

(3) Refine Interoperability questions (or challenges) for structuring the Phase II Interoperability Review.

Tentative dates:

September 1st - 3rd

Phase II (Interoperability Review)

One to two day meeting during which GA will present their proposed system in the context of the Interoperability questions framed in Phase I. GA will indicate in detail how their system meets Interoperability recommendations from earlier PS-WP/4, respond to Interoperability questions and will identify where non-concurrent devices of multiple constituencies can not met.

Review Board will be constituted of members selected from previous PS-WP/4 Review Board plus new members. We plan to extend invitations to the following as Review Board Participants:

PS-WP/4 Review Board

Liebhold	(Apple)
Tanner	(CableLabs)
Hopkins	(ATSC)
Gerovac	(DEC)
Bellisio	(Bellcore)
Hamalainen	(Matsushita)
Utteyendale	(ABC)
Demos	(DemoGrafx)
Fuhrer	(Hitachi)
Hanover	(EIA)

Additional Review Board Members

Robert Hummel, Vice President	(Walt Disney Company)
Larry Smarr, Executive Director	(NCSA, University of Illinois)
Tom DeFanti, Ph.D.	(ACM SIGGRAPH)
Carl Fleischhauer, Coordinator	(Library of Congress)
Neil Izenberg, Director	(Nemours Foundations)
Russ Little, Senior Systems Analyst	(National Geographic Society)
Tice de Young, Director	(ARPA, Department of Defense)
Robert Kahn, President, CEO	(CNRI)
Linda Roberts, ED.D Senior Associate	(OTA, United States Congress)

Tentative dates

September 27th - 28th

Report and Recommendations

As in the PS-WP/4 study, the Review Board will meet to agree on a Final Report and Recommendations based on the findings from the Phase II Review. This Report and Recommendations will be delivered to the ACATS Technical Sub-Committee by mid-October, 1993.

Docket
97-268

**Scanning Formats/Compression Expert Group
Report to Technical Subgroup
August 11, 1993**

1. MPEG-2 Compatibility

The Grand Alliance (GA) proposed that the GA System should use MPEG-2 syntax with the added feature of AC-Leak. The GA also proposed that another two features should be studied for possible inclusion in the GA System: multiple Variable Length Code (VLC) tables and Vector Quantization (VQ) with multiple non-uniform quantizers.

The Scanning Formats/Compression (SF/C) Expert Group notes that AC-Leak was proposed to MPEG for inclusion in the MPEG-2 syntax at the July 1993 MPEG meeting, but it was not included. Multiple VLC tables were proposed in the past but were not included. Standard definition experiments were conducted with uniform VQ, but that feature was not included in MPEG-2.

Because AC-Leak, multiple VLC tables, and VQ are not included in the MPEG-2 syntax, they are not compatible with MPEG-2. The SF/C Expert Group believes that compatibility with international standards is a very important issue and that compatibility should be preserved unless there are significant reasons to sacrifice compatibility, such as excessive cost, performance penalties, etc. The SF/C Expert Group has no evidence that inclusion of these three features would add significantly to the performance of the system and believes that even moderate improvements would not be worth the loss of compatibility with MPEG-2. The SF/C Expert Group further believes that other tools already included in the MPEG-2 syntax would add a greater performance improvement.

If the Grand Alliance System used only MPEG-2 video syntax, an HDTV decoder conforming to the MPEG-2 standard would be able to decode a Grand Alliance System bit stream, a "standard definition" MPEG-2 bit stream, and an MPEG-1 bit stream. This interoperability is highly desirable.

The SF/C Expert Group recommends that the GA System compression syntax be compatible with MPEG-2. Should the Grand Alliance insist on maintaining the non-compatible features and therefore not agree with this recommendation, the SF/C Expert Group believes that the burden must be on the GA to prove that these features offer a significant improvement not already available using other MPEG-2 tools, that inclusion of these features will not impede additional features (e.g., VCR trick modes), and that these improvements offer greater value than MPEG-2 compatibility.

2. B-Frames

The Grand Alliance proposed that the GA System would not use B-Frames. The GA also proposed that they would conduct further studies on this issue with the possibility that B-Frames would be added.

