1. Abstract

In RM6, at the scene change frame, the mixture of intra coded macro blocks and no MC not coded macro blocks due to the buffer oveflow after a few GOB's are coded makes subjective quality worse. In this document, more effective coding techniques for intra mode, considering scene change, are described. The techniques are :

1) Coding of DC values for Cr and Cb in intra mode
2) Introduction of intra not coded mode

2. Coding method

2.1 Coding of DC values for Cr and Cb in intra mode

The mean values for Cr and Cb are transmitted with 8 bits FLC (the same coding method as Y) instead of using the mean values 128 which is used in RM6.

Y   : the same coding method as RM6

Cr, Cb : the same coding method as Y ; mean value of 8×8 Cr (MCr) and Cb (MCb) are transmitted with 8 bits FLC, and differential DC value of Cr (or Cb) by comparison with $8 \times$ MCr (MCb) are transmitted.

2.2 Introduction of intra not coded mode

It is desirable that almost all macro blocks are transmitted in intra mode at scene change. However, a lot of bits are allocated to intra mode coding and the reduction of bits for intra mode is needed. Intra not coded mode (only mean values of Y, Cr, Cb are transmitted with 8 bits FLC) is introduced to decrease the EOB code information. The modified VLC for the macro block type is :

macro block type	code with relative addressing
1 . no MC not coded	--
2 . MC coded	1
3 . MC not coded	01
4 . no MC coded	001
5 . Intra coded	0000
6 . Intra not coded	0001

After the blolcks have been declared intra the coefficients are transmitted as depicted below:

1) Intra coded

MY = rounded mean value of the 16×16 MB	MCr = rounded mean value of the 8×8 MB	MCb = rounded mean value of the 8×8 MB

8 bit FLC   8 bit FLC   8 bit FLC

Differential DC value of LSB1 by comparison with 8× MY	AC	EOB

. . .

2 bit

. . . | Differential DC value of LSB4 by comparison with 8× MY | AC | EOB |
|---|---|---|

2 bit

Differential DC value of Cr by comparison with 8× MCr	AC	EOB

2 bit

Differential DC value of Cb by comparison with 8× MCb	AC	EOB

2 bit

2) Intra not coded

MY = rounded mean value of the 16×16 MB	MCr = rounded mean value of the 8×8 MB	MCb = rounded mean value of the 8×8 MB

8 bit FLC   8 bit FLC   8 bit FLC

where   MB = Macro Block
        LSB = Luminance Sub Block

2

3. Simulation

In addition to improvements shown in chapter 2, we introduced following two methods.

1) Buffer overflow
   Inter/Intra switch is also applied in the case of overflow
   Intra mode : transmitted as intra not coded
   Inter mode : transmitted as no MC not coded

2) Condition for coding first frame
   For the coding of first frame, all macro blocks are forced to intra mode and transmitted. The procedures in RM6 for coding first frame, the skipping of the second picture to be coded and the doubling of the bits/picture are eliminated.

Sequence : Scene change (from claire to salesman)

Frame NO.=1 2 ·· ·· 37 38 ·· ···87

claire	salesman
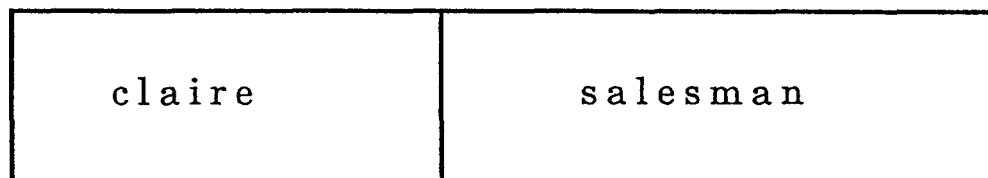
Frame rate ; 10Hz

4. Results

Table 1 and Fig.1~3 show the result of improvements and Table 2 shows that of RM6. The improvements in SNR and subjective quality at scene change are made. At scene change, about 90% of macro blocks are decided intra not coded mode. It is apparent that the coding of intra mode with two kinds of codes, intra coded and intra not coded, are effective.

3

5 . Conclusion

1)   According to introduction of techniques for intra mode , significant improvements are made . In this simulation inter / intra switch is used in all cases , also at the scene change . The information about scene change is not need to be transmitted . By forcing all macro blocks to intra mode for the first frame , it is unnecessary to introduce extra coding method for first frame .

