Final Report of the ATSC Planning Team on Internet-Enhanced Television

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

Specifically, ATSC is working to coordinate television standards among different communications media focusing on digital television, interactive systems, and broadband multimedia communications. ATSC is also developing digital television implementation strategies and presenting educational seminars on the ATSC standards.

ATSC was formed in 1982 by the member organizations of the Joint Committee on InterSociety Coordination (JCIC): the Electronic Industries Association (EIA), the Institute of Electrical and Electronic Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable Telecommunications Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE). Currently, there are approximately 150 members representing the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

ATSC Digital TV Standards include digital high definition television (HDTV), standard definition television (SDTV), data broadcasting, multichannel surround-sound audio, and satellite direct-to-home broadcasting.

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Final Report of the ATSC Planning Team on Internet-Enhanced Television

1. EXECUTIVE SUMMARY

ATSC's Planning Team 3 (PT-3) was charged with exploring options and making recommendations for broadcasters' use of Internet-connected ATSC receivers. To date, PT-3 has examined all known bodies and proposals identified worldwide that are appropriate to its remit. Results of those examinations are detailed in this document, PT-3's Final Report. Early in its work, PT-3 made a fundamental determination that its scope should be clearly limited to systems and services that leverage the Internet as an adjunct to broadcast television operations, which PT-3 refers to as *Internet-Enhanced TV*. While the possible scope of application here is vast, it explicitly does not include "pure" Internet delivery of television content, with no direct association to broadcast services – often called "Over-the-Top" (OTT), and which PT-3 refers to as *Internet TV*.

Beyond technologies *per se*, PT-3 also discovered emerging proposals for best practices and business rules within the sector. These are also summarized in this Report. For the reader's context, this report also presents a quick history of developments to date in the area of Television-Internet convergence, citing relevant consumer-electronics industry and other research as empirical sources to show the rapid growth this sector is experiencing.

PT-3's summary observations indicate that Internet enhancements to broadcast TV (sometimes referred to as "hybridcasting") can be most useful in providing personalized additional content at the user's option, either on the main television screen, or on a user's secondary screen (e.g., handheld or tablet device, used simultaneously with TV viewing). These operations are already possible today, although no single approach seems to have yet gained sufficient deployment or traction adequate to establish dominance.

PT-3 therefore recommends that ATSC continue to monitor this area, with primary focus on a few of the formats PT-3 identifies as most likely to succeed, while remaining aware of other initiatives that may arise. PT-3 also concludes that current activity within the ATSC 2.0 and ATSC 3.0 efforts are sufficient to address current needs of the broadcast TV industry toward standardization or recommended practices. Therefore, no new work items are proposed, but the ATSC 2.0 initiative is strongly encouraged to move forward in its consideration of Internet-based enhancements as enablers for its current work toward interactivity, personalization and other service extensions for digital television broadcasting.

2. SCOPE

The scope of PT-3's review has been focused on identifying and reviewing opportunities for broadcast television's use of Internet-connected ATSC receivers.

This includes industry implementations of Internet-Enhanced Television services and consideration of the benefits and challenges of interoperability of Internet-connected television service implementations. In addition, the committee has continued to monitor the work in ATSC 2.0 to determine any additional requirements that may need to address and any potential synergies between the learning's of PT-3, where it may assist the work of ATSC 2.0, in coordination with TSG/S11.

The goal of this Planning Team is to determine the need for and if necessary, define requirements and recommend standards activities to the ATSC and the ATSC's Board of Directors, per the initial directives to PT-3 upon its formation:[1]

- Identify and review opportunities for broadcast television's use of Internet-connected TVs
- Identify and review various industry implementations of Internet-connected television services
- Consider benefits and challenges of interoperability of Internet-connected television service implementations
- Define requirements and recommend standards activities as appropriate

In order to meet the goals addressed by the committee, it had organized a series of information-gathering sessions on Internet-Enhanced Television services and various implementations within the industry. This resulted in presentations about other industry standards organizations and entities, including the following:

- Hybrid Broadcast Broadband Television (HbbTV), presented to PT-3 by OpenTV
- Enhanced TV Binary Interchange Format (EBIF), presented to PT-3 by Cablelabs
- 3rd Generation Partnership Project (3GPP), presented to PT-3 by Qualcomm
- Connected Television Video Conference, presented to PT-3 by Rovi
- Yahoo Connected TV Platform, presented to PT-3 by Yahoo
- Open Hybrid Television (OHTV), presented to PT-3 by LG
- Open IP TV Forum (OIPF), presented to PT-3 by Samsung
- MPEG Multimedia Transport (MMT), presented to PT-3 by Samsung
- Syncbak Technology, presented by Syncbak
- Open Authentication Technology Committee (OATC), presented by NBCUniversal

3. INTRODUCTION

This report includes three primary components:

1) An overview on the "as-is" landscape of the Internet-Enhanced Television ecosystem (including both technologies and practices)
2) A summary of key observations
3) Recommendations on next steps for the ATSC regarding Internet-Enhanced TV.