The GA did not include B-Frames because the receiver memory cost is higher with B-Frames and because the system latency, or encoding/decoding delay, increases. The disadvantage of increased receiver cost is self-evident. The disadvantage of an increase in system latency is less evident. Broadcasters have expressed concern because they may wish to use a compressed bit stream as an input in production. As an example, a remote input may be used in a split screen with the signal from a local studio; if the delay becomes too great, this would not be feasible. Broadcasters may wish to offer an interactive service. If the delay becomes too great, the service is not acceptable.

The SF/C Expert Group has examined the issue of receiver cost and the issue of system latency:

- 1) The increase in receiver memory is estimated to be less than 32 Mbits (the amount of RAM in many PCs sold today is 8 MBytes or 64 Mbits). According to studies conducted by SS/WP3 the cost of a 50 nS 16 Mbit DRAM in 1998 is predicted to be \$9.55. (If higher speed were required, note that a 10 nS 16 Mbit DRAM is predicted to be \$13.37.) The increase in memory cost in 1998 would thus be less than \$20. Because the cost of memory decreases a factor of two every two years, the increased cost in the 21st century would be negligible.
- 2) When using I-Frames for refresh, the use of B-Frames is estimated to increase system latency three frames, or 0.1 second. The increase in acquisition delay is estimated to be two frames, or 0.07 second. As it is always possible to "turn off" B-Frames at the encoder, a broadcaster may wish to do so in order to achieve the absolute minimum delay for particular programs. It should be noted that the use of I-Frames adds approximately 0.15 seconds of delay when compared with progressive refresh.

The SF/C Expert Group believes that significant improvement can be made in compression capability by the inclusion of B-Frames; the improvement on certain scenes is equivalent to that which would be achieved by allowing the compressed bit rate to increase 20%.

The SF/C Expert Group recommends that the GA System compression syntax should include B-Frames. The increase in receiver cost and the increase in system latency are not of the magnitude to justify the loss, forever, of considerable compression efficiency. It is not possible to add B-Frames after ATV service is initiated without all previously manufactured receivers being made obsolete and unusable. This would not be acceptable. If B-Frames will ever be used, provisions must be made from the outset of the service. Furthermore, the use of B-Frames would be optional on a program by program basis. All receivers, however, would have to have B-Frame capability.

Because the SF/C Expert Group's conclusion was influenced by SS/WP3's predicted cost of memory in 1998, it may be appropriate to review this prediction. Also, the SF/C Expert Group recognizes that viewers may be accustomed to more rapid channel changing than is possible with the encoder/decoder delays that will result from digital compression.

3. Scanning Formats

During the meeting of the Technical Subgroup on June 30 and July 1, 1993 it was stated by the Grand Alliance that there were two proposed source scanning formats. The first was 720x1280x60x1:1. The second was 960x1728x60x2:1 (with the target of 960x1728x60x1:1 as soon as possible). Transmitted formats would be the source formats plus internally generated progressive formats of 720x1280 and 960x1728 at 30 Hz and 24 Hz for film, and 960x1408x60x2:1 as an interim solution to reduce horizontal resolution for ease of compression. The receiver would convert the transmitted format to its own "native" display format.

It was made clear by the Technical Subgroup during the June 30 - July 1 meeting that they preferred that the 960-line formats be replaced with 1080x1920x60x2:1 (with the target of 1080x1920x60x1:1 as soon as possible) and 1080x1440x60x2:1 as the reduced horizontal resolution interim solution.

The SF/C Expert Group examined the issue of 960 vs 1080 active lines to determine if the original Grand Alliance proposal for 960 active lines would be better than the Technical Subgroup's preferred 1080 active lines. The SF/C Expert Group has found no reason for the Technical Subgroup to change its position. Consideration was given to studio issues, ease of compression of the target standard, receiver issues, and general issues. (For 960 active lines, it is noted that 960x1728 produces "virtually" square pixels. Speaking precisely, the pixel aspect ratio is 80:81 rather than 1:1 or, if the pixels are square, the picture aspect ratio is 9:5 rather than 16:9.)

