

SOURCE : CHAIRMAN
TITLE : REPORT OF THE FIFTH MEETING OF THE EXPERTS GROUP FOR
ATM VIDEO CODING IN SINGAPORE (January 6 - 9, 1992)
Purpose: Report

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1. General
 2. Documentation
 3. Tape demonstration
 4. CCITT sole sessions
 5. Joint sessions with MPEG
 6. Next Meeting

1. General

The fifth meeting of the Experts Group consisted of two parts: CCITT sole sessions and joint sessions with ISO/IEC JTC1/SC29/WG11 (MPEG). The list of participants appears at the end of this report.

The first part was held at Harbour View Dai-Ichi Hotel in Singapore on 6 January 1992 with financial support of NTT. The second part was held at Human Development Centre of Asia Matsushita Electric (S) Pte Ltd during 7-9 January 1992 at the kind invitation of Asia Matsushita Electric (S) Pte Ltd. The Experts Group appreciated the support of these two organizations for having provided opportunities to meet in Singapore.

The Experts Group was advised that Belgian Coordination Member changed from Mr. Verbiest to Mr. Poncin.

2. Documentation (TD2)

For this meeting, 28 AVC-numbered documents and 2 temporary documents were available as listed in Annex 1. Furthermore 81 MPEG documents, including 21 AVC-numbered ones, were considered during the joint sessions.

3. Tape demonstration

Tape demonstrations related to AVC-202 (NTA), AVC-186 (Fujitsu) and AVC-184 (RTT Belgium) were given for CCITT Experts Group members on 8 January. Other demonstrations were given during the VIDEO group joint sessions.

4. CCITT sole sessions

4.1 Review of the Yokosuka meeting report (AVC-177R)

Chairman picked up some highlights from the report of the previous meeting in Yokosuka. The meeting confirmed that the Experts Group concentrates on the joint work with MPEG for the development of H.26X video coding algorithm.

As a specific action toward the joint sessions, the meeting agreed to raise the desirability to test the coding algorithm against source signals that are converted from NTSC/PAL/SECAM signals to 4:2:2 digital component signals (see Section 4.1.1/AVC-177R).

4.2 Matters for consideration of the sole session only

4.2.1 Picture format (AVC-203)

Mr. Bjoentegaard presented a new set of conversion filter coefficients for obtaining 576 lines x 720 pels x 59.94 Hz progressive SCIF from 625/50 or 525/60 CCIR 601 signals with tape demonstration.

Contributions are requested toward a decision on the format issue at the next Stockholm meeting (see Section 5.2.3 e for open items).

Mr. Brusewitz announced that his laboratory has facilities to display various picture formats, including progressive ones, which are different from those of the current television system. Advance sending of test data tapes is requested to check appropriate operation of the display system.

4.2.2 VBR control (AVC-202)

Mr. Haskell presented AT&T's recent work on interaction between network restrictions and VBR video coding. The meeting welcomed this stimulating input, awaiting responding contributions toward the next meeting to make progress on the following open issues:

- VBR advantage in obtainable picture quality
- Appropriate UPC for video (audiovisual) coding
- Required window or bucket size for average rate monitoring in the network

4.2.3 Intellectual property (AVC-182)

Mr. May provided information on his patents concerning error concealment. The meeting appreciated this disclosure and discussed shortly what should be the policy of this Experts Group on intellectual property. Chairman presented the following practice of the previous Specialists Group for H.261:

- Disclosure of filed patents: participating organizations agreed to disclose their patents as soon as being filed. In case of patents being filed but not yet in the public domain, short description was given.
- Patent licensing policy statement: participating organizations agreed to submit their patent licensing policy which states non-discriminatory granting on a loyalty-free or reasonable-terms basis.

The meeting felt that disclosing filed patents which are not yet in the public domain may need careful consideration in each organization. Another factor to take into account is that we are working together with other standardization groups this time.

This issue will be further discussed at the next meeting.

4.3 Review of contributions for consideration of the joint sessions

Due to the time constraint, the meeting could have only short presentation of each document. Detailed discussion was left for the joint sessions which took place during January 7-9 with objectives to define TMO and to identify action points toward TMI. Topics and relevant documents were as follows:

1) Architecture --- AVC-181

It was clarified that this flexible layering concept is independent of the flexible format concept.

2) Pre-Processing to obtain 4:2:0 --- AVC-200

The meeting took note of a fact that 4:2:0 is friendly with with existing standards, but slight loss of quality due to 4:2:0 may not be accepted by quality-sensitive application areas such as secondary distribution.

3) Prediction --- AVC-192,194,195

4) Low delay mode or B-frames --- AVC-185,186,187,193,199

Effectiveness of B pictures depends on the test sequence. It is thought that use of B pictures is most effective for those sequences where camera panning or zooming is contained, thus motion compensation works well.

Mr. Bjoentegaard stressed that we need careful study as advantage of B-pictures is related to various factors such as quantization, motion compensation.

5) Compatibility/scalability --- AVC-181,183,188,189

AVC-183 clarified that for forward/backward compatibility the system should support multiplexing of two independent bitstreams; one represents a low resolution image according to the existing standard while the other represents an enhanced resolution image.

For AVC-188, there was a suggestion to plot "simulcast" cases at 4 and 9 Mbit/s, not at 2.5 and 7.5 Mbit/s, in Figure 2

6) Rate control --- AVC-191

7) Future study items --- AVC-183,196,198

4.4 Position of the CCITT Experts Group to the joint sessions with MPEG

4.4.1 Input papers from CCITT EG (AVC-179,190,196,197,205)

The meeting confirmed submission of two Experts Group documents AVC-179 and AVC-196 which had originally been produced at the Yokosuka meeting and refined through correspondence afterward.

The meeting supported Japan's document providing a catalog of cell loss resilient techniques, but with addition of "layered coding" and "use of FEC/CRC cells".

AVC-197 was intended to be made complete through correspondence, but due to time limitation it was submitted for the Experts Group consideration as UK document. After some discussion, the meeting concluded that this should be worked out during the week. Mr. Parke coordinated collaborators and submitted AVC-205 (MPEG92/027) as an Experts Group document to the joint sessions.

4.4.2 Particular efforts of the CCITT group (AVC-196)

The meeting confirmed that the following items are of our greatest concern and that we should make our efforts to reflect them in the joint work with MPEG;

- compatibility with H.261 (scalability),
- low end to end delay,
- cell loss resilience, and
- low bit rate operation.

4.4.3 Generic video coding standard and application oriented coding standard (AVC-204)

Since we are now fully involved in the joint development of "generic" standard with MPEG, the meeting started to discuss how to structure such a generic standard so that it includes necessary characteristics for communication applications in the ATM environment. Mr. Haskell raised whether we have to sacrifice something to achieve the "end of 1992" goal. Mr. Princin pointed out that the video coding standard development be aligned with that of B-ISDN standards.

The meeting concluded that

- we should avoid a situation that different requirements reach different standards,
- this matter be considered continuously by ourselves and be also discussed during the joint sessions.

4.4.4 Representatives to the joint sessions

The meeting appointed the following representatives of the Experts Group for the joint sessions;

Requirements sub-group	S. Okubo
Video sub-group	J. Guichard
Implementation study sub-group	D.G. Morrison

5. Joint sessions with MPEG

5.1 Requirements sub-group (S. Okubo)

5.1.1 General

REQUIREMENTS sub-group met on January 7, 8 and 9 to review whether the current video working program is conforming to the description of PPD (MPEG91/100 Issue 3, August 1991). The main topic was how to structure the "generic" standard.

