the standard
News from ATSC, Volume Nine, Issue Four, December 2008

Mobile/Handheld DTV Project Moves Forward

The work to develop a comprehensive standard for mobile and handheld services—known as ATSC Mobile DTV—has reached a milestone with publication of the A/153 Candidate Standard document set. ATSC Mobile DTV is being developed to support a variety of services including free (advertiser-supported) television and interactive services delivered in real-time, subscription-based TV, and file-based content download for playback at a later time. The standard can also be used for transmission of new data broadcasting services.

ATSC Mobile DTV is built around a highly robust transmission system based on vestigial sideband (VSB) modulation coupled with a flexible and extensible Internet Protocol (IP) based transport system, efficient MPEG AVC (ISO/IEC 14496-10 or ITU H.264) video, and HE AAC v2 audio (ISO/IEC 14496-3) coding. The ATSC Mobile DTV Candidate Standard describes the methodology for new services to be carried in digital broadcast channels along with current DTV services without any adverse impact on legacy receiving equipment.

In addition to live television, the ATSC Mobile DTV system provides a flexible Application Framework to enable new receiver capabilities. Receivers that make use of an optional Internet connection will enable new interactive television services, ranging from simple audience voting to the integration of Internet-based applications and transactions with television content.
Development of the ATSC Mobile DTV system was based on a strategic plan approved by the ATSC Board of Directors in October 2006. ATSC subsequently developed detailed system requirements and issued a request for Proposals (RFP) in May 2007. Work on the ATSC Mobile DTV system has been done within the Specialist Group on ATSC-Mobile/Handheld (TSG/S4), which is led by Mark Aitken of Sinclair Broadcast Group as Chair and Dan Borowicz of Ion Media as Vice-Chair. The major elements of the ATSC Mobile DTV system have been selected and documented. On November 25 the Technology and Standards Group (TSG) approved publication as a Candidate Standard.

The ATSC Mobile DTV Candidate Standard

A Candidate Standard (CS) is a specification that has received significant review within an ATSC specialist group. Advancement of a document to Candidate Standard 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. The parent technology group (TSG) must approve advancement of a document to Candidate Standard status; this done by a ballot of voting members of the group.

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

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elevate a document to Candidate Standard, it also sets the period of time for the CS implementation phase. The CS period for ATSC Mobile DTV extends to May 20, 2009. 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. Suggested laboratory tests and field tests on the system during the CS phase are documented in the test plans developed by ATSC. Testing organizations can request these plans from ATSC or develop their own.

"ATSC has had great success in 2008 in their fast paced mobile/handheld DTV standardization process, adopting a Candidate Standard, and driving industry consensus" said **NAB President and CEO David Rehr.** *"We're very excited that the ATSC Mobile DTV Pavilion will be on the floor of the NAB Show. This will be proof positive that the ATSC Mobile DTV standard is both practical and enthusiastically supported by an eager manufacturing industry, as well as the broadcast community. We're going to see a lot of motion in ATSC Mobile DTV this April in Las Vegas."*

The Open Mobile Video Coalition (OMVC) has announced plans to conduct field trials of the ATSC Mobile DTV system. The OMVC is an alliance of broadcasters whose mission is to accelerate the development of mobile digital television in the United States.

Rounding out the ecosystem for ATSC Mobile DTV devices and services, the Consumer Electronics Association has launched a complimentary Special Interest Group for manufacturers interested in building products to the Candidate Standard.

Documentation

In a tip of the hat to the core ATSC DTV Standard—document A/53—the final ATSC Mobile DTV standard will be known as A/153. Like A/53, A/153 is modular in concept, with the specifications for each of the modules contained separate Parts. (See Figure 1.) The individual Parts of A/153 are as follows:

Part 1 – "Mobile/Handheld Digital Television System"

Part 1 describes the overall ATSC Mobile DTV system and explains the organization of the standard. It also describes the explicit signaling requirements that are implemented by data structures throughout the other Parts.

Part 2 – "RF/Transmission System Characteristics"

Part 2 describes how the data is processed and placed into the VSB frame. Major elements include the Reed-Solomon (RS) Frame, a Transmission Parameter Channel (TPC), and a Fast Information Channel (FIC).

