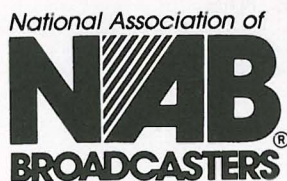


Digital Television Broadcasting in the United States



Graham Jones

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By Graham Jones, National Association of Broadcasters

This report summarizes some of the more significant developments that have occurred in the current reporting period relating to terrestrial transmission and reception, regulatory issues, technical standards, and quality issues.

Terrestrial DTV Transmission

The countdown to February 17, 2009 continues, when U.S. full power broadcasters must end their analog television transmissions and move to all-digital broadcasting. Broadcasters are preparing for this milestone and, by mid-June 2007, 1722 terrestrial digital television (DTV) stations had been granted a license or construction permit and 1610 stations were on air in 211 markets (FCC figures). This compares with 1573 DTV stations on air twelve-months previously, and a current total of approximately 1755 analog stations. One or more local DTV station transmissions are now on air in markets serving nearly 100% of U.S. households, with more than 90% of households in markets with five or more DTV broadcasters. However, most television translators, which extend the coverage of main station transmitters, have not yet been replicated for DTV and these are currently exempt from the February 2009 transition date, pending action on this by the FCC on a transition plan for translators and low power stations.

DTV Programming

The majority of primetime broadcast network programming and a significant amount of daytime television in the U.S. is now produced in high definition (HD). Total broadcast hours of HD television from the six major networks during 2006 was as follows:

ABC	1660 hours (estimate for 2006/2007 season) (previous year 1355 hours)
CBS	1856 hours (previous year 1845 hours)
Fox	1053 hours (previous year 934 hours)
NBC	2460 hours (previous year 1286 hours)
PBS	447 hours (2006/2007 season ending June 30) includes 75 hours repeats (previous year 218 hours)
CW	416 hours (estimate for 2006/2007 season)

In September 2006, the WB Network and UPN ceased operations and were merged to form the new CW network. MyNetworkTV, a new Fox-owned network, also started in September 2006, carrying a limited number of hours of all-HDTV programming on its digital station channels. In January 2007, the "i" Network (previously PAX TV) changed its name to ION Television and its digital stations continued to carry multiple channels of standard definition (SD) programming only. The Spanish-language networks Univision and Telemundo also continued to carry only SD programming on their digital channels.

In March 2007, NBC became the first network to originate its daily national news program in HDTV.

ABC, Fox, and MyNetworkTV use the 720p video format for HD content, while the other networks carrying HD programming all use 1080i. Many HD shows are produced with 5.1 channel surround sound, providing superior sound quality that matches the enhanced video. Most local broadcast stations have facilities for passing through network HD programming, with local 480i SD content being upconverted to HD. As of June 2007, more than 50 stations had also upgraded their station infrastructure for local HDTV production (mainly for news), with many more in progress.

In addition to carrying an HD program, many DTV stations provide multicast program services within their single 6 MHz broadcast channel. A common configuration is one HD program and one SD program—frequently, but not always, a weather- or news-related channel. Some stations carry one HD and two SD programs. Large numbers of stations in several groups, including Raycom Media, Tribune, and Sinclair, carry in their multiplex an SD program from The Tube music network. Other local stations produce or procure material for their multicast channels, and many PBS stations adopt a four-channel SD multiplex during daytime for a variety of informational and educational programs, switching to one HD and one or more SD programs in the evening. Stations owned by ION Television broadcast up to five SD programs in a single multiplex.

Receivers and Reception Issues

DTV Receivers

FCC rules now require that after March 1, 2007, all TV sets and other devices sold with off-air tuners must include the capability to receive DTV signals. Sales of digital televisions have increased greatly as prices have dropped and the Consumer Electronics Association (CEA) figures for shipments of “digital displays” were 24.3 million units in 2006, compared to about 12 million in 2005. CEA figures indicate that at the end of 2006 about 20% of U.S. households had a digital display, with about 15% having an HD display. These numbers are expected to more than double during 2007. It should be noted that CEA “digital display” figures include integrated DTV sets and displays without tuners.

