Q2. See questions 3, 4, 5 & 6 under Broadcast above.

NHK

1. See answers to 3-6 under Broadcast.

GI

1. See answers to 3-6 under Broadcast.

Zenith/ATT

1. See answers to 3-6 under Broadcast.

ATRC

1. Signal distribution to most headends is anticipated to be in final compressed form, requiring on the order of 20 Mb/s, which is easily achieved on a satellite using QPSK.

2. The layered architecture of AD-HDTV allows headends to decode QPSK symbols into a serial data stream and then encode the bits either as SS-QAM or conventional QAM in a 6 MHz channel.

3. Local commercial insertion may be accomplished simply and economically by taking advantage of the spatially-coded frames that occur on a periodic basis in MPEG compression. This allows artifact-free cuts to be made on Group of Pictures (GOP) boundaries, even in the highly-compressed transmission format.

MIT

1. See answers to 3-6 under Broadcast.

Common Carrier

Q1. What form of signal do you propose for transmission over terrestrial common carrier links?

NHK

1. There will be two signal formats, with three quality levels total:

   - Compressed SMPTE 240M with 120 Mb/s for contribution
   - Compressed SMPTE 240M with 60 Mb/s for distribution
   - Digitally compressed Narrow MUSE at 40 Mb/s, reduced from the normal 78 Mb/s of digital N-MUSE

GI

1. The DigiCipher HDTV signal is packetized and can be transmitted along with other forms of data over common carrier links such as fiber or microwave.

Zenith/ATT

1. See Broadcast section, Question 3.

ATRC

1. Transmission is expected within the B-ISDN/ATM framework is expected. The 148 byte data cells of AD-HDTV can be repackaged into ATM's 53 byte data cells. The AD-HDTV layered architecture allows the repackaging to be completely transparent to higher layers, namely, video and audio compression.

2. The data structures are applicable at any data rate from the fully compressed 20 Mb/s signal to the high performance, lower-compression signals.

MIT

1. The (compressed) baseband digital signal can be easily multiplexed onto common carrier links. The baseband digital signal is 26.43 Mb/s for 32-QAM operation.

Q2. Are the SONET bit rates assumed the correct choices?

NHK

1. The SONET bit rate choice of 360 Mb/s is correct for N-MUSE. This value permits multiples of the digitally compressed SMPTE 240M signals (both at 60 Mb/s and at 120 Mb/s) and of the digitally compressed Narrow MUSE to fit well in a single SONET channel.

GI

1. SONET data rates are high enough but have not been specifically studied.

Zenith/ATT

1. Two DSC-HDTV fully compressed 21.5 Mb/s data streams can be accommodated within the basic SONET modular data rate of 51.84 Mb/s.

2. For the 100 Mb/s 2D compressed format, a SONET STS-2 rate of 103.68 Mb/s can be used.

3. For the 200 Mb/s 2D compressed format, a SONET STS-4 rate of 207.36 Mb/s can be used.

ATRC

1. Any data rate on the order of 20 Mb/s is sufficient. This assumes that, particularly during the transition period, distribution will most frequently be at the level of compression used for transmission and that local affiliates/headends will perform minimal decompression and processing of the signal.

MIT

1. Bit rate depends on the application and quality desired. Any of the digital hierarchies supplies rates that seem to be appropriate.

Q3. What bit error rates does your proposed distribution format require of the transport system? Your production contribution format?

NHK

1. Lower than 10^{-6}.

GI

1. The issue is not what error rates are objectively required but what can be tolerated subjectively. Uncorrected errors introduced in distribution or contribution channels should be reduced to the minimum cost effectively achievable.

2. Suggested minimum requirement of less than one uncorrectable error per 10 minutes for distribution and less than one per hour for contribution, corresponding to raw error rates of 1.7×10^{-2} and 1.4×10^{-2}, respectively.

Zenith/ATT

1. A BER of 10^{-4} is satisfactory for both distribution and contribution.

ATRC

1. BER requirements for distribution and contribution will depend on the amount of compression that is used and the error handling capabilities that are designed into them.

2. Ad-HDTV has been carefully designed to tolerate packet error rates on the order of 10^{-3}. BER requirements for distribution and contribution must be significantly lower. Very conservative BER requirements are generally planned in the specification of digital links.

MIT

1. Operates over wide range. "Transparent" error rates might be 10^{-9} for distribution and 10^{-11} for production at the output of the Reed-Solomon decoder, although much higher error rates can be tolerated. If the system carried the same amount of data without error correction, the BER would have been approximately 10^{-2}.

Consumer

Q1. What is required in a consumer VCR for the system? When will such a VCR be available? Is new technology required first? What format is to be recorded? Are any current VCR features not possible with this format? Have you verified this experimentally?

NHK

1. For an analog VCR, no new technology must be developed because the bandwidth of N-MUSE is the same as that of NTSC. A consumer VCR will become available within two years after the FCC decision.

