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Working Party XV/1
Experts Group for ATM Video Coding

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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
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Title : Proposal Package Description for MPEG Phase 2
Source : Chair of Requirements Sub-group
Purpose: Proposal

Document MPEG91/100 for the subject matter has been distributed, which describes the agreements obtained at the previous three meetings; Santa Clara in September 1990, Berlin in December 1990 and Paris in May 1991. Editor's notes are included in { } for further clarification at the next meeting.

This document is an updated version, reflecting the results of the Santa Clara meeting in August 1991. Modified parts are indicated with bars at the left side margin.

List of contents

1. Purpose and content of this document

1.1 Scope of the MPEG-2 standards

Generic 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

The coding method to be defined is expected to have applications in many other areas, so the requirements of other applications will be taken into account during the definition of the MPEG-2 coding system, and close collaboration and liaison with the responsible standardization groups will be essential.

1.2 Target CD

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

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

{how about DSM? produce CD 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 describes the organization of MPEG and the time schedule until the standards are developed. §3 and §4 lists up all the requirements which should be met by the standards for high quality audiovisual coding as a long range target, namely in the course of Committee Draft development, while §5 describes the work method for this CD development. §6-8 provides information on how the candidate algorithms be tested and evaluated, including such practical matters as materials to be submitted.

2. CD development - organization and schedule

2.1 Organization

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2.2 Schedule

- June 30, 1991	Pre-registration for the Kurihama tests
- November 1991	Subjective tests for video at JVC-Kurihama
- Early 1992	Definition of "Test Model" for video coding study
- End of 1992	Development of CD
- 1993	Hardware verification

{other milestones? audio, system and DSM 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 Special Rapporteur's Group

aiming at avoiding 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

Note - Here are incorporated all the requirements identified in various documents. If there may be any contradictory requirements, they should be solved in the application standards.

3.1 Applications

For the second phase work of MPEG, the following application areas have been identified;

CTV	Cable TV Distribution on optical networks, copper, etc.
ENG	Electronic News Gathering (including SNG, Satellite News Gathering)
IPC	InterPersonal Communications (videoconferencing, videophone, etc.)
ISM	Interactive Storage Media (optical disks, etc.)
NDB	Networked Database Services (via ATM, etc.)
SSM	Serial Storage Media (digital VTR, etc.)
STV	Satellite TV Broadcasting
TTV	Terrestrial TV Broadcasting
RVS	Remote Video Surveillance

Their characteristics are summarized in Table 1.

Table 1

It has been expressed that STV 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.

Depending on the applications, the mean bit rate for video is envisaged as follows;

- 5 to 10 Mbit/s (CTV, ENG, STV, TTV)
- 2 to 10 Mbit/s (IPC, ISM, NDB)

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)

{to be confirmed by the audio coding experts}

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 of signal bandwidths assuming CCIR-601 input;

SIGNAL	LUMINANCE Bandwidth in MHz (Approximately)	COLOUR DIFFERENCE (I,Q) or (Cb,Cr) Bandwidth in MHz (Approximately)
Category 1		
PAL/SECAM	3.5	1.0
PAL/VHS(VCR)	2.5	0.6
NTSC	2.7	1.0,0.6
	quality level within 3-5 Mbit/s	
Category 2		
Close to CCIR Rec.601	5.75	2.75
	quality level within 8-10 Mbit/s	

The users of secondary distribution sources will require high levels of quality and low impairment levels, taking account of the viewing distance (4-6H for CTV/EDTV or 3H for HDTV), the entertainment value of the services and the lengthy viewing times. The following criteria concerning quality are concerning quality are considered desirable in the choice of the coding algorithm:

- For the majority of picture sequences representative of typical programmes, impairments shall be usually imperceptible (i.e. an impairment rating better than CCIR grade 4.5 is to be achieved).

- For a small number of picture sequences that are very critical, there is a probability that some impairment may be visible, dependent on content.

- No picture sequence shall create a catastrophic failure of the coding algorithm, but a gradual, graceful and progressive raising of the level of the impairments may be visible as extremely critical sequences are introduced, that are above the activity level of typical, critical programme sequences.

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, several features have been found which need technical investigation in the second phase work of MPEG.

1) Picture formats and display considerations

- Range of picture representations is to be covered

  CCIR-601 format
  720 x 243 x 2 x 30 (Note); 720 x 288 x 2 x 25
  Note - It should be noted that CCIR Rec. 601 defines active numbers per field as 243 for 525/60 systems.
  Coming EDTV format (16:9 aspect ratio)
  e.g. 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 25/30/50/60

- Square pixel representation capability is desirable.
- System for multiple screens/multiple images (e.g. picture in picture) is to be considered.
- Broadcast television and scalable window system (Note) are desirable.