Part 3 – "Service Multiplex and Transport Subsystem Characteristics"

Part 3 covers the service multiplex and transport subsystem, which comprises several layers in the stack. Major elements include Internet Protocol (v4), UniDirectional Protocol (UDP), Signaling Channel Service, FLUTE over Asynchronous Layered Coding (ALC) / Layered Coding Transport (LCT), Network Time Protocol (NTP) time service, and Real Time Protocol (RTP) / Real Time Transport Control Protocol (RTCP).

Part 4 – "Announcement"

Part 4 covers Announcement, where services can optionally be announced using a Service Guide. The guide specified in Part 4 is based on an Open Mobile Alliance (OMA) broadcast (BCAST) Service Guide, with constraints and extensions.

Part 5 – "Application Framework"

Part 5 defines the Application Framework, which enables the broadcaster of the audio-visual service to author and insert supplemental content to define and control various additional elements of the Rich Media Environment (RME).

Part 6 – "Service Protection"

Part 6 covers Service Protection, which refers to the protection of content, either files or streams, during delivery to a receiver. Major elements include the Right Issue Object and Short-Term Key Message (STKM).

Part 7 – "Video System Characteristics"

Part 7 defines the AVC and SVC Video System in the ATSC Mobile DTV system. Additional elements covered in this Part included closed captioning (CEA 708) and Active Format Description (AFD).

Part 8 – "Audio System Characteristics"

Part 8 defines the HE-AAC v2 Audio System in the ATSC Mobile DTV system.

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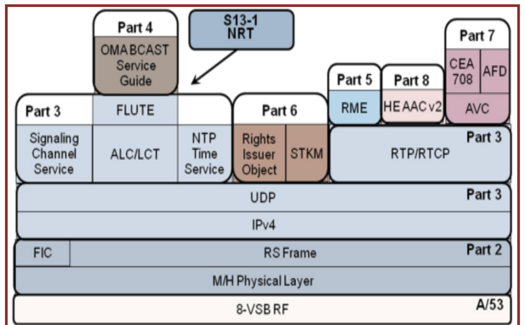

Figure 1 The overall A/153 documentation structure.

An additional Part focusing on content protection is planned for later release.

While the basic capability for sending files is defined in Part 3, it is very general and broad. A constrained set of interoperability points are being defined in a separate ATSC activity (in TSG S/13, the Specialist Group on Data Broadcasting) where non-real-time (NRT) file delivery requirements are being documented for use in both the ATSC Mobile DTV system and the current DTV (8-VSB) system.

TSG/S4 divided the ATSC Mobile DTV task into four main elements, with most of the detailed work taking place in those sub-groups:

- 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 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, 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.

ATSC Mobile DTV System Overview

Design of the ATSC DTV Mobile system has involved hundreds of engineers around the world. This effort has truly been international in scope. Early on in the design process, TSG/S4 clearly stated their intention to utilize existing standards and technologies where possible and appropriate. The benefits of this approach are obvious—improved interoperability of the new system with existing systems, faster time to market, and reduced developmental costs. The end result, as documented in the Candidate Standard, is an efficient hybrid of new and existing technologies.

The ATSC Mobile DTV service shares the same RF channel as the standard ATSC broadcast service described in ATSC A/53 ("ATSC Digital Television Standard, Parts 1 – 6"). The mobile system is enabled by using a portion of the total available 19.4 Mbps bandwidth and utilizing delivery over IP transport. The overall system is illustrated in **Figure 2**.

