Advanced Television Systems Committee Standards Work Update

By Jerry C. Whitaker, Advanced Television Systems Committee

This article summarizes some of the significant work undertaken by the Advanced Television Systems Committee (ATSC) in the current reporting period relating to technical standards for digital television (DTV). The driving force behind this work has been the ATSC Strategic Plan.

Strategic Plan—Guiding New Work on DTV

In July 2008 the ATSC Board of Directors reviewed and updated the ATSC Strategic Plan, a comprehensive roadmap for future work of the organization that reflects the evolution of technology over the next two to five years. The Board developed the Plan taking into account both the likely progression of technology and the importance of backwards compatibility with existing DTV consumer receivers. Ongoing efforts are focused on comprehensive solutions that enable compelling services and products. Major projects already under way include the following:

- **ATSC-M/H**—development of a standard to provide services to mobile and handheld receiving devices.
- **NRT**—development of a standard for non-real-time (NRT) delivery of services that leverage the low cost of storage and provide consumers with content they want, when and where they want it.
- **ATSC 2.0**—new services for conventional fixed DTV receivers. The initial phase of this project involved the distribution to ATSC members of a comprehensive poll on what features should be encompassed by ATSC 2.0. The results of this poll will guide the project as it moves forward. The work of defining the features and capabilities of proposed enhancements to the ATSC DTV system is being undertaken by the Planning Committee, chaired by Graham Jones of NAB.

Although not directly related to new technologies, the current state of DTV audio implementation was identified in the Strategic Plan as an important issue needing further study in coordination with other industry organization. While the AC-3 Digital Audio Standard (document A/52) has been on the books for many years, implementations in the field have varied, in particular with regard to lip-sync and sound levels.

ATSC Mobile/Handheld

The pace of work within ATSC to develop a mobile/handheld (M/H) system continues to accelerate as hundreds of engineers in a dozen countries work toward key upcoming deadlines. The major elements of the ATSC-M/H system have been selected and work now focuses on documenting the overall system.

ATSC-M/H is being developed to support a variety of services including free (advertiser-supported) television and interactive services delivered in realtime, subscription-based TV, and file-based content download for playback at a later time. The standard may also be used for transmission of new data broadcasting services such as realtime navigation data for in-vehicle use.

JERRY WHITAKER currently serves as vice president of standards development at ATSC and is closely involved in work relating to educational programs. He supports the work of the various ATSC technology and planning committees and assists in the development of ATSC standards and related documents.

Whitaker is a Fellow of SMPTE and the Society of Broadcast Engineers (SBE). He is the author and editor of more than 30 books on technical topics, including: *The Standard Handbook of Video and Television Engineering*, 4th ed.; *NAB Engineering Handbook*, 9th ed., *DTV Handbook*, 3rd ed., and *The Electronics Handbook*, 2nd ed. Before joining the ATSC, Whitaker headed the publishing company Technical Press, based in Morgan Hill, CA. He has served as a board member and vice president of SBE.

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About the Process

If all goes as planned, this fall the ATSC Technology and Standards Group (TSG) will be asked to advance the ATSC-M/H specification to Candidate Standard (CS). In ATSC, a Candidate Standard is a specification that has received significant review within a specialist group. Advancement of a document to CS status is an explicit call to those outside of the related specialist group for implementation and technical feedback. This is the phase at which the specialist group is responsible for formally acquiring that experience or at least defining the expectations of implementation.

Because the Candidate Standard phase is intended to gain real-world implementation experience, ATSC member companies are already thinking about possible steps they can take to make sure that the ATSC-M/H system functions as intended, and to identify any elements that might require additional work.

When TSG votes to elevate a document to Candidate Standard, it also sets the period of time of the CS implementation phase. While no decisions have yet been made on the CS period for ATSC-M/H, it is expected to be in the six- to nine-month timeframe. A Candidate Standard may be revised during this period, giving the specialist group the ability to address any issues that are identified during trial implementations. TSG/S4 also plans on conducting laboratory tests and field tests on the system during the CS phase. Draft laboratory and field test plans have already been developed.

