FCC Advisory Committee
Experts Group on Production
& Receiver/VCR Impact

July 14, 1993

MEMORANDUM

1.0 BACKGROUND

Transmission standards proposals prior to the formation of the Grand Alliance assumed a single-format, either 720 p-scan, or 960 or higher i-scan*.

The Alliance has proposed a transmission standard with a multiple scanning format of 720 p-scan/960 i-scan and a migration path to 960 p-scan. (A copy of the Alliance press release is *Attachment 1*.)

The Technical Subgroup, based on work done in the Advanced Television Systems Committee (ATSC), has recommended use of 720 p-scan/1080 i-scan, and a migration path to 1080 p-scan.

As a result, the HDTV transmission standard scenarios under discussion are as follows:

SCENARIO	TRANSMISSION FORMAT(S)	WITH MIGRATION PATH TO . . .
1	720 p-scan (s)	960 p-scan
2	960 i-scan (s)	960 p-scan
3	720 p-scan/960 i-scan (m)	960 p-scan
4	720 p-scan (s)	1080 p-scan
5	1080 i-scan (s)	1080 p-scan
6	720 p-scan/1080 i-scan (m)	1080 p-scan

Legend:
s = single format
m = multiple format

Attachment 2 diagrams these scenarios ("Possible Grand Alliance HDTV Transmission Formats").

The Alliance is of the view that the cost and delivery dates of the professional and consumer equipment needed to support a multiple scanning rate format is not materially

* All scanning formats in this Memorandum and its Attachments are stated in active lines and active horizontal samples. Progressive scan = p or p-scan; interlaced scan = i or i-scan.

different from that for equipment needed to support a single scanning rate format. Our ACATS Experts Group is seeking your views on that issue.

The Technical Subgroup is of the view that the cost and delivery dates of the professional and consumer equipment needed to support a 720 p-scan/1080 i-scan(m) scenario is not materially different from that for equipment needed to support a 720 p-scan/960 i-scan(m) scenario. Our ACATS Experts Group is seeking your views on that issue.

Both the Alliance and the Technical Subgroup want to plan now for a migration path to a higher line-rate, p-scan system. Our ACATS Experts Group is seeking your views on the feasibility, cost and delivery date impacts of accommodating that migration capability in current HDTV equipment.

2.0 HDTV STUDIO ORIGINATION EQUIPMENT

(a) Production Format Assumptions

For purposes of analyzing the impacts on the manufacture and delivery of HDTV studio origination equipment, we are prepared to assume the following production formats will be used with the following transmission formats:

TRANSMISSION	PRODUCTION	
Spatial (H x V)	Spatial (H x V)	Sampling Frequency (MHz)
"Current"		
1280 x 720 p	1280 x 720 p	75.3
1440 x 960 i (approximate)	1920 x 1080 i	74.25
1200-1400 x 1080 i (approximate)	1920 x 1080 i	74.25
"Future"		
1440 x 960 p (approximate)	1920 x 1080 p	148.5
1920 x 1080 p	1920 x 1080 p	148.5

Legend:
H = Horizontal (active samples per line)
V = Vertical (active lines)

Attachment 3 diagrams the above relationships ("Possible HDTV Production Formats as Recommended by the ATSC").

(b) Questions for Professional Equipment Makers

We ask you to advise us of the cost and estimated delivery dates (projected from the time the FCC releases its Final Order on the HDTV Standard) of HDTV production equipment in the following production formats, together with any bases or assumptions utilized:**

Spatial (H x V)	Sampling Frequency (MHz)	Cost	Delivery Dates
1280 x 720 p	75.3		
1920 x 1080 i	74.25		
720 p/1080 i (dual format)	75.3/74.25		

Attachment 4 lists the items of production equipment for which we are seeking information.

Please identify the relative impacts, if any, on operational costs, complexity or delivery date of using one or the other of the identified production formats.