In very simple terms, the system achieves the robustness needed for

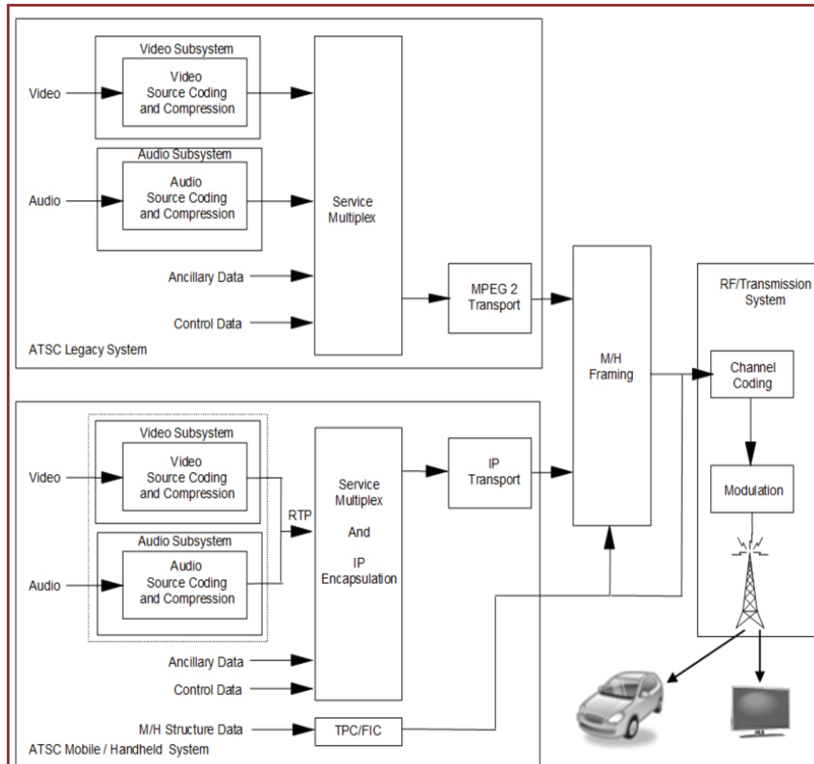

Figure 2 The ATSC Mobile DTV System

mobile reception by adding extra training sequences and forward error correction. The total bandwidth needed for the ATSC

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Mobile DTV... *(continued from Page 3)*

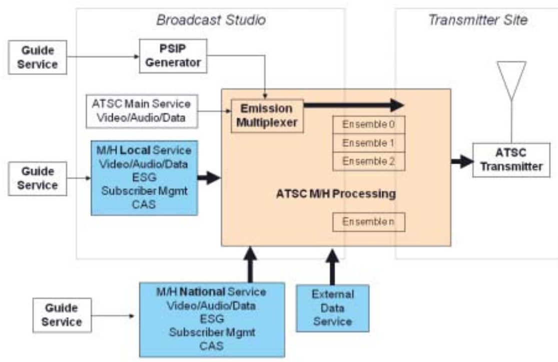

Figure 3 ATSC Mobile DTV broadcast system block diagram.

Mobile DTV service depends on several factors, including the number and type of program services, the quality level, and level of robustness desired—typically ranging from less than one megabit per second to many megabits per second. The ATSC Mobile DTV system converts the current 8-VSB emission into a dual-stream system without altering the emitted spectral characteristics. It does this by selecting some of the MPEG-2 segments (corresponding to MPEG-2 Transport packets in the current system) and allocating the payloads in those segments to carry the M/H data in a manner that existing legacy receivers will ignore. A block diagram representation of the broadcast chain is shown in **Figure 3**.

ATSC Mobile DTV data is partitioned into Ensembles, each of which contains one or more Services. Each Ensemble uses an independent RS Frame (an FEC structure), and furthermore, each Ensemble may be coded to a different level of error protection depending on the application. Encoding includes FEC at both the packet and trellis levels, plus the insertion of long and regularly spaced training sequences into the data stream. Robust and reliable control data is also inserted for use by receivers. The system provides bursted transmission of the data, which allows the receiver to cycle power in the tuner and demodulator for energy saving. A simplified block diagram of the ATSC Mobile DTV transmission system is illustrated in **Figure 4**.

In the ATSC Mobile DTV physical layer system, the data is transferred by a time-slicing mechanism to improve the receiver's power management capacity. Each Frame time interval is divided into five sub-intervals of equal length, called Subframes. Each Subframe is in turn divided into four sub-divisions of length 48.4 ms, the time it takes to transmit one VSB frame. These VSB frame time intervals are in turn divided into 4 Slots each (for a total of 16 Slots in each Subframe).

The data to be transmitted is packaged into a set of consecutive RS Frames, where this set of RS Frames logically forms an Ensemble. The data from each RS Frame to be transmitted during a single Frame is split up into chunks called Groups, and the Groups are organized into Parades, where a Parade carries the Groups from up to two RS Frames but not less than one. The number of Groups belonging to a Parade is always a multiple of five, and the Groups in the Parade go into Slots that are equally divided among the Subframes of the Frame.

