PROPOSAL N°6
FOR MPEG SUBJECTIVE TESTING

VADIS-COST Algorithm Group 2

Proposal Documentation

This proposal is submitted by:

BBC	GB
CCETT	F
FI/DBP	D
Nokia Research Center	SF
Norwegian Telecom	N
NTL	GB
RAI	I
Retevision	E
Siemens AG	D
TCE/DTB	D
Telefonica I+D	E
Telenorma	D
Telletra Spa	I
University of Hannover	D
UP Madrid	E

and has been developped in the framework of European VADIS/COST collaboration.

Date: 30 October 91

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MPEG 91/205

AVC-145

1. INTRODUCTION

This document gives a short description of the algorithm developed by VADIS-COST Algorithm Group 2 and submitted to the MPEG subjective tests (proposal n°6)

This algorithm has some common parts with the CD of MPEG1 which are underlined in the following description.

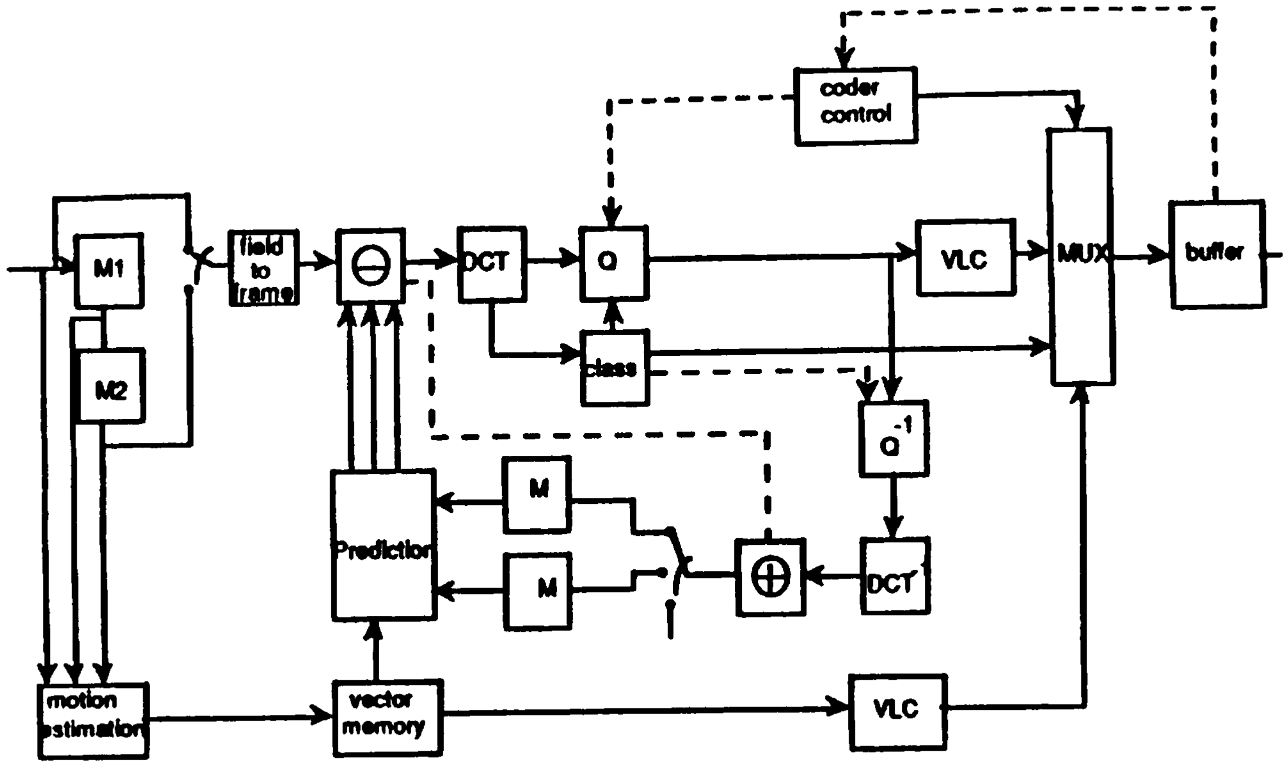
2. GENERAL CODEC OUTLINE

The main features of the codec are:

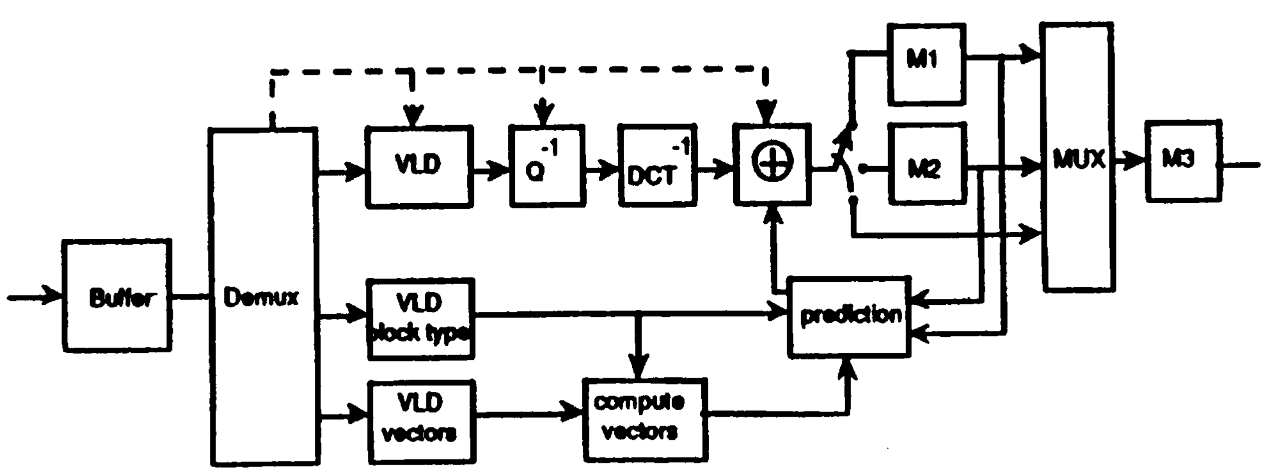
- Input/output in CCIR Rec 601 format
- Full 4:2:2 resolution
- Motion vectors calculated using 16 pixels x 8 lines of luminance samples in a field macroblock
- Motion vector range of ± 7.5 pixels, ± 3.5 lines over 1 picture field
- Motion vector range of ± 15.5 pixels, ± 7.5 lines over 2 picture fields
- Motion vector range of ± 31.5 pixels, ± 15.5 lines over 4 picture fields
- One pair of intrafields every 20 picture fields; pairs of alternate predictive and interpolative picture fields for remainder
- Six basic macroblock modes.
- Mode decision based on absolute differences
- 8x8 DCT blocks of field or frame
- Scanning of DCT coefficients in line with CMTT standard
- Entropy coding

3. VIDEO SOURCE FORMAT AND PRE-PROCESSING

The input and output of the codec is to the 625-line 50 Hz version of the 4:2:2 level of CCIR Rec.601-2. No pre- or post-processing are applied to the 4:2:2 signals.



CODER BLOCK DIAGRAM



DECODER BLOCK DIAGRAM

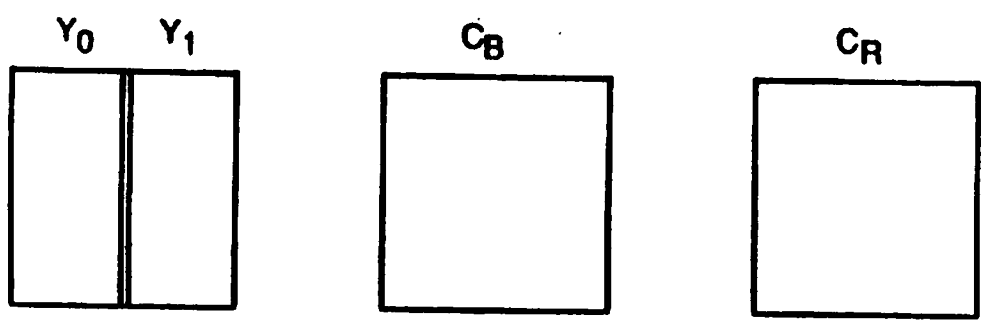
4. LAYERED STRUCTURE OF VIDEO DATA

4.1 Transform Block

A transform block consists of an array of 8 pixels x 8 lines of either the luminance or one of the colour difference signals. The samples may be taken either from one picture field or from one picture frame. The scan sequence is from left to right and then from top to bottom.

4.2 Field Macroblock

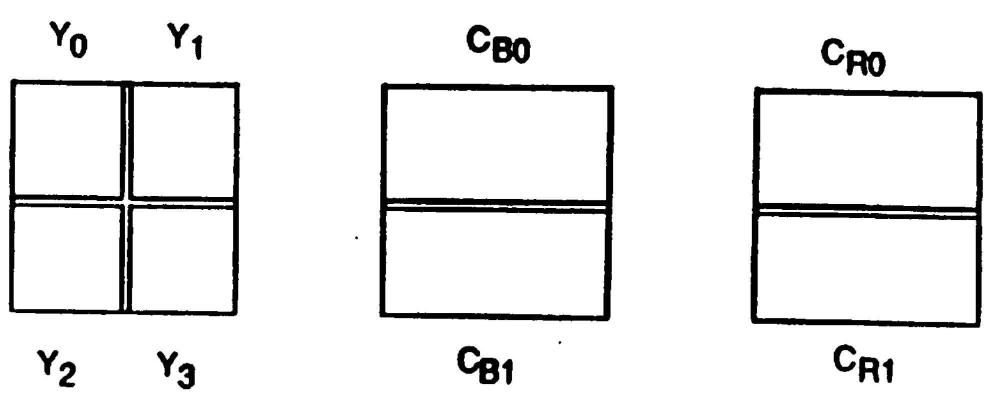
A field macroblock consists of a group of 4 transform blocks from the same picture field. It contains two horizontally adjacent luminance transform blocks (i.e. 16 pixels x 8 lines of luminance samples) and the co-sited single 8x8 C_B and single 8x8 C_R transform blocks. This is illustrated below:



The scan sequence is Y_0, Y_1, C_B, C_R.