As integrated DTV televisions have become the norm, most major manufacturers have stopped manufacturing standalone ATSC terrestrial set-top boxes but models from several lesser-known brands have been introduced. Various digital video recorders, DVD recorders, and HDTV direct-to-home satellite receivers also now include ATSC tuners and there are many DTV tuners available

for use specifically with a computer. These are typically USB devices, either in small boxes or in “thumb-drive” form factor, although PCI plug-in cards are also available. DTV reception capability for these new tuners is greatly improved compared to earlier receivers. However, software decoding and control implementations for the computer-based devices are somewhat variable and performance is heavily dependent on the computer specifications.

DTV Converter Boxes

An estimated 69 million analog televisions currently rely on terrestrial broadcast signals and it is highly desirable that they will continue to receive free over-the-air television service when the analog service is discontinued. High-quality, low-cost, terrestrial DTV-to-analog NTSC converter boxes were demonstrated at the NAB2006 and NAB2007 conventions. The National Association of Broadcasters (NAB) and Association for Maximum Service Television (MSTV) funded the development of prototype boxes by Thomson and LG Electronics and they are expected to form the basis for future commercial products.

A National Telecommunications and Information Administration (NTIA) Notice of Proposed Rule Making (NPRM) on the digital converter box coupon program (see below) was issued in July 2006. It proposed that minimum tuner performance standards be applied toward qualifying digital converter boxes for inclusion in the coupon program and that the ATSC A/74 Recommended Practice on Receiver Performance Guidelines be adopted as a minimum criteria. Joint comments filed by CEA/MSTV/NAB recommended performance figures exceeding the minimum specifications in A/74 in several areas and noted that the prototype boxes meet or exceed A/74 performance levels, by substantial margins in some cases. The final NTIA rules for eligible converter boxes, published in March 2007, adopted the CEA/MSTV/NAB recommendations in full. The rules also stated that qualified converter boxes will only be allowed basic functions to feed SD televisions; boxes with HD outputs or built-in recording functions are not eligible.

Soon after adoption of the final rule for the converter box coupon program, four manufacturers—LG Electronics, Thomson, Samsung, and Jasco (GE brand)—announced their intentions to build eligible set-top boxes.

Smart Antenna

The NTIA rules explicitly permit (but do not require) a CEA 909 smart antenna control interface to be present in the coupon-eligible converter box. Such electronically-steerable smart antennas automatically adjust the preferred signal direction for each particular broadcast emission without the need to manually adjust

the orientation of the antenna. This optimization takes into account factors, such as signal strength, multipath strength, and/or bit error rate and makes DTV reception much more reliable under difficult conditions.

Digital-to-Analog Converter Box Vouchers

As authorized by Congress, all U.S. households will be eligible to request up to two \$40 coupons from the NTIA. These coupons may be used toward the purchase of qualified digital-to-analog converter boxes that allow ATSC HD or SD DTV transmissions to be displayed on NTSC analog televisions. The coupons will be available between January 1, 2008 and March 31, 2009 and \$1.5 billion has been allocated for the program. Details on how to apply will be published later in 2007.

Antenna Selection

The AntennaWeb site, <http://antennaweb.org>, developed by TitanTV and funded by CEA, continues to help DTV owners select the proper antenna and orientation for terrestrial over-the-air reception. The site typically receives several hundred thousand hits per month, reflecting an increasing interest in terrestrial DTV. AntennaWeb uses algorithms for DTV coverage and antenna selection, based on work by the CEA R5 Antenna Systems Committee.

DTV Information

To help prepare consumers for the transition from analog to digital television, the FCC has a comprehensive DTV information website at www.dtv.gov. The NTIA also has responsibility for communicating information on the transition to the public and its activities and publications are available at www.ntia.doc.gov/.

CEA and NAB both announced that they will work with the NTIA to ensure that consumers will be ready for the change to digital broadcasting. In January 2007, NAB launched its own DTV information and education campaign, with a website at www.dtvanswers.com. MSTV also provides DTV information, with a countdown clock to analog turn-off, on its website at www.mstv.org.

In February 2007, the DTV Transition Coalition was formed to work on a comprehensive consumer education campaign to increase awareness of the transition to digital television. The coalition now comprises well over 100 industry organizations, trade associations, civil rights organizations, and community groups, with a website at www.DTVtransition.org.

There are numerous unofficial websites providing information and discussion on DTV and HDTV, including, among many others: the AV Science Forum, Hi Def Forum, TV Predictions, HDTV Infoport, DTV Facts,

HDTV Magazine, and TV Fool. Such sites are generally useful and reasonably well-informed, but not all guidance provided is accurate or complete.