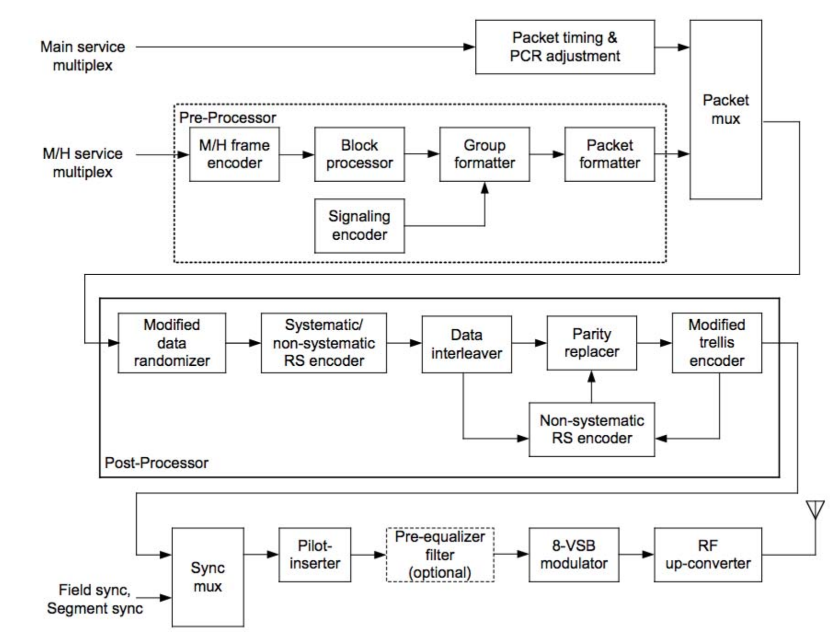

Figure 4 Block diagram of an ATSC Mobile DTV transmission system.

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The RS Frame is the basic data delivery unit, into which the IP datagrams are encapsulated. While a Parade always carries a Primary RS Frame, it may carry an additional Secondary RS Frame as output of the baseband process. The number of RS Frames and the size of each RS Frame are determined by the transmission mode of the physical layer subsystem. Typically, the size of the Primary RS Frame is bigger than the size of Secondary RS Frame, when they are carried in one Parade.

The FIC is a separate data channel from the data channel delivered through RS Frames. The main purpose of the FIC is to efficiently deliver essential information for rapid Service acquisition. This information primarily includes binding information between Services and the Ensembles carrying them, plus version information for the Service Signaling Channel of each Ensemble.

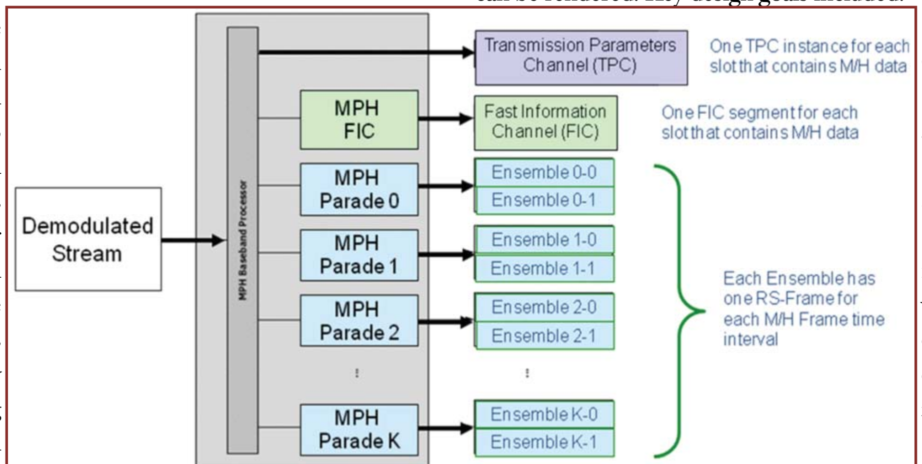

Figure 5 ATSC Mobile DTV physical transport subsystem.