4.3 Frame Macroblock

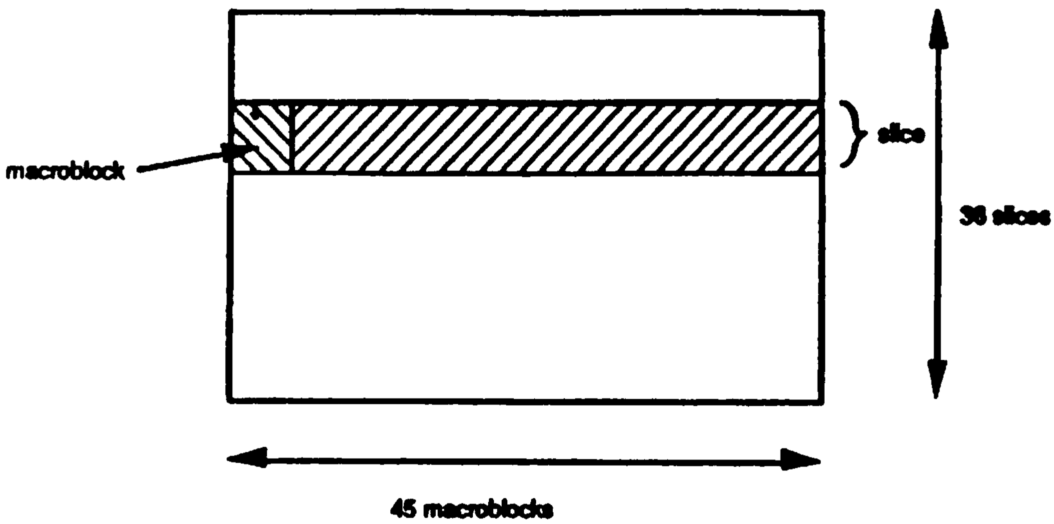
A frame macroblock consists of either two field macroblocks (each from each field of the same frame) as described above (field-based coding), or of a group of 8 transform blocks, each containing data from both fields of the frame (frame-based coding). The transform blocks for the latter are formed by considering the spatial relationship between the two fields, and interleaving lines of the two fields in accordance with the interlace. The transform blocks are illustrated below:



The scan sequence is Y_0, Y_1, C_{B0}, C_{R0}, Y_2, Y_3, C_{B1}, C_{R1}

4.4 Macroblock Slice

A Macroblock Slice consists of a row of Frame Macroblocks across the complete width of the picture frame. The Slice contains 45 macroblocks.

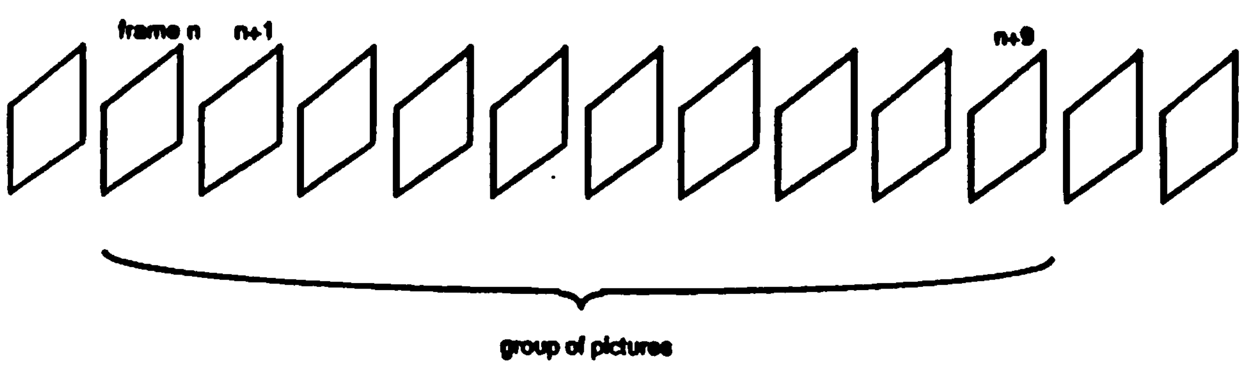


4.5 Picture Frame

A picture frame consists of a pair of interleaved picture fields. It contains 36 Macroblock Slices from top to bottom.

4.6 Group of Pictures

A video sequence is subdivided in group of pictures. The first group of picture has a length of 9 frames and starts with an intra coded frame. Subsequent groups of pictures are 10 frames long with the second frame intra coded.

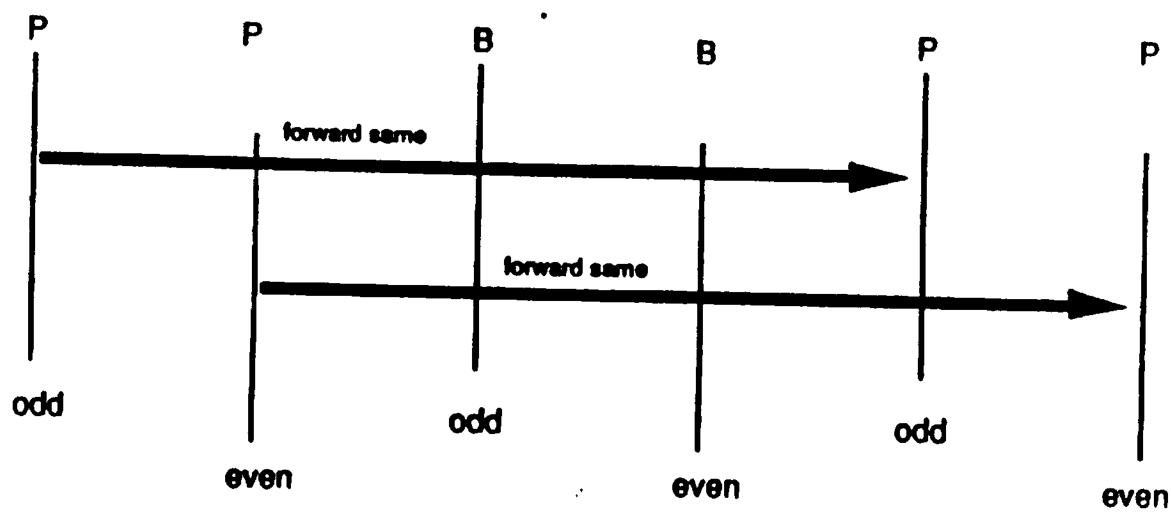


5. MOTION ESTIMATION AND COMPENSATION

Motion compensated prediction or interpolation techniques are used to exploit temporal redundancy in the video signal. Motion compensation is carried out at the field macroblock level.

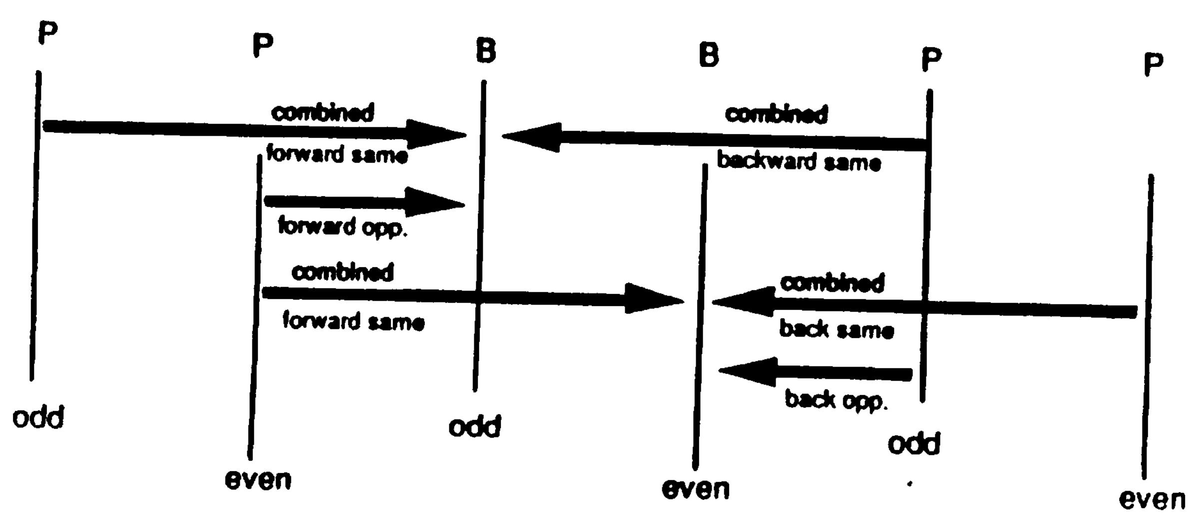
A motion vector is called forward if reference is made to a previous picture field. It is called backward if reference is made to a future picture field.

One forward motion vector is calculated for each field macroblock in a predicted picture field (see Section 6.3). This is calculated with respect to the preceding predicted or intra picture field of the same parity (e.g. the previous predicted odd picture field if the current picture field is odd).



Motion Vectors for Predicted Frames

A total of three motion vectors are calculated for each field macroblock in an interpolated picture field (see Section 6.4). One forward motion vector is calculated with respect to the preceding predicted or intra picture field of the same parity. One backward motion vector is calculated with respect to the following predicted or intra picture field of the same parity. The third motion vector is calculated with respect to the nearest predicted or intra picture field of the opposite parity.



Motion Vectors for Interpolated Frames

5.1 Motion Vector Estimation

Motion estimation is based on the 16 pixels x 8 lines of luminance samples in a field macroblock.

The search area is ± 15.5 pixels by ± 7.5 lines (of the field raster) when the vector is calculated with respect to picture fields displaced in time by 2 field periods (i.e 1 frame periods). The search area is decreased to ± 7.5 pixels by ± 3.5 lines when the vector is calculated with respect to picture fields displaced in time by 1 field period. The search area is increased to ± 31.5 pixels by ± 15.5 lines when the vector is calculated with respect to picture fields displaced in time by 4 field periods (i.e. 2 frame periods).

5.2 Motion-Compensated Prediction

Motion-compensated prediction is carried out on both the luminance and chrominance samples within a field macroblock. The vertical component of the vector used for chrominance has the same value as that used for luminance. The horizontal component is half the value of that used for luminance, rounded down to the nearest half pixel (i.e. n.25 -> n.00 and n.75 -> n.5 for positive and negative n).

There are three forms of motion-compensated prediction: forward, backward and combined.

Forward motion-compensated prediction can be used to predict the value of samples from a preceding picture field.

Backward motion-compensated prediction can be used to predict the value of samples from a following picture field.

Combined motion-compensated prediction can be used to predict the value of samples from a preceding and a following picture field.

6. MODES AND MODE SELECTION

The coding process can adaptively select from a number of different modes of operation for different parts of the picture depending on the nature of the local motion.