Do you believe that equipment in any or all of such formats would continue to be useable in a 960 p-scan or 1080 p-scan transmission environment? Which equipment format, if any, would be more readily useable in, or upgradeable to, such an environment? Please explain.

Finally, if you have any basis now to estimate the cost and delivery date of HDTV studio origination equipment in the 1920 x 1080 p-scan format, please give us your estimates and the basis therefore.

3.0 HDTV CONSUMER EQUIPMENT

Our ACATS Experts Group, as noted above, must also evaluate the cost and timing impacts of multiple-scan transmission formats and forward compatibility on various types of HDTV consumer equipment (CE), such as receivers, VCRs, laser disc players, cable converters, and other future equipment, such as CDs and flat panel displays.

** You may use other existing equipment as a reference, *e.g.* SMPTE 240M (1125/60) or Eureka 95 (1250/50). If you do so, please identify the reference and the percentage variations from that reference.

(a) Transmission Format Assumptions

Please note that the questions regarding consumer equipment (*Attachment 5*, Questionnaire on HDTV Consumer Equipment") assume that the transmission formats to be analyzed are those six scenarios set forth in paragraph 1.0 above.

The questionnaire seeks to evaluate each proposed single-scan format in order to understand their differences and to form a reference against which to compare the proposed multiple-scan formats. The questionnaire also seeks to evaluate each of the different proposed multiple-scan formats.

Finally, the questionnaire seeks to evaluate the cost and timing impacts of forward compatibility for the two potential migration paths. Compatibility among the different consumer equipment products should also be taken into account.

To help you make your assessment, we have attached a block diagram (*Attachment 6*, "ATV Receiver") of an HD receiver which includes the necessary functions to receive and display NTSC signals and to do format conversion. The receiver also must handle 24, 30, and 60 Hz transmission frame rates since the proposed Alliance system will do source adaptive coding to avoid transmitting redundant bits when, for example, transmitting 24-frame per second movies. Please assume this block diagram in your assessment. You may also find it useful in considering other kinds of consumer electronics equipment (VCRs, etc.).

Please note that the receiver is a single display format. The questionnaire requests information about this.

(b) Questionnaire for Consumer Equipment Makers

Using the attached questionnaire (*Attachment 5*), please indicate, relative to an identified reference system, the percentage difference in cost and operational complexity (±%).

Please note that, in 1992, the ACATS Systems Subcommittee Working Party 3 (Economic Assessment) Receiver Costs Task Force assumed second generation receivers manufactured in quantities of one million in a single year (1998). Please use this assumption.

For delivery dates, please indicate for the reference system you select and for other systems cited in the questionnaire the time you believe it will take for consumer electronics equipment initially to become available to consumers from the time the FCC releases its Final Order on the HDTV transmission standard.

For example, please respond by providing your estimation in the following form:

Reference System	Cost	Operational Complexity	Implementation Time
720 p	±%	±%	_____ years
960 i	±%	±%	_____ years

Finally, please comment on any assumption or consideration which you believe needs elaboration.

4.0 FRAME RATE

A recent ATSC analysis recognized that the HDTV broadcasting infrastructure should operate at 59.94 Hz (in order to ensure a simplified HDTV/NTSC simulcast operation) while, at the same time, independent production and post-production facilities would prefer to operate at 60.00 Hz. Thus ATSC recommended that:

- Broadcasters operate HDTV at 59.94 Hz for the "simulcast period" (approximately 15 years during which both NTSC and HDTV would be operating).
- When NTSC shuts down, broadcasters switch to 60.00 Hz.
- HDTV production equipment be switchable between 60.00 and 59.94 Hz.
- HDTV receivers be capable of 60.00/59.94 operation from the outset.

Based upon this recommendation, can you comment on the following:

(a) What are the cost implications of dual frame rate capability in HDTV production equipment, versus a choice of one single rate?

(b) What are the cost implications of dual frame rate on HDTV receivers, versus a single rate?