4. INTERNET-ENHANCED TELEVISION LANDSCAPE

This section presents a broad consideration of the entire emerging area of television and the Internet, which has been thoroughly investigated by PT-3. It then defines the areas within that landscape that are considered to fall within ATSC's scope, and narrows its focus to consider only those sectors of the environment in the remainder of the report.

[1] http://members.atsc.org/apps/org/workgroup/pt-3/download.php/16831/PT3-002r0-Minutes-2010-07-15.doc

4.1 What is Internet-Enhanced Television?

Televisions with built-in capabilities that allow them to connect to the Internet and interact with Internet-delivered data and content are generally called "Internet-Enhanced TVs," "Connected TVs," or "Smart TVs."

Such TVs come with the appropriate physical connectors to the Internet and an on-board platform comprised of silicon, firmware, middleware and software to process Internet data/content.

The physical connectors on a TV that enable Internet connectivity are most commonly an Ethernet port, HDMI port, USB port, or built-in WiFi. In some cases other physical interfaces could be used to connect to the Internet as well. The general connectivity architecture envisions the TV connecting to a Local Area Network (LAN) in the home, which in turn connects to the Internet.

There are a wide variety of platforms in TVs that enable the processing of Internet data. Some are TV OEM-specific and others are cross-OEM. All platforms offer the ability to develop, port and install applications, including a browser. TV-based applications typically include those enabling Internet streaming of video content, casual games, and video telephony. Such platforms also offer a wide variety of built-in navigation options. These options range from TV-specific "mini-browser" implementations based on Webkit, CEA-2014, Widget Engines or other similar technologies, to fully fledged, PC-like web browsers.

The applications enabled by Internet-Enhanced TVs that are most interesting to broadcasters include those offering interaction between broadcast and online content. An example of this would be applications running on the TV that interact with incoming broadcast content and enhance that interaction via an Internet connection to an associated website (such as a game broadcast with which the user plays along locally using the TV platform, and receives feedback on his/her scoring via the Internet connection.).

4.2 Understanding the Shift to Internet-Enhanced Television Viewing

Consumer interest in Internet-Enhanced Television, and the penetration of Internet-equipped TV receivers are growing significantly across all demographic groups. The trend began with consumers watching long-form video content (episodic TV shows, games, movies, etc.) on their computing devices (laptops, desktops, tablets and smartphones). Consumers soon reported that they enjoyed the wide and growing choice of programming, extensive search and discovery, social interactivity and on-demand convenience this method of viewing offers. Subsequently, consumers have become increasingly interested in bringing the same advantages to their large-screen TVs that provide the convenience of the "10-foot-experience" or "lean-back" viewing.

Early adopters have been connecting external Internet-capable devices such as desktop computers, game consoles, Blu-ray players, STBs, digital media adapters (DMAs), etc. to their TVs to add Internet connectivity to their TVs. More recently, built-in Internet-Enhanced TVs have offered similar capabilities without the need for an external device and eliminated device and cable clutter, while also enabling more mainstream users to incorporate this new viewing behavior.

Internet access capability is the fastest-growing feature in TVs being sold today, and sales forecasts[2] predict that the majority of TVs sold in the US by 2014 will be Internet enabled (see

[2] http://mycea.ce.org/2009-2014-Extended-Forecast-Module-January-2011_p_255.html

Table A1 in Annex A). [9] Further, research conducted in August 2010[3] found that among those consumers who viewed Internet-sourced videos on their TVs, a small but significant 6% had already done so via widgets built into their TVs (i.e., they had launched the Internet content by clicking with their TV remotes on icons displayed on the TV screen). [10] This is especially significant when one considers that widget-enabled TVs had only recently been introduced into the marketplace when this research was conducted. At that time consumers had multiple other ways of viewing Internet-sourced videos on their TVs (via the methods noted above), yet the widgets were already showing relatively strong preference.