An "ATSC Mobile DTV Service" is similar in general concept to a virtual channel as defined in ATSC A/65 ("Program and System Information Protocol"). A Service is a package of IP streams transmitted through a multiplex that forms a sequence of programs under the control of a broadcaster, which can be broadcast as part of a schedule. Typical examples of ATSC Mobile DTV Services include TV services and audio services. Collections of Services are structured into Ensembles, each of which consists of a set of consecutive RS Frames.

In general, there are two types of files that might be delivered using the methods described in the ATSC Mobile DTV system. The first of these is content files, such as music or video files. The second type of file that may be transmitted is a portion of the service guide. This includes long- and short-term keys for service protection, logos, and Session Description Protocol (SDP) files. In either case, the delivery mechanisms are the same and it is up to the terminal to resolve the purpose of the files. A simplified block diagram of the organization of the major elements for delivery over the physical transport subsystem is illustrated in **Figure 5**.

Signaling in the ATSC Mobile DTV system provides metadata to the receiver relating to tuning, including whether content should/can be rendered. Key design goals included:

- Keep it compact (low bitrate)
- Make it flexible and extensible
- Support rapid service acquisition
- Support basic functionality even when the receiver does not have up-to-date Service Guide information
- Support unique requirements of roaming, such as hand-off from one transmitter to another for regional and national services when crossing broadcast area boundaries

In the ATSC Mobile DTV system, the Services available on that system (or another system) can be announced via the Announcement subsystem, called a Service Guide. A Service Guide is a special Service that is declared in the Service Signaling subsystem. A receiver determines available Service Guides by reading the Guide

"The ATSC's rapid decision to elevate the Mobile DTV Standard drives our fast-moving progress toward launching full mainstream mobile DTV for U.S. consumers," said **Jim Conschafter, OMVC Member and Media General Broadcast Group Senior VP.** *"This success of this crucial vote allows OMVC members to continue their service development with added direction and focus."*

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"The ATSC's decision to elevate the Mobile DTV Candidate Standard is a significant step in the advancement of Mobile DTV services," said **Brandon Burgess, OMVC President and ION Media Networks Chairman and CEO.** *"Together with consumer device manufacturers, our continued cross-industry research and development will ensure the ultimate objective of full-motion mobile service deployment in 2009."*

Access Table. This table lists the Service Guides present in the broadcast, gives information about the service provider for each guide, and gives access information for each guide.

The ATSC Mobile DTV Service Guide is based on the OMA BCAST Service Guide, with certain constraints and extensions. A Service Guide is delivered using one or more IP streams. The main stream delivers the Announcement Channel, and zero or more streams are used to deliver the guide data. If separate streams are not provided, guide data is carried in the Announcement Channel stream. The Service Guide is designed so that it may also be delivered over a separate connection if a device has two-way connectivity.

The Application Framework is a toolkit that allows for the creation of graphical and syntactical elements to be added in conjunction with the delivery of audio and video. It differs from a middleware specification in that the Application Framework allows for an overlay on top of the audio/video plane rather than a true software control layer controlling all upper layers of the client. The Application Framework data is transmitted in-band alongside the audio and video.

This subsystem enables the broadcaster of the audio-visual service to author and insert supplemental content to define and control various additional elements to be used in conjunction with the audio-visual service. It enables the definition of auxiliary (graphical) components, layout for the service, transitions between layouts and composition of audio-visual components with auxiliary data components. Furthermore, it enables the broadcaster to send remote events to modify the presentation and to control the presentation timeline. The Application Framework further enables coherent rendering of the service and its layout over a variety of device classes and platforms, rendering of action buttons and input fields, and event handling and scripting associated with such buttons and fields. Example applications are shown in **Figure 6.**

Figure 6 Examples of user experiences created with an Application Framework in conjunction with audio and video. Photos courtesy of MobiTV.

The Application Framework is important because it allows the ATSC Mobile DTV system to expand beyond the mobile playback of video and audio, and provide a new set of tools for Internet-style personalization and interaction. This entertainment experience can capitalize on whatever data return channel(s) may be available.

The Application Framework is built around the OMA Rich Media Environment (OMA-RME). The OMA-RME, designed around a similar requirement set, is an umbrella standard encompassing elements in application creation, delivery, and control.