- 1) With regard to the studio issues, it was found that 1080 would have an advantage because it is expected that the studio standard will be 1080 active lines. Conversions between the studio standard and the ATV standard would then be better if both were 1080. Conversions between the ATV standard and the 525-line standard were not found to be a factor in the selection of 1080 or 960.
- 2) With regard to ease of compression of the target scanning format, 960 active lines, being fewer than 1080, would obviously make it easier. This area received a lot of discussion in the SF/C Expert Group. It should be possible today to compress 960x1728x24x1:1 and 960x1728x60x2:1, but it may not be possible today to compress 1080x1920x24x1:1 or 1080x1920x60x2:1 with an acceptable level of artifacts. It is noted, though, that inclusion of B-Frames may change this situation. It is also noted that the use of lower horizontal resolution was introduced for this reason.
- 3) With regard to the receiver issues, neither 1080 nor 960 has an advantage. Use of 960 active lines would mean less receiver memory and lower speed circuits. It is noted, however, that the increase in receiver memory would be less than 16 Mbits; SS/WP3 predicted the cost for a 50 nS 16 Mbit DRAM in 1998 to be \$9.55. Furthermore, it is noted by the SF/C Expert Group that a compliant MPEG-2 decoder would be required to handle 1080 lines in any event.
- 4) With regard to general issues, 1080 was found to have a distinct advantage. The intrinsic picture quality would be higher; support exists internationally for 1080; and migration to the target standard of more than 1000 lines with square pixels progressively scanned at 60 Hz would be easier.

The SF/C Expert Group recommends that the Grand Alliance System accept two source formats — 720x1280x60x1:1 and 1080x1920x60x2:1 (with the target of 1080x1920x60x1:1 as soon as possible). There are strong supporters for each of these formats; generally the supporters of the two different formats have different applications in mind. It is noted that either input will work; neither input would be mandatory; nor would it be appropriate to "forbid" either. The service provider would have an option on format; the receiver would handle both spatial formats. It would be desirable if ATV receivers could handle also the MPEG-2 standard definition spatial format.

The SF/C Expert Group believes that the transmission formats proposed by the Grand Alliance are appropriate (with 1080 active lines replacing 960 active lines). The film modes would be detected inside the GA System and converted to a 24 Hz or 30 Hz progressive scan format inside the GA System to increase the compression efficiency in transmission. It is noted that three of the four original digital ATV system proposals incorporated this feature. It is natural to include it in the GA

System. It should be understood that the internal 24 Hz and 30 Hz frame rates may be accepted directly as source formats in the future if such operation becomes desirable.

4. Vertical Rates

The SF/C Expert Group believes that it may be important for the ATV service to maintain field rate compatibility with NTSC during the simulcasting period. The SF/C Expert Group also believes that it may be desirable for the ATV service to use 60.0 Hz when NTSC is no longer broadcast. To have this flexibility, the SF/C Expert Group recommends that the Grand Alliance System (and thus ATV receivers) be able to operate at both 59.94 Hz and 60.0 Hz. The SF/C Expert Group believes that the cost of this flexibility is low and acceptable.

5. Colorimetry

The SF/C Expert Group examined the issue of colorimetry and recommends that the prototype GA System use SMPTE 240M interim colorimetry; that is the only equipment which is available today. It is noted that SMPTE 240M interim colorimetry and CCIR Recommendation 709 interim colorimetry are different; and that SMPTE and CCIR are working on "final" colorimetry with a wider gamut than is available using the interim colorimetry. Indeed, this issue would be easier if SMPTE and CCIR agreed on "final" colorimetry and if they did this in an expedited manner. For that reason, the SF/C Expert Group urges SMPTE and CCIR to complete this work and strongly urges them to agree on the colorimetry parameter values. The SF/C Expert Group notes that, if the source video format is specified to be in the luminance and two color-difference signal form, the encoder and decoder will be able to accept any of these colorimetry possibilities. The studio standard colorimetry and receiver display colorimetry would need to match, though, for correct color presentation in the receiver. Final resolution of this issue can be delayed until the time of final documentation of the ATV standard.

6. Prototype Schedule

The SF/C Expert Group has recommended that the Grand Alliance System be modified to increase the number of active lines from 960 to 1080 and that the Grand Alliance System compression syntax be modified to include B-Frames. These modifications may have an impact on the schedule for the prototype GA System. The SF/C Expert Group did not assess this possibility. The Technical Subgroup may wish to examine this issue.

7. Migration Paths

The SF/C Expert Group established a specialist group to study possible migration paths to the target scanning format of 1080x1920x60x1:1. This is a complex issue because "extensibility" is required; it is necessary to anticipate the future without knowing precisely how it will ultimately be handled in the hardware. The SF/C Expert Group needs more time to complete this study.