The discussion concentrated on the video related activities this time since only three sub-groups met in Singapore; Requirements, Video and Implementation. The meeting had a common view that similar works should be carried out on audio and system as well.

5.1.2 Process toward the generic standard

Starting from the PPD, we will reach the standard through Test Models iteratively as shown in Figure 1. Each time Test Model is updated, it should be checked against the identified requirements.

At this meeting, we made an exercise of the first iteration as described in Sections 4-6 below.

5.1.3 Clarification of "generic standard"

Though the goal of "generic standard" for the second phase work and the work method using Test Model to reach this goal are generally accepted and supported, it is not yet clear how to structure such a generic standard in diverse interests of the participating members.

There are three possibilities to structure a generic standard which is applicable to wide range of applications as illustrated in Figure 2.

The first option (single standard solution) means that all the decoders conforming to the standard can understand all the bitstreams and reconstruct full pictures as far as the bitstream conforms to the standard. In the third option (toolkit solution), on the contrary, the standard provides all the necessary elements to cover wide range of applications. Application standards specify the elements to be used for their purposes. Decoders for a particular application may not understand the bitstreams of another application. The second option (toolkit with maximum core solution) is intermediate between the first and the third solution. There may be some standardized elements which are used only for a particular application.

One benefit of using a generic standard is to achieve scale merit. Another benefit of the generic standard is more importantly to allow cross application bitstream interchange. Some application fields may require very cheap implementation dedicated to each particular application. These factors are also indicated in Figure 2.

After some discussion, the meeting concluded that the objective of our work should be to achieve the first option as far as possible, but in practice the second option with maximum core may be the solution. There is another notion "supercore" proposed in MPEG92/068 where all the decoders conforming to the standard can understand all the bitstreams but not necessarily reconstruct full pictures. Further elaboration on the structure of generic standard is necessary.

5.1.4 Review of the PPD

We extracted the requirements part from the PPD document and reviewed each item is appropriate or whether there are missing items. The outcome is included in the left hand column of Annex 2. During this work, the following items were identified as more appropriate for the system requirements:

- handling of multiple programs
- signal encryption and/or scrambling for authorized receivers etc.
- mechanism to implement backward compatibility between systems with different bit rates
- editing coded signals in such applications as home video
- error protection in the multiplexed level

It was felt that we need a neat document listing requirements with sufficient definition. This should be worked out through correspondence toward the next meeting.

In response to the request of MPEG/VIDEO during the meeting, we provided "scalability requirements and definition" as in MPEG92/078 to help them to make their action plan.

Another request of MPEG/VIDEO was to consider the necessity of 4:2:2 format instead of 4:2:0 as source coding input. During the discussion of application profile, it was expressed that digital satellite broadcasting and secondary distribution of television signals are two demanding areas.

5.1.5 Application profile

As a step to do the first iteration in Figure 1, we made an application profile as shown in Annex 2, which indicates relevant requirements for three typical applications in three typical fields; DSM, distribution and communication. We need such profiles for other applications. Contributions are requested.

5.1.6 Necessary items in the standard

We briefly reviewed what elements are required to implement each requirement listed in Annex 2 to identify missing techniques. The outcome is contained in Annex 3. Our conclusion was that the current video coding work program is sufficient for the current level of requirements analysis results except the following two items;

- A work program is missing for "editing encoded bitstream without decoding." It requires, however, more fundamental study.

- For "repetition of coding and decoding," we could not identify any explicit techniques to achieve this property. For the moment, this should be tested at some stage of completion of the coding algorithm.

5.1.7 Test sequences

The following test materials should be used to check the robustness of the expected standard;

- Stress materials (very difficult to encode)
- NTSC/PAL/SECAM composite source
- Progressive scan materials
- Impaired sources (Note)

Note: Sometimes coding may amplify defects included in the source.

5.1.8 Action points toward the next meeting

Requirements sub-group agreed on the following recommendations for approval of the plenary;

1) Further elaboration is required on how to structure "generic standard." Reference should be made to the outcome of the Singapore meeting and MPEG92/068. Written contributions are solicited.

2) A list of video requirements should be produced by extracting relevant part of the PPD document and by adding sufficient definition. This work should be carried out through correspondence toward the Haifa meeting. The list is to be used not only inside standardization groups but also for consultation with outside communities.

3) Application profiles should be worked out for probable applications according to the examples obtained at the Singapore meeting. Contributions are solicited.

4) Necessary elements to implement each requirement should be tested and incorporated into TM and the final standard. REQUIREMENTS group considers that the current video coding work program is sufficient for the current level of requirements analysis results except the item "editing encoded bitstream without decoding" which requires fundamental study.

5) The following test materials should be used to check the robustness of the expected standard;

- Stress materials (very difficult to encode)
- NTSC/PAL/SECAM composite source
- Progressive scan materials
- Impaired sources (Note)

Note: Sometimes coding may amplify defects included in the source.

5.2 Video sub-group (J. Guichard)

5.2.1 General

The video group met three days with the following agenda;

- 1) Introduction
- 2) Allocation of contributions
- 3) Discussion of topics
- 4) Toward the Test Model
- 5) Proposal for experiments

The suggestion of the chairman was to have discussion on syntax, pre- and post-processing, quality, rate control, M-Quant, motion estimation in order to define experiments with two concerns: quality and requirements (or functionalities).

5.2.2 Clustering of the documents (numbers are MPEG92/nn)

- | | |
|--|----------------------------------|
| - B-frames vs delay | 03.04.10.15.16.17.28.29.37.58 |
| - VBR | 21 |
| - TM0 proposal | 28.32.39.41 |
| - Compatibility/layering/
scalability | 11.13.18.19.28.41.42.45.46.49.59 |
| - Motion estimation | 06.28.33.42 |

- Cell loss	20,27,28
- Frame vs field prediction	03,22,23,24,25,28,41,45,46,60
- Subsampling of chrominance	28,30,42
- Proposal for core experiments	07,28,33,34,35,36,40,41
- M-Quant/rate control	21,38,56,57
- Non transform coding	40,42,48
- Tape results	42,44,46,61
- Guidelines	26
- Subjective tests	61

5.2.3 Discussion

The discussion of documents took place according to the following items:

- color subsampling
- frame structure: I,P,B; I,P,P'; I,P and frame/field issue
- scalability/compatibility
- rate control
- others

It has been noted that Japan has created an Ad Hoc Group to coordinate the work in that country (chair: Mr. Watanabe). In Europe, the work is coordinated within the COST-VADIS project (chairs: Mr. Bjoentegaard and Mr. Nocture). There is no such a framework structure in the U.S.A.

During the discussion, all the main points were raised; B-frames or no B-frames, half pel requirements, field/frame prediction and scalability/compatibility were the most sensitive topics. A view has been confirmed that the color subsampling issue (4:4:4/4:2:2/4:2:0) was for the requirement group.

In order to clarify the situation, several sub-groups were created;

- Frame/field syntax, mode decision, motion estimation
- M-Quant and rate control
- Scalability/compatibility

Extensive discussion took place to identify the features of the Test Model, but no firm conclusions could be reached.

