CCITT SGXV
Working Paty XV/1
Experts Group for ATM Video Coding

Document AVC-57

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANIZATION INTERNATIONALE DE NORMALISATION

ISO-IEC JTC1/SC2/WG11

CODING OF MOVING PICTURES AND ASSOCIATED AUDIO INFORMATION

ISO-IEC JTC1/SC2/WG11
MPEG91/
May 17, 1991

Title : Preparatory Draft Proposal Package Description for MPEG Phase 2
Source: Sakae OKUBO (NTT)
Purpose : Working document

This document provides a preparatory draft for the subject matter which may help us at the Paris meeting. This has been produced with a simple editing work, collecting related materials from the two meeting reports of San Jose (MPEG90/271) and Berlin (MPEG90/349), and also referring to the previous PPD for MPEG Phase 1. Editor's notes are included in { }.

List of contents

1. Purpose and content of this document

1.1 Scope of the MPEG-2 standards

Coding of moving picture images and of associated sound for digital storage media having a throughput of up to about 10 Mbit/s.

It is intended to generate generic or application-independent standards. The intention of "generic" standard is addressed to the source coding - decoding part (I) as indicated in Figure 1 which will be commonly applied to various applications. Adaptations to application oriented media/channels (II) need specific standards according to the applications.

Figure 1 {Figure 1 of Annex IV to MPEG90/271}

1.2 Target DP

{MPEG-1 practice of three parts is followed?}

Part 1: System
Part 2: Video
Part 3: Audio

{how about DSM? produce DP or alternatively information material?}

MPEG will produce Recommendation regarding suitable DSM for MPEG-2 standard as well as Recommendation regarding interface between DSM and MPEG-2 bitstream.

1.3 Short description of this document

{ }

2. DP development - organization and schedule

2.1 Organization

{ }

2.2 Schedule

- November 1991 Subjective tests for video at JVC-Kurihama
- Early 1991 Definition of "Test Model" for video coding study
- End of 1992 Development of DP
- 1993 Hardware verification

{other milestones? audio and system ones?}

2.3 Coordination with other standardization bodies

MPEG will carry out its work in close collaboration with other standardization bodies, particularly with;

- CCITT SGXV Experts Group
- CCIR TG CMTT/2 Rapporteurs Group

aiming at avoid duplication of work and proliferation of standards for applications of similar nature.

Practical ways of collaboration will be through joint meeting sessions in the area of overlapping interest and responsibility, namely

- source video coding algorithm and video multiplexing,
- system issues concerning multimedia multiplexing and synchronization,
- implementation considerations.

{other groups, e.g. audio related ones?}

3. General requirements for MPEG Phase-2 standards

3.1 Applications

For the second phase work of MPEG, such applications as listed in Table 1 have been identified.

Table 1 {Annex IV to MPRG90/271}

It has been expressed that DBS using digital video is an area which is requiring early standard of the second phase MPEG.

3.2 Target bit rates

The target bit rates for video are defined not at specific fixed values but as a range. The upper bound is 10 Mbit/s. The lower bound, however, is open at the moment. There were some discussions that it might be 5 Mbit/s or 2 Mbit/s considering that bit rate ratio of several to 1 for video coding is practical and that it should cover the range above the first phase MPEG video bit rate. The matter should be further clarified.

The current state of the art for audio coding is summarized as follows;

- production quality at 192 kbit/s per channel
- close to transparent at 128 kbit/s per channel (comparable to Compact Disc quality)

Phase-2 work is aimed at improving the MPEG-1 encoder, awaiting further clarification on the values of bit rate.

It is pointed out that multi-language program may require several channels, thus their aggregate bit rates may affect video performance.

3.3 Quality objectives

The target quality for the second phase video of MPEG is envisaged as not lower than NTSC/PAL/SECAM and up to CCIR-601.

It is also pointed out that tradeoff among quality, bit rate and hardware complexity should be carefully considered when evaluating coding schemes.

Considering prospects for the future technology, target quality and corresponding bit rates for the MPEG Phase-2 work are summarized in the following two categories;

- NTSC/PAL/SECAM level : 3-5 Mbit/s
- "MAC" level : 8-10 Mbit/s

We may select test sequences appropriate for each category to relax the subjective test burden, e.g.