There are three stages to the decision making. Firstly, the coder is able to choose from a number of different forms of motion compensated prediction or it can choose to use intra-picture coding. This decision is taken at the field macroblock level. Secondly, it can choose whether to use field- or frame-based transform blocks. This decision is taken at the frame macroblock level. Finally, the coder can decide whether or not there is useful coded information to be sent. This decision is taken after performing the Discrete Cosine Transform and quantisation (see Chapter 7).

Section 6.1 describes the pattern of picture frame types. The different macroblock coding modes which may be used within the picture frames are described in 6.2, 6.3 and 6.4.

6.1 Picture Frame Coding modes

There are three types of picture frame:

a)Intra frame (I): This uses no information from other picture frames

b)Predicted frame (P): This uses forward motion-compensated prediction from a previous picture frame

c)Interpolated frame (B): This uses bidirectional motion-compensated interpolation from previous and following picture frames

A fixed pattern of picture frame types is used as follows:

B I B P B P B P B P B I B P B ...

|---------------------------- GOP n --------------------------| |-------------------- GOP n+1 ---...

There is a repeated pattern of 10 picture frames (i.e. 20 picture fields) known as a Group of Pictures (GOP) containing:

1 Intra Frame (I)
4 Predicted Frames (P)
5 Interpolated Frames (B)

6.2 Macroblock mode in an Intra Frame

There is 1 Macroblock mode which may is used.

	Prediction Method	Parity of Ref. Field	Motion Comp.	Transform Block	Coded or Not Coded
1	Intra	-	-	frame/field	Coded

Frame based or field based coding may be used for each macroblock. This information is signalled to the decoder.

6.3 Macroblock modes in a Predicted Frame

In predicted (P) frames, there are basically 2 macroblock coding modes : intra and forward motion compensated.

	Prediction Method	Parity of Ref. Field	Motion Comp.	Transform Block	Coded or Not Coded
1	Intra	-	-	frame/field	Coded
2	Forward	Same	No MC/MC	frame/field	Coded/Not Coded

1) Intra-coded
In the intra-coded mode macroblocks are routed directly to the discrete cosine transform process. They are always coded.

Transform blocks can be either field-based of frame-based (see section 4.3). Frame-based coding is chosen if both field macroblocks within a frame are intra-coded.

2) Forward Prediction
Predictively coded macroblocks are encoded in two stages. First, all three components of the macroblock in field k are predicted using motion-compensated forward prediction (see Section 5.2)

from field k-4. This prediction is known as the reference macroblock. The reference macroblock is then subtracted from the actual macroblock components to form a prediction-error macroblock, which is passed to the discrete cosine transform process.

In forward prediction mode, the macroblocks may be declared as:
- No MC or MC
- field based coded or frame based coded
- coded or not coded (this last decision can be applied to luminance and chrominance separatly).

The decision is transmitted at the beginning of the macroblock with the information on macroblock mode.

6.4 Macroblock modes in an Interpolated Frame

In interpolated (B) frames, there are basically 6 macroblock coding modes : Intra, Forward motion compensated, Backward motion compensated, Combined motion compensated, motion compensated from fields of opposite parity (For/Back) and Same As Previous.

Prediction Method	Parity of Ref. Field	Motion Comp.	Transform Block	Coded or Not coded
1 Intra	-	-	frame/field	Coded
2 Combined	Same	MC	frame/field	Coded/Not Coded
3 Forward	Same	MC	frame/field	Coded/Not Coded
4 For/Back	Opposite	MC	field	Coded/Not Coded
5 Backward	Same	MC	frame/field	Coded/Not Coded
6 As previous	As previous	MC	As previous	Not Coded

The decision between intra-coding and the four non-intra macroblock coding modes is made at the field macroblock level, using a comparison between the original macroblock and the prediction-error given by each of the non-intra coding modes.

1) Intra-coded
In the intra-coded mode macroblocks are routed directly to the discrete cosine transform process. They are always coded.

2) Forward Prediction, same parity
The Macroblock is encoded in two stages. First, all three components of the macroblock in field k are predicted using motion-compensated forward prediction (see Section 5.2) from field k-2. This prediction is known as the reference macroblock. The reference macroblock is then subtracted from the actual macroblock components to form a prediction-error macroblock, which is passed to the discrete cosine transform process.

3) Backward Prediction, same parity
The Macroblock is encoded in two stages. First, all three components of the macroblock in field k are predicted using motion-compensated backward prediction (see Section 5.2) from field k+2. This prediction is known as the reference macroblock. The reference macroblock is then subtracted from the actual macroblock components to form a prediction-error macroblock, which is passed to the discrete cosine transform process.

4) Combined Prediction, same parity
The Macroblock is encoded in two stages. First, all three components of the macroblock in field k are predicted using motion-compensated combined prediction (see Section 5.2) from fields k-2 and k+2. This prediction is known as the reference macroblock. The reference macroblock is then subtracted from the actual macroblock components to form a prediction-error macroblock, which is passed to the discrete cosine transform process.

5) Forward or Backward Prediction, opposite parity
The Macroblock is encoded in two stages. First, all three components of the macroblock in field k are predicted using motion-compensated prediction to form a reference macroblock. Forward prediction from the immediately preceding field, k-1, is used for the first field in a picture frame. Backward prediction from the immediately following field, k+1, is used for the second field in a picture frame. The reference macroblock is then subtracted from the actual macroblock components to form a prediction-error macroblock, which is passed to the discrete cosine transform process.

6) Same Type as previous
This macroblock is defined to have the same motion vector and the same type (forward, backward, combined, opposite parity) as the spatially preceding macroblock. It contains no coded information.

Different options may be used in the 6 basic coding modes:
- field based coding or frame based coding (modes 1, 2, 3 and 5)
- coded or not coded (this last decision can be applied to luminance and chrominance separately in modes 2 to 5).

These options are transmitted at the beginning of the macroblock with the information on macroblock mode.

7. TRANSFORMATION AND QUANTISATION

While mode selection and local motion compensation are based on the macroblock structure, the transformation and quantisation is based on blocks of 8x8.

Blocks are transformed with a 2-dimensional DCT as explained in Section 7.1. Each block of 8x8 pixels thus results in 8x8 transform coefficients.

The DCT coefficients are quantised and encoded as described in Sections 7.2 and 7.3.

7.1 Discrete Cosine Transform

For each component (Y, C_R or C_B), the Discrete Cosine Transform (DCT) is applied to blocks of 8x8 pixels. These video component elements are either absolute sample values or else differential values depending upon the macroblock coding mode.

The transformation is the same as the one used in MPEG1 and H261.

The input to the forward transform and the output from the inverse transform are represented with 9 bits. The DCT coefficients are represented in 12 bits. The dynamic range of the DCT coefficients is (-2048,...,2047).

7.2 Quantisation of Intra-coded Transform Blocks

DC Coefficients
The quantiser step-size for the DC coefficient of the luminance and the chrominance components is always 8. Thus, the quantised DC value, QX(0,0), is calculated as:

$QX(0,0) = X(0,0) / 8$ where QX(0,0) is the 11-bit unquantised mean value of a block.

AC Coefficients
AC coefficients X(k,l), where k,l ≠ 0, are first weighted with individual weighting factors:

$$X'(k,l) = (16 \times X(k,l)) / \min(w(k,l), QP \times 16)$$

where w(k,l) is the (k,l)th element of the intra-coded weighting matrix

and QP is the quantiser rate control parameter.

The intra-coded weighting matrix for luminance is:

16	16	17	22	32	45	64	90
16	22	27	29	38	64	76	90
16	22	32	41	54	76	90	107
19	25	35	49	64	76	90	117
26	38	49	64	76	90	107	128
38	49	54	58	76	107	128	165
54	58	64	64	76	107	128	197
54	69	76	76	90	128	181	304

The intra-coded weighting matrix for chrominance is:

16	16	20	22	27	32	32	41
16	17	19	20	27	32	35	49
19	19	20	22	29	35	38	64
20	22	25	25	32	38	45	64
25	27	27	29	35	41	49	69
32	32	35	35	41	54	64	98
38	41	41	41	54	64	83	128
45	45	45	45	69	76	90	152

X'(k,l) is in the range [-2048,2047].

After weighting of the coefficients, the quantised level QX(k,l) is then given by

$$QX(k,l) = f(X'(k,l), QP, class)$$

where class is a measure of the activity of the block and can take 4 different values and f is a non liear function. Two bits per luminance blocks are transmitted to signal the adapted quantiser step size.

QX(k,l) is clipped at +255 and -255.

The activity class for the chrominance blocks is deduced from the activity class of the co-located luminance blocks.

7.3 Quantisation of Non-Intra Transform Blocks

Predicted and interpolated transform blocks are weighted by a matrix similar to the one of the intra-coded blocks prior to quantisation. For these non-intra coded blocks, the rate control parameter affects DC as well as the AC coefficients.

8. CODING

In this Chapter the coding of the macroblocks and their attributes are described. Variable length coding is used to exploit statistical redundancies.

The mode of a macroblock is indicated by a macroblock type. Different sets of macroblock types exist for different frame modes. Macroblocks may be coded either on a frame basis, where the data from the two fields of the frame are combined in the transform blocks, or as two field macroblocks, where the fields are coded independently (see Chapter 4). In the latter case, two macroblock types must be indicated for each frame macroblock. The first indicates the mode of field-based coding for the first field macroblock, and a second macroblock type indicates the mode of field-based coding used for the second field macroblock.

In Section 8.2 the coding of the motion vectors is addressed. Differential motion vector coding is used.

The coding of the transform coefficients uses both VLC and run-length techniques, and is described in Sections 8.3 to 8.5.

8.1 Macroblock Type

Each frame has one of the three picture frame coding modes:
1 Intra
2 Predicted
3 Interpolated

For these three modes different sets of codes are used to indicate the Macroblock types. The tables below also indicate the presence or absence of data fields following the Macroblock type. The coding for Macroblock types of field 1 (or frame) consists of a 1-bit FLC followed by a VLC. The length of the VLC varies from 1 to 6 bits.

Field/frame flag (for I, P and B frames)
0 frame-based coding
1 field-based coding

Intra Frames (I frames)

All Macroblocks (field or frame-based) are intra coded.

Predicted Frames (P frames) have the following MB types and coding:

MB type for Field or Frame	MVD	TCOEFF	CODE
MC, frame, coded	X	X	1z
MC, frame, not coded	X		01
No MC, frame, coded		X	0011z
Intra, frame		X	0001
No MC, frame, not coded			0010

where z is a bit signifying that

- luminance and chrominance are coded when z=1

- luminance only is coded when z=0. No further information is transmitted for chrominance.