This research also found that 40% of respondents across all age groups had viewed Internet-sourced video content on their TVs, including movies, TV shows or video clips from sources such as Netflix, Amazon On-Demand, Hulu, Vudu, CNN, YouTube, and others. The ratio rose to 60% for the 18-24 year-old age group. In addition, 64% of the respondents viewed non-linear/time-shifted content on their TV on a daily basis, and 14% of respondents had viewed long-form Internet-sourced video content on their TVs on a daily basis.

Based on the above findings, some have predicted that consumer attitudes could continue to shift to a point where they will subscribe only to Internet access from their local service providers, and separately buy TV content from online aggregators (e.g., Netflix, Hulu-Plus, Amazon On-Demand, News-Over-Wireless), or directly from content-owner sites like ABC, CBS, NBC, Comedy Central, HBO, and others, as traditional broadcast TV makes the transition to an environment that includes TV apps (e.g., *News-Over-Wireless* app from WRAL-TV for the Yahoo Connected TV platform[4]).

The combination of new TV/video sourcing behaviors, changing demographics of viewers, and the proclivity to time-shifted viewing indicates that consumers of the future are migrating toward on-demand and Internet-Enhanced viewing behavior. Certainly some types of content like sporting events, live breaking news and more will remain in the realm of live broadcast, yet even in these cases, live content could be delivered via widgets on Internet-Enhanced TVs, or live broadcasts/streams could be augmented with applications that offer interactivity via applications built for Internet-Enhanced TVs ("apps"). Several TV Broadcasters already offer live streaming services on their websites, and making the leap to delivering this live stream to Internet-Enhanced TVs via Over-The-Top (OTT, i.e., Internet-delivered) apps could be enabled by cloud services offered by third-party Content Delivery Networks (CDNs) and Online Video Providers (OVPs).

Developments underway in core networks, last-mile services, content delivery networks, video management, CE devices, applications and consumer behavior will likely result in consumers demanding increased interactivity and flexibility of content consumption from content creators, owners and aggregators.

This consumer and CE/content industry evolution provides the impetus for ATSC's PT-3 study group to consider ways of enhancing the broadcast TV experience by leveraging the capabilities of Internet-enhanced TVs, and the availability of an Internet connection on such TVs.

Additional insights from CEA's August 2010 survey[5] of US consumers on their attitudes towards Internet-Enhanced TVs can be found in Table A2 through A6 in Annex A:. [9]

[3] http://mycea.ce.org/Interactive-TV-Engaging-Viewers-Enriching-Content_p_81.html

[4] http://www.newsoverwireless.com/news/story.php?cid=134

[5] http://mycea.ce.org/Interactive-TV-Engaging-Viewers-Enriching-Content_p_81.html

4.3 Defining the Scope of PT-3's Examination

Given the clear trends delineated previously, it behooves ATSC to consider accommodating Internet enhancements of television content delivery in its future work. Despite the rather loose new terminology used in the industry for this environment, PT-3's deliberations have brought to light the importance of clarifying such nomenclature, and refining the definition of Internet-Enhanced Television.

An important distinction must be made in this environment between what is purely video content delivered via the Internet (that happens to be displayed on a TV), and true Internet *enhancements* to broadcast TV content. In the former case, the Internet simply provides an alternate delivery route for video content, which does not involve broadcast delivery in any way—even if it is sourced from a broadcaster's facility or services. Just as such content would be out of scope for ATSC when it was delivered solely to computing devices, it remains so now that it can also be displayed on televisions. Such OTT television content will be henceforth referred to in this report as *Internet TV*.

In contrast, PT-3 defines the term *Internet-Enhanced TV* as applying only to those elements of Internet-delivered content that have some reference to broadcast television services—and which therefore appropriately pertain to ATSC's sphere of interest. As such, Internet-Enhanced TV addresses specifically and exclusively the components of broadcasters' services that are delivered to televisions via their Internet connections, but that remain somehow engaged with or relevant to broadcasters' over-the-air services. This includes so-called "hybrid" services, in which content related to the broadcast program is delivered to the user's display via its Internet connection, providing interactive or personalized elements of the program that are not available in the basic broadcast. [6] In other cases, Internet-delivered content may not be directly program-related, but still provide station-related or other content relevant to the broadcast service (e.g., enhanced EPG data).[7]

Internet-delivered video content that is self-contained and does not involve or engage any broadcast-delivered component (e.g., OTT content) is considered out of scope for any potential ATSC future standardization, and therefore is correspondingly out of scope for PT-3. Therefore, the remainder of this report will consider only Internet-Enhanced TV as defined in this section.[8]

4.4 Proposed Internet-Enhanced TV Systems

This section summarizes presentations made by various entities[9] to PT-3 over the course of its investigations.