5.2.4 Outcome of the video group

Points 4) and 5) of Section 5.2.1 above can be summarized as follows:

Toward the Test Model

No Test Model has been defined but a "simulation framework", which is based on;

- MPEG-1 CD plus SM3 for help if necessary
- 4:2:2 to 4:2:0 conversion according to MPEG92/028
- field/frame prediction according to MPEG92/080 and 079
- rate control and M-Quant according to MPEG92/077
- compatibility syntax extension according to MPEG92/076
- scalability syntax extension according to MPEG92/039
- Guideline for cell loss experiments according to MPEG92/027

Proposal for experiments

It has been explained that, due to the fact that there is no Test Model, only experiments can be carried out (the wording "core experiments" corresponds to experiments within a Test Model!).

The following list of experiments has been agreed:

- Modified quantizer for non intra (as in MPEG92/028)
- Study impact of full search on subjective quality
- Half pel refinement on decoded pictures (as in MPEG92/028)
- Multi-field prediction vs adaptive field/frame (as in MPEG92/046 and 079)
- Experiment on scalability in the frequency domain
- Field based coding option
- Compatibility: embedded bitstream vs simulcast
- I,B,P vs I,P vs I,P',P
- Cell loss resilience
- Adaptive VLC (as in MPEG92/028)
- Overlapped MC
- Alternative to DCT

Ad Hoc Groups

A document which formulates some recommendations has been discussed, and two Ad Hoc Groups have been created:

- "Preliminary Working Draft" group, chaired by Mr. Koster, in charge of gathering the relevant documents for the "simulation framework"
- "Experiments" group in charge of compatibility/scalability related experiments and quality related ones. The former is chaired by Mr. Parke and Mr. Gonzales. The latter is coordinated at the regional level by Mr. Nocture, Mr. Puri and Mr. Yonemitsu.

It has been noted that strong emphasis has been put by some US delegates and that Document MPEG92/078 (scalability requirements and definition) has been issued on this purpose by the Requirements Group.

5.3 Implementation Study (D.G. Morrison)

5.3.1 Kurihama proposal rankings

The work to evaluate encoder and decoder complexity was completed during the meeting as contained in Annex 4, which also includes analysis of influential factors.

5.3.2 Universal transform

The meeting considered MPEG92/048 (Hughes) proposing universal transform whose parameters are transmitted at the sequence layer, but did not reach any agreed views.

5.3.3 Future work

The meeting considered the suggested "Hardware Reference Model" approach, but there was no support.

5.3.4 Action points toward the next meeting

Implementation Study sub-group agreed on the following recommendations for approval of the plenary;

1) MPEG confirm that the purpose of MPEG is to develop a standard which will find widespread use through a combination of several characteristics which include low implementation cost. In particular it remains unclear that B frames are required for reasonable picture quality in low end systems and the implementation group recommends that further study on restricting the Test Model to forward prediction coding schemes be carried out.

2) The Implementation Studies Group has provided results which should be of value for the MPEG second work item. We request a response from MPEG Video detailing how the Implementation Studies Group work is to be incorporated into the algorithm design. The Implementation Studies Group remains open to suggestion as to how the content and format of its results may be improved as work continues.

3) Means be sought to improve the coupling of implementation studies with other MPEG activities. We consider that modifications could be made to the meeting schedules to allow more interaction between us and other MPEG groups.

6. Next Meeting

March 18-20 in Stockholm (sole sessions)
March 23-27 in Haifa (joint sessions with MPEG)

Annexes

- Annex 1 Documents for the fifth meeting of the Experts Group
- Annex 2 Examples of Application Profile
- Annex 3 Possible techniques to implement each requirement
- Annex 4 Kurihama proposal rankings

END

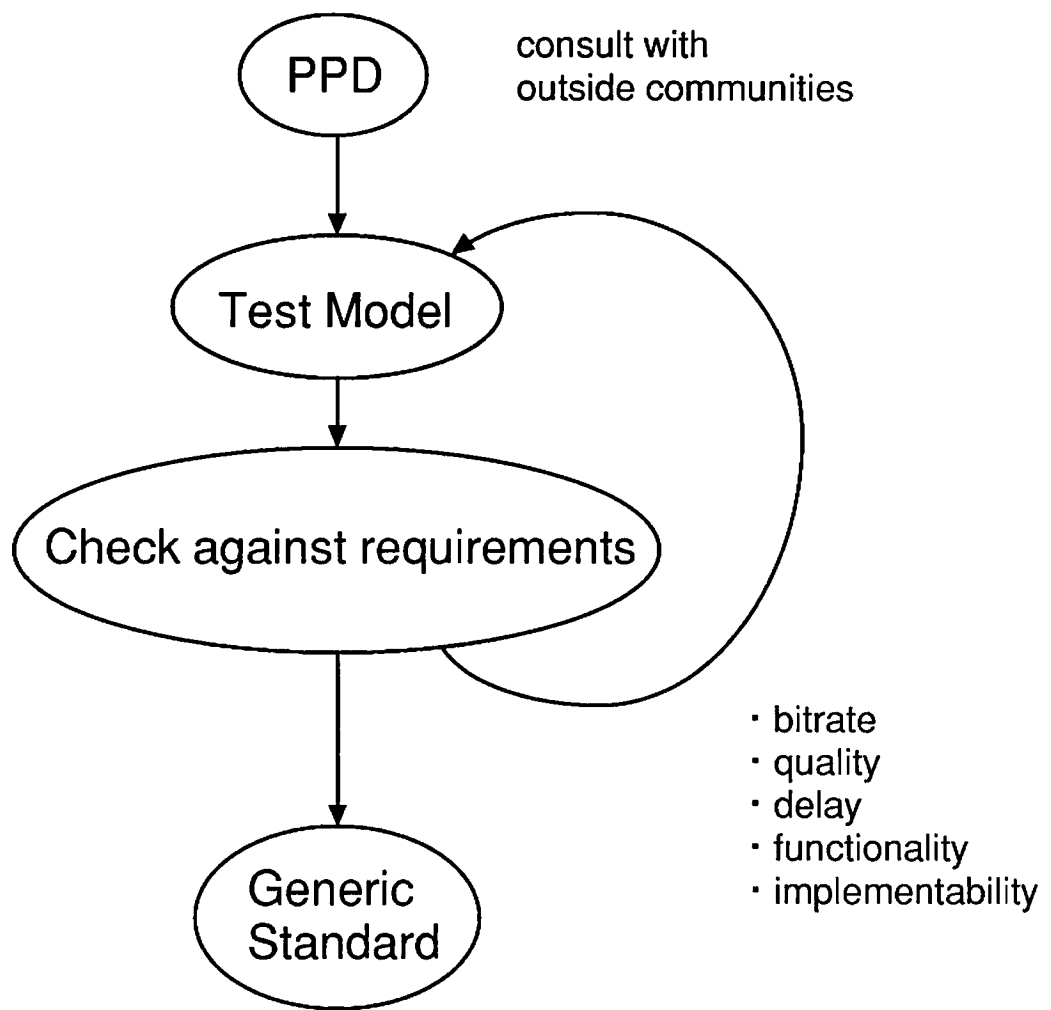
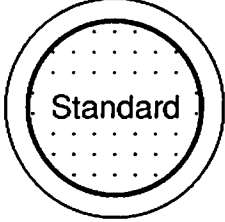
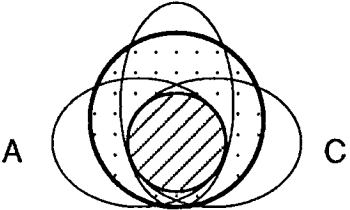
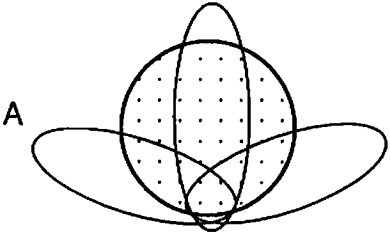