- lower bit rates : A,B,C,D
- higher bit rates: C,D,E,F

It is expected that the overlapping test sequences would provide information concerning bit rate dependency of proposed coding algorithms.

{how about audio?}

3.4 Technical implications

Based on the possible applications, there have been found several features which need technical investigation in the second phase work of MPEG.

1) Picture formats

- Range of picture representations is to be covered
  CCIR-601 format
  720 x 240 x 2 x 30; 720 x 288 x 2 x 25
  Coming EDTV format (16:9 aspect ratio)

960 x 240 x 2 x 30; 960 x 288 x 2 x 25
Progressive scan format
e.g. 960 x 576/480 x 1 x 25/30

- Interlaced pictures are to be coded (inter-frame and inter-field prediction?).
- System for multiple screens/multiple images is to be considered.
- Broadcast television and scalable window system are to be considered.
- Raster format and quality are to be independently considered.

2) Statistical multiplexing

- Utilization of MPEG bit stream properties such as I-B-P structure
- Buffering and rate control for multichannels

3) Short decoding delay from an arbitrary point of the program

- Random channel selecting in broadcasting reception
- Granularity of random access

4) Signal encryption/scrambling

- for authorized reception

5) Error protection for different channels

- Selective protection for headers etc.
- More frequent synchronization words for noisy channels

6) Repetition of coding-decoding (up to 3 times)

7) Wider range of motion compensation

8) Adaptation to ATM transmission

9) Practical fast forward and reverse playback for disk and tape

10) Symmetry of coding and decoding

There are three cases of different symmetry in terms of allowable complexity:

- Decoder << Coder
  e.g. broadcasting reception
- Decoder-~ Coder
  e.g. VTR, visual telephony
- Decoder >> Coder
  e.g. ENG/SNG

This issue was thought to be sorted out at a later stage when we can see possibilities of coding schemes to be developed. It was pointed out that minimum encoder-decoder combination should provide targeted performance.

11) Compatibility

a. Forward and backward compatibilities

There are two notions for "compatibility"; forward and backward. These are

defined as shown in Figure 2.

Figure 2 {Fig..3 in Annex IV to MPEG90/271}

It is felt that the backward compatibility is more difficult to achieve. There were several opinions whether these compatibilities be counted as a necessary feature for the second phase work of MPEG. The items to be considered are;

- if significant performance improvements are not obtained, the second phase work loses ground.
- if compatibilities are not guaranteed, the first phase product will not be accepted.
- software and hardware implementations may have different requirements.
- compatibility may cost something in implementation and quality at a given bit rate.

{X. upward/downward caompatibility between a range of TV and HDTV formats}

b. Guideline

We discussed in Santa Clara and Berlin how to relate the second generation standard for up to 10 Mbit/s and the first one for 1.5 Mbit/s. A major problem seems to be whether we can achieve target quality by maintaining a close relation between the two generation standards.

After extensive discussion, we agreed as a guideline to seek "compatibility" to the maximum extent.

c. Clarification of "compatibility"

During the discussion, however, it was found that the "compatibility" may mean different things according to the proponent. Clarification is required. Some attempt was made to list up possible approaches for achieving compatibility as illustrated in Figure 3.

Figure 3 {Figure in Annex IV to MPEG90/349}

There was a suggestion that we could study compatibility issues by evaluating additional transcoding boxes necessary for achieving forward- and/or backward-compatibility.

d. Requirement for the algorithm proposal

Each algorithm proposal for subjective tests is required to describe the "compatibility" aspect.

e. Weighting factor of "compatibility"

There was a remark that the weighting factor of this functionality be clarified before progressing to the request for algorithm proposal since this factor affects the choice of the first Test Model. The matter is still under study as described in Section 3.3.3.

f. Conclusion

This issue should be further studied from various points of view.

Contributions are awaited toward obtaining definite conclusions at the next meeting.

3.4 Items to be further discussed for completion of PPD

1) Definition of the lower bound of the target bit rate range

2) Clarification of quality objective's, e.g. by using CCIR 5 grade scale?