4.4.1 HbbTV

Hybrid Broadband Broadcast TV (HbbTV) is a pan-European specification, based on HTML and web technologies, targeted to hybrid terminals (e.g., connected TVs) that receive an over-the-air

[6] In some contexts, program-related enhancements are referred to as *bound* applications, as opposed to *unbound* applications, which are wholly unrelated to program content.

[7] The term "Hybrid Television" is sometimes used to refer to all features of Internet-Enhanced TV, to more clearly distinguish it from Internet TV.

[8] Note that some of the systems considered in this report include both Internet-Enhanced TV and Internet TV components, as defined herein. Therefore some system descriptions may include references to those systems' Internet TV elements.

[9] The presenting entities for each system are listed in Section 2.

transmission and can be connected to the Internet via a broadband interface. Founding Members of the initiative include ANT, Astra, France Television, IRT (representing ARD and ZDF), OpenTV, Philips, Sony, Samsung, TF1, and EBU. The HbbTV specification unifies a number of existing technologies and specifications:

- Open IPTV Forum (OIPF)
  - JavaScript APIs for TV environment (e.g., tuning, PVR, etc.)
  - Media formats (and protocols)
- CEA
  - JavaScript APIs for video streaming
  - Subset of W3C specifications & image formats
  - Remote control support
- DVB
  - Application signaling
  - Application transport (DSM-CC)
  - Stream events
  - DVB URI
- W3C
  - XHTML
  - CSS 2.1, CSS-TV
  - DOM-2
  - ECMAScript
  - XML HTTP Request

The HbbTV specification was approved by ETSI as a standard (TS 102 796) in June 2010. More than 60 companies support the standard, including UK DTG. Products and services have been deployed in Germany, and a rollout has been planned in France.

A presentation supplied to ATSC PT-3 by Nagra and OpenTV suggests the possibility of a formal liaison between the HbbTV consortium and ATSC, for exploring potential harmonization of future technical specifications [1]. The presentation suggests the following possible areas for such harmonization:

- Application signaling
  - Using the AIT table
  - Possibly, some minor modifications required for adaptation to ATSC PSIP
- Transport:
  - DSMCC Object Carousel
  - Can be used “as is” if compatible with ATSC carousel specification
- Content format
  - Specification mostly independent from the broadcast format
  - For broadband streaming
    - Containers: MPEG2 TS and MP4
    - Video: AVC
    - Audio: HE AAC, E-AC-3
    - Easy to profile for ATSC
- Javascript APIs
  - Small changes required for channel lists, metadata and selection

- Small changes required for program lists and their metadata (e.g. parental rating scheme)

4.4.2 CableLabs Enhanced Television

Enhanced Television (ETV), commonly referred to as EBIF (Enhanced TV Binary Interchange Format), presented to PT-3 by CableLabs, is a platform that enables interactivity and provides the ability to run interactive applications, not just on newer advanced set-top boxes but also on legacy and low-end set top boxes. Cable operators estimate that they now have 30-40 million households EBIF-enabled.[10] With the necessary business agreements in place, EBIF can be used by broadcasters to make their content interactive for their cable subscriber audiences.[11]

EBIF applications span a variety of uses including click-for-info, voting/polling, trivia, and more, including applications that connect television content to Internet content.[12] Due to the potentially widespread adoption of EBIF applications that connect television content with Internet content, many consumers may become accustomed to the user interface and types of capabilities offered via the EBIF platform. Uses of Internet-connected television may follow a similar track, taking advantage of consumer familiarity with EBIF applications' look, feel and function.

Technical challenges exist for broadcasters that are absent on cable networks. Primarily the challenge of preserving EBIF metadata from the point of insertion to the set-top box and ensuring the metadata does not disrupt non-EBIF-enabled downstream equipment (such as over-the-air receivers).

4.4.2.1 How EBIF Works

ETV Binary Interchange Format (EBIF) defines the first two components of ETV—the user agent behavior, and the application structure. The third component defines application signaling and messaging, utilizing the ETV Integrated Signaling Stream (EISS).

MSOs deploy EBIF User Agents to STBs via a software download from the headend. The user agent detects and runs EBIF applications delivered to the STB via the in-band or out-of-band network. The EBIF User Agents are resident on the STBs, whereas the EBIF applications (apps) are transient and are only present during an interactive event. STBs can only run one EBIF app at a time.