Work on the mobile/handheld system has been focused in TSG/S4, the Specialist Group on ATSC-M/H, which has divided the task into four main elements. TSG/S4 is led by Mark Aitken of Sinclair Broadcast Group as Chair and Dan Borowicz of Ion Media as Vice-Chair.

Documentation

The current focus of TSG/S4 is developing the Working Draft documentation. In a tip of the hat to the core ATSC DTV Standard—document A/53—the final ATSC-M/H standard will be known as A/153. Like A/53, A/153 will be modular in concept, with the specifications for each of the modules containing separate Parts. As currently planned, the major Parts are as follows:

Part 1—"Mobile/Handheld Digital Television System"
Part 2—"RF/Transmission System Characteristics"
Part 3—"Service Multiplex and Transport Subsystem Characteristics"
Part 4—"Announcement"
Part 5—"Presentation Framework"
Part 6—"Service Protection"
Part 7—"Video System Characteristics"
Part 8—"Audio System Characteristics"

Part 1 of A/153 includes an overall system description and serves to tie the other Parts of the document together. An additional Part focusing on content protection is planned for later release.

The four TSG/S4 sub-groups have studied the various options for ATSC-M/H services and arrived at conclusions with regard to how the system should be built. They are currently focused on writing elements of the Parts listed above. The sub-groups are as follows:

- **S4-1**, Physical Layer Group. Led by Michael Doerr of Coherent Logix as Chair and Bruce Franca of MSTV as Vice-Chair, the Physical Layer Group is focusing on the RF, forward-error-correction, and legacy transport elements.
- **S4-2**, Management Layer Group. Led by Rich Chernock of Triveni Digital as Chair and Alan Moskowitz of MobiTV as Vice-Chair, the Management Layer Group is focusing on ATSC-M/H transport, signaling, announcement, streaming and file delivery, service protection, and content protection.
- **S4-3**, Presentation Layer. Led by Brett Jenkins of ION Media as Chair and Dakx Turcotte of Neural Audio Corporation as Vice-Chair, the Presentation Layer Group is focusing on audio coding, video coding, and image formats.
- **S4-4**, Systems. Led by Art Allison of NAB as Chair and Azfar Inayatullah of Sarnoff Corporation as Vice-Chair, the Systems Group is focusing on interface and project management issues.

The current work plan for ATSC-M/H meets the often-stated broadcaster need to announce the availability of future mobile/portable/handheld services in the first quarter of 2009. If all goes as planned, TSG will be asked to approve a ballot on an ATSC-M/H Proposed Standard by May 2009, with the ATSC process ending with final membership approval in Q3 of 2009.

NRT

Work is well under way within the ATSC Specialist Group on Data Broadcast (TSG/S13) to develop a comprehensive standard for nonrealtime services. As envisioned in the ATSC Strategic Plan, the increasing desire for "everything-on-demand" has changed customer expectations in the media industry. NRT capabilities are envisioned to cover a wide spectrum—some are similar to traditional television, such as clip services (news, sports, weather) and long-form content (push video-on-demand movies and personalized TV channels)—while others are relatively new to the broadcast space (music distribution, games, interactive applications, and reference material). Some NRT-enabled services may be totally invisible to the viewer (such as in-receiver targeted ad insertion).

The Planning Committee developed a comprehensive set of usage scenarios and requirements, which formed the basis for the work now under way. TSG/S13 is chaired by Michael Dolan, and Rich Chernock of Triveni Digital chairs the NRT ad-hoc group. Where possible, the work on NRT will utilize existing technologies and standards. In addition to speeding the development process, this approach serves to increase interoperability with other systems and devices.