* * *

Attachments:

(1) ACATS press release announcing formation of the Grand Alliance, May 24, 1993
(2) "Possible Grand Alliance ATV Transmission Formats"
(3) "Possible HDTV Production Formats as Recommended by the ATSC"
(4) "List of Production Equipment"
(5) "Questionnaire on HDTV Consumer Equipment"
(6) Block Diagram of "ATV Receiver"

Advisory Committee on Advanced Television Service

FOR IMMEDIATE RELEASE: May 24, 1993

HDTV 'Grand Alliance' Proposal
Will Be Considered by FCC Advisory Committee

Washington, D.C. The Federal Communications Commission's Advisory Committee on Advanced Television Service (established by the Commission in 1987) will review a single digital high definition television (HDTV) system proposed today by a "Grand Alliance" of entities that, until now, had sponsored the four remaining competitive HDTV systems. These entities (AT&T, the David Sarnoff Research Center, General Instrument, Massachusetts Institute of Technology (MIT), North American Philips, Thomson Consumer Electronics, and Zenith Electronics) today reached a business and technical agreement and submitted to the Committee a merged system proposal.

The proposed system, if recommended by the Advisory Committee and adopted by the FCC, could place the U.S. in the forefront of high definition video technology. An all-digital standard, which would facilitate interoperability among broadcasting, cable, computer, and telecommunications technologies, has worldwide potential.

Advisory Committee Chairman Richard E. Wiley, who had encouraged the complex negotiations leading to the agreement, said "I believe the Grand Alliance proposal, subject to Advisory Committee and ultimate FCC approval, will help to conclude a process that has fostered the development of highly advanced digital HDTV technology. The members of the Alliance should be commended for their accomplishments." Wiley added that the benefits of the Grand Alliance include development of a digital system incorporating the

best elements of the four systems and acceleration of HDTV service implementation. The FCC's Advisory Committee endorsed the Alliance concept at a meeting in February.

Important aspects of the Grand Alliance technical proposal submitted today include the employment of progressive scan transmission (where entire picture frames are transmitted sequentially) and the use of so-called "square pixels" (where the dots on a television screen are arranged in equally spaced rows and columns). Both of these design aspects are important for the interoperability of HDTV with computers, telecommunications, and other media and applications. Interlaced scan transmission (as deployed in today's TV systems) would also be accommodated in the initial deployment.[1]

Specifically, the proponents agree that all large-screen HDTV receivers (34 inches in diagonal and above) will incorporate a 60 frame per second 787.5 line or higher progressive scan display mode. Progressive display would be optional initially for smaller screen receivers. The proponents also concur that all transmission of film material will be in a progressive scan format beginning immediately upon the commencement of HDTV service. Finally, the Grand Alliance proponents unanimously endorse the objective of migrating the standard to a high line number (i.e. thousand-line plus) progressive scan transmission, as soon as feasible, and will work together to eliminate interlaced scanning format from the transmission path in the future.

To support multiple transmission formats, the merged system will feature source adaptive processing. Moreover, to promote system flexibility and extensibility, the merged system also will feature a prioritized, packetized data transport structure. Additionally, the

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[1] MIT believes that a digital video broadcast standard that exclusively utilizes progressive scan transmission, from the beginning, is in the best interests of the United States.

Grand Alliance entities agree to support the Alliance's proposed HDTV compression system in the International Standards Organization as the MPEG-2 HDTV profile.

Over the next few weeks, Advisory Committee participants will review the technical merits of the Grand Alliance proposal, which includes procedures for deciding on a few remaining component designs based on the results of specific tests. Various subgroups of the Advisory Committee will work with the Grand Alliance members as their merged system concept is finalized and, eventually, will oversee the testing of the completed system. Based on the results of those tests, the Committee may recommend the system to the FCC as the basis for a high definition television standard for our country. The FCC, of course, has the ultimate authority to adopt transmission standards.