The My Free HDTV website, www.myfreehdtv.org, established by a group of local broadcasters in 2004, provides information on the availability and advantages of free over-the-air HDTV and DTV broadcasting and includes a public service announcement intended for use by broadcasters, with broadcast-quality tapes available. Many local broadcast stations and networks also provide information about digital television on their own websites and most listings identify programs that are available in HDTV. However, most broadcasters have not yet started to promote over-the-air HDTV or DTV reception with on-air information or announcements.

FCC Actions on DTV

Spectrum Repacking

At the start of the DTV transition, most stations were assigned a second RF channel for their DTV service. In order to optimize the repacking of the spectrum as analog channels are closed down, some of these assignments will need to change, and to complete the transition all stations must have moved into the "core" channels 2-51. This move from the upper 700 MHz spectrum band will free up 84 MHz for auction to mobile wireless carriers and others and 24 MHz set aside for emergency response agencies. The FCC allowed stations to choose (subject to approval) their final channel for the DTV service.

In October 2006, the FCC released its Seventh Further Notice of Proposed Rule Making on Digital Television Service. In this NPRM, the Commission proposed a new DTV Table of Allotments, providing all eligible stations with final channels for operations after the completion of the transition, and sort public comments on the table. A final table will be issued after comments have been resolved.

Stations that will be impacted by repacking are working to devise appropriate transition scenarios. This process is complicated by the fact that a number of DTV stations will need to move to channels now occupied by NTSC stations. Considerable coordination of equipment and resources will be required to switch off a large number of analog transmitters on various frequencies and put a like number of DTV transmitters on the air. It seems unlikely that this will all occur in one night on February 17, 2009 and some flexibility may be needed.

Translators and Low Power Stations

As of July 2007, the FCC has not finalized rules for DTV operation by the approximately 4,500 TV translators and 2,700 low-power and Class A television stations.

It has indicated, however, that it will consider requests from low-power stations to operate DTV service on replacement channels on a case-by-case basis. In many cases, TV translators will make the transition to DTV by simply changing from analog to DTV operation on their existing channels at some point in time. In other cases, new translators will be added to provide DTV service on new channels.

The NTIA has announced that from October 2007 it will make payments of up to \$10 million under a program through which certain broadcasters may receive compensation toward the purchase of a digital-to-analog conversion device that will enable them to convert incoming digital TV signals to analog format. This will help enable continuing analog transmissions on eligible translators and low-power repeating stations after February 2009. NTIA also announced that from October 2008, it will make payments of no more than \$65 million to implement a program to reimburse eligible rural low-power television stations for upgrading to digital TV technology. Priority for both these programs will be given to non-profit corporations and stations that serve rural areas of fewer than 10,000 viewers.

Third DTV Periodic Review

In May 2007, the FCC released its Third Periodic Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television. This review provides a progress report on the DTV transition, describes the status and readiness of existing TV stations to complete the transition, analyzes and proposes procedures and rule changes necessary to complete the transition, and addresses other issues related to the transition.

The key elements in the NPRM propose: to restrict future extensions of time to construct digital facilities, offer expedited processing to stations applying for a construction permit for their post-transition channel, consider allowing early turn-off/power reduction of analog to facilitate construction of post-transition facilities, and permit stations that have different pre-transition and post-transition channels to devote their resources to building their post-transition channel. They also require stations to file the form outlining their transition plan by December 1, 2007, and establish February 17, 2009 as the construction deadline for stations with new channel allotments.

In addition to the proposed rules related to the Table of Allotments, the NPRM proposes to update the FCC rules to reflect revisions to the ATSC Standards concerning DTV transmission and PSIP since the adoption of the Second DTV Periodic Report and Order. The FCC also asks whether broadcasters should be required to include Active Format Descriptor (AFD) and Bar Data.

Closed Captioning

FCC rules for closed captioning on DTV channels require that since January 1, 2006, 100% of most new video programs (there are some programs that are exempt) must be captioned with closed captions in accordance with the CEA-708 DTV Closed Captioning standard.