The experts working on NRT believe the new services that will be enabled by this technology will be an important benefit for broadcasters. TV viewers have become accustomed to getting content when they want. As persistent storage is becoming commonplace in receivers, content can be pushed ahead of use to allow viewer consumption whenever desired.

Audio Issues

As noted in the ATSC Strategic Plan, some areas of DTV audio implementation continue to be problematic, in particular loudness variations and audio synchronization with video. Because these issues can only be corrected with a cross-industry effort, the ATSC established two groups within the Specialist Group on Video and Audio Coding (TSG/S6), led by Pat Waddell of Harmonic, to focus on audio:

- **Audio Loudness Group** (S6-3), led by Jim Starzynski of NBC Universal.
- **Audio Synchronization Group** (S6-4), led by John Henderson of CEA.

The first order of business for each group was to identify the scope of the problem and what elements in the signal chain from the studio to the receiver in the consumer's home contribute to it.

Loudness

It is important for the digital television system to provide uniform subjective loudness for all audio content. Consumers find it annoying when audio levels vary when changing channels, and when watching a single channel. Dialog, the spoken word, has been identified as the element to which audiences adjust their volume. Achieving an approximate level match for average dialog level from all content is a desirable goal. While the AC-3 audio specifications in ATSC Standard A/52 provide syntax that makes this goal achievable, system implementation in the real world has proven more difficult than expected.

The digital audio-coding system is greatly different from analog, and it can provide a significant increase in dynamic range with no technical reason for dialog to be encoded near 100 percent, a common NTSC practice. Even so, there is no assurance that all digital program channels, or all content on a given DTV channel, will have dialog encoded at the same level. Without a uniform loudness level for dialog or the proper use of DTV audio metadata components, there will be inevitable audio-level fluctuations between channels across the dial, and between programs and commercials on a single channel.

Addressing the loudness issue encompasses a number of elements, which include mixing, monitoring, and proper encoding of local and network programs, commercials, promos, and all other content. The S6-3 study group continues to explore all facets of DTV loudness. The group's goal is to identify problem areas and recommend practical solutions. S6-3 has approved an outline of a Recommended Practice on Audio Loudness; development of the Working Draft is under way.

Audio/Video Synchronization ("Lip Sync")

It is critically important that digital television deliver audio and video in proper synchronization to the viewer. However, the end-to-end DTV audio-video production, distribution, and broadcast system consist of a complex array of digital processing, compression, decompression, and storage devices. Each component in the system can impose delay on the audio and/or video signals flowing through it. Operationally, unequal delays can be imposed on the audio and video signals, respectively, and these delays compromise audio-video synchronization. While a given synchronization error may cause either a positive or negative differential shift in audio-video timing, the video signal is typically subjected to greater delay than the audio signal, and the tendency is therefore toward video lagging behind audio. Sound arriving in advance of the image is an unnatural physical phenomenon and is particularly noticeable and annoying to viewers.

The end-to-end DTV system may be divided into four general segments, as outlined below:

- **Acquisition/Post Production**—At the production/post-production stage, audio-video synchronization errors can occur in capture, processing, editing, and special effects.
- **Release Facility**—The release facility segment contains a number of devices through which the DTV audio and video signals are passed, which variously impose compression and de-compression, processing, and storage and their attendant differential delays on the signals.
- **Distribution System**—This segment includes the network distribution, the local affiliate station, including the ATSC encoder, and the transmission system. The affiliate station contains a number of devices that are similar to those encountered in the release facility segment, which generate the same types of differential audio-video delays.
- **Receiver**—An integrated receiver should adjust internally for any differential audio/video decoding issues. Errors could result, however, if synchronization signals are not tracked accurately and continuously, especially when receiving signals that may have been switched or spliced. This situation is further complicated if a set-top-box (STB) or other device feeds a separate display screen and a separate audio decoding/amplifying device.