Figure 1

		Scale Merit	Cross-application Bitstream Interchange	Cheap Imple. for Particular Application
All applications 	Single standard	yes	yes	no *
Application B 	Toolkit with common core	yes		
Application B 	Toolkit standard	yes	no	yes

*cost: unnecessary elements, sub-optimum parameters

Figure 2

Participants of the fifth meeting of
Experts Group for ATM Video Coding
(6-9 January 1992, Singapore)

FRG	Mr. F. May Mr. G. Zedler	Daimler-Benz DBP Telecom	CM CM
Australia	Mr. H.G. Lim Mr. J. Princin Mr. G. Smith	Monash University Telecom Australia AUSSAT	(CM)
Belgium	Mr. O. Poncin	RTT Belgium	CM
Canada	(advised that no one can attend)		
USA	Mr. B.G. Haskell Ms. A. Wong	AT&T Bell Labs Bellcore	(CM)
France	Mr. G. Eude Mr. J. Guichard	CNET CNET	CM
Italy	Mr. Gandini	CSELT	(CM)
Japan	Mr. T. Fukuhara Mr. K. Hibi Mr. Y. Katayama Mr. S. Okubo Mr. K. Sakai Mr. T. Tanaka Mr. M. Tsujikado Mr. H. Ueno Mr. T. Yukitake	Mitsubishi Sharp GCT NTT Fujitsu NTT Oki Toshiba Matsushita	Chairman CM
Norway	Mr. G. Bjoentegaard	Norwegian Telecom	(CM)
Netherlands	Mr. A. Koster	PTT Research	(CM)
UK	Mr. I. Parke Mr. D.G. Morrison	BT BT	CM
Sweden	Mr. H. Brusewitz Ms. C. Verreth	STA STA	CM
Korea	Mr. J-G. Choi Mr. J-Y. Nam	ETRI ETRI	Observer Observer

CM: Coordinating Member
(CM): Substitute for CM

Documents for the fifth meeting of the Experts Group
6-9 January 1992, Singapore

Normal Documents

Note: Contributions with "*" have also been submitted to MPEG.

AVC-177R REPORT OF THE FOURTH MEETING OF THE EXPERTS GROUP FOR
ATM VIDEO CODING IN YOKOSUKA (CHAIRMAN)

Achievements and action points obtained at the fourth meeting are recorded to facilitate our discussion at this meeting.

AVC-178 (reserved for the report of SGXVIII meeting in Melbourne)

AVC-179* DEFINITION OF END TO END DELAY (CCITT EXPERTS GROUP)

All possible delays are described in a general way so that they can be applied to various coding schemes. The aim is to allow a proper comparison between coding schemes and to give reasonable grounds for determining the delay budget among the elements constituting end to end delay.

AVC-180 SUBJECTIVE TEST RESULTS OF MPEG-2, KURIHAMA MEETING
(CHAIRMAN OF MPEG/TEST)

This is the official report of the Kurihama subjective test for proposed video coding algorithms. List of proposals, list of assessors, testing and data processing methods and test results are given.

AVC-181* EFFICIENT FLEXIBLE LAYERED CODING
(AUSTRALIAN "UNIVERSAL VIDEO CODEC" PROJECT)

The source of inefficiency which arise in layered coders, and methods which can be used to reduce inefficiency, are described. Experimental results for a combined subband/pyramid scheme are presented to show that layered coders can be quite efficient in comparison with non-layered coders. It is suggested that the general principles should be useful in the design of efficient layered coders.

AVC-182 PATENT INFORMATION (DAIMLER-BENZ)

Information is given on a filed patent regarding cell loss concealment method.

AVC-183* CORE EXPERIMENT ON COMPATIBILITY (BT)

This document proposes a method of modifying SM3 to produce a first Test Model for MPEG-2 which maintains compatibility with MPEG-1 by incorporating a compatible prediction mode. Items of the core experiment are also proposed; simulcast vs compatibility, performance of various up-conversion schemes, down-sampling methods to generate the SIF, improvements by use of motion compensation to the MPEG-1 prediction etc.

AVC-184* SIMULATION RESULTS OF PROPOSAL 30 (RTT BELGIUM)

It is informed that the submitted D1 tape suffered from field inversion except Mobile & Calendar at 9 Mbit/s.

AVC-185* EXPERIMENT OF LOW DELAY MODE (GCT)

Four prediction modes (IP, IP'P, IBP and IBBP) are compared on a frame-based SM3 algorithm at 4 Mbit/s, concluding that the IBBP mode performs the best in terms of average SNR.

AVC-186 LOW DELAY CODING MODE (FUJITSU)

Three prediction modes (IPB, IPP' and IP) are compared on a field-based MPEG-1 algorithm at 4 and 9 Mbit/s, concluding that backward prediction contributes to improving average luminance SNR by 1.8 dB and 1.4 dB in sacrifice of coding/decoding delay.

AVC-187* CODING EFFICIENCY IN LOW DELAY MODE (KDD)

Two prediction modes are compared on a field-base SM3; IBBP with N=30, M=3 and IP with N=15 and M=1. It is found that IBBP performs better in luminance SNR by 5 dB.

AVC-188* COMPARISON AMONG COMPATIBLE CODING, NON-COMPATIBLE CODING, AND SIMULCAST (FUJITSU)

The three coding modes are compared in a Hierarchical Laplacian Pyramid Coding scheme, providing SNR data at 4 Mbit/s and 9 Mbit/s. The layered coding looks effective at 4 Mbit/s, but it performs similarly to the simulcast coding at 9 Mbit/s.

AVC-189* COMPARISON BETWEEN PYRAMID (EMBEDDED) AND SIMULCAST (TOSHIBA)

The two coding modes are compared in an RM8-based coding scheme where the base layer has either of CIF or QCIF resolution. It is found that the simulcast mode performs better than the pyramidal mode supposedly due to the fact that motion compensation becomes less effective for the differential signal in the pyramidal scheme.

AVC-190* CONSIDERATIONS ON CELL LOSS RECOVERY TECHNIQUES (JAPAN)

The following five techniques for the cell loss recovery are detailed; leaky prediction, demand refresh, error concealment, video multiplex structure, and packetization. Items of standardization are pointed out.

AVC-191* RATE CONTROL METHOD BASED ON SUB-BAND CODING FOR VBR TRANSMISSION (OKI ELECTRIC)

Experimental results are reported on a control method for maximum coding rate, measured with 1 frame time jumping window, in a 7 sub-band coding scheme. The control method is to start with the previous frame quantizer step sizes and adjust them in the order of UU, UL, LU, LLUU, LLUL and LLLU band.