Interpolated frames (I frames) have the following MB types and coding:

MB Type for Frame MBs	MVD1	MVD2	TCOEFF	CODE
Interp., frame, coded	X	X	X	1z
Interp., frame, not coded	X	X		011
Forw., frame, coded	X		X	010z
Forw., frame, not coded	X			0001
Back., frame, coded		X	X	0010z
Back., frame, not coded		X		0011
Diff. MV=0, same type as previous, frame , not coded				00001
Intra, frame			X	000001

MB Type for Field MBs	MVD1	MVD2	TCOEFF	CODE
Interpolated, coded	X	X	X	1z
Interpolated, not coded	X	X		01
Forward, coded	X		X	00011z
Forward, not coded	X			00010
Backward, same, coded		X	X	00100z
Backward, same, not coded		X		00101
Diff.parity, coded		X	X	00110z
Diff.parity, not coded		X		00111
Diff. MV=0, same type as previous, field , not coded		X		00001
Intra			X	000001

where z is a bit signifying that

- luminance and chrominance are coded when z=1

- luminance only is coded when z=0. No further information is transmitted for chrominance.

8.2 Motion Vectors

Motion vectors for macroblocks in predicted and interpolated frames are coded differentially within a Slice, obeying the following rules:

- Every forward or backward motion vector is scaled to a time displacement of 2 field periods for interpolated macroblocks and 4 field periods for predicted macroblocks. The scaled motion vector is coded relative to the last vector of the same type (Forward/Backward).

- The prediction motion vector is set to zero in the MBs at the start of a Slice, or if the last MB was coded in the intra mode. (Note that for predicted MBs, a No MC decision corresponds to a reset to zero of the prediction motion vector.)

- For MBs in interpolated picture frames, only vectors that are used for the selected prediction mode are coded.

The motion vectors are coded as twice the differential value using the VLC codes given in pages 36, 37, 39 of MPEG video CD (doc. MPEG 90/176 rev 2). The selection of table is determined by the allowed range of the motion vector.

Range of Vector:	±7.5	±15.5	±31.5
Application:	V1-2	V3-4,H1-2	H3-4
VLC from Table	1	2	3

where "V1-2" indicates a vertical motion vector for a time displacement of 1 or 2 field periods.

8.3 Intraframe Coding (I frames)

Adaptive quantisation

A two bit codeword is transmitted at the beginning of each luminance intra coded block to indicate the class of the block (function of the activity of the block).

Class	Code
0	00
1	01
2	10
3	11

DC Prediction

After the DC coefficient of a block has been quantised to 8 bits, it is coded losslessly by a DPCM technique. Coding of the luminance blocks within a MB follows the block scan sequence given in Section 4.3. The DC value of the 4th luminance block becomes the DC predictor for 1st block of the following MB.

At the left edge of a Slice, the DC predictor is set to 128 (for the first block of the luminance, and for each of the chrominance blocks). Apart from the left edge of a Slice, the DC predictor is simply the previously coded DC value of the same type (Y, C_R, or C_B).

At the decoder the original quantised DC values are exactly recovered by following the inverse procedure. The differential DC values thus generated are categorised according to their "size" as shown in the table below:

Size	Differential DC	Code
0	0	
1	-1,1	0,1
2	-3,-2,2,3	00,01,10,11
3	-7...-4,4...7	000...011,100...111
4	-15...-8,8...15	0000...0111,1000...1111
5	-31...-16,16...31	.
6	-63...-32,32...63	.
7	-127...-64,64...127	.
8	-255...-128,128...255	00000000...01111111,10000000...11111111

For each category sufficient additional bits are appended to the Size code to identify uniquely which difference value in that Size category actually occurred. The additional bits thus define the signed amplitude of the difference data. The number of additional bits (sign included) is equal to the Size value. The Size category is coded using the following VLC table:

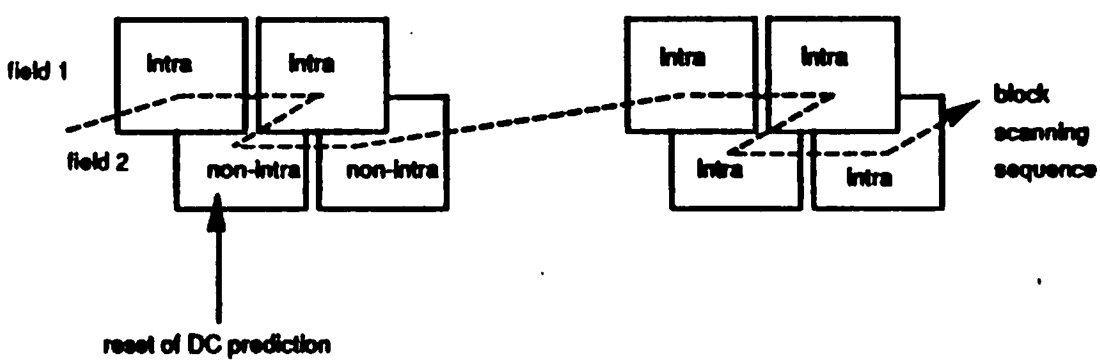
Size	Luminance Length	Luminance Code	Chrominance Length	Chrominance Code
0	3	100	2	00
1	2	00	2	01
2	2	01	2	10
3	3	101	3	110
4	3	110	4	1110
5	4	1110	5	11110
6	5	11110	6	111110
7	6	111110	7	1111110
8	7	1111110	8	11111110

AC Coefficients
AC coefficients are coded as described in Section 8.5.

8.4 Non-Intraframe Coding (P and B frames)

Intra blocks
Intra blocks in non-intra frames are coded as in intra frames.

The DC predictor for luminance and chrominance are set to 128, unless the previous block was also intra, in which case, the predictors are obtained from the previous block. When in the scan sequence a non-intra block is present, the DC predictor is reset to 128.



AC coefficients are coded as described in Section 8.5.

Non-intra blocks
The presence or absence of transform coefficient data is determined by the MB type. The quantised transform coefficients are scanned and coded as described in Section 8.5.

8.5 Coding of Transform Coefficients

The most commonly occurring combinations of runs of a number of successive zero-valued coefficients (RUN) and the following non-zero coefficient value (LEVEL) are encoded with variable length codes such as the ones used in MPEG1 CD. The scan path of the quantised coefficients is given below:

0	2	6	12	20	28	36	44
1	5	11	19	27	35	43	51
3	7	13	21	29	37	45	52
4	10	18	26	34	42	50	57
8	14	22	30	38	46	53	58
9	17	25	33	41	49	56	61
15	23	31	39	47	54	59	62
16	24	32	40	48	55	60	63

Scan Path for Luminance

0	2	3	9	10	20	21	35
1	4	8	11	19	22	34	36
5	7	12	18	23	33	37	48
6	13	17	24	32	38	47	49
14	16	25	31	39	46	50	57
15	26	30	40	45	51	56	58
27	29	41	44	52	55	59	62
28	42	43	53	54	60	61	63

Scan Path for Chrominance

The table of variable length codes for the common (RUN,LEVEL) combinations is given in Annex B. The End of Block is signalled by the EOB code. The last bit of the VLC shown as 's' denotes the sign of the level, '0' for positive, '1' for negative.

Other combinations of (RUN,LEVEL) are encoded with a 20 or 28 bit word consisting of 6 bits ESCAPE, 6 bits RUN and 8 or 16 bits LEVEL.

Codes following ESCAPE:

RUN	CODE
0	0000 00
1	0000 01
2	0000 10
.	.
.	.
63	1111 11

LEVEL	CODE
-256	FORBIDDEN
-255	1000 0000 0000 0001
.	.
.	.
-129	1000 0000 0111 1111
-128	1000 0000 1000 0000
-127	1000 0001
.	.
.	.
-2	1111 1110
-1	1111 1111
0	FORBIDDEN
1	0000 0001
2	0000 0010
.	.
.	.
127	0111 1111
128	0000 0000 1000 0000
129	0000 0000 1000 0001
.	.
.	.
255	0000 0000 1111 1111

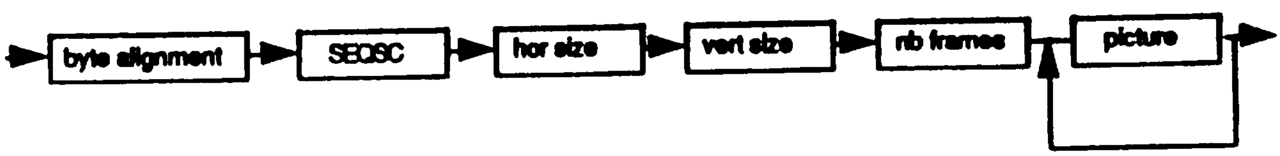
9. VIDEO MULTIPLEX LAYER

A video multiplex layer is defined in ATM2 and described below.

Unless specified otherwise the most significant bit occurs first. This is Bit 1 and is the left most bit in the code tables hereafter.

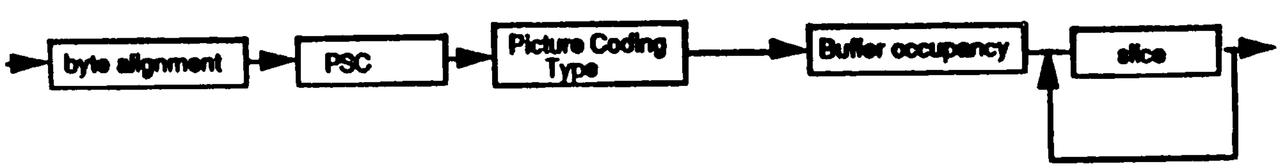
Each layer is described by a syntax diagram showing the order of codewords and the options in the bitstream.

