	1,654	1,935	1,821	1,827.83
vs.(1)	72	153	217	108	152.98
Method (3)	2,048	1,562	1,761	1,698	1,706.71
vs.(1)	19	61	43	-15	31.86
vs.(3)	-125	-105	-72	-41	
Method (4)	1,923	1,457	1,689	1,657	1,626.14
vs.(1)	-106	-44	-29	-56	-48.71

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Annex 2 to Doc. #461

Title: Signaling coded sub-blocks
(cf. CBP on page 29 of the Annex 3 to Doc. #445R)
Source: Japan

1. Introduction

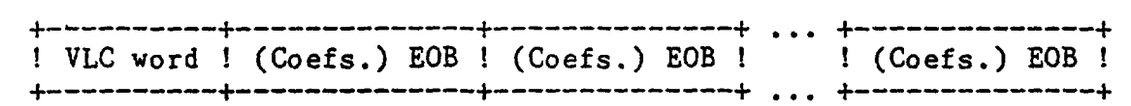
In Doc. #357, a method that signals coded sub-block patterns within coded macro-blocks was proposed. Based on an independent study, several methods were compared in Doc. #418. It says that the performance of the method in Doc. #357 is the best but that the hardware would be complex compared with other methods. The major difference between these methods is whether EOB-only sub-block exists or not as is shown in the next section. To make the results of this study as general as possible, extra processing power for encoding and decoding such sub-blocks has been estimated in terms of the required number of times to look up the 2-D VLC table, which is independent of hardware architectures.

2. Signaling methods

The following three methods have been investigated.

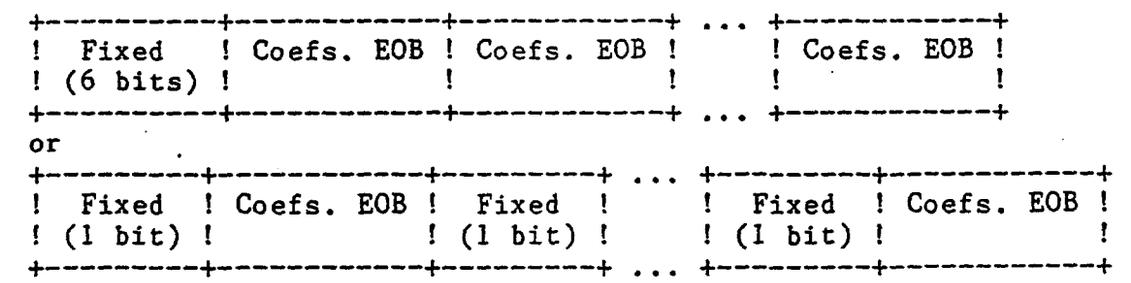
(1) Method 4 in Doc. #357

Send VLC word to indicate one out of 7 patterns. Send EOB words for all designated sub-blocks within the pattern.



(2) Method 3 in Doc. #418

6 bits per coded macro-block.



(3) Method 4 in Doc. #418

VLC word unique for each of 63 possible patterns.

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VLC word	Coefs.	EOB	Coefs.	EOB	...	Coefs.	EOB

Notes:

1) "Coefs." means variable length coded words for coefficients.
2) "(Coefs.)" shows that coefficients are not always transmitted, in other words, some sub-blocks have only EOB words.

3. Comparison

The encoding and decoding processes that relate with this study can be divided into three categories.

(a) coded sub-block pattern

(b) coded sub-block

(c) EOB-only sub-block

method	(a) pattern length	(b) coded sub-block	(c) EOB-only sub-block	performance (Doc. #418)
(1)	variable	0	0	base(0)
(2)	fixed	0	-	+80 - 250 bits
(3)	variable	0	-	+35 - 140 bits

0: necessary

To estimate the extra processing power for EOB-only sub-blocks, a computer simulation has been carried out based on the RM6 with p=1, 5, and 25. The detailed result is shown in the Annex 1. The meaning of each row is:

a: EOB word/frame
average number of EOB words per frame.

b: Y mc coded sub-block/fr.
average number of MC CODED sub-blocks of Y per frame

c: Y coded sub-block/fr.
average number of CODED sub-blocks of Y per frame

d: UV coded sub-block/frame
average number of CODED sub-blocks of UV per frame

e: necessary EOB word/frame
average number of EOB words per frame as a terminator of coefficient words

f: EOB-only sub-block/frame
average number of EOB-only sub-blocks per frame

h: Y non-zero coef./sub-block
average number of non-zero coefficients of Y per coded sub-block

i: C non-zero coef./sub-block
average number of non-zero coefficients of C per coded sub-block

j: non-zero coefficient/frame
average number of non-zero coefficients per frame

k: (coef.+necessary EOB)/frame
average number of non-zero coefficients plus terminating EOB words per frame

m: ratio of EOB-only sub-block
average extra processing power for EOB-only sub-blocks in terms of the required number of times to look up the 2-D VLC table

