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 vaEder way 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
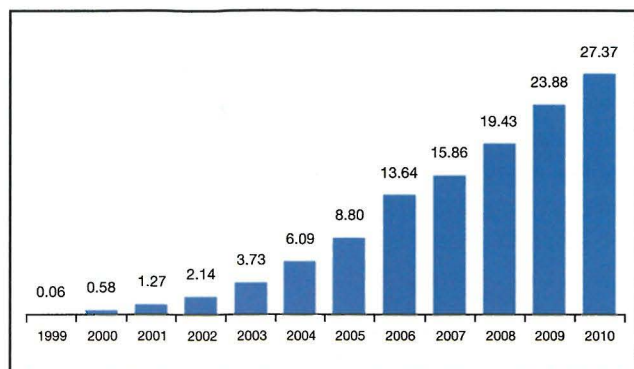
Figure 1. HDTV Set and Monitors
Millions of Unit Shipments.

Figure 2. Mix of flat panel, projection and direct view CRT
technologies that make up TV sales.

media, and economists. CEA produces more than 25 unique consumer surveys dealing with buying patterns, awareness of new technologies, interest in product features, and a host of other issues. In addition, the Market Activity Reports and Analysis (MARA) program at CEA produces nearly 30 reports each year, issued on a monthly or weekly basis, that track sales of consumer electronics products from manufacturers to dealers.

CEA research on digital televisions shows that consumers are reaping the benefits of the highly competitive consumer electronics industry. Quality is up, and prices are down. Digital televisions overtook analog TVs in unit sales last year—a sure sign that DTV has gone mainstream. Furthermore, consumers are buying HDTVs at an increasing clip. Figure 1 shows the uptake of HDTVs in the form of both integrated sets (with ATSC tuners) and monitors.

What exactly are consumers bringing home in the way of HDTVs? The answer is beautiful, flat panel TVs. CRTs are the casualty in the adoption of flat panel technologies. Figure 2 shows the mix of flat panel, projection, and direct-view CRT technologies that make up TV sales. Projection remains a steady component of the mix, but CRT is substantially displaced by flat panels. Both LCD and plasma flat panel TVs have proven to be highly desirable due to the ability to have a larger image area combined with sleek designs that better fit room décor.

Price pressure on DTVs has been enormous, to the benefit of consumers. Figure 3 shows the average DTV price since 1998. By way of comparison, color TV prices declined 27% in the first seven years after introduction, but DTV prices fell 55% in the seven years following 1998. Manufacturing partnerships have cropped up to combine expertise and launch new flat
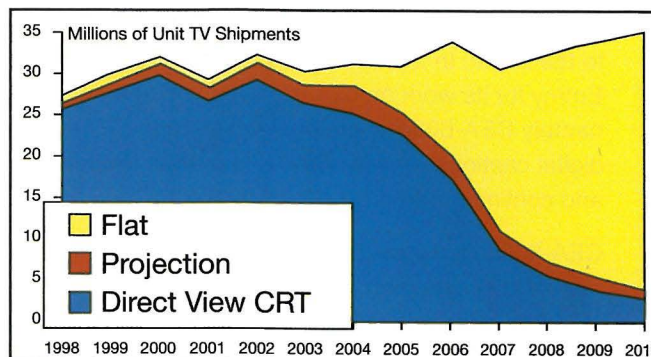
panel manufacturing plants. More brands and more manufacturers are competing for consumers' eyes and wallets.

CEA Technology & Standards Activities

With accreditation from the American National Standards Institute (ANSI), the CEA Technology & Standards Department has more than 1,000 industry-wide participants in committees, subcommittees, and working groups involved in a proactive and participative standards-setting process. The Video Systems standards committee, R4 in CEA lingo, is a very active group responding to the standards needs of the video industry. R4 has two equally active subcommittees, R4.3 and R4.8, covering Television Data Systems and DTV Interface standards, respectively. One of the most impressive aspects of these groups is the diverse and generally cooperative nature of participants. Broadcast, cable TV, component, and TV manufacturers all contribute to the standards process.