  Note - A scalable video format is defined as one where the parameters of decoding are independent of those of encoding. A bitstream is scalable when some coded bits can be disregarded and a usable image still results. Scalability facilitates decoding the images at different rates and resolution scales through the design of the bitstream or data representation itself (see MPEG91/108).

- Raster format and quality are to be independently considered.

2) Flexibility in bit rates

- Variable bit rate video coding should be possible.
- Constant quality video coding should be possible.
- On-line transmission bit rate selection on demand should be possible.
- MPEG bit stream properties such as I-B-P structure may be utilized for statistical multiplexing.
- Buffering and rate control for multichannels should be considered.
- From a bit stream corresponding to a certain quality/bit-rate level it should be possible and easy to extract a bit stream corresponding to a smaller quality/bit-rate. Note - This is particularly required in LAN or multi-LAN environments.

3) Coding/decoding delay

- Short coding/decoding delay for conversational services (e.g. less than 150 ms, a more precise required value needs further clarification)
- 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
- for conditional access

5) Error protection for different channels

- Selective protection for headers etc.
- More frequent synchronization words for noisy channels
- Error resilience for cell loss encountered in ATM networks

- Robustness to data corruption can be stated as follows from the implications of the transport media;

    * High quality service at BER of 10^{-4} including error bursts of up to 30 bits (necessary for ENG, STV, TTV)
    * Service continuity at BER of 10^{-3} including error bursts of up to 30 bits (necessary for ENG, STV, TTV)
    * Service continuity after loss of multiple successive ATM cells, i.e. up to e.g. about 1500 missing bits (necessary for IPC and NDB via ATM networks)

{Specific required values need reference to well established papers}

While the channels used for secondary distribution of television are generally near error-free, unusual circumstances may introduce significant levels of errors. In that situation, it is believed desirable that;

- in the presence of uncorrectable errors, the decoder should fail gracefully (progressive and gradual increase of impairment levels with increasing error-rate and may resort to error mitigation techniques (e.g., error concealment) to maintain acceptable output.

- a priority must be placed on the maintenance on the recovery of synchronisation during error overloads.

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

7) Adaptation to various storage and transport methods

{technical implications to the video coding should be clarified}

a. DSM

{ }

b. ATM networks

- The video coding system must optimize performance, in terms of picture quality and end to end delay, on the B-ISDN. This must include cell loss tolerance and could take advantage of VBR coding.

- The video coding system must provide for maximum integration of all video services on the B-ISDN.
- The video coding system must permit advantage to be taken of the flexibility of transport offered by the B-ISDN; high/low priority channels, VC (Virtual Channel) based multimedia multiplex, multipoint distribution in the network, etc.
- The video coding must provide rate control for conforming to the usage parameter control of the network.

  Note - "ATM Networks" are not a type of media, but a transport method which is independent of the medium. It could be used as the transport for the satellite/terrestrial broadcasting applications mentioned in (c), for example.

c. Satellite broadcasting

- The video coding system must have adequate performance at low C/N levels.

  * The video coding system must provide a graceful failure mode during heavy rain attenuation periods,
  * provide robustness against interference,
  * able to operate in saturation region of a satellite TWT transponder.

d. Terrestrial broadcasting

- Provide robustness against ghosting.
- Provide robustness against interference
- Optimized performance achievable possibly with CO FDM techniques

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

9) Complexity of coder and decoder

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

- high performance encoder with low complexity decoder
  e.g. CTV, ISM, NDB, STV, TTV
- balance of performance / complexity between encoder and decoder
  e.g. IPC, SSM
- low complexity encoder with high performance decoder
  e.g. ENG/SNG

The standard should be flexible enough to allow both high performance / high complexity and low performance / low complexity coders and decoders.

It was also pointed out that capability to operate in intraframe mode only may offer advantages in some cases (e.g. for low complexity).

This issue of balancing coder and decoder complexities 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.

10) Compatibility

a. Definition

Upward and downward compatibility

Compatibility here refers to a transmission system, where different picture formats are used for the video encoder and video decoder. Different picture formats do not imply different standards. The system is:

- **upward compatible** if a higher resolution receiver is able to decode pictures from the signal transmitted by a lower resolution encoder.

- **downward compatible** if a lower resolution receiver is able to decode pictures from the signal or part of the signal transmitted by a higher resolution encoder. Two ways of downward compatibility can be discerned:

  * The decoder reconstructs the entire picture at lower resolution.
  * The decoder reconstructs a window of the input picture.

  When no further notice is made, it is assumed the decoder reconstructs the entire picture at lower spatial resolution. The frame rate is not necessarily equal.