9.1 Sequence layer



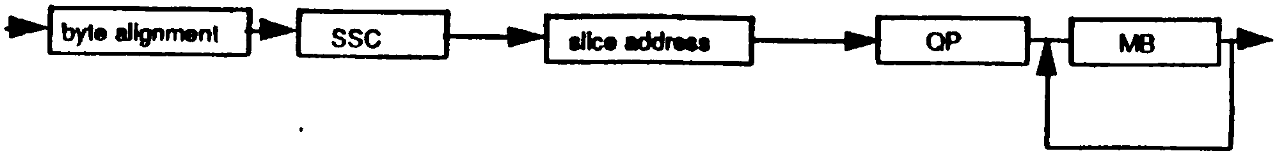
Sequence Start Code (SEQSC):	32	0000 0000 0000 0000 0000 0001 1111 1111	
Horizontal Size : (number of macroblocks)	8	0000.0000	0 block
		.	.
		1111 1111	255 blocks
Vertical Size : (number of macroblocks)	8	0000.0000	0 block
		.	.
		1111 1111	255 blocks
Number of frames:	8	0000.0000	0
		.	.
		1111 1111	255 frames

9.2 Picture layer



Picture Start Code (PSC):	32	0000 0000 0000 0000 0000 0001 0000 0000	
Picture Coding Type :	2	00	I frame
		01	P frame
		10	B frame
Buffer Occupancy (BO): (by step of 1 kbyte)	8	0000.0000	0 ≤ BO < 1 kbyte
		.	.
		1111 1111	255 ≤ BO < 256 kbytes

9.3 Slice layer

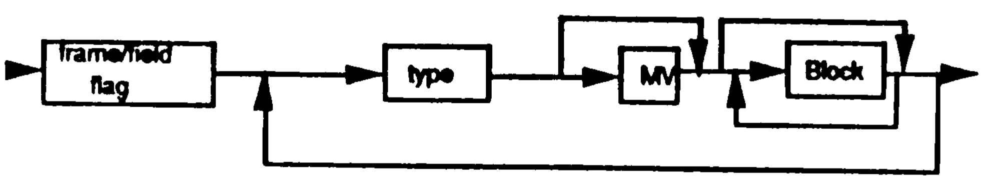


Slice Start Code (SSC):	24	0000 0000 0000 0000 0000 0001	
Slice Address:	8	0000.0001	slice number 1
		.	.
		1111 1110	slice number 254
QP:	5	00001	QP=1
		.	.
		11111	QP=31

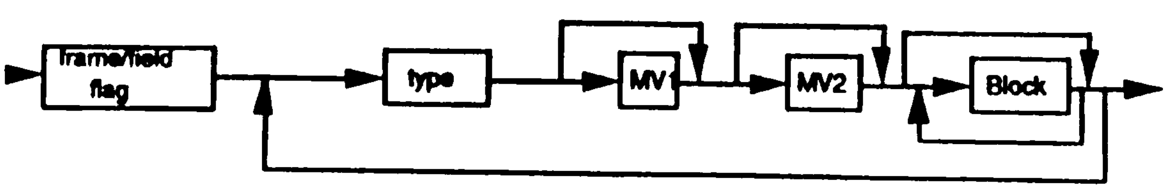
9.4 Macroblock layer

9.4.1 I-frame macroblock

9.4.2 P-frame macroblocks

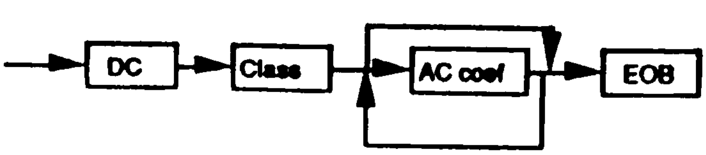


9.4.3 B-frame macroblocks

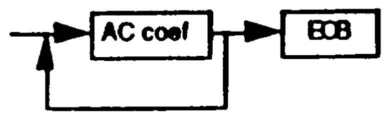


9.5 Block Layer

9.5.1 Intra coded blocks



9.5.2 Inter coded blocks



10. OTHER FEATURES

10.1 Compatibility with MPEG1

The algorithm described above has a number of functions in common with MPEG1 video CD : DCT, forward and backward motion estimation, forward, backward and interpolative prediction , VLC. These common features enable forward compatibity with a low implementation cost.

Full compatibility (Forward and Backward) can be assured by simulcast : in the same channel, bitstreams for MPEG1 and MPEG2 are transmitted together with no common information. A MPEG1 (or MPEG2) decoder will use the appropriate information to reconstruct video sequences.

This functionnality will be demonstrated with the following conditions :
- MPEG1 bitstream at 1.15 Mbit/s
- MPEG2 bitstream at 2.85 Mbit/s or 7.85 Mbit/s
- total bitrate 4.00 Mbit/s or 9.00 Mbit/s

10.2 Short delay

By forbidding backward prediction for B frames, ordering the bitstream in the classical viewing order, limiting the buffer size to 3 coded images, a short delay of around 200 ms can be obtained (including 1 frame delay on the coder side, 1 frame delay on the decoder side and 3 frames delay for buffering). This short delay mode can be made optional in the coder.

Picture quality at 4 and 9 Mbit/s in the short delay mode will be demonstrated.

10.3 Others

Fast Forward and Fast Reverse are obtained by picking each intra-coded picture in each group of picture (1 picture out of 10). This features will be included in the demonstration tape.

With the group of frames structure of the bitstream, random access to any picture is very easy. The maximum delay is the time required for decoding 5 pictures (1 I frame and 4 P frames).

ANNEX A: VLC Tables for Motion Vectors

Table 1: see MPEG Video CD, Annex B (MPEG 90/176 rev 2, 18 December 90) Table B4a, page 36.

Table 2: see MPEG Video CD, Annex B (MPEG 90/176 rev 2, 18 December 90) Table B4b, page 37.

Table 3: see MPEG Video CD, Annex B (MPEG 90/176 rev 2, 18 December 90) Table B4d, page 39.

ANNEX B: VLC Table for Transform Coefficients

RUN	LEVEL	VLC
EOB		10
0	1	11s
0	2	0100 s
0	3	0010 1s
0	4	0000 110s
0	5	0010 0110 s
0	6	0010 0001 s
0	7	0000 0010 10s
0	8	0000 0001 1101 s
0	9	0000 0001 1000 s
0	10	0000 0001 0011 s
0	11	0000 0001 0000 s
0	12	0000 0000 1101 0s
0	13	0000 0000 1100 1s
0	14	0000 0000 1100 0s
0	15	0000 0000 1011 1s
0	16	0000 0000 0111 11s
0	17	0000 0000 0111 10s
0	18	0000 0000 0111 01s
0	19	0000 0000 0111 00s
0	20	0000 0000 0110 11s
0	21	0000 0000 0110 10s
0	22	0000 0000 0110 01s
0	23	0000 0000 0110 00s
0	24	0000 0000 0101 11s
0	25	0000 0000 0101 10s
0	26	0000 0000 0101 01s
0	27	0000 0000 0101 00s
0	28	0000 0000 0100 11s
0	29	0000 0000 0100 10s
0	30	0000 0000 0100 01s
0	31	0000 0000 0100 00s
0	32	0000 0000 0011 000s
0	33	0000 0000 0010 111s
0	34	0000 0000 0010 110s
0	35	0000 0000 0010 101s
0	36	0000 0000 0010 100s
0	37	0000 0000 0010 011s
0	38	0000 0000 0010 010s
0	39	0000 0000 0010 001s
0	40	0000 0000 0010 000s
1	1	011s
1	2	0001 10s
1	3	0010 0101 s
1	4	0000 0011 00s
1	5	0000 0001 1011 s
1	6	0000 0000 1011 0s
1	7	0000 0000 1010 1s
1	8	0000 0000 0011 111s
1	9	0000 0000 0011 110s
1	10	0000 0000 0011 101s
1	11	0000 0000 0011 100s
1	12	0000 0000 0011 011s
1	13	0000 0000 0011 010s
1	14	0000 0000 0011 001s
1	15	0000 0000 0001 0011s
1	16	0000 0000 0001 0010s
1	17	0000 0000 0001 0001s
1	18	0000 0000 0001 0000s
2	1	0101 s
2	2	0000 100s
2	3	0000 0010 11s
2	4	0000 0001 0100 s
2	5	0000 0000 1010 0s
3	1	0011 1s
3	2	0010 0100 s
3	3	0000 0001 1100 s
3	4	0000 0000 1001 1s
4	1	0011 0s
4	2	0000 0011 11s
4	3	0000 0001 0010 s
5	1	0001 11s
5	2	0000 0010 01s
5	3	0000 0000 1001 0s
6	1	0001 01s
6	2	0000 0001 1110 s
6	3	0000 0000 0001 0100s
7	1	0001 00s
7	2	0000 0001 0101 s
8	1	0000 111s
8	2	0000 0001 0001 s
9	1	0000 101s
9	2	0000 0000 1000 1s
10	1	0010 0111 s
10	2	0000 0000 1000 0s
11	1	0010 0011 s
11	2	0000 0000 0001 1010s
12	1	0010 0010 s
12	2	0000 0000 0001 1001s
13	1	0010 0000 s
13	2	0000 0000 0001 1000s
14	1	0000 0011 10s
14	2	0000 0000 0001 0111s
15	1	0000 0011 01s
15	2	0000 0000 0001 0110s
16	1	0000 0010 00s
16	2	0000 0000 0001 0101s
17	1	0000 0001 1111 s
18	1	0000 0001 1010 s
19	1	0000 0001 1001 s
20	1	0000 0001 0111 s
21	1	0000 0001 0110 s
22	1	0000 0000 1111 1s
23	1	0000 0000 1111 0s
24	1	0000 0000 1110 1s
25	1	0000 0000 1110 0s
26	1	0000 0000 1101 1s
27	1	0000 0000 0001 1111s
28	1	0000 0000 0001 1110s
29	1	0000 0000 0001 1101s
30	1	0000 0000 0001 1100s
31	1	0000 0000 0001 1011s
ESCAPE		0000 01

File sizes of bitstreams

FG4JAP.BIT;1	4938
FG9JAP.BIT;1	11111
MOB4JAP.BIT;1	4923
MOB9JAP.BIT;1	11069
TT4JAP.BIT;1	4924
TT9JAP.BIT;1	11052
POP9JAP.BIT;1	11052