3) Symmetry of encoding and decoding

4) Forward and backward compatibilities

4. Particular requirements (if identified)

4.1 System requirements

4.2 Video requirements

- Relation to H.261/H.26X, CCIR Rec. 723

4.3 Audio requirements

4.5 DSM requirements

5. Work method

5.1 Competition and collaboration

The MPEG-2 work is phased into the competition part and the collaboration part. During the first phase, various proposals are welcome to survey a wide range of possibilities, while during the second phase, all efforts are expected to converge into elaborating a common scheme.

5.2 Collaboration phase work

It is the MPEG intention to define "Test Model" and refine it in the collaboration phase according to the previous practices in MPEG and CCITT.

5.3 Objectives of the subjective test

We confirm that the objectives of the subjective tests are;

- to quantify the picture quality of candidate algorithms, and
- to find promising schemes for further collaborative elaboration.

5.4 Weighting for requirements

We are going to develop a video coding standard which meets several requirements including picture quality and functionalities. Picture quality is expected to be measurable with the subjective test method. The problem is how to evaluate the functionality as well as the mixture of picture quality and functionality.

It is a general opinion of MPEG that the scoring to weight each performance/capability as was practiced for the MPEG Phase-1 need not be

repeated. We have agreed that for the competition purpose we will initially concentrate on the picture quality.

If we succeed to narrow down the number of candidates as intended from the comparison of picture quality, then we may apply such criteria as compatibility, complexity toward defining TM1(Test Model 1). Appropriate criteria for this purpose are to be studied further.

6. Testing methods

6.1 System

6.2 Video

6.2.1 Picture quality

1) Test sequences

Test sequences are limited to those with both 625 and 525 versions. The following test sequences have been selected (Note 2; the time codes with respect to the CCIR library tapes are given in Annex 1).

5 second sequences from

- Flower garden
- Susie
- Popple
- Table Tennis
- Mobile & Calendar
- Tempete (with/without noise)
- Edit

2 seconds of

- Football (Note 2)

Note 1 - "average TV picture material" but not covered in the test sequences

- sense of depth (i.e. CCIT Test Sequence TREES - 60Hz)
- dissolve (cross-fade)
- rapid motion
- special effects
- rolling captions

Note 2 - This is in response to the need to have a sequence with rapid motion. Since this sequence is available only in 60 Hz, a 50 Hz version is produced by adding gray bars on top and bottom to change the number of lines from 480 to 576.

(The final selection of which takes from the sequences to use for the Kurihama test should be made at the Paris meeting.)

Additional sequences will be used for further verification during the cooperative phase.

Test sequences will be supplied either on D1 or Exabyte. In general there

exists possibility to directly grab the test sequences from the CCIR library tapes if available. Those requiring the test sequences should contact their area coordinator:

North America: Hughes - D. Mead
(free on Exabyte, small charge for D1)

Asia : JVC - T. Hidaka

Europe : RAI - G. Dimino
(D1 only, send tape)
Dutch PTT - A. Koster (missing in Westerkamp's report?)
(Exabyte)

2) Test methodology

Formal subjective test will be carried out only for normal play based on the agreement that this is the most important decision criterion.

CCIR Rec. 500-3 "double stimulus" method is to be used. This method has been proven its effectiveness in numerous tests worldwide and the picture quality expected does not need special precautions in the testing procedure as was necessary last time because of the limited quality of the candidate algorithms.

Details of the testing method is described in Annex 2.

3) Test conditions

- The algorithm is tested at 4 Mbit/s and 9 Mbit/s; different parameter values are allowed but not fundamental change of algorithm.

- The maximum delay for random access (Note) must be less than about 2/5 second (10 frames at 25 Hz, 12 frames at 30 Hz). The coding delay (for random access?) is to be be specified (stated?).

  Note - The measure of single frame random access is defined as the maximum time elapsed from start to finish of reading from the DSM any frame following a request. See 7.2.3 of MPEG89/128.

- Fast forward/reverse operation must be demonstrated. This picture quality will not be tested.