Possible Grand Alliance ATV Transmission Formats

	Transmission Format(s)	With Migration Path To:
OPTION 1	720 Progressive →	960 Progressive
OPTION 2	960 Interlace →	960 Progressive
OPTION 3	720 Progressive AND 960 Interlace (Requires Dual Format Production Equipment)	960 Progressive
OPTION 4	720 Progressive →	1080 Progressive
OPTION 5	1080 Interlace →	1080 Progressive
OPTION 6	720 Progressive AND 1080 Interlace (Requires Dual Format Production Equipment)	1080 Progressive

Attachment 2

Possible HDTV Production Formats as Recommended by the ATSC

	Production Format(s)	With Migration Path To:
OPTION 1	720 Progressive →	1080 Progressive
OPTION 2	1080 Interlace →	1080 Progressive
OPTION 3	720 Progressive AND 1080 Interlace (Requires Dual Format Production Equipment)	1080 Progressive

Attachment 3

LIST OF PRODUCTION EQUIPMENT

Cameras
Telecine
VTR
Routing Switcher
Production Switcher
DVE
Paint/Graphic Systems
Distribution Equipment (serialisers, deserialisers)

Downconverters to 525 television
Downconverters to 625 television
Upconverters from 525/625 television

FCC Advisory Committee
Experts Group on Production
& Receiver/VCR Impact

QUESTIONNAIRE
on
HDTV Consumer Equipment

The Experts group will consider the various types of HD consumer equipment (CE) such as receivers, VCR's, disc players, cable converters and future equipment, such as CD's and flat panel displays.

For CE, our Experts group has two goals:

1) To assess and compare the impact of single format CE with multiformat CE.

It is possible that a single scan form transmission scheme may be selected or two formats may be allowed in the initial phase of HDTV transmission. The questionnaire asks to evaluate the proposed single format to understand their differences and to form a reference to compare the proposed multiformat combinations. The questionnaire also asks to compare the proposed multiformat with all others.

2) To assess and compare the impact of various migration paths to a single higher bit rate format.

It is possible that a different, higher bit rate transmission scan format will be used when practical in the future, CE designers may want to take this into account for forward compatibility. The questionnaire asks to what extent this will impact CE design assuming that interim CE is desirable. There are also specific questions dealing with the compatibility issue.

***

In assessing impact, please consider cost, complexity and implementation time. Compatibility among various CE products should also be considered.

To help make your assessment, we have attached a block diagram of an HD receiver which also includes the necessary functions to receive and display NTSC signals and do the format-conversion. It also handles 24, 30, and 60Hz transmission frame rates since the proposed system will do source adaptive coding to avoid transmitting redundant bits when, for example,

transmitting 24 frame movies. Please assume this block diagram in your assessment. We believe that it will also be useful in considering the other kinds of CE equipment.

Please note that the receiver uses a single display format. The questionnaire requests information about this.

Please enter your estimates into the following tables, selecting one of the indicated formats as a reference.

Please indicate, the percentage difference in cost and complexity (+/-%) of the other receivers using your indicated referenced format. In 1992 the ACATS specialist group on cost assumed second generation receivers manufactured in 1 million quantities in a single year. Please use this assumption for implementation time.

Please indicate the time you believe it will take for CE to initially become available to consumers from the time the FCC releases its final order.

Example:

Format	Cost	Complexity	Implementation Time
720P	*+5%*	*0%*	*1 3/4 years*
960I	*ref*	*ref*	*2 years*

Finally, please remark on any impact consideration which you believe needs elaboration on a separate sheet.

1. HD Receivers

The HD receiver will do scan format conversion if necessary. Please indicate if your assumptions are different.

Format	Cost	Complexity	Implementation Time
720P			
960I			
1080I			
720P and 960I			
720P and 1080I			

Now reassess the above assuming that forward compatibility is added, specifically:

720P and 960P			
960I and 960P			
1080I and 1080P			
720P,960I,and 960P			
720P,1080I, and 1080P			

2. HD VCR. We will assume that the compressed code needs minimal reformatting so as not to impact the VCR and that the HD receiver will do scan format conversion if necessary. Please indicate if your assumptions are different.