A revised version of the standard, CEA-708-C, was published in July 2006 (a further update is expected later in 2007). This standard has been harmonized with revised versions of SMPTE standard 334M and ATSC A/53 to better define the requirements and implementation of closed captioning from production to receiver. In April 2007, the ATSC published a Candidate Standard amendment to A/53, which includes related updates to closed captioning, and before the end of 2007, SMPTE is expected to complete related revisions to SMPTE 334M, RP2007, SMPTE 333M, and EG43 for carriage of captioning data in the studio domain.

Regulatory Issues

Unlicensed Devices in TV White Spaces

In October 2006, the FCC released a First Report and Order and Further Notice of Proposed Rulemaking in the so-called "White Spaces" proceeding dealing with operating unlicensed devices in the TV bands. The intent is to allow unlicensed wireless devices to operate on vacant channels in the TV bands on a non-interference basis, in order to foster the development of new unlicensed broadband services such as wireless internet. The FCC concluded that fixed-location low-power devices could be allowed to operate on vacant TV channels. However, these devices would not be allowed to go on sale until after the end of the DTV transition in February 2009 and the FCC invited comment on a range of technical issues regarding interference to DTV reception.

In January 2007, NAB and MSTV filed comments that told the FCC that their proposals in the FNPRM were inadequate to protect broadcasting from interference caused by unlicensed devices. In March, the FCC released the results of their own technical study, which examined the ability of 30 consumer DTV receivers to withstand interference of various types. NAB and MSTV filed comments that applauded the Commission for conducting the tests and pointed out that the data in the FCC Report substantiates MSTV and NAB's concerns that TV band devices would cause significant interference to TV service. The FCC intends to carry out further testing using a simulated interfering device and a final Report and Order is expected in October 2007.

Meanwhile, the Institute of Electrical and Electronic Engineers (IEEE) 802.22 committee is developing a

technical standard for how unlicensed devices using a Wireless Regional Area Network (WRAN) could operate in the TV bands on a non-interference basis. The committee is currently reviewing WRAN system proposals and the goal is to complete the technical standard by January 2008.

2 GHz BAS Relocation

Sprint Nextel has continued the FCC-mandated process that requires broadcasters who operate Broadcast Auxiliary Services (BAS) (as used for remote news contribution links) in the 1990–2110 MHz band, to convert to new channels in the reduced 2025–2110 MHz BAS band. Seven current 17/18 MHz channels will be migrated to seven new 12 MHz channels.

Sprint Nextel is required to provide “comparable facilities” to enable eligible broadcasters to operate in the new channel plan and is implementing a so-called “Narrowed in Place” process by which BAS equipment will be replaced with digital equipment that operates on the center frequencies of the existing 17/18 MHz channels, but with a narrowed emission bandwidth. Once all of the licensees in a particular market have installed the new equipment, the licensees will simultaneously convert to the new compressed 12 MHz channel plan by shifting the center frequencies to the new channel plan.

The transition is in progress and Sprint Nextel 2 GHz relocation teams are working with licensees in multiple regions throughout the country to manage the transition, but it seems unlikely that the target completion date of September 2007 will be met.

2 GHz Data Return Links

The seven new 12 MHz BAS channels have a remaining 1 MHz of spectrum arranged as two 500-kHz wide guard bands, at 2025.0–2025.5 MHz, and 2109.5–2110 MHz. Within each of these guard bands will be twenty 25-kHz wide data return link (DRL) channels intended to be used from a central receive site to a remote electronic newsgathering platform attempting to communicate with the receive site.

Anticipated uses for the DRL channels would be as a homing beacon and as a highly robust “handshaking” signal, to help the ENG truck operator establish a successful link. This would allow automatic transmitter power control and other facilities for the remote ENG site. The ATSC Specialist Group on Digital ENG (TSG/S3) has continued work on the parameters and permissive uses for the DRL channels, and in January 2007, ATSC published a revised Candidate Standard for Automatic Transmitter Power Control (ATPC) and Data Return Link (DRL). If broadcasters do not start using the 1 MHz of 2 GHz spectrum that the DRL channels represent soon, it

is possible that the FCC may re-allocate that highly-in-demand spectrum to other users.