The R4.3 subcommittee establishes standards and guidelines for the delivery and preservation of closed captions and certain other data delivered to the consumer via television signals, and to facilitate the use
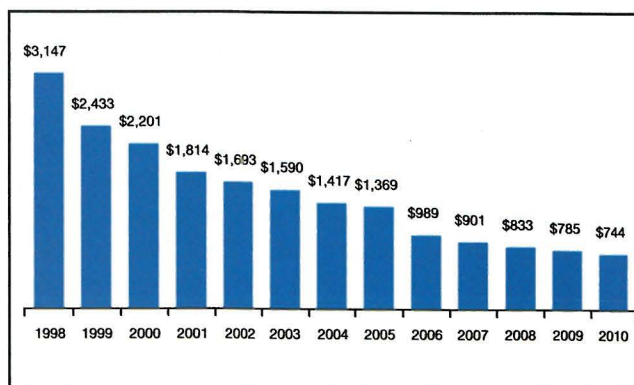

Figure 3. DTV pricing.

of television signals to deliver such data and services to the home. In 2005, CEA was awarded a technical Emmy for its work on closed captioning standards, namely CEA-608 for analog captions and CEA-708 for digital captions. These standards are the product of and continue to be maintained by R4.3.

CEA-608, titled *Line 21 Data Services*, covers much more than captioning as its name suggests. The standard addresses all aspects of data that is carried in line 21 of the vertical blanking interval of the NTSC video signal. The standard defines the waveform, data formats, closed captioning, and eXtended Data Service (XDS) packets, which carry content advisory, Copy Generation Management System Analog (CGMS-A), and other ancillary data. In 2005, the standard underwent a major revision to bring it up to date and integrate design guidance that had been accumulated since the standard was originally published. Other revisions and corrections were made in 2006 to arrive at the currently published version, CEA-608-D.

Arguably more relevant to the future of digital television, is R4.3's work on CEA-708, *Digital Television Closed Captioning*. This standard was revised starting in 2005. It turned out to be a major undertaking that rippled through to ATSC and SMPTE standards. The ripple was caused by the correct decision to more cleanly delineate the boundaries of DTV captioning-related standards among the three organizations. CEA worked to make CEA-708 transport agnostic, leaving transport to the other standards. The working group that revised the standard processed hundreds of comments to bring the standard up to date and remove transport references. The multi-organization coordination in DTV captioning standards was carried out by a few engineers who happened to participate in more than one venue to the benefit of all involved.

R4.8 establishes standards and guidelines for RF, analog and digital interfaces for the purpose of defining connectivity and interoperability among analog/digital TV receivers and other consumer devices that deliver analog and digital A/V and other digital data services. This subcommittee maintains a portfolio of extremely important interface standards, including those related to IEEE 1394, SD and HD component video, modulated DTV, and one of the key standards underpinning HDMI. R4.8 is never lacking for work.

Most of these interfaces have more than one standard that define its complete behavior in a consumer electronics application. For example, a DTV with an IEEE 1394 interface to a set-top box or digital video recorder makes use of CEA-775-C, *DTV 1394 Interface Specification*, which defines mechanisms to allow a source of MPEG service to utilize the MPEG decoding and display capabilities in a DTV and a method to allow the On-Screen Display Producer to supply bitmap graphic overlays for blending and composition in the DTV over decoded video. CEA-775-C also supports an optional baseband analog audio/video connection between an audio/video source device and the DTV. The standard allows the source device to control the selection of the audio/video source for display in the DTV between an MPEG service decoded in the DTV and incoming analog audio/video supplied to it via an external input. The set-top box may want to generate a menu on the TV composited over the video image. For this application, the set-top box makes use of CEA-799-A, which specifies syntax and semantics for bitmapped graphics data. The pixel formats include optional alpha-blend and transparency attributes to support composition of graphics over analog or digitally decoded video within the display.