Service Protection refers to the protection of content, be that files or streams, during its delivery to a receiver. Service Protection assumes no responsibility for content after it has been delivered to the receiver. It is intended for subscription management. It is an access control mechanism, only.

The ATSC Mobile DTV Service Protection system is based on the OMA BCAST DRM Profile. It consists of the following components:

- Key provisioning
- Layer 1 registration
- Long-Term Key Message (LTKM), including the use of Broadcast Rights Objects (BCROs) to deliver LTKMs
- Short-Term Key Messages (STKM)
- Traffic encryption

The system relies on the following encryption standards:

- Advanced Encryption Standard (AES)
- Secure Internet Protocol (IPsec)
-

Traffic Encryption Key (TEK)

In the OMA BCAST DRM Profile there are two modes for Service Protection—interactive and broadcast-only mode. In interactive mode, the receiver supports an interaction channel to communicate with a service provider, to receive Service and/or Content Protection rights. In broadcast-only mode, the receiver does not use an interaction channel to communicate with a service provider. Requests are made by the user through some out-of-band mechanism to the service provider, such as calling a service provider phone number or accessing the service provider website. The OMA BCAST 4-layer key hierarchy is illustrated in **Figure 7.**

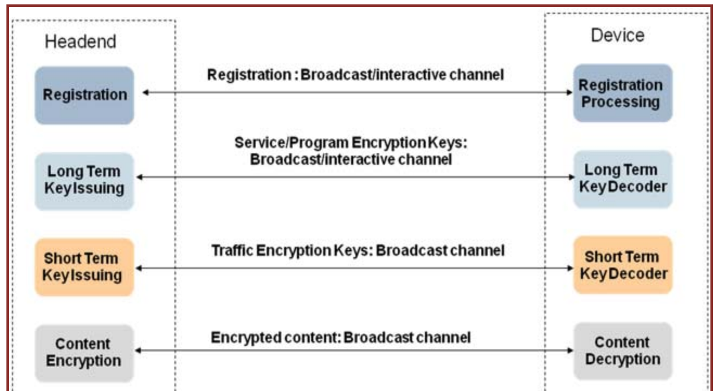

Figure 7 OMA BCAST 4-layer key hierarchy.

The ATSC Mobile DTV system uses MPEG-4 AVC and optionally SVC video coding as described in ISO/IEC 14496 Part 10, with certain constraints. A single base format of 240 lines x 416 pixels, 16:9 aspect ratio, progressive scan, is specified, with the ability to increase the resolution or quality through use of the SVC option.

AVC is the international video coding standard ISO/IEC 14496-10 (MPEG-4 Part 10) "Advanced Video Coding," finalized in 2003. It supports a wide range of applications, from low-bit-rate mobile video streaming to high-bit-rate HDTV broadcast and DVD storage.

Audio coding for the ATSC Mobile DTV system utilizes HE AAC v2, specified in ISO/IEC 14496-3 – MPEG-4 Audio. Constraints include the following:

- HE AAC v2 Profile, Level 2, maximum of two audio channels up to 48 kHz sampling rate.
- Bit rate and buffer requirements comply with the MPEG-4 HE AAC

Our efforts to develop ATSC Mobile DTV are a part of a strategy to provide the broadcast industry with the technical ability to deliver content to consumers on the move. The architecture of the Candidate Standard will make terrestrial broadcasting an important segment of the Internet." **Glenn Reitmeier, Chairman of the ATSC Board of Directors**

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audio buffer model.

- Supported sampling frequencies are 32 kHz, 44.1 kHz, and 48 kHz

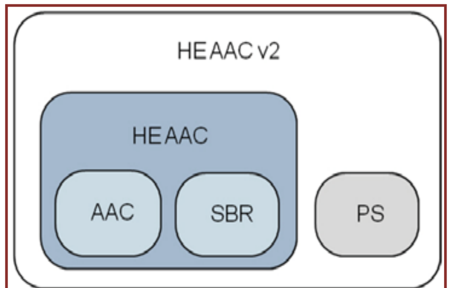

Figure 8 Toolkit of the HE AAC v2 system.