Forward and backward compatibility

Here, compatibility refers to a transmission system where different standards are used for video encoder and video decoder, i.e. an existing standard and a new standard. The picture formats of these standards can, but need not differ. The system is:

- **forward compatible** if the new standard decoder is able to decode pictures from the signal or part of the signal of an existing standard encoder.

- **backward compatible** if an existing standard decoder is able to decode pictures from the signal or part of the signal of a new standard encoder.

See Figure 2. It is assumed the entire input picture is reconstructed by the decoder, possibly at different spatial or temporal resolutions.

Figure 2

There are several possible implementation methods for these compatibilities; simulcasting, embedded bit stream, syntactic extension, switchable encoder, standard families. Definitions for these methods are given in Annex 1.

b. General views on forward/backward compatibility

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.

In summary, there are two contradictory views on this issue. From the point of view of those applications where the use of MPEG 1 is envisaged, both forward and backward compatibilities are considered to be important (IPC, ISM, NDB). From the point of view of other applications, compatibility is not considered to be important and should not be allowed to jeopardize quality and/or coding efficiency (CTV, ENG, STV, TTV).

For compatibilities between MPEG standard and other standards, the followings need consideration;

- It is desirable that cascading a CMTT contribution quality codec with an MPEG codec should give zero or negligible reduction in quality (CTV, ENG, STV, CTV).
- Compatibility with H.261 should be taken into account (IPC, NDB).

For the "future" backward compatible extension of the new high quality video coding standard, some provisions are required such as "extension_start_code" in MPEG-1 and "PEI/GEI" in H.261.

c. General views on upward/downward compatibility

- A range of TV and HDTV formats should be covered by the new standard.
- Compatibility with future HDTV coding should be taken into account (CTV, ENG, STV, TTV).

d. Guideline

We discussed in Santa Clara, Berlin and Paris 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.

e. 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

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

f. Requirement for the algorithm proposal

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

g. 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 5.4.

h. Conclusion

This issue should be further studied from various points of view. It is noted that several contributions have suggested "layered coding" may provide a solution for the compatibility issue.

Contributions are awaited.

11) Multimedia multiplex

- Medium may contain multiple audiovisual services.
- Statistical multiplexing of multiple services should be possible.
- Medium may contain additional data (e.g. Teletext) or audio-only services.
- Differing methods may be applicable according to the medium. For ATM networks, Virtual Channel based (namely cell based) multiplex may be suitable.

12) Transcoding

- The ability to perform real-time transcoding between different bit rates is desirable.

13) Lifetime of the standard

- The lifetime of a TV distribution standard is expected to be some tens of years, during which the technology of TV receivers and of storage media will evolve. The standard must not be bound to the present state-of-the-art in receivers and recorders, conversely, allow for harmonized evolution of the functionalities and the technologies of these terminals.

14) Editing encoded bitstreams

- The ability to edit encoded bitstreams is desirable (see MPEG91/155).

3.5 Implementation aspects

Algorithm developers seek solutions which allow flexibility in the choice of implementation architectures, thus giving manufacturers the opportunity to design equipment for the widest range of applications.

4. Particular requirements (if identified)

4.1 System requirements

- Relative timing of sound and vision (lip sync) should be within the range:

-20 ms < sound delay relative to video < +40 ms

for existing television standards (see CCIR Rec. 772)

- System multiplex must include provision for time codes, source codes, transmitter codes

4.2 Video requirements

- Relation to H.261/H.26X, CCIR Rec. 723
- Provision for real time aspect ratio changes

    * Pan/scan
    * Letter box changes

4.3 Audio requirements

4.5 DSM requirements

5. Work method

5.1 Competition and collaboration

The MPEG-2 work is divided into the competition phase and the collaboration phase. 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 combination 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 2).

5 second sequences from

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

5 seconds of

- Football (Note 2)

<u>Note 1</u> - "average TV picture material" but not covered in the test sequences

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

<u>Note 2</u> - 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.

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 (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.

Reference to the detailed testing method is given in Annex 2.

3) Test conditions

a. The algorithm is tested at 4 Mbit/s and 9 Mbit/s.

b. Test sequences shown in Table 2 are used in the Kurihama test. The selection of the number of overlapped sequences depends upon the number of proposals, namely the capacity of testing facilities and testing hours.

c. Maximum interval between two entry points for random access must be less than about 2/5 second (equivalent to 10 frames at 25 Hz, 12 frames at 30 Hz)

d. Coding and decoding delay should be stated (including a single frame, namely two fields in a set, random access).