Total of 7 files: 59069 blocks

comment: one block = 512 bytes

Sequence Flower Garden, 9 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	1156652	32.09	37.42	64	190822	33.30	37.20
2	208560	32.37	37.05	65	368442	32.28	36.62
3	403553	31.49	36.29	66	194229	32.94	36.70
4	232621	30.53	35.73	67	368659	31.77	36.25
5	379145	30.96	35.83	68	133368	32.34	36.34
6	199083	30.84	35.67	69	317683	31.61	35.93
7	323352	29.95	35.17	70	104331	32.69	37.26
8	150502	28.64	34.50	71	1435161	32.27	37.24
9	277461	29.43	34.75	72	135061	32.60	37.15
10	194721	31.70	36.64	73	347829	31.99	36.80
11	1188500	32.11	37.38	74	161454	33.24	37.20
12	220034	32.45	37.01	75	382315	32.70	36.83
13	344844	31.13	36.22	76	172145	32.24	36.47
14	226425	33.00	37.09	77	397797	30.54	35.48
15	362828	32.02	36.44	78	129155	30.27	35.17
16	211421	32.90	36.87	79	349374	29.76	34.98
17	359608	31.67	36.15	80	161502	31.22	36.41
18	148196	31.97	36.22	81	1387654	32.13	37.18
19	322336	31.03	35.74	82	175713	32.67	37.21
20	132921	32.54	37.34	83	330966	31.22	36.29
21	1380189	33.06	37.96	84	212357	30.38	35.73
22	162156	33.16	37.63	85	367497	30.44	35.65
23	356660	32.58	37.23	86	191748	30.63	35.49
24	180384	32.84	37.16	87	337444	29.60	34.95
25	385162	31.18	36.13	88	133904	29.68	34.80
26	187561	32.36	36.61	89	295987	29.02	34.47
27	373283	31.66	36.13	90	201264	29.40	35.29
28	127225	30.42	35.55	91	1371714	31.98	37.18
29	326193	29.87	35.23	92	223072	30.44	36.01
30	153177	32.38	37.18	93	303416	29.87	35.59
31	1330959	32.26	37.58	94	243791	29.79	35.39
32	177715	31.99	36.93	95	316859	29.98	35.32
33	364920	31.02	36.23	96	215684	29.94	35.17
34	202458	31.99	36.55	97	301642	29.07	34.72
35	369134	31.30	36.19	98	148525	29.11	34.56
36	198614	32.56	36.70	99	271519	28.68	34.35
37	350627	32.08	36.42	100	182313	30.89	36.31
38	130553	31.68	36.14	101	1326374	31.94	37.21
39	305940	30.57	35.59	102	193234	32.28	36.99
40	145862	31.87	36.94	103	328424	30.16	35.62
41	1419060	32.44	37.68	104	224159	30.02	35.41
42	188586	31.65	36.87	105	367881	30.18	35.33
43	337643	30.95	36.23	106	223602	29.25	34.91
44	215591	31.21	36.20	107	332819	29.40	34.78
45	345580	30.96	35.98	108	172436	28.68	34.60
46	214530	30.75	35.58	109	248640	30.11	35.02
47	331326	30.39	35.32	110	237393	30.18	35.80
48	150293	28.29	34.36	111	1342089	32.00	37.26
49	285139	28.93	34.44	112	243672	30.95	36.24
50	174467	32.40	36.95	113	281916	29.61	35.49
51	1292668	31.58	36.95	114	222957	31.49	36.18
52	199646	32.36	36.91	115	309410	29.88	35.27
53	345404	30.64	35.87	116	205971	31.53	36.07
54	209684	31.41	36.02	117	310162	30.83	35.61
55	376411	30.14	35.28	118	143215	30.74	35.41
56	196392	30.72	35.47	119	302302	29.48	34.90
57	353533	29.80	35.01	120	134555	32.39	36.98
58	127166	29.56	34.73	121	1378567	32.39	37.34
59	301169	28.94	34.42	122	166254	31.74	36.66
60	140167	32.09	36.82	123	374806	31.14	36.25
61	1360298	31.93	37.15	124	189849	31.91	36.39
62	175444	33.16	37.39	125	362219	31.45	36.11
63	330747	32.12	36.78				

Sequence Mobile & Calendar, 4 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	502487	25.02	34.52	64	52073	26.15	34.14
2	65034	26.17	34.72	65	184857	26.15	34.11
3	159430	25.68	34.14	66	52935	26.15	33.77
4	54300	26.09	34.31	67	184496	26.05	33.91
5	172319	25.43	33.68	68	55793	26.17	33.58
6	51656	25.71	34.01	69	192677	25.93	33.75
7	185206	25.36	33.41	70	51893	26.47	34.88
8	53276	25.59	33.84	71	621520	26.00	35.10
9	190966	25.47	33.17	72	54995	26.25	34.87
10	45454	26.28	35.02	73	169570	26.62	34.32
11	601860	25.76	35.13	74	57303	26.06	33.96
12	48449	26.26	35.17	75	170924	26.49	33.64
13	167228	26.53	34.64	76	53980	26.06	33.79
14	48073	26.69	34.86	77	172643	26.53	33.66
15	176024	27.16	35.07	78	58839	26.05	33.51
16	51269	27.05	34.80	79	187486	26.07	33.18
17	190848	27.45	35.22	80	53427	26.43	34.61
18	62583	27.38	34.75	81	620963	25.90	35.02
19	206151	27.42	35.18	82	51401	26.60	34.78
20	58618	27.02	35.26	83	169392	26.55	34.33
21	617717	26.03	35.06	84	54044	26.82	34.30
22	54039	26.86	35.02	85	178333	26.45	33.92
23	167146	27.00	35.08	86	51469	26.70	34.02
24	51263	26.91	34.69	87	185997	26.08	33.41
25	166361	27.04	35.03	88	53156	26.64	33.89
26	53480	27.23	34.75	89	187286	26.11	33.34
27	176417	27.59	35.26	90	47187	27.39	35.21
28	63661	27.67	34.76	91	619277	26.12	35.27
29	193050	27.60	35.20	92	46929	26.98	35.32
30	59525	27.55	35.08	93	177530	26.59	34.90
31	623043	26.03	35.12	94	47047	27.18	35.06
32	51830	26.83	34.98	95	184741	26.80	34.72
33	173000	26.70	35.11	96	51828	27.34	34.97
34	50796	27.10	34.76	97	192309	26.82	34.59
35	171193	27.19	35.24	98	55751	27.18	34.64
36	51649	27.21	34.85	99	189228	26.72	34.14
37	179256	27.07	35.02	100	50525	27.43	35.49
38	56879	27.80	34.99	101	617394	26.13	35.33
39	184040	27.44	35.20	102	52782	26.72	35.11
40	50743	28.23	35.76	103	174151	26.47	34.56
41	623702	26.07	35.41	104	51755	26.21	34.30
42	48902	27.14	35.59	105	173886	26.18	33.69
43	177204	26.81	35.28	106	47416	25.88	33.68
44	46393	27.27	35.36	107	175729	25.98	33.12
45	180664	26.75	35.08	108	55417	26.04	33.55
46	51124	27.23	35.11	109	183679	26.01	33.03
47	186813	26.75	34.74	110	47394	26.68	34.60
48	57670	27.11	34.86	111	619406	25.88	34.83
49	183966	27.12	34.35	112	50942	26.48	34.57
50	56125	26.73	35.27	113	177224	26.24	34.12
51	621593	26.04	35.21	114	55410	26.46	34.06
52	53687	26.30	34.89	115	177494	26.46	33.72
53	172045	26.28	34.34	116	51556	26.66	33.95
54	52353	25.70	34.05	117	173069	26.43	33.55
55	177539	25.66	33.78	118	60852	26.74	33.93
56	52010	25.49	33.54	119	188914	26.52	33.51
57	178322	25.71	33.62	120	50660	27.20	35.04
58	47420	26.03	33.48	121	619135	25.76	34.82
59	176928	26.08	33.65	122	54116	26.69	34.93
60	42792	26.67	34.76	123	173730	26.74	34.56
61	622587	25.94	34.98	124	53447	26.92	34.58
62	45698	26.28	34.54	125	171820	26.65	34.11
63	172011	26.14	34.63				

Sequence Table Tennis, 9 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	1081006	30.82	40.37	64	124428	35.38	42.06
2	178591	31.46	40.00	65	430541	36.26	42.14
3	326163	31.15	39.83	66	118836	35.91	42.37
4	204705	32.17	39.97	67	575622	37.76	42.75
5	322691	32.25	39.96	68	108076	36.08	42.52
6	72635	28.67	39.39	69	457852	37.59	42.78
7	707837	29.51	39.22	70	74763	35.72	42.75
8	92629	31.14	38.94	71	1262673	35.27	42.74
9	339028	31.20	39.03	72	116490	34.93	41.99
10	101010	33.43	41.12	73	355466	35.35	42.01
11	1234724	37.78	43.59	74	139035	35.79	42.35
12	145343	34.58	41.91	75	447577	36.76	42.51
13	341443	34.68	41.68	76	148012	36.33	42.61
14	175929	34.78	41.73	77	502953	37.97	42.86
15	389058	35.14	41.55	78	129055	36.35	42.73
16	192374	35.29	41.78	79	416550	37.53	42.86
17	383485	35.47	41.61	80	77243	35.83	42.79
18	177873	35.39	41.77	81	1265063	35.30	42.81
19	380399	35.63	41.64	82	39317	32.43	40.95
20	154327	36.04	42.59	83	773603	28.74	37.62
21	1217457	39.37	44.42	84	34789	31.87	39.20
22	182768	36.31	42.78	85	341526	32.54	39.45
23	336807	35.77	42.00	86	36321	33.50	40.10
24	197325	35.96	42.19	87	460179	34.78	40.53
25	401860	35.90	41.70	88	36196	34.58	40.88
26	197046	35.82	41.87	89	529453	36.49	41.38
27	402371	35.88	41.51	90	45795	35.53	42.11
28	145005	35.27	41.38	91	1330343	34.51	42.32
29	382137	35.66	41.31	92	88831	34.62	41.74
30	139391	35.45	41.81	93	330938	34.98	41.68
31	1258912	38.06	43.50	94	115339	35.55	42.02
32	194505	35.78	42.06	95	444417	36.21	42.06
33	319827	35.25	41.49	96	132823	35.97	42.15
34	203241	35.32	41.51	97	491333	36.42	42.19
35	419609	35.50	41.37	98	139679	35.66	42.02
36	170200	34.84	41.04	99	486260	35.39	41.77
37	439485	35.45	41.18	100	81714	34.73	42.26
38	112210	34.10	40.34	101	1327636	34.61	42.29
39	398111	34.85	40.65	102	134092	34.42	41.45
40	134975	34.68	41.13	103	328129	34.07	41.25
41	1229904	37.52	43.18	104	175423	33.43	41.12
42	174359	34.97	41.30	105	385271	34.68	40.72
43	354807	35.02	41.06	106	201042	33.59	40.61
44	182017	34.76	40.92	107	371975	34.41	40.49
45	419908	35.30	40.98	108	216132	33.96	40.81
46	164171	34.66	40.73	109	363157	34.92	40.85
47	413352	35.26	40.79	110	125403	33.27	41.04
48	113492	34.05	40.20	111	1322473	34.40	42.30
49	393542	34.86	40.57	112	171225	34.06	41.34
50	142690	34.71	41.04	113	309473	34.27	41.01
51	1169101	36.67	42.56	114	196946	33.99	40.81
52	188508	35.08	41.24	115	336231	34.15	40.81
53	343465	34.95	40.93	116	216354	35.31	41.41
54	39164	32.14	40.05	117	337977	35.02	41.05
55	815049	33.54	41.00	118	100228	32.58	41.02
56	34785	33.73	40.75	119	605506	35.89	41.12
57	377983	34.98	41.22	120	96586	32.69	41.01
58	38686	34.15	40.81	121	1218299	34.03	41.70
59	381312	35.63	41.45	122	145570	33.75	40.67
60	66742	34.98	42.03	123	325298	34.14	40.89
61	1759448	35.35	42.78	124	179243	33.60	40.47
62	94945	34.40	41.74	125	357839	34.57	40.71
63	377257	35.09	41.77				