2 GHz Interference Concerns

In 2006 and early 2007, Clarity Media Systems submitted numerous applications to the FCC requesting a waiver of Part 78 of the FCC Rules in order to create a new video programming service in the 2025–2110 MHz band. This proposed service would provide 70 channels of television programming to truck drivers parked at truck plazas around the country. NAB, MSTV, and various broadcasters filed comments with the FCC opposing Clarity’s request on the grounds that their system would cause harmful interference to broadcasters’ ENG operations. In May 2007, the FCC dismissed all the applications stating, among other things, that Clarity has not demonstrated that its proposed system will not cause harmful interference to BAS/ENG operations. Clarity and the KlaasKids Foundation filed an Application for Review asking the FCC to reverse its order. NAB and MSTV again filed with the FCC in opposition.

Emergency Alerting

Next-Generation Emergency Alert System

In July 2007, the FCC released a Second Report and Order and Further Notice of Proposed Rulemaking intended to strengthen the nation’s Emergency Alert System (EAS) and promote the development of fully digital next-generation technologies and delivery systems. In particular, the Order requires EAS Participants (which now includes digital as well as analog broadcast stations, and cable, satellite, and other networks) to accept messages using the Common Alerting Protocol v1.1 (CAP), no later than 180 days after FEMA publishes its adoption of such a standard.

The order also requires EAS Participants to adopt whatever next-generation EAS delivery systems FEMA develops, no later than 180 days after FEMA releases standards for such systems. It also requires that Wireline Video providers (such as Verizon’s FiOS) will now deliver EAS messages, and expands the mandate for EAS Participants to transmit state and locally targeted alerts originated by governors or their designees. The Notice seeks comments on how best to deliver EAS emergency information to persons with disabilities and non-English speakers, and on various other non-technical matters.

National Digital Emergency Alert System

Following successful pilot projects in 2005–2006, in April 2007, the Association of Public Television Stations (APTS) started the rollout of a national Digital Emergency Alert System (DEAS) for the Federal Emergency Management Agency (FEMA). This system is designed to enhance the delivery of federal alerts and warnings

during times of national crisis through the use of datacasting technologies over local public television's digital infrastructure.

In this system, emergency messages are packaged as data files and, using CAP protocol, video, audio, and text can be sent simultaneously. They will be distributed to 356 local public television stations using the PBS Next Generation Interconnection System, a new satellite/fiber hybrid network distribution architecture now being deployed for PBS. At the PBS station, DEAS files will be multiplexed as data in the DTV broadcast bit stream for over-the-air transmission to receiving sites at authorized media sites and government offices. At this time, DEAS is not intended to be received directly by members of the public and the system will work in conjunction with the existing and next-generation EAS. Appropriate messages distributed by DEAS will be received and forwarded in video and audio to the public by other TV and radio broadcasters, cable TV, DBS, and wireless carriers, and internet media services.

The first phase of the rollout will focus on coastal states in the eastern United States. By the end of 2007, all Public Television stations will be equipped to receive and retransmit the digital emergency signal.

Transmission Enhancements

Distributed Transmission

Distributed transmission allows a DTV station to improve its coverage by using multiple single-frequency synchronized transmitters spread around the service area. Following initial deployment in 2003 of two distributed transmission transmitters at WPSX-DT in State College, PA, other stations followed during 2006 and 2007. WVPT-DT in Staunton, VA, is on air with three transmitters and WVPY-DT in Front Royal, VA, with four transmitters, and WTVE-DT in Reading, PA, has a network of eight transmitters nearing completion. A 3-channel parallel system with a total of 14 transmitters is under construction in New York as a test facility for fill-in over-the-air coverage, following destruction of transmitters on the World Trade Center. The A-VSB mobile DTV demonstration at NAB2007 (see below) also included a parallel demonstration of a single-frequency network using three low-power channel 38 transmitters, with 100-watt transmitters on the Stratosphere and Paris Hotels, and a 10-watt transmitter inside the Las Vegas Convention Center.

A-VSB

Work by ATSC continued during 2006 and 2007 on the evaluation of the A-VSB system proposed by Samsung and Rohde & Schwarz. A-VSB promises a number of benefits including improved reception in dynamic and low

signal-to-noise reception environments, in what would be a "backwards-compatible" modification to the DTV Standard.

Mobile/Handheld Video Broadcasting

MediaFLO

Several U.S. telco carriers have been testing MediaFLO technology during 2006 and 2007.

AT&T/Cingular announced an agreement with Qualcomm's MediaFLO USA subsidiary, with plans to deliver mobile TV services by late 2007. Sprint Nextel, however, has announced that it has decided not to proceed with commercial deployment of the technology.