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

f. For the Kurihama test purposes, the input and output signals are both CCIR 601 4:2:2 ones. Some coding algorithms may subsample or crop the input signal, which should be stated in the coding algorithm description. Different parameters or even different algorithms may be switched for 4 Mbit/s and 9 Mbit/s, but the bit stream should contain all the necessary bits for the purpose so that the decoder can correctly identify these parameters and operate.

g. Every coding algorithm proposal should describe what compatibility features it has and demonstrate the processed pictures in the claimed compatibility mode(s) such as illustrated in Figure 4(a).

h. The greatest degree of compatibility would be achieved by a core MPEG-1 decoder operating on a bit stream in the range of 1.0-1.5 Mbit/s.

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

j. Any claims for additional features (such as cell loss and random bit error resilience) should be supported by demonstrations.

4) Materials to be submitted

a. Description

Every proposer is requested to submit the proposal document according to the MPEG document management agreement (see Recommendation 9.4 of the WG11 Santa Clara meeting).

It is noted that the hosting laboratory, JVC, does <u>not</u> provide copying service for these algorithm proposal documents.

Good documentation containing the following materials is requested to make convergence easier after the Kurihama tests (see §5.3 for objectives of the subjective tests)

- Algorithm including block diagram and syntax diagram

- Compatibility feature
- Random access feature
- Coding/decoding delay
- Any other functionalities

- VLC, FLC tables employed for coding of classification related overhead, motion vectors, coefficient data, various synchronization words, etc.

- Statistics

  * number of bits and SNR for each frame
  * cumulative bit count once every 0.4 second (excluding the last 0.2 second) for each sequence
  * several items (such as motion vector count, luminance and chrominance bit counts, overhead bits) averaged over each sequence following the formats in SM3/RM8 tables as a guideline

- Paper listing for each sequence which indicated the corresponding coded bit stream file in a format "ls -l" output (see §7 of this document)

- Implementation document - must list for encoder and decoder

  * number and sizes of all picture buffers, including necessary display buffers
  * size of coded date buffer

- for each module

  * size and width of memory (on/off chip)
  * memory bandwidth (on/off chip)
  * number and width of additions per second
  * number and width of multiplications per second
  * table sizes (specify fixed or downloaded)
  * number of table lookups per second (specify fixed or downloaded)
  * a functional description including data, control, and address generation function and flow. Similarly, if any,

to well known modules such as DCT, VLC decoder should be pointed out. Any "tricks" that can simplify implementations e.g. symmetry in tables should be stated.

- global

  * Any implementations on coder and decoder when altering modes, parameters etc. to suit applications.
  * Any claims with supporting justification that the algorithm is amenable to simple,cheap implementation.
  * Block diagrams etc. and explanation of algorithm operation (likely to be similar to, if not same as, information required by VIDEO group)

- It is a very desirable objective that it be possible to implement fully automatic encoders. The extent to which any non-automtic adjustment of coding parameters has been used to generate the pictures submitted to the Kurihama tests must be declared. The nature of these must be described such that an assessment can be made of the feasibility of eventual automation in real encoders.

b. D-1 tape for subjective tests of normal playback for agreed test sequences at 4 Mbit/s and 9 Mbit/s

c. D-1 tape for demonstration excluding the normal playback pictures

- fast forward
- fast reverse
- compatibilities if claimed
- low coding/decoding delay mode pictures if claimed
- any other functionalities if claimed (Note)

<u>Note</u> To demonstrate cell loss resilience, it is recommended to simulate 10^{-3} cell loss ratio, e.g. by replacing 384 coded bits every 0.1 sec with '0', decoding the resultant bit stream and reconstructing pictures. Exact method of simulation should be described.

Each proposer is requested to bring his/her D-1 tape directly to the meeting for demonstration of those features other than normal play back (see §6.2.1 4) c.).

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

- fast forward
- fast reverse
- low codec processing delay (if claimed)

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

During the Paris meeting, the followings were identified as items to be considered in the collaboration phase work;

- Artificial patterns to check particular elements in the coding algorithm such as presented in MPEG91/021.
- Coding performance for progressively scanned materials. For this purpose, provision of test sequences and monitors should be further considered.
- Conversion from CMTT to MPEG coding as in MPEG91/065.
- partial decoding and recoding for rescaling
- on-line transmission bit rate selection on demand

3) Not consider at the moment

- normal reverse
- slow motion

<u>Note</u> - These functionalities are rather media dependent.

6.3 Audio

{6.4 DSM ?}

7. Verification of correct generation of test materials

Each picture to be tested at Kurihama should be reconstructed from a coded bit stream. A paper listing should be given for each sequence which indicates the corresponding coded bit stream file in a format such as UNIX "ls -l" output.