2)   Simulation results show appoximately 90% of macro blocks are decided intra not coded mode at scene change . In this case of succesive intra not coded , for the saving of macro block type bits , intra continue mode which indicates numbers of intra not coded (or coded) macro blocks are continued can be added . After the macro block type , a VLC indicating the 'number of intra not coded (coded) blocks' is followed . The item is for further study , however we expect , by using Intra continue mode , about 1500 bits / frame could be saved , in the case all macro blocks are intra not coded .

6 . Annex
Annex 1   : A simple Intra mode decision as effective as in #396
Annex 2   : Reduction of the block-distortion by using interpolation method

			— Claire —>|<—— Salesman —			
Frame NO.		36	37	38	39	40
1. RMS FOR LUMINANCE		3.16	3.12	21.05	20.75	18.33
FOR CHROMINANCE(U)		2.86	2.85	8.59	8.33	7.55
FOR CHROMINANCE(V)		1.98	1.99	8.49	8.43	7.34
2. SNR FOR LUMINANCE		38.13	38.24	21.67	21.79	22.87
FOR CHROMINANCE(U)		39.01	39.03	29.45	29.72	30.57
FOR CHROMINANCE(V)		42.21	42.15	29.55	29.61	30.82
3. MEAN VALUE OF STEP SIZE		20.00	19.56	61.44	64.00	63.89
4. MEAN VALUE OF THE NUMBER OF NON-ZERO COEFFICIENTS		3.14	2.83	6.17	1.35	2.07
5. MEAN VALUE OF THE NUMBER OF ZEROEZ BEFORE THE LAST NZ-COEFFICIENT		4.77	4.55	15.83	1.39	3.49
6. BLOCK	! NO MC NOT CODED	274	290	17	369	257
TYPE	! MC CODED	59	50	0	14	66
OF	! MC NOT CODED	6	3	0	3	9
MACRO	! NO MC CODED	57	53	0	3	48
	! INTRA CODED	0	0	12	0	2
	! INTRA NOT CODED	0	0	367	7	14
7. BLOCK	! NO MC NOT CODED	1239	1285	1539	1509	1175
TYPE	! MC CODED	169	136	0	39	164
OF	! MC NOT CODED	91	76	0	29	136
Y	! NO MC CODED	85	87	45	7	109
8. BLOCK	! NO MC NOT CODED	653	677	768	758	640
TYPE	! MC CODED	24	30	0	0	8
OF	! MC NOT CODED	106	76	0	34	142
UV	! NO MC CODED	9	9	24	0	2
9. NUMBER	! MACRO ATTRIBUTES	526	453	1921	154	657
OF	! BLOCK ATTRIBUTES	272	260	0	34	235
BITS	! END OF BLOCK	792	716	144	124	780
	! MOTION VECTORS	365	303	0	228	899
	! ! Y	4245	3468	1716	264	2603
	! COEFFICIENTS ! U	135	200	1333	0	104
	! ! V	110	85	1346	0	124
	! ! TOTAL	4490	3753	4395	264	2831
	! DC COEFFICIENTS	0	0	9096	168	384
	! TOTAL	6445	5485	15556	972	5786