- Pre-/post-processing is allowed only in a complementary forward/inverse pair (e.g. subband filtering). The resulting complexity must be taken into account when compiling the complexity figure. "Pre-conditioning" by pre-filtering only is not allowed, nor is "polishing" by means of post-processing.

- (pre-specified decoder buffer verifier? MPEG90/292)

- If compatibility with MPEG-1 is claimed, the resulting picture quality must be demonstrated.

- If a maximum coding delay of 150 msec is claimed by changing parameters, the resulting picture quality must be demonstrated.

- Any claims for additional features should be supported by

demonstrations.

6.2.2 Other functionalities

We considered a number of functionalities required for the second phase of MPEG work in terms of the following three categories (note that the list is not yet exhaustive). The objective was to maximize the efficiency and effectiveness of the "competition and collaboration process".

1) Require demonstration for proposal

- random access (see PPD of MPEG1 for the definition)
- fast forward
- fast reverse
- low codec processing delay

2) Check at the later stage

- repetition of coding-decoding
- protection against errors
- ATM network capability
- recovery of synchronization after an arbitrary point
- variable pel aspect ratio

3) Not consider at the moment

- normal reverse
- slow motion

Note: These functionalities are rather media dependent.

6.3 Audio

{6.4 DSM ?}

7. Verification of correct generation of test materials

{It should be decided whether bit stream file and executable code are required for submission of candidate algorithms.}

8. Evaluation of hardware implementability

It should be further studied how to evaluate the complexity of candidate algorithms.

Implementation Studies Group has concluded that it would not be possible to obtain any implementation scores for competing algorithms with sufficient accuracy or absolute value to allow meaningful collation with the picture quality scores from the subjective tests. The performance versus complexity compromise will have to be made in MPEG in the same way as in real life - a value judgment based on experience and instinct.

END

Table 1

	Application	Required performance	Bit rate (Mbit/s)	MPEG 1 Compati-bility	CCIR601 input / output format	Start from an arbitrary point	Special playing modes	Symmetry in allowed complexity	Notes
a	Digital video disk/VTR		3-5	yes			yes	C≃D	
b	Advanced videotex through B-ISDN or quasi distributire network			yes			yes	C≫D	
c	Interactive video on next generation DSM			yes		yes	yes	C≫D	
d	Reception / transmission of broadcast TV programs	Quality : NTSC/PAL/SECAM ~CCIR601			yes	yes		C≫D	· constant quality per ch. · statistical multiplexing · BER $<10^{-4}$
e	Reception / transmission of TV programs via CATV		<10		yes	yes		C≫D	
f	Recetion / transmission of TV programs via B-ISDN				yes	yes		C≫D	
g	ENG / SNG							C≪D	
h	Interpersonal audiovisual communications through B-ISDN							C≃D	
i	High quality multimedia applications involving trasmission of live video via computer networks (including FDDI) or distribution of stored information		~5					C≃D or C≫D	

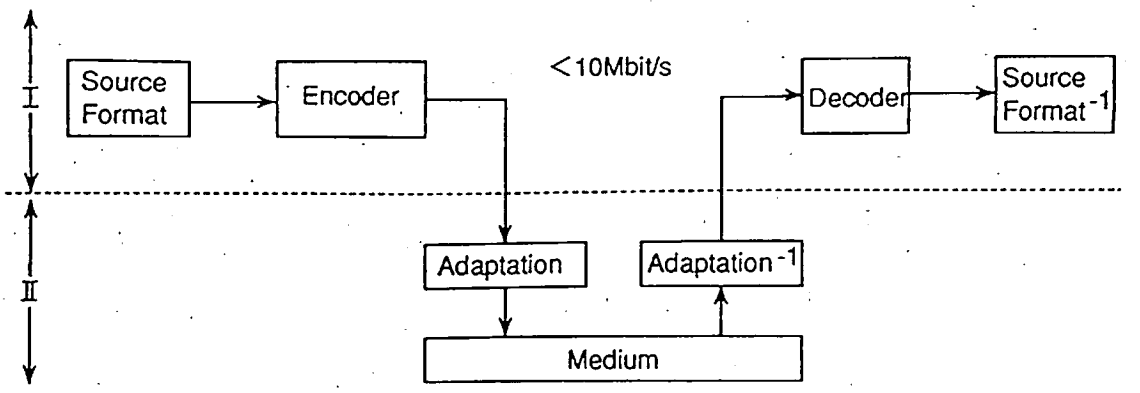

I
II
Source Format
Encoder
<10Mbit/s
Decoder
Source Format -1
Adaptation
Adaptation -1
Medium