There are two classes of EBIF applications: *unbound* and *bound*. Unbound applications are those that are unrelated to the content being viewed, such as caller ID. Bound applications are tightly coupled to the content being viewed such as a request for information (RFI) on a product or program. Unbound apps are purely the purview of the MSO and are not discussed in this document.

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[10] http://www.itvt.com/story/8015/tvot-connected-tvs-mobile-devices-drive-interactive-tv

[11] Although this technology is not strictly speaking an "Internet enhancement" of broadcast television, it provides similar functionality that might be available for broadcasters' use within the cable television environment, and therefore it is included in this report.

[12] Examples of ETV used to connect television content with Internet content include Clickable TV® from BCM http://www.bcm.tv/clickabletv.html; AltiConnect from Alticast http://www.alticast.com/pressroom/pressroom_release_read.html?years=2010&num=455; TV Widgets® by Fourthwall Media, including eBay on television http://www.fwm.tv/Prod-TvWidgets.aspx; and others.

Bound apps are delivered via the in-band signal as two additional PIDs in the MPEG TS; namely, these PIDs are the ETV PID which carries the app, such as a voting/polling app, and the EISS PID which carries the event, such as the specific polling question and button assignments for answers. The PMT/VCT must include the additional PIDs with the EBIF standard PID descriptors. A data carousel connected to a multiplexer is used to add the EBIF data to the transport stream. A target of using 100kbps or less bandwidth has been recommended as a best practice by Canoe Ventures.[13]

This data can be inserted at any point in the supply chain provided that the data survives from insertion to STB (e.g., taking a signal down to baseband will strip the EBIF data). Insertion of EBIF data can be done in two ways called "pre-bound" and "late-bound." Using "pre-bound", the EBIF data is added to a TS file which is stored for later playout. Using "late-bound", the EBIF data is added "on the fly" as the content is being broadcast.

When the EBIF-enabled STB detects the EBIF PIDs, it runs the app and displays the event. The time it takes a STB to render an event varies depending on bit rate and app size, but is usually at least 3 seconds. Therefore event insertion needs to be done synchronously with the content, but does not need to be frame-accurate.

Responses to ETV events travel back through the coax to the headend where an aggregation server collects and distributes the data for fulfillment and reporting. (See Figure 4.1.)

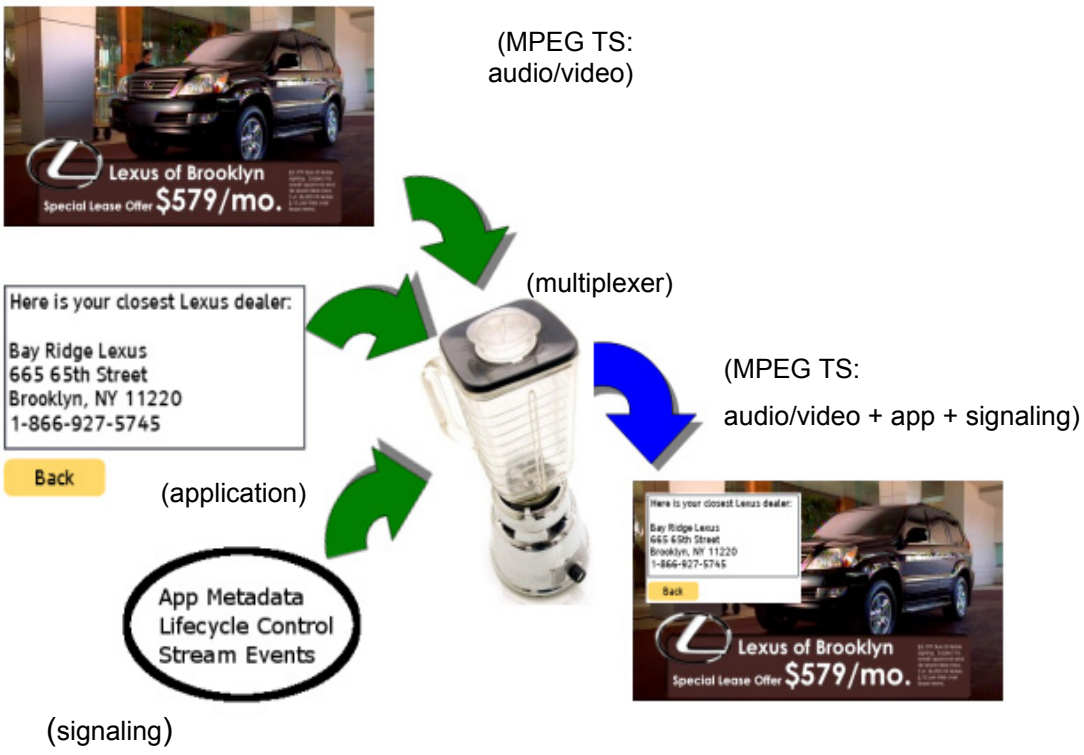

Figure 4.1 EBIF system.