8. Testing

At this point, the SF/C Expert Group has not identified any requirements for "Bake-Off" tests or Subsystem tests in advance of the laboratory tests and field tests. The SF/C Expert Group will

continue to monitor testing requirements. All recommended changes should be incorporated in the Grand Alliance System prototype, however, prior to the laboratory and field tests.

Appendix

Note: All Scanning Formats/Compression Expert Group documents are attached to the minutes of the meeting for which the document was distributed.

Appendix A: Scanning Formats/Compression Expert Group Membership List

Appendix B: Minutes of the July 9, 1993 Conference Call

Appendix C: Minutes of the July 21, 1993 Conference Call

Appendix D: Minutes of the July 29, 1993 Meeting

Appendix E: Minutes of the August 3, 1993 Conference Call

Appendix F: Minutes of the August 4, 1993 Conference Call

Scanning Formats/Compression Expert Group

Membership List

Members

Robert Hopkins, Chair	ATSC
Michael Haley	IBM
Paul Hearty	A TEL
Renville McMann	Consultant
Richard Prodan	CableLabs
Robert Sanderson	Eastman Kodak
Peter Smith	NBC

Ex Officio

Keiichi Kubota	NHK
Jose Tejerina	RTVE (EBU)
Victor Rojas	Televisa

Grand Alliance

Robert Keeler	AT&T
Woo Paik	GI

Docket 87-268

**STATUS REPORT:
TRANSMISSION EXPERT GROUP
AND
SPECIALIST GROUP**

John Henderson

David Bryan

August 11, 1993

TOPICS

Coverage Model

Bryan / Tawil

Weighting Factors

Bryan

Analysis & Testing Schedule - QAM & VSB

Henderson

Status of OFDM Investigation

Henderson

SCHEDULE
(QAM, SS-QAM, and VSB)

Coverage Sensitivity Analysis	ongoing
Agreement on GA Modem Performance Numbers	8/20
New Coverage Analysis	8/31
Complete Transmission Weighting Matrix	9/15
Agreement on Results of Analysis	9/30
 If Analysis Process Does Not Produce a Clear “Winner,” Then We Must Test Hardware of “Surviving” Systems:	
Complete, Testable Hardware Available	10/31
Finish Hardware Tests	11/19
Coverage Analysis & Recommendation Based on Test Results	11/31

COMMENTS

Expert Group Will Receive and Approve Claimed Modem Performance Improvements and Inputs to Weighted Transmission Matrix

Expert Group Will Witness Hardware Tests

Final Test Plan Not Yet Prepared, But Will Be Similar to Tests Performed in First Round

Modem Tests Will be Conducted at GA Facilities, Subject to Approval by Expert Group. (We Assume Final Complete System Tests at ATTC, ATEL, and CableLabs, as in First Round.)

Hardware Will be Built by its Advocates

INVESTIGATION OF OFDM

TASK:

Update an earlier ACATS investigation of OFDM to see if recent developments warrant reconsideration of this modulation format.

APPROACH:

Technical scrutiny and analysis of available data

Visit(s) to OFDM advocates in Europe. Visit(s) will be preceded by written questions from the Expert Group and the Grand Alliance. Discussions of answers will form the “meat” of the visit.

If the Expert Group determines that new developments warrant it, then hardware testing will be recommended.

If hardware is tested, it must be a complete demodulation system, including tuner, channel coding, error correction, equalization, and OFDM demodulator. The system must work in 6 MHz US channel spacing and must support the same payload data rate as the GA system.

INVESTIGATION OF OFDM (continued)

PROGRESS:

Contacts with CCETT (M. Michon) and HD Divine (P. Pettersson)

Sharing of information from visits to CCETT and NTL by group of North American broadcast interests 7/26-27, including members of Expert Group

Visit arranged to CCETT during week of 9/13 (exact day to be finalized after European vacation period). This is earliest opportunity.

ISSUES:

Impact on ACATS schedule (If testing were recommended, hardware will not be available to support a decision by end November.)

If testing were recommended, who would build the hardware?