The challenge in dealing with lip sync is that some aspects of the problem are not well understood because of the large number of potential variables involved. The ATSC S6-4 group is working to identify where the largest potential errors lie, and how they can be dealt with in the scope of real-world television broadcasting, focusing on issues related to ATSC emission bitstreams, encoding, and decoding, including professional and consumer equipment implementations that reply on ATSC standards. A SMPTE group working on these issues is concentrating mainly on the parts of the broadcast chain upstream of the emission encoder.

The Consumer Electronics Association (CEA) has undertaken the writing of an Engineering Bulletin (CEB) on receiver processing of time stamps. This work was identified in S6-4 and transferred to CEA as the logical place to author a document relating to receivers. The committee membership of CEA R4 WG15 has significant overlap with ATSC S6-4. Drafting of the document was under way as this issue went to press.

PMCP/PSIP Interoperability

Recognizing the need for improved industry-wide PMCP interoperability, and thus more accurate PSIP, the ATSC has formed a Working Group on PSIP Workflow Interoperability, known internally by the group name PC-7. This group reports to the ATSC Planning Committee and is chaired by Chris Lennon of Harris Corporation.

For those not familiar with it, PMCP (ATSC Standard A/76B) is the Programming Metadata Communication Protocol. It provides a standardized means of communicating PSIP-related data among the systems that manage it. PMCP has been around for some time, and has recently enjoyed a significant uptake in the industry as interest in and awareness of the need for dynamic, accurate PSIP increases.

Part of the scope of the ATSC Planning Committee is to "support the use of ATSC Standards and Recommended Practices through activities such as education, training, demonstrations and fostering interoperability." The goal of the PC-7 Working Group is to assemble a group of broadcasters and vendors who are implementing (or plan to implement) dynamic PSIP by way of PMCP interfaces between systems such as listing services, program management, traffic, automation, and PSIP generator systems. The group will work to improve interoperability of these systems by way of information exchange regarding PMCP and implementation issues.

The PC-7 Working Group hopes to provide members a forum in which vendors and broadcasters can work out interoperability details in an open, cooperative environment, benefiting not only the vendors, but the broadcasters who will be implementing these interfaces. Having all PMCP-compliant systems truly interoperable is in everyone's best interest.

The Role of PMCP

The Programming Metadata Communication Protocol can greatly simplify the process of generating highly accurate PSIP data. A/76 was developed by the ATSC Specialist Group on Metadata Communications, TSG/S1, under the leadership of Graham Jones of NAB, and is now chaired by Art Allison of NAB.

Because PSIP and other DTV metadata is originated or processed by several separate systems and related equipment, there are often difficulties in communicating the appropriate metadata to the PSIP generator. Implementing PMCP helps ensure that the transmitted PSIP information is complete and correct, with minimum manual intervention by the broadcaster.

PMCP is based primarily on XML (extensible markup language). It enables broadcasters and manufacturers to more easily interconnect systems that process PSIP and other DTV metadata. This includes, but is not limited to:

- Traffic
- Program management
- Listing service
- Automation
- MPEG encoder
- PSIP generator

PMCP is also extensible for other types of metadata, and can convey private information within the current data structure.

With the XML schema being both human and machine readable, PMCP implementation becomes a more simplified process by specifying exactly which elements are allowed in messages, their relationships, individual attributes, and data types.

PMCP references and is complementary to existing ATSC Standards. It supports the ISO Standard ISAN for unique identification of program content and carries all the information needed in one message structure for:

- Virtual channels
- PSIP events
- Programs
- System Time Table
- Directed Channel Change Table
- Regional Ratings Table
- Private Information

RP on Conversion of ATSC Signals for Distribution to NTSC Viewers

ATSC has completed a draft Recommended Practice on distribution and conversion of ATSC signals for use over multichannel video program distribution systems. The document provides guidance to broadcasters and other creators of ATSC high-definition (HD) or standard-definition (SD) content and to the operators of Multichannel Video Programming Distribution (MVPD) systems (such as cable or direct to home satellite). It recommends the equipment capabilities needed to provide the highest quality programming to viewers who only receive NTSC services. The RP covers professional equipment and excludes any recommendations for design or implementation of consumer equipment. Delivery to the home is not addressed by the document.