AVC-192* COMPARISON OF PREDICTION/CODING METHODS IN AN RM8-BASED SCHEME (NTT)

Three prediction/coding methods (frame, field and adaptive) are compared in an RM8-based coding scheme in terms of rate vs distortion characteristics. It is concluded that frame coding with simple field merging is a reasonable starting point and that if field mode is the choice two preceding fields should be used for motion compensated prediction.

AVC-193* OBSERVATION OF SEQUENCES WITH CYCLICALLY DISTORTED PICTURES (NTT)

Flower Garden sequence is processed by inserting intra coded pictures with constant step size in every other frame. Just noticeable degradation is given for the three parts: flowers, roof tile, and twigs. A possibility of exploiting cyclic coarse quantization is suggested but not firmly concluded.

AVC-194* FIELD ADJUSTED MC FOR FRAME-BASE CODING (MATSUSHITA)

A new motion compensation method is proposed for the frame-based coding of interlaced pictures, hence for TM0. A motion vector is sent per MB, from which a field-time difference compensation vector is derived. Odd (even) field pels are MC-predicted by the picture at the previous odd (even) field position that is composed of the original previous odd (even) field pels and even (odd) field pels shifted by the field-time difference compensation vector.

AVC-195* CODING EFFICIENCY COMPARISON BETWEEN FRAME FORMAT AND FIELD FORMAT (HITACHI)

Coding efficiency is compared between three frame-based coding (frame DCT, field DCT, field/frame adaptive DCT) and one field-based coding in an SM3-based coding scheme. Used test sequences are Mobile & Calendar (panning) and Table Tennis (zooming out). It is found that there is small difference among the three frame-based coding and that frame-based coding performs better for Mobile & Calendar but field-based coding performs better for Table Tennis.

AVC-196* GUIDING PRINCIPLES FOR THE SINGAPORE MEETING (CCITT EG)

Some guidelines are proposed for defining TM0; starting from a very simple scheme for later inclusion of verified elements, room for optimizing low delay mode, core experiment for backward/forward compatibility with MPEG-1 and H.261, room for forward prediction only, scalability and low bit rate operation.

AVC-197 SIMULATION OF RANDOM CELL LOSS (UK)

A method of simulating cell loss is given, where bitstream specification, cell loss occurrence model, mean cell loss rate and mean burst of consecutive cells lost, programs for cell loss and random number generation are described. Parameter values are proposed for common experiments.

AVC-198 CORE EXPERIMENT FOR TESTING B-FRAMES/NO B-FRAMES (NTA)

It is proposed to compare "B-frames as in MPEG-1", "low resolution predicted frames in prediction loop", "low resolution predicted frames out of prediction loop", and "prediction based on two previous frames". Experimental conditions are also proposed.

AVC-199* A STUDY ON THE EFFECT OF B FRAME (NEC)

Comparison of coding efficiency is made between IBP and IP structures, concluding that the former gives better SNR results.

AVC-200* A STUDY ON SUBSAMPLING OF CHROMINANCE SIGNALS (NEC)

Four chrominance subsample methods to obtain 4:2:0 signals are compared in terms of SNR and subjective impression; line subsampling and repeating/filtered interpolation, filed drop and repeating/filtered interpolation. It is concluded that a method performing no worse than the line subsampling and filtered interpolation is required.

AVC-201* SUMMARY OF FUNCTIONALITY PROPOSALS (CHAIRMAN OF MPEG/REQ)

Description of functionalities (fast replay, random access, compatibility, low delay mode, scalability, cell loss resilience) is listed which appear in the 30 proposal documents.

AVC-202 SELECTION OF TRAFFIC DESCRIPTORS AND THE IMPACT OF BUFFERING (AT&T)

Distinction between TD (Traffic Descriptor) and UPC (Usage Parameter Control) is first given. An algorithm to select parameters for TD's (sliding window and leaky bucket) is next provided such that the UPC will find no violations, demonstrating that an additional peak rate constraint is advantageous and that the leaky bucket is a better choice. Furthermore, it is shown that buffering in the video system can reduce the necessary parameters.

AVC-203 CONVERSION FILTER FOR PRODUCING SCIF (NTA)

A filter is defined to convert from either 525/60 or 625/50 signal to SCIF. Tape demonstration is accompanied.

AVC-204* EVALUATION OF SM3 FOR MPEG2 (PTT RESEARCH)

It is reminded that the following requirements should be considered for appropriate actions before starting with a modified SM3 as TM0; end to end delay, error protection, adaptation to various storage and transport methods, and compatibility.

AVC-205* CELL LOSS EXPERIMENT SPECIFICATIONS (EXPERTS GROUP)

This is an update of AVC-197 with some modification in the bitstream specification and parameter values.

Temporary Documents

- TD-1 Agenda for the fifth meeting in Singapore (Chairman)
- TD-2 Available documents (Chairman)

END

Examples of Application Profile

This list provide three examples of the application profile in typical applications fields; ISM (Interactive Storage Media using optical disks) in DSM field. STV (Satellite TV Broadcasting) in distribution filed. IPC (InterPersonal Communication such as videoconferencing) in communication field. Requirements for each application is marked with "X".

Further examples are solicited using this format, putting notes if detailed explanation is necessary.

	ISM	STV	IPC
1. BIT RATE <01>			
a) NTSC/PAL/SECAM level at 3-5 Mbit/s	X	X	X
b) Close to CCIR 601 level at 8-10 Mbit/s	X	X	X
2. PICTURE QUALITY <01>			
a) High quality	<31>	<31>	<31>
b) Graceful degradation for critical scenes	X	X	X
c) Minimum coder-decoder combination should provide targeted performance <02>	<32>	<32>	<32>
3. PICTURE FORMAT (INPUT/OUTPUT)			
a) CCIR601 4:2:2		X	<33>
b) CCIR601 4:4:4			
c) EDTV (16:9 aspect ratio)	X	X	<33>
d) Progressive format (film source etc.)	X	X	<33>
e) Square pixel			<33>
4. MULTIPLE SCREENS/MULTIPLE IMAGES (e.g. picture out of picture <03>)		X	X<34>
5. FLEXIBILITY IN BIT RATE			
a) CBR and VBR	X	X	X
b) Rate control for VBR under bit generation constriction <04>		X	X

	ISM	STV	IPC
6. BITSTREAM SCALABILITY <05>			
a) Spatial resolution scalability	X	X	X<35>
b) Temporal resolution scalability	X		X<35>
c) Coding noise scalability			
d) Complexity scalability			
7. CODING/DECODING DELAY <06>		<500ms	<150ms
8. ERROR PROTECTION FOR STORAGE AND TRANSPORT METHODS <07>			
a) Bit error resilience (random and burst)	X	X	X
b) Cell/packet loss resilience			X
c) Graceful degradation for severe cases		X	X
d) Recovery of synchronization after an arbitrary point <08>		X<36>	X<36>
9. REPETITION OF CODING AND DECODING			X<34>
10. COMPLEXITY FLEXIBILITY			
a) Flexibility to allow tradeoff between performance and complexity <09>	X	X	X
b) Intraframe mode only codec			
11. COMPATIBILITY			
a) forward compatibility with MPEG1/H. 261	MPEG1	MPEG1	H. 261
b) backward compatibility with MPEG1/H. 261	MPEG1	MPEG1	H. 261
c) u/d compatibility with EDTV, HDTV, SDTV <10>			
d) Provision for future extension (e.g. extension to larger formats as HDTV)	X	X	X
12. EDITING ENCODED BITSTREAMS			
a) Partial decoding and recoding for rescaling <11>	X<37>		X<34>