Sequence Mobile & Calendar, 9 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	1115901	29.54	38.35	64	196092	29.42	36.82
2	185095	30.28	37.94	65	349975	29.17	36.28
3	344291	29.44	37.04	66	209163	29.31	36.42
4	176417	29.62	37.19	67	347897	28.98	36.02
5	348329	28.33	36.01	68	221267	29.31	36.24
6	180715	28.82	36.47	69	354465	28.89	35.82
7	348578	27.88	35.41	70	190952	29.96	37.43
8	186252	28.38	36.03	71	1258794	30.49	38.67
9	343020	27.85	35.02	72	194096	29.93	37.64
10	165161	29.81	37.53	73	319166	30.20	36.84
11	1245285	30.21	38.60	74	205946	29.29	36.65
12	181096	29.86	37.93	75	328474	29.62	35.82
13	328337	30.08	37.20	76	215058	29.23	36.39
14	201127	30.27	37.57	77	321322	29.44	35.69
15	327111	30.95	37.55	78	230066	29.16	36.11
16	223475	30.67	37.50	79	334482	28.64	35.04
17	329612	31.02	37.44	80	193694	30.01	37.33
18	247137	30.92	37.45	81	1252376	30.11	38.48
19	345404	30.70	37.12	82	194248	30.81	37.77
20	189301	30.54	37.91	83	318146	30.03	36.91
21	1324234	31.36	38.89	84	199601	30.78	37.33
22	193825	30.94	38.17	85	344399	29.58	36.30
23	309171	31.00	37.82	86	195955	30.24	36.88
24	202113	30.48	37.51	87	356053	28.84	35.54
25	305505	30.63	37.40	88	199522	30.15	36.70
26	219896	30.83	37.55	89	355396	28.93	35.44
27	303910	31.32	37.52	90	154720	31.57	38.04
28	240215	31.19	37.56	91	1293724	30.91	39.09
29	316114	30.70	37.19	92	166163	31.94	38.53
30	168272	31.02	38.10	93	356286	30.85	37.93
31	1327730	31.46	38.92	94	178507	31.88	38.16
32	184881	31.05	38.05	95	363583	30.90	37.48
33	314848	31.01	38.06	96	189441	31.95	37.99
34	203554	30.87	37.73	97	362327	30.81	37.20
35	317758	31.43	37.87	98	194075	31.23	37.39
36	209519	31.33	37.75	99	360628	29.82	36.38
37	317897	30.36	37.37	100	162572	31.55	38.20
38	226185	31.95	37.98	101	1283983	31.09	39.09
39	329369	30.95	37.58	102	170342	31.06	38.12
40	111792	32.50	38.54	103	347039	30.01	37.17
41	1358694	31.51	39.33	104	181710	29.49	36.92
42	139402	32.46	38.77	105	349454	29.16	35.91
43	358489	31.96	38.48	106	187140	28.91	36.21
44	155430	32.04	38.51	107	338995	28.72	35.15
45	371207	31.05	38.00	108	205130	29.01	36.13
46	173238	31.51	38.07	109	342279	28.66	35.02
47	380966	30.56	37.42	110	178917	30.27	37.39
48	192806	30.92	37.57	111	1245775	30.15	38.39
49	370641	30.58	36.61	112	187013	30.27	37.60
50	179037	30.17	37.85	113	331493	29.73	36.69
51	1319412	31.34	39.05	114	198243	29.75	36.85
52	178872	30.00	37.79	115	339739	29.54	35.96
53	338269	29.89	36.85	116	202598	30.19	36.71
54	188337	28.72	36.41	117	330895	29.32	35.68
55	350094	28.48	35.73	118	231896	30.39	36.74
56	195612	28.43	35.85	119	352998	29.44	35.61
57	328975	28.30	35.46	120	165605	31.33	37.93
58	191618	28.91	35.95	121	1300004	30.52	38.72
59	314096	28.64	35.52	122	182821	31.44	38.21
60	171126	30.15	37.37	123	334290	30.92	37.62
61	1257299	30.36	38.51	124	188719	31.03	37.69
62	179961	29.98	37.44	125	339105	30.26	36.75
63	320666	29.62	37.10				

Sequence Popple, 9 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	1128388	33.75	42.37	64	247540	34.50	41.1[illegible]
2	190406	33.26	40.41	65	338412	34.55	41.1[illegible]
3	343390	33.70	40.80	66	244652	34.59	40.9[illegible]
4	215396	33.87	40.52	67	324340	34.72	41.0[illegible]
5	314404	33.92	40.77	68	222243	34.55	40.6[illegible]
6	228276	34.10	40.60	69	304142	34.78	40.87
7	297772	33.90	40.72	70	245306	34.92	41.28
8	232629	34.09	40.62	71	1103333	38.65	45.30
9	283745	33.94	40.64	72	248839	34.94	41.35
10	170326	33.60	40.36	73	377224	35.62	42.16
11	1326978	34.53	42.99	74	253451	34.82	41.02
12	200115	33.49	40.66	75	303688	34.70	40.93
13	298813	33.34	40.75	76	249189	34.43	40.51
14	225989	33.85	40.58	77	302447	34.39	40.43
15	302357	33.68	40.65	78	242423	34.29	40.14
16	245358	34.14	40.74	79	272717	34.24	40.01
17	296285	33.81	40.65	80	264120	34.73	40.76
18	247443	34.15	40.64	81	1016132	38.43	45.08
19	290555	33.81	40.50	82	215012	34.04	39.53
20	163249	33.34	40.16	83	426030	34.84	40.79
21	1340947	34.24	42.83	84	200555	33.44	38.29
22	196703	33.12	40.29	85	352217	34.35	40.11
23	296651	32.90	40.36	86	196298	32.78	37.35
24	222812	33.50	40.32	87	368861	34.28	39.72
25	299990	33.33	40.34	88	190922	32.30	36.71
26	243604	33.91	40.48	89	371059	33.92	39.17
27	295570	33.59	40.43	90	256821	33.16	38.02
28	248145	33.99	40.49	91	1070273	36.55	43.63
29	293378	33.78	40.45	92	253264	33.04	37.87
30	165774	33.27	40.22	93	321429	32.23	37.53
31	1338375	34.51	42.95	94	262873	32.66	37.07
32	195695	33.00	40.39	95	310028	32.11	36.87
33	297509	33.06	40.49	96	260978	32.08	36.48
34	220770	33.60	40.42	97	305081	31.79	36.26
35	300254	33.37	40.47	98	166279	30.32	33.73
36	237855	33.79	40.54	99	507597	33.30	37.98
37	295776	33.67	40.51	100	218450	31.02	35.04
38	245338	33.88	40.63	101	667699	33.35	40.50
39	298551	33.60	40.54	102	252092	31.46	35.85
40	182411	33.29	40.40	103	444247	32.26	37.42
41	1316677	34.65	43.07	104	263653	31.61	35.85
42	200381	33.08	40.46	105	449482	32.15	36.98
43	316149	32.86	40.41	106	248399	31.72	35.72
44	213316	32.77	40.03	107	427795	32.20	36.79
45	351573	32.04	40.00	108	210215	31.12	34.88
46	212687	32.26	39.66	109	319593	31.26	35.56
47	350230	31.70	39.72	110	260262	31.71	36.00
48	183364	30.41	38.86	111	728107	34.19	40.95
49	328555	30.94	39.35	112	272122	32.17	36.49
50	251200	31.18	39.62	113	469147	32.95	37.55
51	1141354	33.90	43.00	114	270243	31.98	36.05
52	253794	32.14	40.05	115	438511	32.28	36.85
53	348608	31.78	40.01	116	240759	31.52	35.40
54	249940	32.25	39.81	117	422316	31.92	36.25
55	323570	32.00	39.80	118	190952	30.53	33.95
56	248220	31.90	39.60	119	350838	31.34	35.32
57	302422	32.20	39.71	120	239121	31.29	35.25
58	200982	31.94	39.27	121	682000	33.18	39.90
59	270435	32.45	39.68	122	257307	31.80	35.99
60	238090	33.66	40.69	123	462667	32.38	37.02
61	1117615	37.17	44.69	124	259971	31.75	35.72
62	248728	34.50	41.51	125	446818	32.43	36.76
63	292442	33.95	40.80				