In March 2007, Verizon Wireless went live in 20 U.S. markets with "V Cast Mobile TV" using MediaFLO. The service offers eight video channels with transmissions on channel 55. Reception is on new mobile phone handsets from Samsung and LG, with a Motorola handset expected later in 2007. By April, the service had expanded to 25 markets and Verizon plans nationwide deployment, but the schedule is dependent on the FCC's 700 MHz spectrum clearing program.

DVB-H

Following trials in Pittsburgh in 2005, in February 2007 Modeo launched a commercial-grade DVB-H trial mobile TV service in New York City, offering seven video and eight audio channels. The beta service is available only to selected users equipped with a Modeo Mobile TV Smartphone, supplied by HTC of Hong Kong. The system has about 65 transmitters covering Manhattan, part of New Jersey, and Long Island. Transmission frequencies are L-Band 1670-1675 MHz. Content is encoded using Windows Media 9, with QVGA 24 frame/sec video at 232 kbits/sec and audio at 48 kbits/sec.

Modeo states that it has designs already in place for moving into the top 30 markets in the U.S., but no schedule or telco partnerships have been announced.

Mobile DTV Demonstrations

At the NAB Convention in April 2007, there were live demonstrations of two different systems for mobile broadcast DTV reception, both using tour buses traveling around Las Vegas.

The Samsung/Rohde & Schwarz demonstration used an enhanced version of the A-VSB system already under evaluation by ATSC. It used the KVMY-DT station transmitter 12 miles from the city, operating on channel 22 at 750 kW ERP. Two H.264-encoded programs, at source rates of 1 Mbit/sec and 0.5 Mbit/sec, were each encoded into 2 Mbit/sec streams, with different levels of error protection. In addition, a Supplementary Reference

Sequence (SRS) signal required an additional 1 Mbit/sec, taking a total of about 5 Mbits/sec from the 19.39 Mbit/sec transport to accommodate two A-VSB programs. Two receive antennas were mounted on the top of the bus for reception. The demonstration also included a prototype two-antenna handheld device in addition to the van-mounted receiver.

The Harris/LG demonstration of their Mobile Pedestrian Handheld (MPH) system used a transmitter on station KVCW-DT on channel 29, at the same location as the KVMY-TV transmitter, with approximately the same power and height. The main DTV program was reduced to about 15 Mbits/sec and two simultaneous programs, encoded using H.264 encoding, were transmitted in the MPH portion of the transmission. Source rates for the two programs were 299 kbits/sec and 557 kbits/sec, each encoded in a 2.2 Mbit/sec stream, with different levels of error protection. A single 6-in. whip antenna mounted on the roof of the bus was used for reception.

The bus routes chosen by the two system proponents presented a variety of conditions and both systems showed very good reception at both low and high speeds. For comparison, normal 8-VSB-reception was shown to be very poor or non-existent, except when the buses were stationary.

Open Mobile Video Coalition

In April 2007, nine of the largest U.S. television broadcast groups announced the launch of the Open Mobile Video Coalition, an industry alliance to accelerate the development of mobile digital broadcast television and realize the full potential of the television spectrum in the U.S. The Coalition's work will include promoting development of industry technical standards; defining technical objectives and requirements of broadcasters, equipment manufacturers, service operators, content developers, and consumers; accelerating the development of new technology, solutions, and content; driving regulatory support and promoting consumer adoption of mobile digital broadcast television. Membership in the coalition is open to all U.S.-based television broadcasters, and in June, the NAB Television Board unanimously passed a motion to support the efforts of the Coalition. In July, the Coalition was expected to announce the addition of 10 more companies, growing the number of TV stations in membership from 281 to about 500.

ATSC Request for Proposal

In May 2007, the ATSC issued a Request for Proposal for technology to enable development of an ATSC Mobile and Handheld Standard that will enable broadcasters to deliver television content and data to mobile and handheld devices via their DTV broadcast signal. Ten

responses were received in July, including A-VSB and MPH, although not all proposals were for complete systems. An evaluation period will follow to select a technology, with a subsequent start of the planned standardization process. The planned schedule is intended to enable DTV mobile and handheld services to be announced by February 2009.