Fig.1

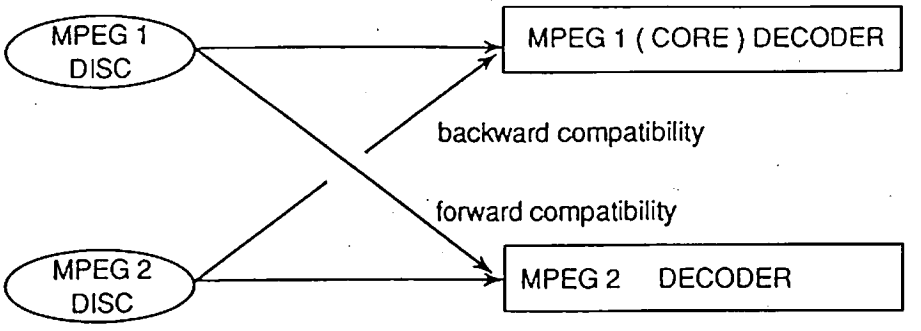
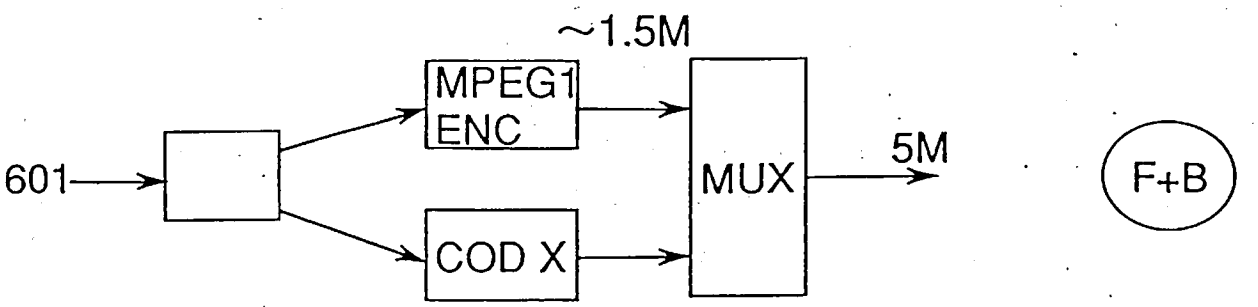
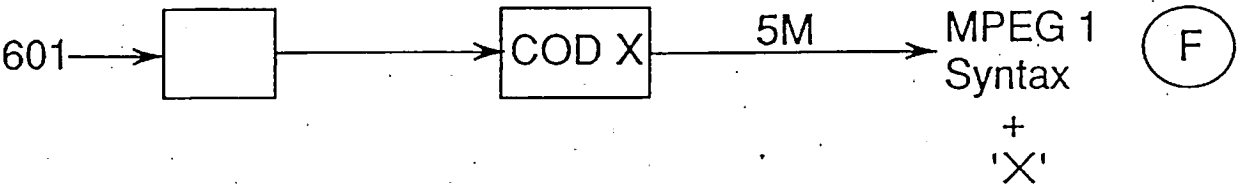

MPEG 1 DISC
MPEG 1 (CORE) DECODER
backward compatibility
forward compatibility
MPEG 2 DISC
MPEG 2 DECODER