	ISM	STV	IPC
13. TRICK MODE			
a) Fast playback (forward, backward)	X		
b) Normal reverse playback			
c) Slow motion			
14. RANDOM ACCESS / CHANNEL HOPPING	X	X	X<38>
15. REAL TIME ASPECT RATIO CHANGES <12>			
a) Pan/scan		X	
b) Letter box changes		X	

Notes

- <01> The standard should be flexible enough to cover a range of picture quality corresponding to a range of bit rates.
 - <02> Clarification is needed in the light of note <01>.
 - <03> 16:9 picture can contain one full size 4:3 picture with three additional 1/9 sized 4:3 pictures.
 - <04> In case of ATM network, this network constriction is called Usage Parameter Control. In case of multichannel transmission in the CBR environment, each channel rate should be controlled so as to maintain the aggregate bit rate should be constant.
 - <05> A bitstream is scalable when some coded bits can be disregarded and a usable image still results. Bitstream scalability facilitates decoding the images at different rates and resolution scales through the design of the bitstream or data representation itself. Real time transcoding between different bit rates can be achieved with this bitstream scalability. See also MPEG92/078.
 - <06> See MPEG92/010 (AVC-179) for definition.
 - <07> Error protection will also be supported at the system level.
 - <08> Recovery after the channel is lost for a while.
 - <09> There is an unanswered question whether the standard should guarantee performance in addition to bitstream interchangeability.
 - <10> Awaiting definition of EDTV, HDTV, SDTV
 - <11> Home video editing may require this functionality. MPEG1 system capability of cut and paste in GOP unit is sufficient for this purpose?
 - <12> Indicating sender's desire concerning what part of the 16:9 picture be displayed on 4:3 monitors.
-
- <31> Quantification is necessary for required picture quality for each application. "Distribution" field, such as STV, is thought most quality demanding.
 - <32> Awaits clarification of the requirement.
 - <33> Awaits the conclusion on the picture format issue for H.26X.
 - <34> Continuous presence multipoint videoconferencing where all participants are displayed simultaneously.
 - <35> Multipoint videoconferencing involves H.261 and H.26X signals. Temporal scalability may be eventually achieved if H.261 uses reduced frame rate in low bit rates.
 - <36> This may eventually be achieved by the random access and channel hopping requirement.
 - <37> Editing materials for data base etc.
 - <38> Continuous presence multipoint videoconferencing. This functionality is also required when pictures should appear quickly after the channel is connected.
 - <39> This may be required in switched video multipoint configuration.

END

Possible techniques to implement each requirement

Note: Reference to the Singapore meeting document MPEG92/nn is indicated as /nn/, but the reference list is not exhaustive.

1. BIT RATE <01>

- a) NTSC/PAL/SECAM level at 3-5 Mbit/s
- b) Close to CCIR 601 level at 8-10 Mbit/s

2. PICTURE QUALITY <01>

- a) High quality
 - pre-processing
 - temporal prediction
 - motion estimation
 - non transform coding
 - rate control
 - etc.
- b) Graceful degradation for critical scenes
 - rate control mechanism
- c) Minimum coder-decoder combination should provide targeted performance <02>

3. PICTURE FORMAT (INPUT/OUTPUT)

- a) CCIR601 4:2:2
 - b) CCIR601 4:4:4
 - c) EDTV (16:9 aspect ratio)
 - d) Progressive format (film source etc.)
 - e) Square pixel
- support of a range of formats, both interlaced and progressive
 - format indication bit

4. MULTIPLE SCREENS/MULTIPLE IMAGES
(e.g. picture out of picture <03>)

- the same technique to achieve scalability
- system's support for higher multiplex (multiple programs)

5. FLEXIBILITY IN BIT RATE

- a) CBR and VBR
 - b) Rate control for VBR under bit generation constriction <04>
- rate control mechanism

6. BITSTREAM SCALABILITY <05>

- a) Spatial resolution scalability
 - b) Temporal resolution scalability
 - c) Coding noise scalability
 - d) Complexity scalability
- subband splitting
 - pyramidal scheme /18,19,49/
 - hierarchical layers in the DCT frequency domain /11,39,45/
 - frequency scanning /28/

7. CODING/DECODING DELAY <06>

- forward prediction /28/
- field based coding /46/
- use of INTRA slice instead of I pictures

8. ERROR PROTECTION FOR STORAGE AND TRANSPORT METHODS <07>

- a) Bit error resilience (random and burst)
- b) Cell/packet loss resilience

- video multiplex structure such as slice design and absolute MB address
 - leaky prediction /46/
 - demand refresh
 - error concealment
 - packetization
 - layered coding
 - use of FEC/CRC cells
 - use of two CLP's /28/
- See /20/ for general info. on cell loss resilience.

- c) Graceful degradation for severe cases

- layered coding

- d) Recovery of synchronization after an arbitrary point <08>

- GOP start code

9. REPETITION OF CODING AND DECODING

(no positive techniques identified)

10. COMPLEXITY FLEXIBILITY

- necessary minimum specifications in the normative part of standard

- a) Flexibility to allow tradeoff between performance and complexity <09>
- b) Intraframe mode only codec

11. COMPATIBILITY

- a) forward compatibility with MPEG1/H.261
- b) backward compatibility with MPEG1/H.261
- c) u/d compatibility with EDTV, HDTV, SDTV <10>
- d) Provision for future extension (e.g. extension to larger formats as HDTV)

- layered coding /11,19/
- embedded /13,18,59/
- simulcast
- syntactic extension /28,59/
- "hooks" in the syntax

12. EDITING ENCODED BITSTREAMS

(no positive techniques except editing on a GOP basis in the MPEG1 system)

- a) Partial decoding and recoding for rescaling <11>

- GOP structure

13. TRICK MODE

- a) Fast playback (forward, backward)
- b) Normal reverse playback
- c) Slow motion

- regularly spaced I pictures
- use of scalable features

- 14. RANDOM ACCESS / CHANNEL HOPPING - regularly spaced I pictures
- 15. REAL TIME ASPECT RATIO CHANGES <12> - indication bit
 - a) Pan/scan
 - b) Letter box changes

Notes

- <01> The standard should be flexible enough to cover a range of picture quality corresponding to a range of bit rates.
- <02> Clarification is needed in the light of note <01>.
- <03> 16:9 picture can contain one full size 4:3 picture with three additional 1/9 sized 4:3 pictures.
- <04> In case of ATM network, this network constriction is called Usage Parameter Control. In case of multichannel transmission in the CBR environment, each channel rate should be controlled so as to maintain the aggregate bit rate should be constant.
- <05> A bitstream is scalable when some coded bits can be disregarded and a usable image still results. Bitstream scalability facilitates decoding the images at different rates and resolution scales through the design of the bitstream or data representation itself. Real time transcoding between different bit rates can be achieved with this bitstream scalability. See also MPEG92/078.
- <06> See MPEG92/010 (AVC-179) for definition.
- <07> Error protection will also be supported at the system level.
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- <09> There is an unanswered question whether the standard should guarantee performance in addition to bitstream interchangeability.
- <10> Awaiting definition of EDTV, HDTV, SDTV
- <11> Home video editing may require this functionality. MPEG1 system capability of cut and paste in GOP unit is sufficient for this purpose?
- <12> Indicating sender's desire concerning what part of the 16:9 picture be displayed on 4:3 monitors.