DTV Quality

DTV broadcasting has the capability for greatly improved picture and audio quality compared to traditional analog transmissions, particularly with enhanced resolution and elimination of noise and ghosting. However, several degradations that are largely unique to DTV are on occasions observed on DTV transmissions. These relate primarily to compression artifacts, image formatting, audio levels, and lip sync.

Compression Artifacts

Compression artifacts degrade DTV pictures when the bit rate or allocated bandwidth is insufficient for the demands of the program material. Minimum bit rates and compression levels are not specifically covered by mandatory technical standards, and degradations such as pixel blocking, loss of resolution, and certain types of noise are a concern for engineers as business decisions are made on what is the best mix of HD, SD, and data services to be carried in the 19.39 Mbit/sec bandwidth available for over-the-air transmission. Quality considerations are not always at the top of the list.

Compression artifacts may be reduced or eliminated by using a higher efficiency encoder or, where possible, by applying statistical multiplexing to the programs making up the multiplex. It seems that further coding efficiency gains with MPEG-2 encoders will be small and a change to an advanced video codec may eventually be required to resolve the situation.

Image Formatting

Image format problems due to the change from 4:3 to 16:9 aspect ratio for production, transmission, and display continue to be a challenge. Inconsistencies at different points in the program chain may result in pictures with bars at the top and bottom or on each side, with the possible result of the infamous "postage stamp" image in the middle of a black background. It is also common to see widescreen displays showing 4:3 produced programming stretched to fit. Following a coordinated effort by ATSC, SMPTE, and CEA to produce harmonized standards, the SMPTE 2016-1 standard *Format for Active Format Description and Bar Data* and SMPTE 2016-3 *Vertical Ancillary Data Mapping of Active Format Description and Bar Data* were published in May 2007. These standards complement the standards for

carriage of AFD and Bar Data metadata as now defined for DTV transmission in ATSC standard A/53 and the recommended practice for use by consumer receivers in CEA-CEB-16. Associated SMPTE standards, SMPTE 2016-2 and SMPTE 2016-4 were also published for carrying pan-scan metadata through the professional distribution chain to allow downstream extraction of different aspect ratio images from a widescreen program master.

AFD and Bar Data will enable DTV receivers and displays to intelligently adjust the image for optimum appearance on the display when program source and displayed aspect ratio do not match. Consumer electronics manufacturers have not yet announced such products, but it is likely they are in development. Several ATSC encoder manufacturers are known to be planning product upgrades to add the capability to insert AFD and Bar Data from the VANC data space of incoming video into the transmitted bitstream. Product releases are expected later this year.

Format conversion products from several manufacturers are already available to generate the new metadata and also process video, based on incoming AFD codes. The first implementation of the SMPTE 2016 standard was for format conversion signaling and control in the professional domain and, in 2005/2006, Miranda Technologies provided NBC Universal with numerous up/down/cross converters to handle HD/SD signal processing for its television production facilities and transmission area in New York.

In the Third DTV Periodic Review, the FCC sought comments on whether voluntary efforts for implementation of AFD and Bar Data are sufficient, or if broadcasters should be required to provide the correct metadata.

Audio Levels

Undesirable variations in audio levels during and between programs are not new to DTV but the severity of variations has increased with digital broadcasting. Audio compression systems such as AC-3 provide sophisticated methods using metadata for setting and adjusting audio level and dynamic range by the receiver, and little or no audio compression and limiting is typically done at the broadcast station. It is thus necessary that the audio metadata parameters should be correctly set in the audio encoder, but they are not always adjusted as required. Stations and networks have become increasingly aware of the need to generate and distribute metadata to enable audio encoder parameters to be correctly set for each program segment. The increasing use of the Dolby E multichannel compressions system for program distribution enables this metadata to be carried

and interfaced to a Dolby Digital AC-3 audio encoder for emission and other methods are also possible. In reality, however, most programs and advertisements are delivered to the networks and local stations without accurate audio metadata. In April 2007, the ATSC formed a new working group S6-3 to investigate this problem and make recommendations for a solution.