The result is summarized as follows.

p	m		
	min.	max.	ave.
1	11.10%	19.72%	15.49%
5	8.04%	23.84%	12.87%
25	4.48%	8.20%	5.50%

4. Conclusion

We don't think that the difference between fixed length pattern word and variable length pattern word is large. And the extra processing power for EOB-only sub-blocks, 4.5% to 24%, is not so large compared to the whole codec hardware.

As a consequence, we admit that our method needs extra processing power, but it makes a hardware slightly complex.

As for the transmission order of the sub-blocks within a coded macro-block, we propose the following one, which is the same as was proposed in Annex 3 to Doc. #409.

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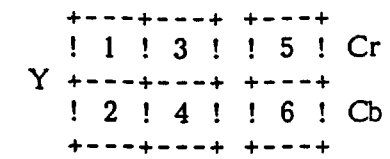

Sub-block transmission order

Annex 1 (1/3): Signaling coded sub-blocks RM6, p=1, 10Hz

		Miss America	Swing	Salesman	Claire	average	
EOB word/frame		501	384	385.5	382	413.13	a
Y	mc coded sub-block/fr.	131	17	90	124	90.50	b
Y	coded sub-block/frame	78	175	152	106	127.75	c
UV	coded sub-block/frame	106	48	14	37	51.25	d
necessary EOB word/frame		315.00	240.00	256.00	267.00	269.50	e=b+c+d
EOB-only sub-block/frame		186.00	144.00	129.50	115.00	143.63	f=a-e
Y non-zero coef./sub-block		2.30	2.46	2.71	3.08	2.64	h
C non-zero coef./sub-block		1.39	2.15	1.18	1.63	1.59	i
non-zero coefficient/frame		628.04	575.52	672.34	768.71	657.67	j=(b+c)·h+d·i
(coef.+necessary EOB)/frame		943.04	815.52	928.34	1035.71	927.17	k=e+j
ratio of EOB-only sub-block		19.72	17.66	13.95	11.10	15.49	m=f/k·100%

Annex 1 (2/3) : RM6, p=5, 15Hz

		Miss America	Swing	Salesman	Claire	average	
EOB word/frame		1292	1111.5	905.5	947.5	1064.13	a
Y	mc coded sub-block/fr.	199	19	109	137	116.00	b
Y	coded sub-block/frame	307	609	208	377	375.25	c
UV	coded sub-block/frame	406	125	104	159	198.50	d
necessary EOB word/frame		912.00	753.00	421.00	673.00	689.75	e=b+c+d
EOB-only sub-block/frame		380.00	358.50	484.50	274.50	374.38	f=a-e
Y non-zero coef./sub-block		3.28	2.20	4.59	4.63	3.68	h
C non-zero coef./sub-block		2.29	2.22	1.50	2.26	2.07	i
non-zero coefficient/frame		2589.42	1659.10	1611.03	2739.16	2218.70	j=(b+c)·h+d·i
(coef.+necessary EOB)/frame		3501.42	2412.10	2032.03	3412.16	2908.45	k=e+j
ratio of EOB-only sub-block		10.85	14.86	23.84	8.04	12.87	m=f/k·100%

Annex 1 (3/3) :

RM6, p=25, 30Hz

		Miss America	Swing	Salesman	Claire	average	
EOB word/frame		1970.5	1592.5	1376.5	1330	1567.38	a
Y	mc coded sub-block/fr.	327	41	195	82	161.25	b
Y	coded sub-block/frame	644	1186	790	592	803.00	c
UV	coded sub-block/frame	613	85	105	275	269.50	d
necessary EOB word/frame		1584.00	1312.00	1090.00	949.00	1233.75	e=b+c+d
EOB-only sub-block/frame		386.50	280.50	286.50	381.00	333.63	f=a-e
Y non-zero coef./sub-block		3.86	3.88	4.78	4.64	4.29	h
C non-zero coef./sub-block		3.84	2.14	2.23	2.08	2.57	i
non-zero coefficient/frame		6101.98	4942.66	4942.45	3699.36	4829.25	j=(b+c)·h+d·i
(coef.+necessary EOB)/frame		7685.98	6254.66	6032.45	4648.36	6063.00	k=e+j
ratio of EOB-only sub-block		5.03	4.48	4.75	8.20	5.50	m=f/k·100%