END

Kurihama proposal rankings on implementation complexity

ENC12SA.XLS

Reg.	Name	Assessors' rankings												Mean	S D	p.
7	NTA	4	1	1.5	2	5	2	5	1	1	2	4.5	1.5	2.54	1.53	
26	NHK	3	4	3	4	1	2	9.5	2	3	3	8	1.5	3.67	2.45	
30	RTT	1	5	1.5	2	3	2	16.5	8	2	1	2	4.5	4.04	4.23	
9	OCETT	2	2.5	12.5	5	4	6.5	1	6	4.5	4	2	4.5	4.54	2.88	
12	HHI	8	2.5	17.5	2	2	11	18	7	6	5	6.5	4.5	7.50	5.22	
34	Thomson-LEP	5	6	17.5	6	8	6.5	16.5	14	4.5	6	4.5	4.5	8.25	4.63	
40	EPFL	12	12	15	9	6	6.5	3	20	8	8	2	8	9.13	4.81	
37	UCL	6	7	17.5	7	20	6.5	13.5	9	7	7	6.5	7	9.50	4.58	
6	VADIS-Gp2	9	16	4.5	10	13	13	12	5	13.5	9	11.5	13	10.79	3.31	
39	Columbia	11	19	8	14	9	15.5	4	4	13.5	13	9.5	10	10.88	4.26	
27	Philips TCE	13	14	4.5	12.5	10	13	21	11	10.5	11	9.5	13	11.92	3.64	
14	IBM	16	17	8	12.5	15	13	20	10	10.5	10	18	10	13.33	3.65	
31	Sharp	7	15	23.5	20	21	13	8	3	18	12	13.5	24	14.83	6.42	
25	NEC	26	13	17.5	11	7	6.5	2	23	25	20	18	10	14.92	7.50	
16	JVC	15	10	8	19	14	20	23	18	12	22	11.5	17	15.79	4.62	
11	GCT	19	26	8	15	17	13	6.5	24	21	14	13.5	13	15.83	5.64	
24	Mitsubishi	20	21	12.5	18	11	20	11	15	15	17	15	19	16.21	3.36	
2	AT&T	10	23	8	22	22	20	6.5	17	18	15	18	15.5	16.25	5.30	
20	Matsushita	18	24	20.5	17	24	13	19	16	18	16	16	15.5	18.08	3.21	
8	BT	23	8	20.5	16	18	25.5	9.5	12	22	21	21	22	18.21	5.39	
5	Bellcore	17	25	23.5	23	16	20	22	25	9	19	21	22	20.21	4.35	
33	Sony	21	20	12.5	21	23	20	24	19	18	18	23	25	20.38	3.22	
23	MIT	27	11	26	8	12	29	15	28	26	25	24	22	21.08	7.14	
36	Toshiba	14	22	23.5	24	19	20	25	26	18	23	21	18	21.13	3.33	
18	RNL-LEP	29	18	12.5	25	25	25.5	13.5	29	23	27	25	20	22.71	5.32	
17	KDD	22	27	28.5	29	26	13	27	22	24	29	29	29	25.46	4.53	
4	Aware-2	24	9	28.5	28	30	29	29	13	30	30	29	30	25.79	6.85	
38	Waseda	28	29	23.5	27	27	25.5	26	27	27	24	26	26	26.33	1.48	
3	Aware-1	25	30	28.5	30	28	29	28	21	28	26	27	27	27.29	2.37	
10	Fujitsu-Hitachi	30	28	28.5	26	29	25.5	30	30	29	28	29	28	28.42	1.40	
Check		465	465	465	465	465	465	465	465	465	465	465	465			
Updated		cS	c	c	cS	S	cS		c	cS	c	c	cS			
c: Assessor participated in ad-hoc correspondence group after Kurihama meeting																
S: Assessor participated at Singapore meeting																

Reg. Name	Assessors' rankings					Mean S D p		
26 NHK	3	4	1	2	3	1.5	2.42	1.02
30 RTT	1	2	3	2	2	4.5	2.42	1.10
7 NTA	4	2	5	2	1	1.5	2.58	1.43
9 CCETT	2	5	4	6.5	4.5	4.5	4.42	1.34
12 HHI	8	2	2	11	6	4.5	5.58	3.22
34 Thomson-LER	5	6	8	6.5	4.5	4.5	5.75	1.25
40 EPFL	12	9	6	6.5	8	8	8.25	1.95
37 UCL	6	7	20	6.5	7	7	8.92	4.97
6 VADIS-Gp2	9	10	13	13	13.5	13	11.92	1.74
27 Philips TCE	13	12.5	10	13	10.5	13	12.00	1.26
39 Columbia	11	14	9	15.5	13.5	10	12.17	2.32
14 IBM	16	12.5	15	13	10.5	10	12.83	2.17
25 NEC	26	11	7	6.5	25	10	14.25	8.11
16 JVC	15	19	14	20	12	17	16.17	2.79
11 GCT	19	15	17	13	21	13	16.33	2.98
24 Mitsubishi	20	18	11	20	15	19	17.17	3.24
31 Sharp	7	20	21	13	18	24	17.17	5.64
20 Matsushita	18	17	24	13	18	15.5	17.58	3.35
5 Bellcore	17	23	16	20	9	22	17.83	4.67
2 AT&T	10	22	22	20	18	15.5	17.92	4.21
36 Toshiba	14	24	19	20	18	18	18.83	2.97
23 MIT	27	8	12	29	26	22	20.67	7.91
8 BT	23	16	18	25.5	22	22	21.08	3.17
33 Sony	21	21	23	20	18	25	21.33	2.21
17 KDD	22	29	26	13	24	29	23.83	5.46
18 RNL-LEP	29	25	25	25.5	23	20	24.58	2.71
38 Waseda	28	27	27	25.5	27	26	26.75	0.80
3 Aware-1	25	30	28	29	28	27	27.83	1.57
10 Fujitsu-Hitachi	30	26	29	25.5	29	28	27.92	1.64
4 Aware-2	24	28	30	29	30	30	28.50	2.14
Check	465	465	465	465	465	465		
Updated	cS	cS	S	cS	cS	cS		
c: Assessor participated in ad-hoc correspondence group after Kurihama meeting								
S: Assessor participated at Singapore meeting								