Format	Cost	Complexity	Implementation Time
720P			
960I			
1080I			
720P and 960I			
720P and 1080I			

Now reassess the above assuming that forward compatibility is added, specifically:

720P and 960P			
960I and 960P			
1080I and 1080P			
720P,960I,and 960P			
720P,1080I, and 1080P			

3. HD Laser disc players. We ask you to make the same assumptions as for VCR's unless you indicate otherwise.

Format	Cost	Complexity	Implementation Time
720P			
960I			
1080I			
720P and 960I			
720P and 1080I			

Now reassess the above assuming that forward compatibility is added, specifically:

720P and 960P			
960I and 960P			
1080I and 1080P			
720P,960I,and 960P			
720P,1080I, and 1080P			

4. Cable Converters. These units will also be required to decompress the digital 525 format which cable operators will use for premium near video on demand.

Format	Cost	Complexity	Implementation Time
720P			
960I			
1080I			
720P and 960I			
720P and 1080I			

Now reassess the above assuming that forward compatibility is added, specifically:

720P and 960P			
960I and 960P			
1080I and 1080P			
720P,960I,and 960P			
720P,1080I, and 1080P			

5. HD LCD or other light valve projector technology.

Format	Cost	Complexity	Implementation Time
720P			
960I			
1080I			
720P and 960I			
720P and 1080I			

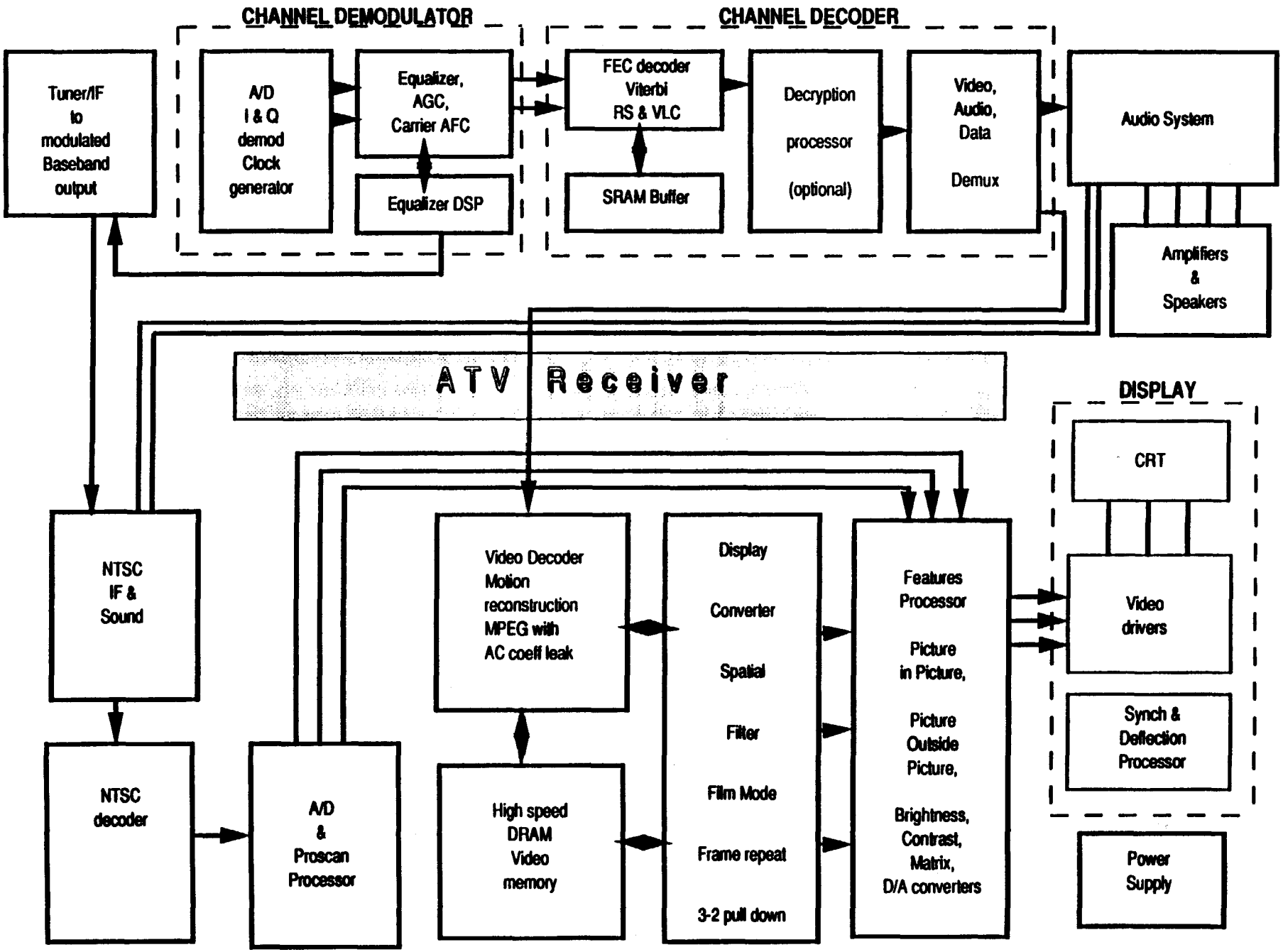
Now reassess the above assuming that forward compatibility is added, specifically:

720P and 960P			
960I and 960P			
1080I and 1080P			
720P,960I,and 960P			
720P,1080I, and 1080P			

6.) Given the various transmission scan format scenarios (e.g. start with 7260P and 960I and finish with 960P), discuss the CRT raster format which you believe would be the most appropriate. Factors to consider are complexity of the receivers's scan conversion scheme, the complexity of display drives, size of display, possible artifacts caused by the conversion, and the use of sources adaptive coding (i.e, 24, 30 and 60Hz frame rate will be transmitted, depending on the source material).

7.) Given that the final transmission format is a higher bit rate, either 960P at 60Hz or 1080P at 60Hz, discuss how the early receivers would be compatible with the chosen higher bit rate transmission format. For example, the higher bit rate format may require additional compression to fit within the 6 MHz broadcast channel bandwidth. The compression may not be completely determined when the first receivers are built. How can this flexibility in receivers be provided for the high bit rate transmission format? If the receivers do not provide compatibility, they may not be able to reproduce a picture. How might the receivers still be made usable?

8.) If the high speed data rate is completely specified, but not yet practical, can early receivers be made compatible using, for example, a hierarchial scheme?



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Attachment 6

Docket 87-268 TS-010

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SEP 20 1995

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

GRAND ALLIANCE ANSWERS TO QUESTIONS FROM ADVISORY COMMITTEE ON ADVANCED TELEVISION (ACATS) ON VIDEO COMPRESSION FORMAT PROPOSAL

1. *What new compression techniques are added that have not previously been part of a tested system? What is performance improvement from changes? What features are being removed from compression used in two systems that had best quality in ATTC/ATEL tests?*

In addition to the compression techniques that have been already employed in tested systems, the following new compression techniques will be added:

- Two VLCs (Variable Length Coding) optimized for inter and intra
- Adaptive field/frame motion compensation
- Alternate scan for interlaced raster
- Programmable intra-frame and intra-slice refresh rate

Total performance improvement is expected to be approximately 10-20% in bit savings. Inter/intra decision on an 8x8 block basis will be removed from the DigiCipher system as it makes little difference in HDTV resolution, and "B frame" is removed from the AD-HDTV system as it adds cost and channel acquisition time. The "B frame" and the following encoder implementation features/compression techniques are being considered:

- VQ for non-zero DCT coefficient selection with perceptual weights
- Predicted frame motion estimation
- Large range hierarchical motion estimation
- Coefficient selection coding
- Non-uniform quantization with new VLC's

2. *What are the features of the baseline system which make it better than any of the previous proposals? What techniques have been added to ensure that transmission of 787/1:1/60 images is sufficiently improved over what was previously achieved?*

The baseline system combines most of key compression techniques used in the previously tested systems and new compression techniques listed above, hence it will outperform any of the previously tested systems. Picture quality of 787/1:1/60 system was affected most dominantly by high level of source noise and hardware implementation errors rather than any deficiency in compression techniques. Therefore sufficiently improved picture quality will be achieved in 787/1:1/60 format.