Table 1 Result of Improvements

— Claire - —>|<——— Salesman ———

Frame NO.	36	37	38	39	40
1. RMS FOR LUMINANCE	3.21	3.16	54.66	43.45	30.59
FOR CHROMINANCE(U)	2.82	2.79	24.42	19.20	12.83
FOR CHROMINANCE(V)	1.92	1.93	17.48	14.01	9.69
2. SNR FOR LUMINANCE	38.01	38.12	13.38	15.37	18.42
FOR CHROMINANCE(U)	39.14	39.22	20.37	22.47	25.96
FOR CHROMINANCE(V)	42.47	42.44	23.28	25.20	28.40
3. MEAN VALUE OF STEP SIZE	19.78	19.00	61.44	64.00	63.89
4. MEAN VALUE OF THE NUMBER OF NON-ZERO COEFFICIENTS	3.20	2.78	2.56	1.92	1.81
5. MEAN VALUE OF THE NUMBER OF ZEROEZ BEFORE THE LAST NZ-COEFFICIENT	4.95	4.60	4.37	2.55	2.34
6. BLOCK TYPE OF MACRO ! NO MC NOT CODED	281	297	262	278	264
! MC CODED	58	47	9	18	22
! MC NOT CODED	9	3	0	6	14
! NO MC CODED	48	49	2	8	18
! INTRA CODED	0	0	99	72	70
! INTRA NOT CODED	0	0	24	14	8
7. BLOCK TYPE OF Y ! NO MC NOT CODED	1237	1296	1286	1299	1246
! MC CODED	157	139	24	48	58
! MC NOT CODED	111	61	12	48	86
! NO MC CODED	79	88	262	189	194
8. BLOCK TYPE OF UV ! NO MC NOT CODED	655	680	679	673	654
! MC CODED	34	36	17	31	21
! MC NOT CODED	100	64	1	17	51
! NO MC CODED	3	12	95	71	66
9. NUMBER OF BITS ! MACRO ATTRIBUTES	480	414	742	677	680
! BLOCK ATTRIBUTES	255	250	36	82	104
! END OF BLOCK	748	744	1308	1096	1144
! MOTION VECTORS	361	295	133	280	371
! COEFFICIENTS ! Y	4147	3559	3996	2475	2338
! U	190	228	1818	357	344
! V	118	84	1641	286	266
! TOTAL	4455	3871	7455	3118	2948
! DC COEFFICIENTS	0	0	984	688	624
! TOTAL	6299	5574	10658	5941	5871