One area of active, some may say hyperactive, development is CEA-861, *A DTV Profile for Uncompressed High-Speed Digital Interfaces*, which is the core standard upon which HDMI builds. The working group that maintains this standard is a prime example of how coordination is maintained among multiple parties that control standards and specifications necessary to make a modern digital interface work. In this case, the parties and their relationship are: CEA through CEA-861 and sponsorship of interoperability testing (more on that later); SMPTE due to the video formats in 296M, the Video Electronics Standards Association (VESA) through reference to key VESA standards, the HDMI consortium that requires compliance with CEA-861 and sets the future direction of HDMI, and the DCP LLC that licenses High-bandwidth Digital Content Protection (HDCP) and sponsors interoperability testing with CEA. Most of the coordination is carried out through the expertise and overlapping involvement of the engineers involved.

CEA-861 is being revised to include the most up-to-date references to HDMI 1.3a, ATSC E-AC-3 audio, WMA Pro; add missing SMPTE video format timings, wide color gamut metadata, HE-AAC audio type, Active Format Description (AFD); simplify video format timings; accommodate deep color and xvYCC; and clean up about a dozen detailed issues. It is a busy

group. The importance of this work is best emphasized by noting the rapid adoption of HDMI in DTV products. In one interoperability event hosted by CEA a couple of years ago, approximately two-thirds of products had DVI connectors and one-third had HDMI. Just six months later, the percentages were reversed, and now any trip to a CE store tells you HDMI is the digital interface of choice.

The top-level video committee, R4, creates and maintains standards that do not fall under the domain of R4.3 and R4.8. R4 owns a handful of historical standards, such as CEA-109-D, *Intermediate Frequencies for Entertainment Receivers*, and CEA-TVSB5, *Multi-Channel TV Sound System BTSC System Recommended Practices,* which were inherited from prior EIA activities. Like all ANSI-accredited standards organizations, CEA is required to review standards every five years. Upon inheritance, or more accurately discovery, of these documents, R4 undertook their review and determined that both needed to at least be preserved for public access as the content could not be found in newer documents. CEA-109, which is internally called the Elvis standard, came to R4 untouched after its initial publication in 1955. The assigned working group actually did spend quite a bit of time investigating modern IF usage in radios, televisions, and cable set-top boxes to match current practice. CEA-TVSB5 was reaffirmed in 2005 without change from its 1985 publication state.

R4 is also on the cutting edge of better pictures, better reception, and better energy efficiency. In July 2006, the committee published CEA-CEB16, *Active Format Description (AFD) & Bar Data Recommended Practice*. This bulletin provides guidance for the development and implementation of consumer devices that process information related to aspect ratio signaling, Active Format Description (AFD), and bar data. With the conclusion of SMPTE's work on AFD and migration of AFD signaling into the content flow and receiver processing, consumers should be able to escape the frustration of postage stamp video and stretched images.

The most recent work of R4 is the adoption of an update to CEA-909, *Antenna Control Interface*, to allow a single coaxial cable interface between the "smart" antenna and DTV receiver. The previous version required a separate upstream control wire and connector from the downstream RF on coax. Although we will not know until equipment hits the market, many believe that the smart antenna interface may be a critical option on the ATSC-to-NTSC converter boxes expected to be sold as

the nation moves to all-digital broadcast television.

In the category of better energy efficiency, R4 completed work on a pair of standards for measuring standby and active power of digital set-top boxes, CEA-2013 and CEA-2022, respectively. The work began on CEA-2013 in anticipation of being able to respond to agencies working on energy efficiency of consumer electronics. Before the standards were complete, both the Environmental Protection Agency (EPA) in the U.S. and the Canadian Standards Association (CSA) requested to either adopt the standards outright or incorporate in part. The impetus for such rapid adoption in the U.S. was the EPA's project to launch an Energy Star program for simple ATSC-to-NTSC converter boxes.