HE AAC v2 is the combination of three audio coding tools, MPEG-4 AAC, Spectral Band Replication (SBR), and Parametric Stereo (PS). The HE AAC toolkit is shown in **Figure 8.**

Evolving the ATSC Mobile DTV System

The experts in TSG/S4 recognize that technology will continue to move forward. As such, a mechanism to evolve the ATSC Mobile DTV system over time is important. This capability has been built into the System Configuration Signaling architecture. The goal of this system is to support a configuration change of the protocol stack used by the broadcaster. Key considerations include:

- The system must provide information about each piece of content and how it is transmitted
- A receiving device must be able to determine if it can support such a content before the content is exposed to the user

As designed, the signaling is multilayer and will support two types of changes:

Major Version Change: a non-backward-compatible level of change.
Minor Version Change: a backward-compatible level of change, provided the major version level remains the same. Decoders/receivers can assume a minor change does not prevent them from rendering content.

The following signaling requirements were established for the ATSC Mobile DTV system:

- Capable of signaling the addition of a new elementary subsystem. For example, a Digital Rights Management capability may be added.
- Capable of signaling the removal of an elementary subsystem. For example, service protection is removed and replaced with functionality that resides outside of the ATSC system; i.e., an out-of-band method.
- Capable of signaling the replacement of an elementary subsystem. For example, one encryption is replaced with another encryption—the black box operation is equivalent.
- Capable of signaling service compatibility in an expedient manner, where the receiver is able to determine if it can support a service within one complete frame time.
- Capable of signaling all functionality needed to support a service correctly (i.e., transport, file management, SVC sync, and so on).
- Capability to support the Electronic Service Guide not displaying an event that cannot be decoded by the receiver.
- Signaling of the elementary subsystem functions must be complete enough for the receiver to definitely determine if it can process the content.

- Capable of signaling multiple generations of service carried concurrently, in the same ATSC Mobile DTV emission.
- Capable of signaling services that are intended for the equivalent of a multicast group (target is subset of receivers grouped by activity).
- Capable of signaling legacy services with optional extensions, such that the legacy receiver ignores the optional functionality signaling, and supports the legacy portion of the service.
- Capability to change the System Configuration Signaling system protocol without adversely affecting products built to the original signaling protocol.
- Capability to support a receiver determining a channel is out of service.
- Capable of signaling that the protocol version of a single elementary subsystem has changed.
- Capable of communicating a code for the version of each elementary subsystem required to decode and correctly display the services offered.

The signaling approach is hierarchal, with the physical of RF layer being considered the bottom of the stack. Much of the signaling is defined as integral parts of the data structures. At the bottom-most layer a simple (one-bit) signaling means was established. A major change of the entire physical layer can be signaled by use of another such bit. Other signaling for the RF layer is implemented with a simple version field in key data structures, each of which enables signaling of changes in the data structure above.

At higher layers more signaling capability is established, reflecting the increasing likelihood of change in those layers as time progresses.

Schedule

The current work plan for ATSC Mobile DTV 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 the ATSC Mobile DTV Proposed Standard by May 2009, with the ATSC process ending with final membership approval in Q3 of 2009.

The ATSC Mobile DTV Candidate Standard document set can be downloaded from the Candidate Standard page on the ATSC Web site: *http://www.atsc.org.* ◆

"ATSC Mobile DTV will allow broadcasters to leverage the wireless and local nature of their DTV transmission. Broadcasters will be able to provide new compelling services to consumers utilizing a wide array of wireless receiving devices including mobile phones, small handheld TVs, laptop computers, and in-vehicle entertainment systems." **Mark Richer, ATSC President**

the standard

Advanced Television Systems Committee, Inc.

To join ATSC, call us, 202 872-9160 fax us, 202 872-9161 or log on to www.atsc.org

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The ATSC is an international, non-profit organization developing voluntary standards for digital television. The ATSC has member organizations representing the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

Welcome Wagon

ATSC would like to welcome it's newest members:

Axel Technologies Oy, C&S Technologies, Eiden Co., Ltd. , ENENSYS Technologies, Meintel, Sgrignoli & Wallace, LLC , and NXP Semiconductor.

These companies have recently become members. We eagerly anticipate their contributions to the DTV standards currently being developed in the ATSC, and we know their participation will have an immeasurable effect on the future of digital television.