Decoder executable codes should be made available upon request of MPEG. If this requirement is not met, the proposal can not be considered as part of promising schemes.

8. Evaluation of hardware implementability

Implementation Studies Group meeting in Berlin had come to the conclusion that the complexity assessment procedure used for MPEG-1 should not be repeated for MPEG-2. It had been an objective process which produced hard numbers. However, there were severe doubts about the accuracy of such numbers. There would also be the difficulty of converting these numbers into agreed units which could be combined with the results from the picture quality tests etc.

The meeting in Paris agreed to use a subjective process in which the proposals would be rank ordered. The first stage would involve assessment by implementation experts working individually. Their rankings would then be compared. Hopefully these would be similar but if not, discussions would take place to reach a common view.

It was thought to be too demanding to assess in detail all the candidates as some 20 to 30 are expected. Some pre-selection will therefore be required. The group felt strongly that simply taking those which did best in the picture quality tests should not be the pre-selection method.

The aim of the complexity assessment would be to provide information to enable MPEG to progress after the November tests. The Implementation Studies group would in effect seek to classify proposals into three groupings:

- algorithms which are much simpler than average to implement. Even if their picture quality were not among the best these should not automatically be discarded. The collaborative efforts of MPEG might be able to improve their quality while retaining some or all of their simplicity.

- algorithms which are much more complex than average to implement. Even if their picture quality were among the best these should not automatically be retained. MPEG would have to decide whether the extra picture quality was worth the extra complexity and whether other simpler approaches could be improved to be competitive.

- algorithms which are of average complexity to implement. For these the implementation complexity would not be a major factor in deciding to retain or discard them.

In addition to the descriptions, block diagrams, flow charts etc. which will accompany proposals some other information could be helpful to assessors. It was suggested that the group devise a questionnaire for proposers to complete.

END

Table 1

	Application	Required performance	Bit rate (Mbit/s)	MPEG 1 Compatibility	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	Network database through B-ISDN or quasi distributive 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 Cable TV		<10		yes	yes		C≫D	
f	Recetion / transmission of TV programs via B-ISDN				yes	yes		C≫D	
g	ENG / SNG							C≪D	
h	Remote video surveillance RVS					yes		C≪D	
i	Interpersonal audiovisual communications through B-ISDN							C≃D	
j	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	

Table 2 Test sequences

Picture \ No. of common pictures / Bit rate	2 (4 M)	2 (9 M)
A : Flower Garden	X	X
B : Suzie		
C : Popple		X
D : Table Tennis	X	X
E : Mobil and Calender	X	X
F : Tempete		
G : Edit		
H : Football	X	
NUMBER of TEST PICTURES	4	4