Table 2 Result of RM6

dB
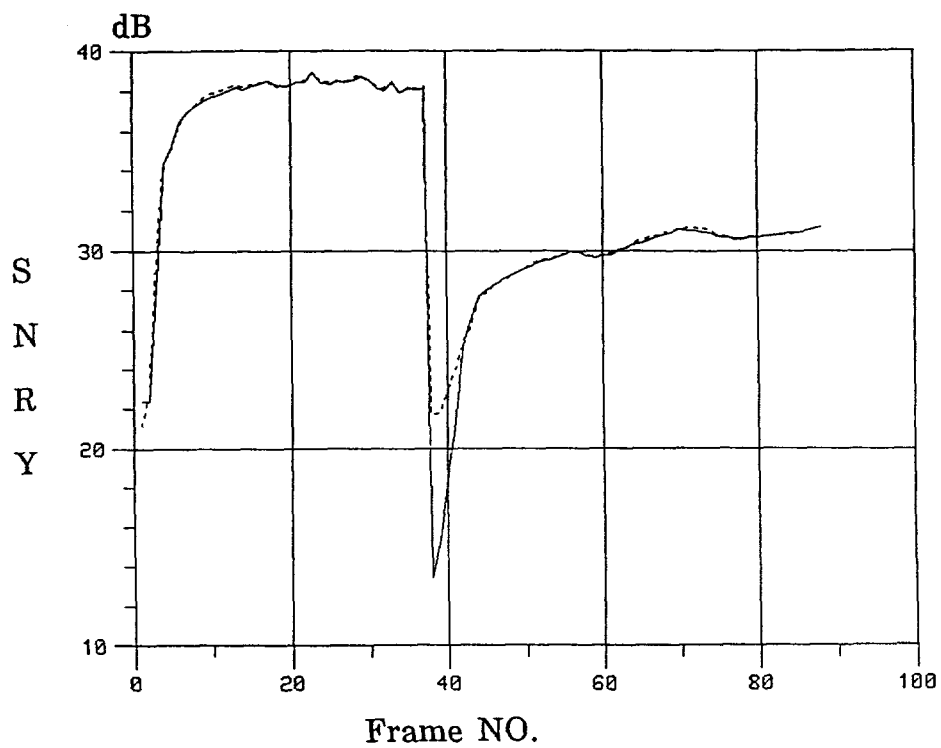
Fig.1 SNR for Luminance Y

——————— RM6

– – – – – Improvement

dB
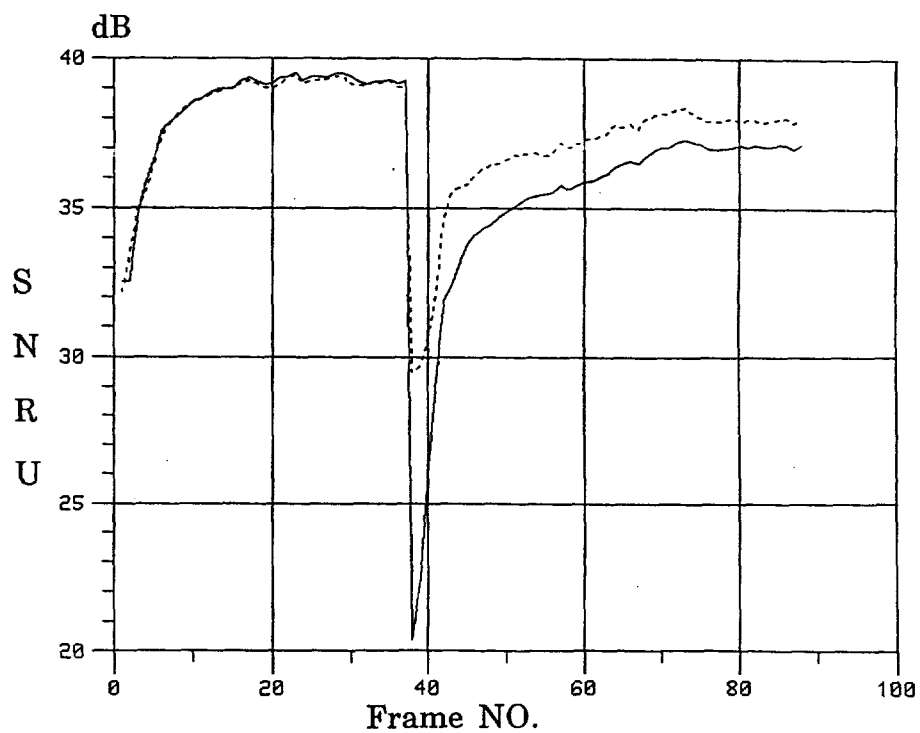
Fig.2 SNR for Chrominance U

——————— RM6

– – – – – Improvement

Fig.3 SNR for Chrominance V

——————— RM6

- - - - - Improvement
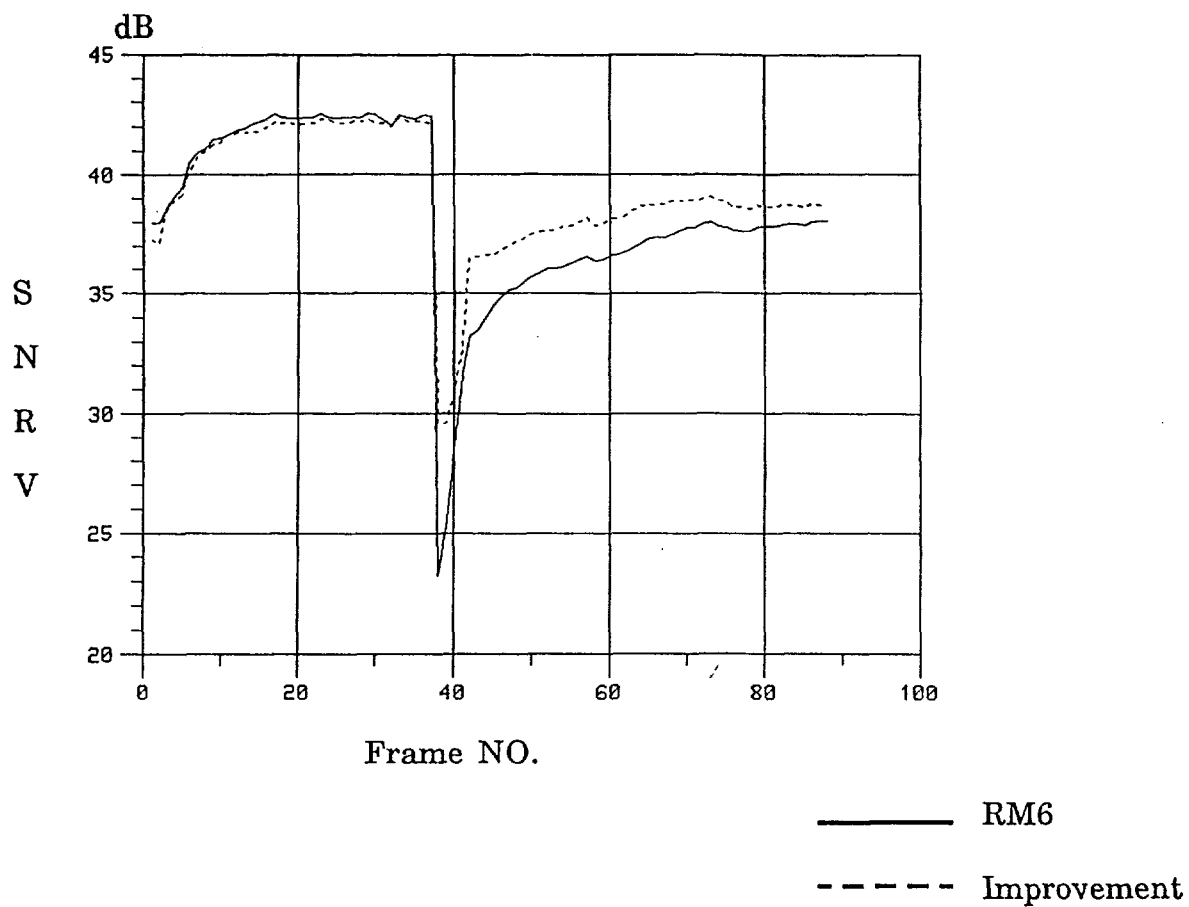
TITLE : Intra Mode Decision at the MC Stage