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3. *Explain what you mean by statement that "further interoperability of compressed bit streams will be enhanced". Does that statement apply to a 1000-line progressive system? If so, explain how and why?*

The statement that "further interoperability of compressed bit streams will be enhanced" means that compressed bit streams of the Grand Alliance (GA) system can be decoded easily by MPEG compliant HDTV decoders with minor variations. It does not apply to a 1000-line 60 frames/sec progressive system as it is subject to further study.

MPEG RELATED ISSUES

1. *Anticipate some delivery to the consumer based on MPEG-2 format. Support for achieving as much commonality as is practical with this international standard. How would proposal as stated interrelate with emerging profiles being defined within ISO MPEG-2?*

   The GA system will fit into MPEG-2 Simple Profile, High Level or Main Profile, High Level (if "B frames" are included) with minor differences. The number of differences will be kept minimized under the constraint that there be no significant compromise of performance.

2. *Baseline system proposed by GA does not conform to MPEG-2 syntax agreed to by MPEG committee for "Main Profile, Main Level" applications. Some coding features proposed by GA have not been accepted by MPEG experts because of inconclusive benefits offered?*

   Baseline system does not conform to MPEG-2 syntax for Main Profile (or Simple Profile), High Level because "AC Leak" has been rejected by MPEG experts due to insufficient benefits on the scenes tested by MPEG using leak of 1/16.

3. *GA proposed MPEG-2 syntax is somewhat different from MPEG-2 (main profile, main level) profile proposed by MPEG Committee. Could you identify and describe the major differences between the two profiles and the reasons for not incorporating the same features in the GA proposal?*

   See items 1 & 2 above.

4. *Will your system be compatible with (i) the MPEG-2 "Main" profile, (ii) other Profiles?*

   See items 1 & 2 above.

5. *How do you maintain compatibility with main profile & main level of MPEG-2? Which profile in MPEG-2 does compression algorithm specified correspond to? In MPEG-2 "no B frames" corresponds to simple profile, & "frequency dependent leak" to next profile.*

   See items 1 & 2 above.

6. *Unless different profile (or level within an existing profile) in defined in MPEG, that can fully & precisely accommodate these features, the bit-stream syntax proposed by GA will not be MPEG compatible.*

   See items 1 & 2 above.

7. *How do you see your system fitting into the MPEG-2 Profiles?*

   See items 1 & 2 above.

8. *To the extent that the GA proposed approach differs from that of MPEG-2, how would any advantages of this approach be demonstrated?*

   Computer simulation will be used to evaluate the performance advantages.

9. *Can you quantify or qualify the technical advantages & disadvantages of the additional MPEG-2 syntax elements you propose?*

   The only additional syntax element proposed in the baseline system is AC leak. It helps error recovery and compression efficiency in certain conditions.

10. *Who will do it and where will the testing of improvements to MPEG-2 be done?*

    GA specialist group on compression will carry out the evaluation at various GA facilities.

11. *MPEG-2 is supposedly compatible with MPEG-1. Will this be true with the proposed system? (will it decode MPEG-1, CDI, etc.).*

    Compatibility with MPEG-1 and CDI will be up to receiver manufacturers.

12. *How faithfully will system use MPEG-2 syntax? After random access, like channel change, info such as frame rate and buffer size could not be guaranteed. Will sequence headers be allowed to vary? What about the sequence extensions?*

    The system will conform to MPEG-2 syntax including sequence headers and extensions. Sequence headers and extensions will be transmitted frequently enough to allow fast channel acquisition.