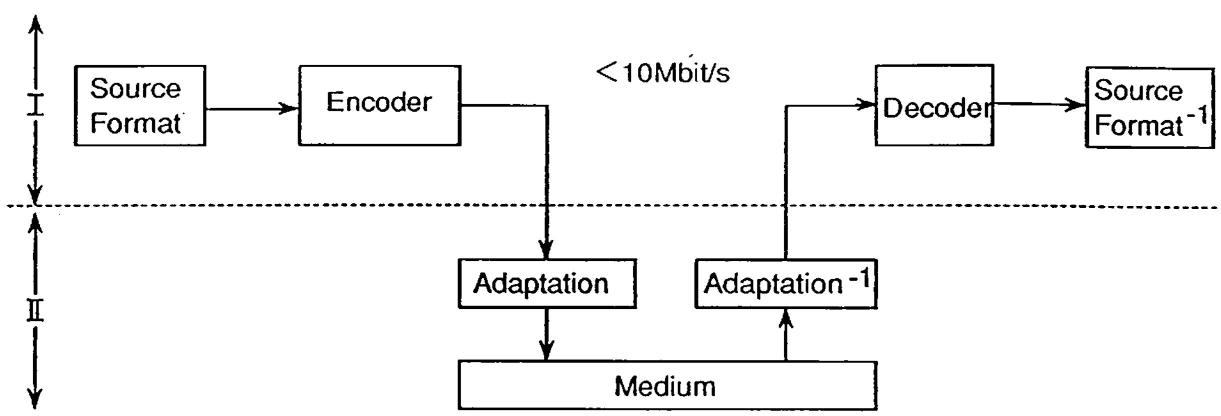


Fig. 1

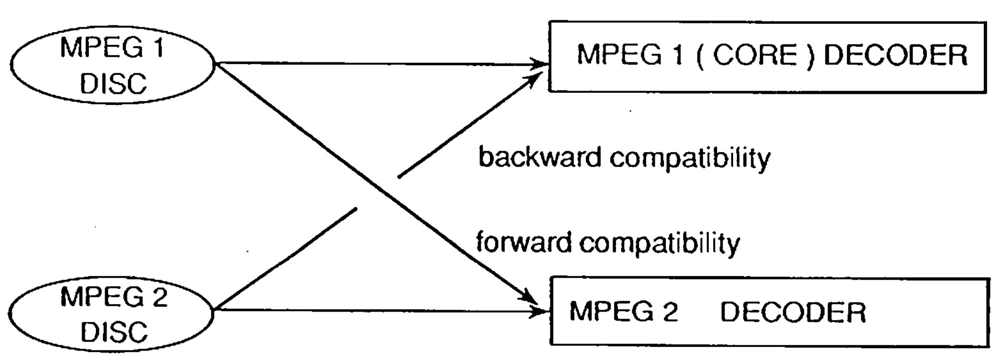
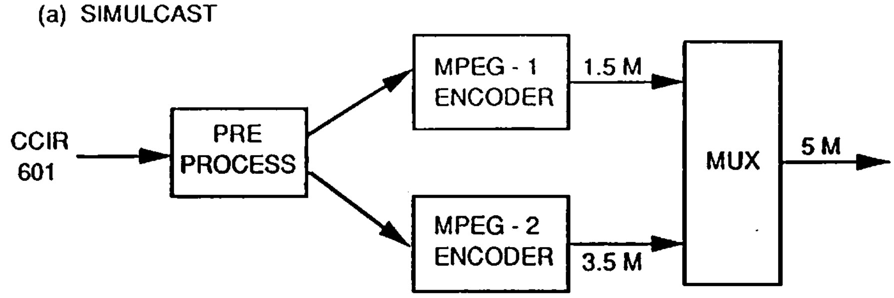