1. Introduction

In document #396, a method of Intra mode decision was described. In this annex, another method of decision is introduced, which is possible to reduce the complexity for implementation and gives almost the same effect as described in #396.

2. Scheme

In the process of motion compensation, Intra / Inter mode is decided using the following procedure.

1. A mean value of 16×16 block (luminance components) is calculated at the MC stage.
2. The mean value is evaluated using block matching method as same as the other motion-compensated blocks (probably adopting some offset value).
3. If the mean value gives better prediction, Intra mode is decided. Otherwise, Inter mode is decided.

Note that the above method is different from the method in #396 at the following points.

1. A sum of absolute differences is adopted as the evaluation function.
2. Intra / Inter mode is decided at the MC stage before the loop filter processing.

3. Simulation

Using RM6 (#396) and sequence "salesman", we have certified the above scheme. Both the original RM6 and the modified RM6 using the above scheme have given the same average number of Intra mode blocks.

5. Conclusion

A method of Intra mode decision at the MC Stage was described. This method can be implemented by adding subtle function to the MC unit and gives almost the same effect as described in #396.

Interpolation on 1st Frame

Introduction

At the most of Macro Blocks(MBs) in the 1st frame, only the mean values of Y,U,and V are transmitted. Therefore, the picture quality is degraded by Block-Distortion. The purpose of this modification is to examine the improvement of picture quality of the 1st frame and following several frames, by introducing a new interpolation method to reduce the Block-Distortion of the 1st frame.

Techniques

To reduce the Block-Distortion without any extra data, pixels should be interpolated from the mean values of several surrounding MBs.

Though several methods have been presented, these methods need special hardware for interpolation.

A new idea that needs no additive hardware for interpolation is proposed here as shown in fig.1.

1.) The mean values of surrounding MBs(here,5x5) are transformed by micro-processor, and

2.) these transformed coefficients are inverse transformed by I-DCT chip(s) to get interpolated 80x80 pixels for Y and 40x40 pixels for U and V.

3.) The central pixels(16x16 for Y, and 8x8 pixels for U and V) are taken, displayed and used for the reference signals of the 2nd frame.

Results of Simulation

Table 1 shows the Simulation results.