2. Narrow MUSE can be recorded using FM, as with NTSC. The sync circuit in the current VCR design must be modified. Chroma circuitry can be removed. A time base corrector is required.

3. Technology for a 40 Mb/s consumer VCR capable of two hours of digital recording is already available. A digital consumer VCR will become available within two years of the FCC decision.

4. The distinction of moving and stationary areas, as provided by the use of the motion vector, is essential to obtain the full capability of N-MUSE. Whether or not an N-MUSE decoder can perform these functions in VCR stunt modes depends on the decoder design. With proper decoder design, the N-MUSE signal can be fully decoded in slow, still, and reverse motion.

GI

1. A consumer VCR for DigiCipher HDTV has been demonstrated recording and playing back the 18.22 Mb/s of a fully-compressed DigiCipher HDTV signal. Implementation of current VCR playback features has been studied, and it is believed that a full set can be implemented. This has been substantiated through simulation.

2. Speed search functions will utilize PCM (intraframe) refresh data, which is used to continuously refresh one-eleventh of the picture each frame and thus the whole picture every 11 frames. There are no restrictions on speeds caused by the technique.

Zenith/ATT

1. The level of mechanical and electronic technology of current full-featured S-VHS VCR's will be appropriate for the fully-compressed DSC-HDTV signal at 21.5 Mb/s.

2. Consumer grade VCR's will be available at about the same time as DSC-HDTV receivers.

3. Most features are possible. Speed search simulations have yielded satisfactory results.

ATRC

1. Consumer VCR's require tradeoffs between compression format and data rate. The lowest cost VCR would directly record the transmitted data in compressed form. No new head/tape technology will be required for such a recorder.

2. The periodically occurring, spatially coded frames of MPEG compression provide advantages in achieving features such as search modes. These capabilities have not been demonstrated in experimental hardware.

3. All features are expected to be available in top-of-the-line models. Low cost models may have fewer features. The frame-based compression in AD-HDTV has no significant impact on search mode performance, but it does permit full-resolution stills to be presented in freeze-frame mode.

MIT

1. The signal may be directly recorded in digital format. Current VTR features possible, but very flexible control (i.e. arbitrary-rate, undegraded fast-forward and rewind) may require higher data rate and less recursive format.

2. Rewind search operations will utilize the intra-frame encoding mode. One twentieth of each frame is refreshed continuously, thereby encoding three frames/second using the intra-frame mode. These frames can be used for rewind search mode.

Satellite

Q1. Is it possible to carry the ATV signal and an NTSC signal on the same transponder? If so, at what bandwidth? What other multiples are possible with your system?

NHK

1. Required quality level determines the bandwidth needed for simultaneous transmission of ATV and NTSC signals. When the signal formats described in answer to Common Carrier Question 1 are used for satellite transmission, the bit rates and bandwidths for QPSK operation are as shown in the following table:

ATV	NTSC	Total bit rate	Bandwidth
40 Mb/s	17 Mb/s	57 Mb/s	34 MHz
60 Mb/s	17 Mb/s	77 Mb/s	46 Mb/s
120 Mb/s	34 Mb/s	144 Mb/s	92 Mb/s

   8ϕ PSK can also be used.

2. Narrow MUSE can also be transmitted using conventional FM modulation. In such a case, 45 MHz is required to transmit both N-MUSE and NTSC as described in the answer to Question 5 in the Broadcast section above.

GI

1. It is possible. One HDTV and two NTSC signals can be carried within 24 MHz using QPSK.

Zenith/ATT

1. See Broadcast section, Question 6.

ATRC

1. Analog satellite links can use an FDM arrangement of AD-HDTV on a QPSK carrier, occupying 6 MHz at baseband, with NTSC on an FM carrier. FDM could be performed at either RF or IF. This could be accomplished using standard transponders, with a lower modulation index for NTSC. This would lower the CNR threshold for NTSC.

2. With digital satellite links providing about 60 Mb/s, a TDM mix of AD-HDTV and/or compressed digital NTSC can be carried. Three AD-HDTV channels can also be carried in a single transponder. C-band (K-band) satellites can deliver 60 Mb/s using a 36 MHz (54 MHz) transponder with QPSK modulation.

MIT

1. Transponder bandwidths are typically between 36 and 72 MHz. FDM can be used to carry both ATV and NTSC signals. TDM can also be used to carry ATV and digital NTSC signals. The CCDC HDTV signal would require 12 MHz bandwidth using QPSK modulation (8PSK trellis coded). A single transponder can easily carry several CCDC-HDTV signals.

Q2. See questions 3 & 7 under Broadcast above.

NHK

1. See the answers to 3 and 7 under Broadcast.

GI

1. See the answers to 3 and 7 under Broadcast.

Zenith/ATT

1. See the answers to 3 and 7 under Broadcast.

ATRC

1. See the answers to 3 and 7 under Broadcast.

MIT

1. See the answers to 3 and 7 under Broadcast.