Lip Sync

Although many shows are broadcast with excellent audio-video synchronization, synchronization errors, commonly known as lip sync, continue to be a problem for some programming. Such errors may be introduced at different stages in the broadcast chain from production through transmission and in the receiver. SMPTE, the European Broadcasting Union, the International Electrotechnical Commission TC100 group (with JEITA), and the World Broadcasting Union's ISOG, all have instigated investigations into the magnitude and causes of such errors and methods for reducing or eliminating the problem. The EBU has already published two reports: Tech 3311 *EBU Guidelines for Multichannel Audio in DVB* and Recommendation R37-2006, *The relative timing of the sound and the vision components of a television signal* but work is ongoing in SMPTE and JEITA to produce standards and recommended practices to address this common problem. In April 2007, the ATSC formed a working group S6-4 to investigate this problem from the point-of-view of DTV encoding, transmission, and reception.

Advanced Codecs

The video industry has continued to consider the use of advanced compression technologies, in particular AVC/H.264 and SMPTE VC-1. These may be used in place of MPEG-2 video codecs to decrease the amount of bandwidth required to transmit digital video while maintaining high quality. More than a year ago, both DirecTV and Dish Network introduced satellite direct-to-home services using AVC compression, with new channels providing local HD broadcast stations to local customers. In January 2007, DirecTV announced they will have 100 national HD channels in service by the end of 2007 and it is expected that these will use AVC compression.

The cable television industry has continued to investigate the introduction of AVC compression, including provision for bitstream splicing for local advertisement insertion, but as yet, no deployments have been announced. However, in June 2007, HBO announced that they will change to use AVC for all their HD program distribution, with 26 HBO HD channels in place by 2008. Cable companies will then have to transcode these programs to MPEG-2 or upgrade their head-end and systems to handle AVC.

AT&T previously indicated that its Lightspeed broadband TV distribution system will use both AVC and VC-1, but deployment of this system has been delayed.

Work is still in progress within ATSC for adding advanced video codecs as options for compression, and candidate standards have been published for a number of ways for mobile/handheld and nonrealtime services. However, at this time, MPEG-2 continues to be the only codec used for terrestrial broadcasting in the U.S., and an acceptable strategy for introducing a new codec for broadcasters in their main DTV services has yet to be defined.

Conclusion

The broadcast industry continues to address the migration to high-definition formats and multicast standard-definition programming, to prepare itself for the end of analog television and for the possible introduction of mobile DTV services. It also has to deal with a variety of regulatory issues. There is ever-increasing competition from other distribution media, and over-the-air broadcasters face considerable challenges in the coming years. However, technical systems and standards now in place, and under development, will provide opportunities to offer new and improved services for viewers for many years to come.

An Update on Digital Television from the CEA



Brian Markwalter

Markwalter is vice president of technology and standards for the Consumer Electronics Association (CEA), a trade association representing the \$140 billion U.S. consumer technology industry. Markwalter is responsible for overseeing CEA's ANSI-accredited standards development operation and provides key engineering support. CEA hosts more than 70 committees, subcommittees, and working groups that produce standards used in millions of consumer devices. CEA standards are referenced by EPA, FCC, and other government agencies. In addition, CEA was awarded a Technology Emmy for its closed caption standards.



By Brian Markwalter, Consumer Electronics Association

This past year has been a busy one for any organization involved in television in the U.S. The same is true for the Consumer Electronics Association (CEA). This report summarizes DTV activities from CEA's perspective, with particular emphasis on technology, standards, and policies affecting television receivers.

Background on CEA and Recent Changes

The Consumer Electronics Association started as the Radio Manufacturers Association in 1924, since radios were "the technology" in the 1920s. In the early 1950s with technology expanding, the association expanded its focus and name to the Radio and Television Manufacturers Association. In the late 1950s, the organization became the Electronic Industries Association (EIA)/Consumer Electronics Group. In 2000, the CE Group became its own incorporated entity and changed its name to the Consumer Electronics Association.

Until 2003, the CE Group and then CEA conducted its standards work through EIA's ANSI accreditation. CEA gained its own accreditation that year and re-designated standards formerly known as EIA/CEA to simply CEA-xxx. All standards created and maintained by CEA now carry the CEA name only; although many references to the old EIA prefix remain, including several Federal Communications Commission (FCC) rules. Up until January 2005, CEA was an affiliate of the Electronics Industries Alliance (EIA) at which time CEA severed remaining ties with EIA and now operates as a completely separate non-profit trade association. The most significant change of late is CEA's June 2007 move to our own building in the Crystal City section of Arlington, VA, not far from PBS's headquarters.

CEA Market Research on DTV

With a rich 75-year history of objective market research, CEA is relied upon for our industry sales data by the technology community, financial markets, the