This modification slightly improves the 1st frame SNRs and makes visible improvement in picture quality. Other frames, however, have a quite little difference from no-modified-RM6.
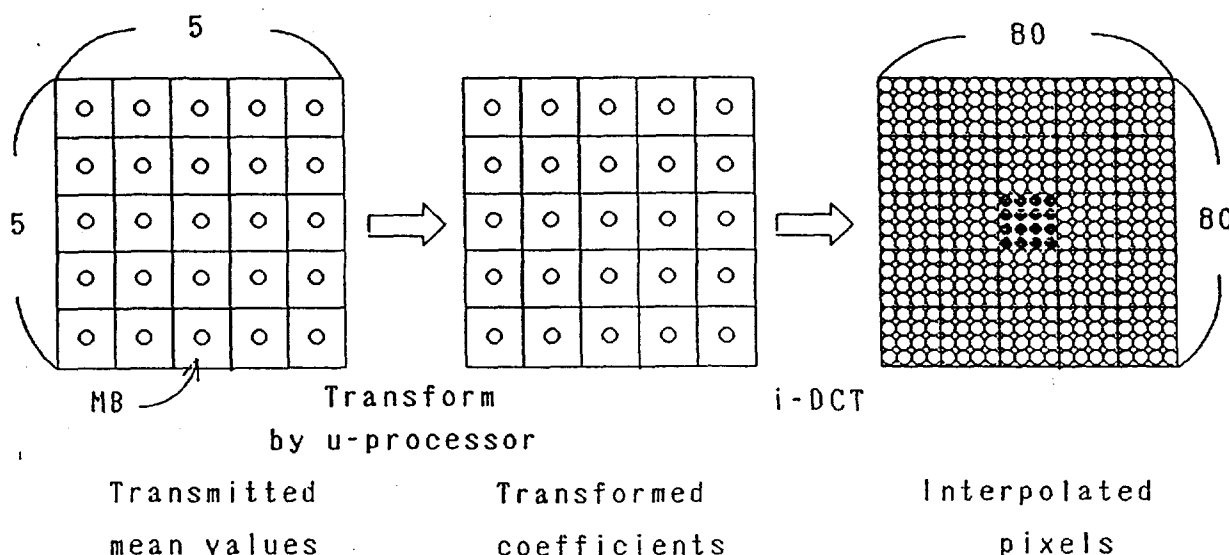

MB   Transform   i-DCT
      by u-processor

Transmitted   Transformed   Interpolated
mean values   coefficients   pixels

Fig.1. Interpolation using mean values of MBs.

Table 1. Results of Simulation

STATISTICS RM6
SEQUENCE   : SALESMAN
MODIFICATION   : INTERPOLATION on 1st frame   FRAME RATE : 1CHz

FRAME	1	2	3	15
RMS for Y	18.45(-1.44)	16.24(-0.45)	14.54(-0.05)	8.34(+0.06)
SNR for Y	22.81(+0.65)	23.92(+0.24)	24.88(+0.03)	29.70(-0.07)
SNR for U	33.38(+0.44)	35.09(+0.13)	36.31(+0.02)	37.19(-0.06)
SNR for V	33.08(+0.40)	35.36(+0.25)	37.34(+0.19)	38.18(-0.06)
SNR for C	33.23(+0.42)	35.22(+0.18)	36.79(+0.09)	37.66(-0.06)
MEAN STEP SIZE	61.33(0)	64.00(0)	63.89(+0.11)	30.67(+0.34)
MEAN Numb. of Y	3.05(-0.32)	2.02(-0.01)	2.15(+0.21)	2.26(-0.02)
Nonzero Coeff. C	6.86(-0.20)	3.31(-0.19)	3.22(-1.11)	1.04(-0.02)
MEAN Numb. of Y	4.74(-0.35)	3.39(-0.12)	4.09(+0.60)	5.75(+0.25)
zero Coeff. C	28.20(-0.74)	7.54(-0.88)	7.44(-3.56)	1.96(+0.27)
Block INTRA	68(+10)	6(+5)	8(+6)	3(0)
type FIXED	328(-10)	245(-16)	246(-3)	227(+8)
of CODED & MC	0(0)	61(-20)	72(0)	46(0)
Macro FIXED & MC	0(0)	35(+15)	38(+14)	8(0)
CODED	0(0)	49(+16)	32(-17)	112(-8)
Block FIXED	1388(-10)	1058(-40)	1064(-39)	1192(+7)
type CODED & MC	0(0)	137(-72)	167(-15)	109(-5)
of FIXED & MC	0(0)	247(+52)	273(+71)	107(+5)
Y CODED	196(+10)	142(+60)	80(-17)	176(-7)
Block FIXED	757(-1)	779(-1)	783(-3)	769(-7)
type C CODED	35(+1)	13(+1)	9(+3)	23(+7)
MACRO ATTRIB.	0(0)	914(+101)	839(-32)	1084(-51)
End of block	816(+120)	792(+8)	736(-48)	968(+12)
Motion Vector	0(0)	1181(+11)	1232(+203)	332(-12)
DC intra & 1st frame	9900(0)	48(+40)	64(+48)	24(0)
Coeff. Y	3692(-152)	2767(-115)	2669(+37)	3383(-153)
Coeff. C	3876(+18)	257(0)	170(+14)	109(+34)
Coeff. Total	18284(-14)	5959(+29)	5710(+222)	5900(-170)
Buffer count	6404(-14)	6423(+15)	6193(+237)	2605(-50)

Annex 2 to Doc. # 407