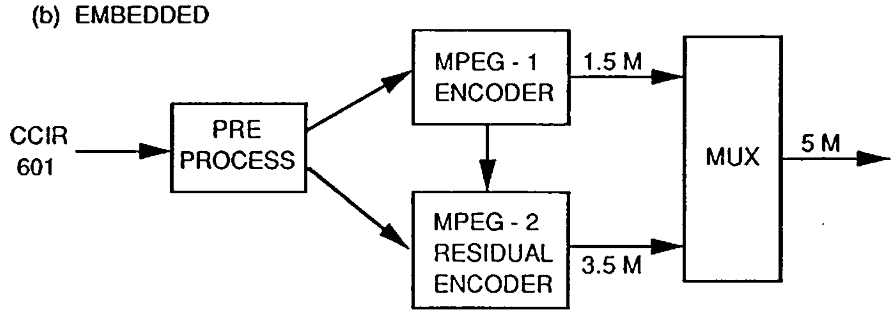
Fig. 2

Fig. 3 VARIOUS COMPATIBLE SCHEMES

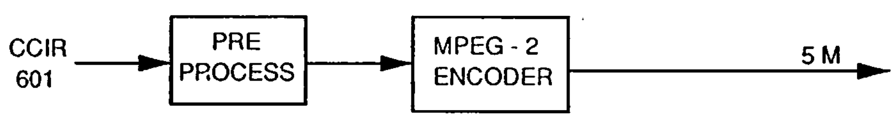
(a) SIMULCAST



(b) EMBEDDED

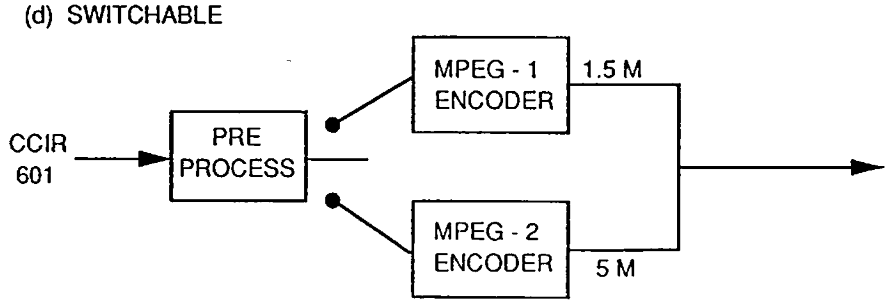


(c) SUPERSET



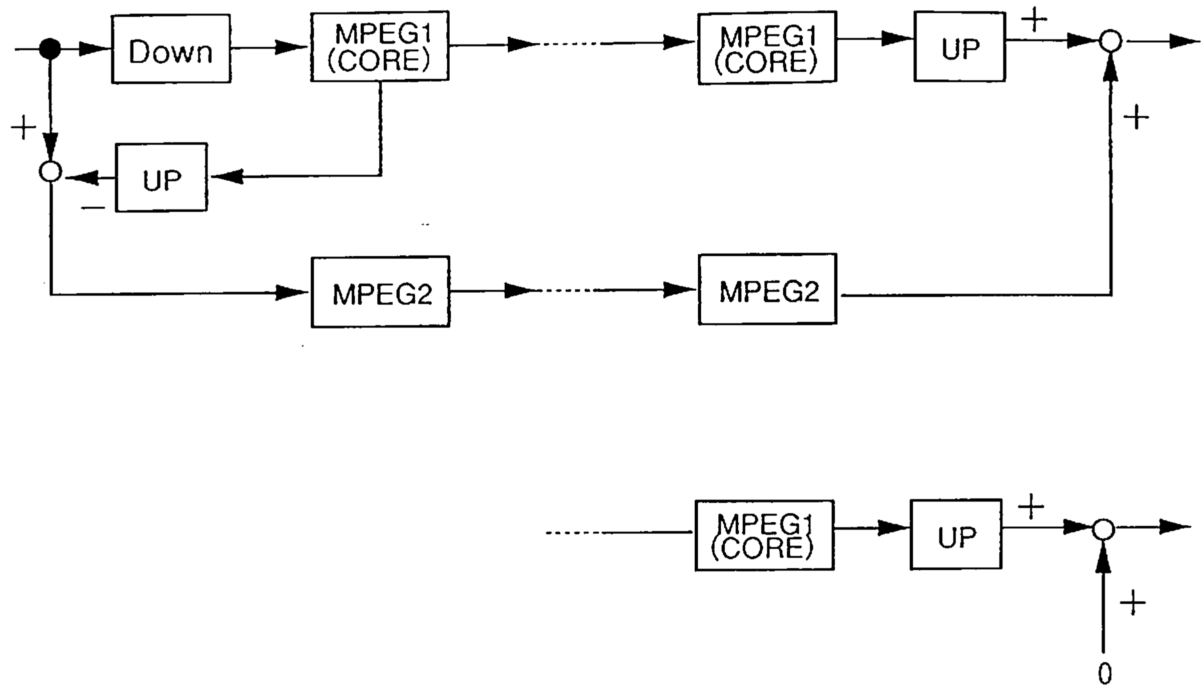
MPEG -2 Syntax = MPEG -1 Syntax + EXTENSION Syntax

(d) SWITCHABLE

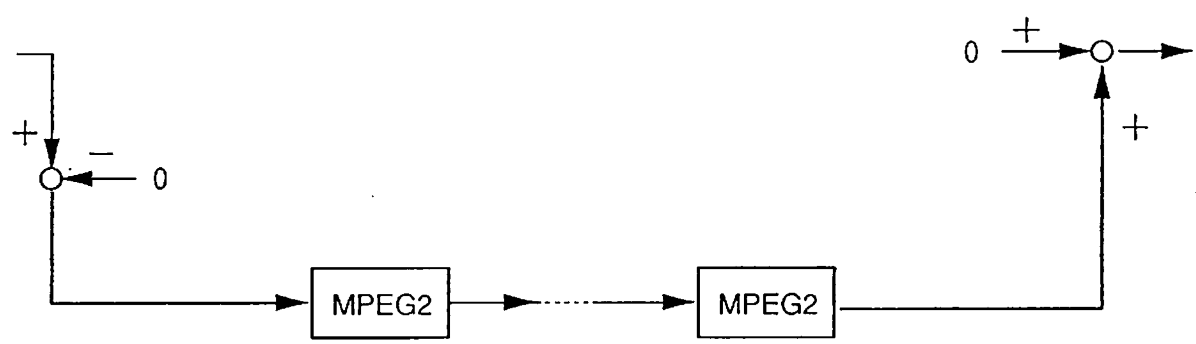


COMPATIBITY FEATURES SUMMARY

SCHEME	FORWARD COMPATIBILITY	BACKWARD COMPATIBILITY	UPWARD COMPATIBILITY	DOWNWARD COMPATIBILITY
SIMULCAST	NO GUARANTEE	YES	NO GUARANTEE	YES
EMBEDDED	YES	YES	YES	YES
SUPERSET	YES	NO	YES	NO
SWITCHABLE	YES, IF BOTH STANDARD MODES EXIST		YES, IF BOTH RESOLUTIONS EXIST	



a) Compatible mode



b) Non-Compatible mode

Figure 4 Operational modes

Annex 1 Definition of compatibility methods

1) <u>Simulcasting</u>

In this case the encoder system is characterized as follows. Typically, two encoders operate in parallel, one according to an existing standard and picture format, the other according to a new standard and/or picture format.

a - It transmits N (with N > 1) multiplexed streams of data, which may be separated at the decoder.
b - Data streams 1..K-1 (with K <= N) are decodable by an existing standard decoder after demultiplexing.
c - In a new standard decoder pictures are decoded from a set of one or more data streams K..N without making reference to data streams 1..K-1.