13. *How does GA proposed baseline system intend to establish bit-stream interoperability with true, MPEG-based bit streams?*

The bit stream of the baseline system can be decoded by any MPEG-2 decoders that are compliant to Main Profile, High Level and have additional features to decode the AC leak.

14. *Throughout MPEG-2 process, coding experimentation and visual examination has been carried out with I (interlaced) pictures. What is the performance of an MPEG-2 compression algorithm when used with progressive scan pictures?*

The MPEG-2 compression algorithm is expected to perform well for progressive scan pictures, but may need improvements that require additional syntax elements.

15. *If new proposals to the compression algorithm are to be examined by the GA, how are these changes going to be submitted to MPEG committee for their evaluation and acceptance if common syntax is to be maintained?*

MPEG-2 is frozen. Consideration of "new" syntax will be either at the request of individual companies or National Bodies. Changes after "frozen" will need to show that MPEG-2 as is is inadequate or "broken".

16. *Does GA plan that MPEG should include such features in MPEG-2? When will GA present arguments to MPEG? IF MPEG doesn't agree to features, would GA drop them? If MPEG doesn't include and if GA doesn't drop features, would this preclude MPEG-2 decoders?*

GA will present such new proposals to the September MPEG meeting. GA's decision will not be affected by MPEG's decision <u>if</u> the new compression algorithm provides significant performance advantage. IC manufacturers can easily add additional features supported by the GA to maintain compatibility.

17. *What changes, if any, will be proposed by GA at the July MPEG meeting in New York?*

GA did not propose any new changes at the July MPEG meeting.

18. *When will GA present their compression scheme to MPEG-2 Committee? Will submissions be made at 7/12-16 meeting in New york? Describe specific commonalities and differences with current MPEG-2 proposed algorithm. What are specific benefits of MPEG-2 compatibility?*

GA presented a paper entitled, "Constraints on MPEG-2 Syntax for the U.S. HDTV Standard". It was mainly for informational purposes. The baseline system complies to MPEG-2 except the inclusion of AC leak. MPEG-2 compatibility will make the system

more acceptable as a worldwide HDTV standard, and will help IC manufacturers develop low cost video decoder VLSI.

19. *What is frequency dependent leak? Is it similar to or different from leak used in DSC-HDTV? or leak evaluated by MPEG? What is its benefit considering additional complexity? Would it be mixed with other types of predicted coding? If so, how?*

    The frequency dependent leak attenuated AC components in the feedback loop of motion compensation on P frames. It is similar but different from the leak used in the DSC-HDTV. It helps error recovery and compression efficiency in certain conditions.

IMPLICATIONS OF DROPPING B FRAMES

1. *What are the implications of having dropped the B frames?*

   B frames improve the performance in certain scenes but add complexity and channel acquisition time. The previously tested DigiCipher system had no B frames while the AD-HDTV system had B frames. Both systems performed well. MPEG B frames are being evaluated as improvements to the existing GA baseline system.

2. *With progressive refresh and no B frames is there a difference between I and P frames?*

   With progressive refresh, I frames are not needed except for editing purposes.

3. *What motion estimation range is intended for "standard" system and with hierarchical motion estimation? Will the decision on whether or not to use B-frames include the effect on motion estimation in the encoder as well as memory in the receiver?*

   The system will support unlimited motion estimation range in horizontal direction and ±128 in vertical direction. Initial encoders will have smaller motion estimation range. Exclusion of B frames will substantially simplify the motion estimation in the encoder and reduce the memory in the decoder.

RECEIVER ISSUES

1. *Proposals made with MPEG-2 syntax with extra elements. What if MPEG rejects these features? Will U.S. receivers have added complexity, or follow international Standard?*

   See item 16 of MPEG Related Issues.

2. *If intent to phase out interlaced format soon, why burden all receivers with extra modes for field/frame inverse DCT's.*

   Field/frame inverse DCT's do not add any significant complexity.