WEIGHTING FACTORS FOR TRANSMISSION SYSTEM SELECTION

ATV COVERAGE AREA / NTSC SERVICE AREA LOSS - 70 %

- **TOTAL ATV UHF / VHF SERVICE AREA CONSIDERING CO-CHANNEL, ADJACENT CHANNEL, AND TABOOS - 35 %**
- **NTSC SERVICE AREA LOST CONSIDERING ATV UHF / VHF CO-CHANNEL, ADJACENT CHANNEL, AND TABOOS - 35 %**

WEIGHTING FACTORS FOR TRANSMISSION SYSTEM SELECTION

ROBUSTNESS - 15 %

- DIFFERENCE BETWEEN C/N THRESHOLD WITH MULTIPATH AND C/N THRESHOLD WITHOUT MULTIPATH - 4 %
- PHASE NOISE LEVEL AT WHICH SYSTEM CAN ACQUIRE AND OPERATE ERROR FREE - 2 %
- RESIDUAL FM LEVEL AT WHICH SYSTEM CAN ACQUIRE AND OPERATE ERROR FREE - 2 %
- PULL-IN RANGE - 2 %
- ACQUISITION TIME - 2 %
- IMPULSE NOISE TOLERANCE - 1.5 %
- BI-LEVEL DATA / ALTERNATE MODE SYSTEM - 1.5 %

WEIGHTING FACTORS FOR TRANSMISSION SYSTEM SELECTION

SYSTEM ATTRIBUTES - 15 %

- **NET TERRESTRIAL DATA RATE AFTER FEC - 5 %**
- **PEAK-TO-AVERAGE RATIO - 2 %**
- **RECEIVER COST - 2 %**
- **NET CABLE DATA RATE AFTER FEC - 4 %**
- **CABLE INTEROPERABILITY - 2 %**

RECEIVED

SEP 20 1993

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

FCC Advisory Committee on Advanced Television Service

Technical Subgroup

MASTER CALENDAR**DRAFT**
RECEIVED

SEP 20 1993

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

<u>Event</u>	<u>Action/Schedule</u>		
	<u>Grand Alliance</u>	<u>Technical Subgroup</u>	<u>ACATS/ Other</u>
1993			
Technical Subgroup meeting • Review GA proposal, Q&A • Develop work plan, draft schedule		6/30-7/1	
Expert Groups meet with GA • Audio • Interoperability (Joint Expert Group) • Production & Receiver/VCR Impact • Scanning Formats/Compression Systems • Transmission • Transport	7/2-8/10	7/2-8/10	
GA follow-up/responses to Subgroup questions	8/5		
Technical Subgroup meeting • EG/GA status reports • Establish development/decision schedule		8/11	
GA submits final specifications for Audio and Transport	8/31		
GA submits final specifications for Scanning Format	9/14		
GA submits final specifications for Compression System	9/30		
Technical Subgroup meeting • Specs on Audio, Compression, Scanning Format, Transport • Review work plan, schedule		10/19	
GA submits final specifications for Transmission System	11/30		
SS/WP-2 submits draft laboratory Test Plan			12/15
Technical Subgroup meeting • Spec on Transmission • Review laboratory Test Plan • Review work plan, schedule		12/15	

(more)

Technical Subgroup—Master Calendar

DRAFT RECEIVED

RECEIVED

OFFICE OF THE SECRETARY
FEDERAL COMMUNICATIONS COMMISSION
1994

OFFICE OF THE SECRETARY
FEDERAL COMMUNICATIONS COMMISSION

Event

Action/Schedule

	<u>Grand Alliance</u>	<u>Technical Subgroup</u>	<u>ACATS/ Other</u>
Transmission system verification at ATTC			
• GA Move-In/Set-Up at ATTC	1/10		
• Verification testing			1/17-31
SS/WP-2 submits final Laboratory Test Plans			2/15
Laboratories implement Test Plans requirements, prepare for testing			2/15-6/3
Start of GA system integration:			
• Video Encoder	2/28		
• Encoder/Decoder	3/31		
• System	4/30		
GA Move-In/Set-Up at ATTC	6/6-17		
Interface/Dry-Run at ATTC			6/20-24
Laboratory Tests at ATTC (@ 9 weeks)			6/27-8/29
Preparation/Tape Review at ATEL			7/12-18
Laboratory Tests at ATEL (@ 9 weeks)			7/19-9/21
Laboratory Tests results/comments drafted (GA, labs)			
• ATTC, CableLabs with GA	9/1-22		
• ATEL with GA	9/26-10/17		
Submit all Laboratory Reports			10/21

Legend:
 GA - Grand Alliance
 EG - Experts Group (of ACATS Technical Subgroup)

268