Backward compatibility is achieved by feature b, whereas forward compatibility is not guaranteed. A new standard decoder will discard the existing standard data streams 1..K-1. Decoding of the existing standard may or may not be included as a special option.

Considering upward and downward compatibility, downward compatibility is achieved by feature b, while upward compatibility is not guaranteed, as the information for the two picture formats is transferred and processed independently.

In principle, this compatibility method under certain circumstances could be wasteful of bandwidth as the same picture information is transferred several times in different multiplexed data streams.

2) <u>Embedded bit stream</u>

In this case the encoder is characterized as follows:

a - It transmits N (with N > 1) multiplexed streams of data, which may be separated at the decoder.
b - Data streams 1..K-1 (with K <= N) are decodable by an existing standard decoder (backward) or a decoder with smaller picture format (downward) after demultiplexing.
c - From data streams 1..K-1 pictures may be decoded without reference to the other data streams, but decoding pictures from a data stream M (with K <= M <= N) is not possible without making reference to one or more of the data streams 1..K-1. Data streams K..N carry information additional to data streams 1..K-1.

Backward or downward compatibility are achieved by feature b. Forward compatibility is achieved as the new standard decoder can decode pictures of existing standard quality from data streams 1..K-1 only.

This also implies that upward compatibility is achieved, as data streams 1..K-1 carry lower resolution pictures, while data streams K..N carry the additional information for full resolution pictures.

In principle there is no waste of bandwidth since the N multiplexed data streams carry complementary information only. In practice however, the constraint of an existing standard or for the data streams 1..K limits the achievable coding efficiency when comparing with an equivalent stand-alone system.

3) Syntactic extension

In this case only one data stream is transmitted. The data stream produced by the new standard encoder has a syntax which is an extension of the existing standard. This allows for forward compatibility, as the new standard decoder is equipped for the syntax of the existing standard and may decode the existing standard when little adaptations in the decoding process are made.

A similar description is possible for upward compatibility: the data stream for the full resolution pictures is an extension of the data stream for the lower resolution pictures, such that the full resolution decoder can decode the signal of the lower resolution encoder.

Backward or downward compatibility is not achieved by this method, as the signal for the existing standard or lower resolution decoder as such is not embedded or simulcasted in the data stream. A transcoder with more than a demultiplexer and multiplexer would be needed to obtain the existing standard or lower resolution signal.

4) Switchable encoder

This method of compatibility is mainly intended for services where the type of receiver(s) can be identified by the transmitter, e.g. for point to point conversational services.

The encoder is characterized as follows:

a - It transmits one stream of data only.
b - To achieve forward and backward compatibility, the encoder is capable to operate in new standard or existing standard mode. For upward and downward compatibility, the encoder must be capable to produce the signal for full resolution or for lower resolution decoders.
c - Encoder and decoder(s) negotiate to determine which standard and/or picture format will be used for the connection.

5) Standard families

This is not a compatibility method, but allows for joint developments for several standards. A new standard having many commonalities with an existing standard, or a family of standards for several picture formats, may reduce efforts for development and optionally facilitate development of dual(or multiple) standard equipment. This may be beneficial for introduction of a new service.

Note to "Layered Coding"

Both "Embedded Bitstream" and "Syntactic Extension" compatibility methods are versions of layered coding. The difference between the methods is that all the data passes through the decoder (though some may be ignored) in the case of "syntactic extension". With the "embedded bitstream" method, the unused bitstreams need not be presented to the decoder.

Annex 2

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

Table Time code of test sequences

sequence	50Hz	60Hz
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 01:28:00:14 - 02:20 + 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 - 18:22
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 3 Subjective assessment procedures for high-transfer-rate MPEG

The following MPEG documents provide detailed information on the subjective tests to be carried out at Kurihama in November 1991;

MPEG91/023	Chair/Test	Data processing for MPEG-2
MPEG91/024	Chair/Test	Actual MPEG-2 assessment
MPEG91/025	Chair/Test	D-1 tape editing for MPEG-2 assessment
MPEG91/026	Chair/Test	Schedule for MPEG-2 assessment
MPEG91/027	Chair/Test	Format of MPEG-2 D-1 test tape
MPEG91/028	Chair/Test	Subjective assessment procedure for MPEG-2
MPEG91/116	Chair/Test	Details of MPEG-2 subjective assessment

END