Sequence Flower Garden, 4 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	531626	27.25	33.79	64	41103	28.64	34.21
2	70912	27.81	33.78	65	177735	28.56	34.14
3	186246	27.50	33.63	66	45258	28.60	33.95
4	68621	26.32	33.29	67	184310	28.38	34.00
5	185696	27.49	33.48	68	41620	28.47	33.92
6	55005	26.82	33.14	69	175373	28.34	33.75
7	169338	27.02	33.18	70	41359	28.96	34.45
8	50711	25.42	32.82	71	673342	27.43	33.87
9	160197	26.96	32.99	72	43707	28.08	33.93
10	48135	27.49	34.21	73	184613	27.80	33.80
11	652619	28.18	34.60	74	42445	28.54	34.08
12	46555	27.99	34.27	75	184585	28.51	34.02
13	172370	27.92	34.15	76	45393	27.95	33.76
14	46706	28.45	34.22	77	189236	27.18	33.36
15	177120	28.41	34.18	78	40934	26.68	33.07
16	46939	28.46	34.08	79	169622	26.70	33.00
17	179459	28.21	33.91	80	42909	26.96	33.89
18	43488	27.96	33.77	81	673015	27.28	33.81
19	171567	27.85	33.61	82	41225	27.86	33.96
20	44969	28.55	34.59	83	174967	27.47	33.65
21	667906	28.08	34.50	84	50720	26.09	33.54
22	45177	28.54	34.42	85	181827	27.20	33.57
23	192146	28.38	34.23	86	43304	26.57	33.24
24	48489	28.36	34.19	87	173259	26.69	33.09
25	188679	27.74	33.90	88	40924	26.28	32.94
26	43976	27.86	33.77	89	173603	26.61	32.93
27	176449	27.87	33.68	90	48439	25.23	33.38
28	44891	26.87	33.39	91	674725	27.30	33.90
29	163083	26.93	33.24	92	46898	25.90	33.69
30	42080	28.17	34.45	93	170212	27.07	33.64
31	671829	27.74	34.40	94	52023	25.53	33.37
32	43801	27.50	34.22	95	170737	27.16	33.49
33	177106	27.64	34.10	96	47813	25.97	33.09
34	43747	27.54	33.98	97	169127	26.60	33.10
35	174086	27.83	34.00	98	42434	26.00	32.84
36	44433	28.14	34.02	99	171113	26.61	32.93
37	176814	28.51	34.17	100	43668	26.75	33.93
38	41672	27.97	33.91	101	673718	27.33	33.93
39	167316	27.68	33.69	102	42850	27.55	33.96
40	42186	27.96	34.38	103	178549	27.03	33.57
41	672090	27.69	34.35	104	49691	25.74	33.39
42	48572	26.94	34.09	105	182272	27.10	33.45
43	184735	27.39	33.91	106	50399	25.15	33.04
44	50839	26.76	33.73	107	170206	26.58	33.03
45	181503	27.62	33.83	108	46540	25.31	33.01
46	50227	26.41	33.28	109	154850	27.44	33.27
47	175810	27.28	33.28	110	50072	25.57	33.64
48	48008	25.20	32.71	111	671087	27.30	33.95
49	159075	26.38	32.73	112	48864	26.23	33.74
50	38652	28.01	34.08	113	169142	26.93	33.65
51	675236	27.35	33.94	114	43526	27.27	33.73
52	43168	27.53	34.00	115	178422	27.22	33.55
53	175284	27.37	33.76	116	43355	27.73	33.74
54	42155	26.86	33.53	117	181173	28.06	33.81
55	176183	26.89	33.31	118	42332	27.50	33.52
56	42785	26.53	33.15	119	182775	27.16	33.37
57	180528	26.84	33.11	120	40058	28.31	34.33
58	41350	26.31	32.84	121	670149	27.43	33.94
59	171960	26.39	32.75	122	44576	27.20	33.89
60	39019	27.93	34.13	123	187705	27.29	33.78
61	672463	27.34	33.90	124	42176	27.41	33.65
62	42025	28.43	34.20	125	177648	27.72	33.74
63	171540	28.38	34.20				

Sequence Table Tennis, 4 Mbit/s

fr.	bits	Y SNR	C	fr.	bits	Y SNR	C
1	488532	25.41	37.55	64	27770	32.19	39.60
2	65456	25.93	37.45	65	195235	32.79	39.83
3	128655	25.62	37.46	66	30861	32.82	39.80
4	26058	26.41	37.42	67	242301	33.64	40.20
5	239936	26.90	37.88	68	33099	33.36	40.09
6	48344	25.87	37.40	69	257679	34.25	40.51
7	247645	25.78	37.29	70	26995	33.11	40.22
8	65873	29.45	36.47	71	632980	30.53	39.50
9	178643	29.55	37.38	72	29121	31.57	39.38
10	56915	31.81	39.37	73	153857	31.91	39.64
11	633181	33.61	41.17	74	32814	32.47	39.70
12	55971	32.52	39.86	75	175044	32.87	39.96
13	153628	32.51	39.86	76	38926	33.28	40.12
14	58470	32.41	39.58	77	211264	33.66	40.34
15	148201	32.53	39.38	78	45085	33.88	40.42
16	63257	32.74	39.33	79	243274	34.31	40.66
17	150888	32.91	39.41	80	42998	33.69	40.47
18	68352	33.07	39.29	81	583761	30.91	39.79
19	162093	33.13	39.30	82	32208	29.88	38.45
20	65335	34.08	40.57	83	418122	25.21	35.08
21	579594	35.10	41.84	84	21476	28.35	36.86
22	66298	34.20	40.61	85	165890	28.64	37.04
23	177925	33.94	40.32	86	21030	29.10	37.38
24	65811	33.65	39.86	87	139073	29.45	37.60
25	183634	33.60	39.76	88	20685	29.93	37.83
26	65052	33.36	39.42	89	152712	30.29	37.99
27	182166	33.43	39.40	90	21037	31.08	39.37
28	60719	33.11	39.09	91	616927	29.82	39.41
29	171959	33.15	39.06	92	23968	31.30	39.48
30	59968	33.38	39.61	93	172489	31.54	39.51
31	623488	34.39	41.00	94	28888	32.25	39.67
32	62535	33.41	39.67	95	206085	32.50	39.79
33	169491	33.31	39.72	96	33538	32.81	39.84
34	65095	32.78	39.06	97	223494	32.82	39.95
35	174638	32.93	39.24	98	48938	32.69	39.77
36	65639	32.41	38.51	99	246535	32.15	39.73
37	167374	32.46	38.70	100	40967	31.73	39.89
38	63144	31.98	38.06	101	615960	29.99	39.37
39	152020	32.06	38.22	102	44575	31.01	39.12
40	62101	32.53	38.88	103	189754	30.89	39.19
41	630876	33.89	40.69	104	62491	30.22	38.93
42	68009	32.57	38.93	105	178216	31.24	38.84
43	148481	32.34	38.82	106	56034	30.00	38.57
44	71420	32.11	38.23	107	160058	30.82	38.65
45	153676	32.10	38.43	108	60040	30.31	38.56
46	69697	31.98	38.01	109	174414	31.39	38.81
47	153671	31.97	38.14	110	60193	30.76	39.12
48	70000	31.90	37.84	111	610773	29.81	39.41
49	155200	31.92	38.02	112	60713	30.33	39.13
50	68691	32.56	38.77	113	164239	30.69	38.92
51	615064	33.21	40.14	114	61229	30.47	38.49
52	67759	32.50	38.86	115	163066	30.45	38.82
53	168188	32.35	38.89	116	59438	31.63	39.03
54	34360	29.03	37.18	117	163456	31.49	38.99
55	393970	29.58	37.87	118	77035	30.63	38.82
56	28213	29.87	37.59	119	191964	31.44	38.83
57	90249	30.22	38.01	120	58414	30.52	39.06
58	31477	29.98	37.63	121	602950	29.72	39.25
59	83810	30.29	38.00	122	60182	30.19	38.76
60	36769	31.29	39.21	123	167883	30.37	38.97
61	591748	30.88	37.76	124	61903	30.26	38.46
62	28826	31.19	39.32	125	174520	31.10	38.79
63	169579	31.73	39.56				

Flower Garden, 4 Mbit/s

fr.	cumulative bits total	400 ms	average/fr. total	400 ms
10	1526487	1526487	152648	152648
20	3108279	1581792	155413	158179
30	4721155	1612876	157371	161287
40	6304145	1582990	157603	158299
50	7913656	1609511	158273	160951
60	9501324	1587668	158355	158766
70	11094110	1592786	158487	159278
80	12710896	1616786	158886	161678
90	14312179	1601283	159024	160128
100	15900929	1588750	159009	158875
110	17500076	1599147	159091	159914
120	19100810	1600734	159173	160073

Flower Garden, 9 Mbit/s

fr.	cumulative bits total	400 ms	average/fr. total	400 ms
10	3525650	3525650	352565	352565
20	7042763	3517113	352138	351711
30	10674753	3631990	355825	363199
40	14251535	3576782	356288	357678
50	17913750	3662215	358275	366221
60	21455990	3542240	357599	354224
70	25000013	3544023	357143	354402
80	28671806	3671793	358397	367179
90	32306340	3634534	358959	363453
100	35884875	3578535	358848	357853
110	39539837	3654962	359453	365496
120	43036086	3496249	358634	349624

Mobile & Calendar, 4 Mbit/s

fr.	cumulative bits total	400 ms	average/fr. total	400 ms
10	1480128	1480128	148012	148012
20	3091231	1611103	154561	161110
30	4693890	1602659	156463	160265
40	6286319	1592429	157157	159242
50	7898882	1612563	157977	161256
60	9473571	1574689	157892	157468
70	11088613	1615042	158408	161504
80	12689300	1600687	158616	160068
90	14288528	1599228	158761	159922
100	15903693	1615165	159036	161516
110	17483296	1579603	158939	157960
120	19088823	1605527	159073	160552

Mobile & Calendar, 9 Mbit/s

fr.	cumulative bits total	400 ms	average/fr. total	400 ms
10	3393759	3393759	339375	339375
20	7011644	3617885	350582	361788
30	10594899	3583255	353163	358325
40	14138432	3543533	353460	354353
50	17818342	3679910	356366	367991
60	21394753	3576411	356579	357641
70	25022490	3627737	357464	362773
80	28623588	3601098	357794	360109
90	32194004	3570416	357711	357041
100	35821310	3627306	358213	362730
110	39406299	3584989	358239	358498
120	42992554	3586255	358271	358625

fr.	total	400 ms	total	400 ms
10	1541057	1541057	154105	154105
20	3100433	1559376	155021	155937
30	4713559	1613126	157118	161312
40	6319084	1605525	157977	160552
50	7908805	1589721	158176	158972
60	9458664	1549859	157644	154985
70	11062757	1604093	158039	160409
80	12668120	1605363	158351	160536
90	14244114	1575994	158267	157599
100	15885943	1641829	158859	164182
110	17487678	1601735	158978	160173
120	19098005	1610327	159150	161032

Table Tennis, 9 Mbit/s

fr.	cumulative bits total	400 ms	average/fr. total	400 ms
10	3426295	3426295	342629	342629
20	7001250	3574955	350062	357495
30	10603417	3602167	353447	360216
40	14254492	3651075	356362	365107
50	17842734	3588242	356854	358824
60	21297529	3454795	354958	345479
70	24919292	3621763	355989	362176
80	28514346	3595054	356429	359505
90	32076588	3562242	356406	356224
100	35718265	3641677	357182	364167
110	39346525	3628260	357695	362826
120	43039524	3692999	358662	369299

Popple, 9 Mbit/s

fr.	cumulative bits total	400 ms	average/fr. total	400 ms
10	3404732	3404732	340473	340473
20	7001874	3597142	350093	359714
30	10605448	3603574	353514	360357
40	14217982	3612534	355449	361253
50	17942114	3724132	358842	372413
60	21519529	3577415	358658	357741
70	25104949	3585420	358642	358542
80	28722380	3617431	359029	361743
90	32316287	3593907	359069	359390
100	35992539	3676252	359925	367625
110	39535976	3543437	359417	354343
120	43158092	3622116	359650	362211