Reg.	Name	Assessors' rankings												Mean	S D	p
30	RTT	2	4.5	2	2	1.5	2.5	4	1	2	2	5	3	2.63	1.19	
7	NTA	1	3	2	2	4.5	2.5	13.5	5	1	1	2	1	3.21	3.36	
26	NHK	3	1	2	2	1.5	6.5	6	13	3	3	4	5.5	4.21	3.15	
9	OCETT	4	6	17.5	5	7	18	1	10	4.5	4	3	3	6.92	5.30	
6	VADIS-Gp2	6	15.5	5	6	10	2.5	2	6	13.5	5	13	13.5	8.17	4.49	
40	EPFL	9	20	20.5	7	4.5	18	7.5	4	8	9	1	7.5	9.67	6.11	
27	Philips TCE	13	9	5	11.5	10	12	9	8	10.5	6	13	21.5	10.71	4.06	
39	Columbia	5	11	17.5	16	10	18	13.5	20	13.5	10	7	13.5	12.92	4.34	
11	GCT	19	10	11	20	17	12	5	7	21	14	6	13.5	12.96	5.24	
16	JVC	17	4.5	11	14	17	12	24	15	12	16	9	13.5	13.75	4.61	
24	Mitsubishi	11	17	11	16	17	6.5	16.5	16	17.5	13	9	21.5	14.33	4.08	
34	Thomson-LEP	23	7	24.5	8	23.5	18	7.5	2	4.5	25	25.5	5.5	14.50	9.04	
14	IBM	16	24	11	11.5	23.5	12	13.5	22	10.5	8	13	13.5	14.88	5.15	
31	Sharp	8	14	11	22.5	26.5	8	20	14	17.5	7	9	21.5	14.92	6.31	
5	Bellcore	12	15.5	17.5	13	17	6.5	19	19	9	17	18	21.5	15.42	4.25	
8	BT	7	8	11	18	10	12	18	28	22.5	19	18	13.5	15.42	6.00	
12	HHI	24	2	24.5	4	3	18	25	26	6	22	27.5	3	15.42	10.26	
37	UCL	21	21	24.5	9	17	18	10	3	7	24	23.5	7.5	15.46	7.37	
2	AT&T	15	18	11	20	17	23	13.5	12	17.5	11	16	13.5	15.63	3.54	
36	Toshiba	10	12.5	11	22.5	23.5	19	23	9	17.5	18	13	13.5	16.04	5.00	
20	Matsushita	18	23	11	16	17	12	22	18	17.5	12	13	13.5	16.08	3.75	
33	Sony	14	19	5	20	28.5	10	21	21	17.5	15	20	21.5	17.71	5.82	
25	NEC	28	12.5	24.5	10	6	23	3	11	25	23	25.5	21.5	17.75	8.27	
18	RNL-LEP	20	26	17.5	25	17	12	11	17	22.5	20	23.5	13.5	18.75	4.76	
10	Fujitsu-Hitachi	22	22	24.5	28	17	26.5	29	27	27	21	18	26	24.00	3.78	
3	Aware-1	27	30	20.5	26	10	29	26	24	28	26	27.5	26	25.00	5.09	
23	MIT	30	28	24.5	29	23.5	29	16.5	30	29	28	21	28	26.38	4.01	
17	KDD	29	25	28.5	24	26.5	23	27	25	24	27	29	30	26.50	2.21	
38	Waseda	26	29	28.5	30	28.5	26.5	28	29	26	29	22	29	27.63	2.10	
4	Aware-2	25	27	30	27	30	29	30	23	30	30	30	26	28.08	2.33	
	Check	465	465	465	465	465	465	465	465	465	465	465	465	465		
	Updated	cS	c	c	cS	S	cS		c	cS	c	c	cS			
c: Assessor participated in ad-hoc correspondence group after Kurihama meeting																
S: Assessor participated at Singapore meeting																

Reg.	Name	Assessors' rankings					Mean	S	D	p
7	NTA	1	2	4.5	2.5	1	1	2.00	1.26	
30	RTT	2	2	1.5	2.5	2	3	2.17	0.47	
26	NHK	3	2	1.5	6.5	3	5.5	3.58	1.81	
9	OCETT	4	5	7	18	4.5	3	6.92	5.10	
6	VADIS-Gp2	6	6	10	2.5	13.5	13.5	8.58	4.10	
40	EPFL	9	7	4.5	18	8	7.5	9.00	4.25	
12	HHI	24	4	3	18	6	3	9.67	8.26	
39	Columbia	5	16	10	18	13.5	13.5	12.67	4.22	
27	Philips TCE	13	11.5	10	12	10.5	21.5	13.08	3.89	
5	Bellcore	12	13	17	6.5	9	21.5	13.17	4.96	
37	UCL	21	9	17	18	7	7.5	13.25	5.58	
34	Thomson-LER	23	8	23.5	18	4.5	5.5	13.75	8.01	
8	BT	7	18	10	12	22.5	13.5	13.83	5.12	
16	JVC	17	14	17	12	12	13.5	14.25	2.08	
14	IBM	16	11.5	23.5	12	10.5	13.5	14.50	4.39	
4	Mitsubishi	11	16	17	6.5	17.5	21.5	14.92	4.86	
20	Matsushita	18	16	17	12	17.5	13.5	15.67	2.19	
11	GCT	19	20	17	12	21	13.5	17.08	3.32	
31	Sharp	8	22.5	26.5	8	17.5	21.5	17.33	7.10	
2	AT&T	15	20	17	23	17.5	13.5	17.67	3.13	
36	Toshiba	10	22.5	23.5	19	17.5	13.5	17.67	4.75	
18	RNL-LEP	20	25	17	12	22.5	13.5	18.33	4.65	
33	Sony	14	20	28.5	10	17.5	21.5	18.58	5.84	
25	NEC	28	10	6	23	25	21.5	18.92	8.05	
3	Aware-1	27	26	10	29	28	26	24.33	6.50	
10	Fujitsu-Hitachi	22	28	17	26.5	27	26	24.42	3.81	
17	KDD	29	24	26.5	23	24	30	26.08	2.65	
38	Waseda	26	30	28.5	26.5	26	29	27.67	1.57	
4	Aware-2	25	27	30	29	30	26	27.83	1.95	
23	MIT	30	29	23.5	29	29	28	28.08	2.13	
Check		465	465	465	465	465	465			
Updated		cS	cS	S	cS	cS	cS			
c: Assessor participated in ad-hoc correspondence group after Kurihama meeting										
S: Assessor participated at Singapore meeting										
Note: Where an algorithm had options, the assessments were on version corresponding to submitted D-1 tapes.										
Eg #14 assessments are not for hierarchical version.										

1. The number of frame buffers required is a dominant factor in both encoder and decoder cost.

2. A 525 line 4:2:0 frame fits within a single 4 Mbit DRAM. A 625 4:2:0 frame does not. 4:2:2 frames do not fit in 4 Mbit.

$$4 \text{ Mbit} / (720 \text{ pels} * 8 \text{ bits} * 1.5) = 485.44 \text{ maximum lines per frame}$$

3. The use of bi-directional prediction adds complexity and cost in terms of memory storage, memory management, block averaging filters and on chip cache. The following table is indicative of frame buffer storage for decoders using conservative DRAM timing designs.

Video Option	# Frame buffer		4:2:0		4:2:2	
			#chips		#chips	
	525	625	525	625	525	625
No B	2	2	2-3	3-4		
No B, 3:2 pulldown	2-3	NA	3-4	NA		
B, m=2	3	3	4	4		
B, m=2, 3:2	3-3.5	NA	4	NA		
B, m>2	4	4	4	5-8		
B, m>2, 3:2	4-4.5	NA	4-5	NA		

The number of chips for 4:2:2 to be determined. However number of pels is increased by 33% over 4:2:0. The number of chips does not necessarily scale by this factor because of memory bandwidth (might increase number) and quantisation (might reduce number).

In 1992 each 4 Mbit (256K x 16) chip costs approx US\$13.50.

1994

9

1996

11

4. Complex predicted macroblock filters, especially when large overlap is required, increase memory bandwidth requirements.

5. Adaptive entropy encoders which require no arbitrary mappings (such as adaptive arithmetic coders) can, in general, be implemented more efficiently than coders which rely on large downloaded lookup tables.

v2