Of course, movies and television have associated sound. In CEA, audio standards are developed by the R3 Audio Systems Committee. CEA's Audio Systems Committee is working on a standard method for measuring and reporting output power from multichannel amplifiers. Advances in amplifier design have made measuring multichannel output power more complicated than it may seem. Surround sound systems are controlled by computer logic that can be customized by the manufacturer to create a specific type of performance, and this frequently results in something other than a one-to-one relationship between the different inputs to a multichannel amplifier and their associated outputs. For example, some amplifiers have integrated bass management systems that filter the signals on each channel. Also, integrated DVD players essentially require that a test disc be developed, though one needs to be careful when using a test disc in a situation where there is no integrated DVD player, because the player used to generate the signal can impact the results.

There seems to be some consensus at this point that amplifiers with output powers of 20 watts or less should be outside the scope of the standard, which would eliminate many amplifiers that are integrated components of TV sets. However, some TV set amplifiers might be included within the standard's scope, and multichannel amplifiers that are accessories to TV sets would certainly be included.

Information on all of CEA standards activities, including how to get involved, is available at www.ce.org/standards.

Improving Interoperability

CEA supports a number of programs for the industry

that use product marks to convey useful information to consumers. These product marks help to facilitate connectivity, identify products that meet certain performance levels, or enable consumer comparison-shopping. Product marks are usually registered by CEA and licensed to participants with an associated administration fee. CEA's product marks include: Amplifier Power for Mobile Electronics, DTV product marks, Public Alert, Television Antenna marks, and Portable Electronics Devices on Aircraft. The relevant product marks for video products are the DTV and Television Antenna logos. The DTV marks are a family of logos with associated definitions for standard, enhanced, and high-definition monitors, tuners, and integrated TVs. The Television Antenna marks are a pair of logos that indicate compliance with CEA standards for outdoor and indoor antenna performance. The outdoor antenna color-coding scheme is used with CEA's www.antennaweb.org website to help consumers locate the best antenna for their location. Surprisingly, with very little promotion, this website consistently ranks among the highest trafficked of CEA's web properties.

As mentioned earlier in discussing CEA-861 and the HDMI interface, CEA has become involved in hosting interoperability events at the behest of manufacturers seeking to improve products before they ship. CEA conducts these innovative PlugFests each year, focusing on connectivity and interoperability. These events allow manufacturers to come together and test interfaces in a semi-private, round robin fashion. Designers can sort out connectivity issues between different manufacturers before products get in consumers' hands. PlugFests held by CEA included those dedicated to products with CEA-861 (HDMI/HDCP) interfaces and CEA-775 (IEEE 1394 DTV) interface. What began as a simple gathering of a couple dozen device teams has blossomed into a week-long event bringing together more than 400 engineers, jam packed with testing opportunities and technical sessions. This program has dual benefit. It gives immediate feedback to participants about potential problems in their designs, and it provides a feedback loop to the standards process to improve the core documents against which the designers implement.

DTV Education

CEA operates four websites that promote the DTV transition through consumer and dealer education.

- *www.myCEknowhow.com.* To help consumers navigate the new features and options made available by digital television, CEA has produced interactive CEknowhow Buying Guides. The Guides are designed to introduce consumers to digital television and to ease confusion about the technology before shoppers even enter the store.
- *www.antennaweb.org.* This interactive website shows consumers and salespeople the free, over-the-air DTV signals that can be received at their location and what type of antenna is needed to do so. The site receives approximately 100,000 hits per month.
- *www.CEknowhow.com.* This is an online retailer education program that is designed to equip retailers with up-to-date product category training for sales associates. In 2006, more than 38,000 sales persons completed training via CEknowhow. com. There is a specific module for digital television.
- *www.CEAconnectionsguide.com.* The Connections Guide website is an interactive resource designed to help consumers better understand how to connect their audio and video (including DTV) products.

Lastly, CEA teamed with a variety of broadcast, public television, cable, and consumer groups to launch the DTV Transition coalition. The mission of the coalition is to ensure that no consumer is left without broadcast television due to a lack of information about the end of analog broadcasting on February 17, 2009.