Fig. 2

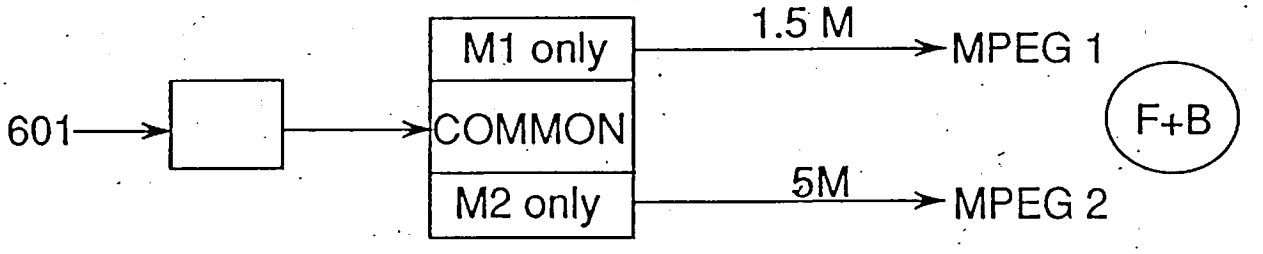
a) Multiplexed multiple bit stream approach



b) MPEG1 superset approach



c) Switchable equipment approach



Note 1: Bitrates are for example.
Note 2: Definition of forward- and backward compatibility is as follows.

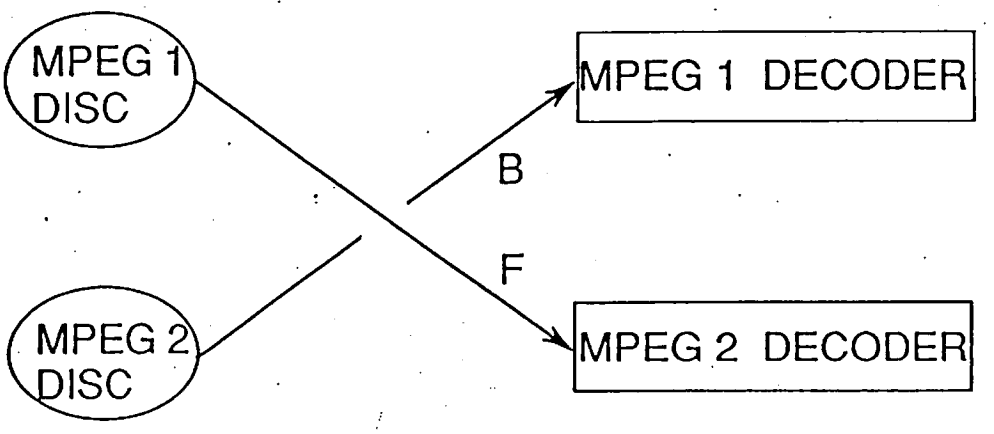


Figure 3 Examples of approach to "compatibility"

Annex 1

List of test sequences with the timecodes on the CCIR library tapes

(Reproduction of Annex 2 to Annex IX of MPEG90/349

The following table summarizes the above specifications of 5-seconds cuts of test sequences. Time codes are given as hh:mm:ss:ff - ss:ff.

Sequence	50 Hz	60 Hz
Table Tennis frames of 10 seconds already used time code	1 - 53 + 74 - 102 + 121 - 163 01:28:00:00 - 02:02 + 04:17 - 05:20 + 12:15 - 14:07	1 - 67 + 90 - 119 + 149 - 201 01:28:00:15 - 02:21 + 05:07 - 06:06 + 13:04 - 14:26
Flower Garden	01:14:23:08 - 28:07	01:14:17:17 - 22:16
Susie	01:15:06:00 - 10:24	01:15:07:00 - 11:29
Popple	01:27:05:00 - 09:24	01:27:05:00 - 09:29
Mobile&Calendar	01:29:19:00 - 23:24	01:29:17:15 - 22:14
Tempete without + with noise	01:43:07:00 - 09:12 + 44:11:00 - 13:11	01:43:07:00 - 09:15 + 44:07:00 - 09:13
Football	suppl. by Thomson/LER	01:37:13:23 - 15:23
Edited sequence: Table Tennis + Flower Garden + Susie + Popple + Mobile&Calendar	 frames 1 - 23 1 - 29 1 - 23 1 - 29 1 - 21	 frames 1 - 29 1 - 31 1 - 29 1 - 29 1 - 32

Annex 2

(Reproduction of MPEG90/254 "Subjective assessment procedures for high-transfer-rate MPEG" or its updated version)