Background

In preparation for the 2009 digital transition, broadcasters, cable systems and satellite providers will need to arrange for distribution of broadcast channels to their standard definition viewers. Many markets will not have direct access to NTSC or serial digital interface (SDI) SD versions of broadcast services, but will be limited to direct reception of ATSC digital television (DTV) signals. These DTV signals may contain HD or SD formats. This RP provides guidance for the creation of the replacement NTSC signal. Two cases are explicitly covered and one

case is implicitly covered. The first case is direct delivery via NTSC on an RF channel. The second case is for head-end facilities that have SDI interconnections from the receive rack to the transmit rack (which may hold NTSC modulators or other suitable transmission equipment), which requires different techniques than those used for direct conversion to NTSC. These guidelines cover equipment capabilities needed to support both scenarios. The implicit case is for systems that do not have the ability to deliver an analog signal (except at the output of the consumer's STB), such as IPTV or DBS, which are treated as a "black box" with the RP only addressing how to replicate the NTSC input to the IPTV or DBS head-end.

The Working Draft RP provides basic technical recommendations and guidelines for equipment capabilities supporting distribution of HD originated broadcasts, SD 16:9, and all other ATSC standard coding formats with provisions for either direct down-conversion to analog, or an intermediary down-conversion to SDI which then is converted to analog for rendering on consumers' NTSC sets. Employing these capabilities will make it possible to ensure that DTV broadcast formats are properly formatted and delivered for analog/digital SD viewers.

This RP is the result of considerable contributions from a wide range of participations—both inside and outside of ATSC. The project was led by Pat Waddell. The Working Draft Recommended Practice was at TSG ballot as this issue went to press.

Active Groups and Committees

Table 1 lists the current active specialist groups and committees within ATSC. Work in ATSC is open to all with a direct and material interest in the work. If you are interested in participating in any of the ongoing work of the organization, please contact the author. All ATSC standards and recommended practices can be downloaded at no charge from the ATSC website at www.atsc.org.

GROUP NUMBER	GROUP NAME	CHAIR
TSG	Technology and Standards Group	John Henderson, CEA
TSG/S1	PSIP Metadata Communication	Art Allison, NAB
TSG/S2	Advanced Common Application Platform	Thomas Jung, Alticast
TSG/S3	Digital ENG	Dane Ericksen, Hammett & Edison
TSG/S4	ATSC M/H	Mark Aitken, Sinclair
S4-1	ATSC-M/H Physical Layer	Michael Doerr, Coherent Logix
S4-2	ATSC-M/H Management Layer	Rich Chernock, Triveni Digital
S4-3	ATSC-M/H Presentation Layer	Brett Jenkins, Ion Media
S4-4	ATSC-M/H Systems Layer	Art Allison, NAB
TSG/S6	Video and Audio Coding	Pat Waddell, Harmonic
S6-3	Loudness Issues	Jim Starzynski, NBC Universal
S6-4	Lip Sync Issues	John Henderson, Hitachi
TSG/S8	Data Multiplex/Transport	Mark Eyer, Sony
TSG/S9	RF Transmission	Charles Einolf, MSTV/CBS
TSG/S10	Receivers	John Henderson, Hitachi
TSG/S13	Data Broadcasting	Mike Dolan, TBT
S13-1	NRT Services	Rich Chernock, Triveni Digital
PC	Planning Committee	Graham Jones, NAB
PC-4	ATSC 2.0	Walt Husak, Dolby Laboratories
PC-6	Education and Training	Jerry Whitaker, ATSC
PC-7	PSIP Interoperability	Chris Lennon, Harris

Table 1. Active ATSC specialist groups and committees.