[13] See www.canoe-ventures.com.

4.4.2.2 Steps and Standards for Using EBIF

There are a number of steps involved in using EBIF. Table 4.1 shows that many steps are defined by existing standards and some steps are, as of yet, undetermined.

Table 4.1 EBIF Process Steps

	Step	Description	Standard
1	Creation	Defining a given ETV event	None, depends on app
2	Event file prep	Preparing ETV event file for carousel	CoDF (CableLabs)
3	Response destination	Informing MSO where to send response data	SaFI CIP (CableLabs)
4	Scheduling	Scheduling the event to play out	Traffic & Billing, BXF? (SMPTE)
5	Triggering	Trigger the data carousel to play the event	Varies, e.g. VDCP, Harris Universal SerCom, GV Ignite, etc.
6	Insertion (see also MSO insertion below)	Streaming ETV data to muxer	MPEG
7	Monitor	Analyzing output to verify EBIF insertion	MPEG
8	Reconciliation	Comparing insertion with schedule (as-run)	Traffic & Billing, BXF? (SMPTE)
9	Receive responses	Receiving responses and metrics	SaFI SMS and IAF (CableLabs); Traffic & Billing, BXF? (SMPTE)

4.4.2.3 MSO Insertion

EBIF data can be inserted at the cable headend onto a broadcaster's stream. This ensures that the data is not stripped out at any point in the supply chain and also provides the cable operator with a degree of flexibility for MSO-specific variations on a given app.

To ensure that the MSO adds the appropriate EBIF data at the correct moment, the MSO must be aware of what is being broadcast at any moment including last-minute schedule adjustments such as for breaking news. Insertion of a content ID in some manner such as in the VANC is being considered. One such initiative is the Entertainment Identifier Registry (EIDR).[14] If this becomes accepted practice, broadcasters, cable networks and other upstream programmers would insert UUIDs into the content. This may happen at a granular level, such as per ad and even per story within a newscast.

4.4.2.4 Conclusion

It is possible that ATSC will not need to develop any new standards to accommodate EBIF. At the transport stream level it conforms with existing MPEG standards (although the EBIF PID descriptors are uncommon in broadcast). Outside of the transport stream, standards like

[14] See www.eidr.org.

SMPTE's BXF[15], and CableLabs SaFI specifications[16] will likely accommodate all aspects of EBIF use.

The potential exception to this is the MSO Insertion design described above, in which UUIDs are inserted into the content, so that MSOs can accurately add EBIF data downstream of the broadcaster. There is some logic and benefit to that architecture, and MSOs are therefore currently applying resources toward it. The nature of the UUIDs, their method of creation and insertion, and their location in the transport stream are yet to be determined, but might affect future ATSC standards.

It is recommended that ATSC monitor the development and rollout of EBIF. Technical challenges in the delivery of EBIF metadata to the STB may arise. In particular, ATSC may want to monitor the potential for implementing the "MSO insertion" design.

Finally, EBIF deployments in the cable TV environment may provide familiarity for consumers with interactive television applications, which may subsequently engender greater general uptake of Internet-delivered enhancements to broadcast television.

4.4.3 Connected Television Video Conference

The Connected Television Conference (CTVC) is an organization made up of content providers, CE manufacturers and solution providers organized by Rovi Corporation. The organization has about 80 members on its mailing list and has held three meetings in 2010.

The focus of the group is to understand the standards efforts, best practices, and common practices around connected TV content. The group aims to provide a forum for communication between CE companies and content providers and an opportunity for content providers to discuss their requirements. The areas of interest include identifying video and linking it to associated online content, reviewing emerging standards and supporting these standards among CE manufacturers and addressing the "fragmented" market for connected television platforms.

Due to a variety of factors, including multiple platforms and the speed with which the technology is evolving, the group has come to the conclusion that they need to hold off on any standards efforts at this point in time. They will continue to monitor the overall standards landscape and plan to put together the use-cases for content linking and association in the near future. The group plans to hold future meetings and use them as an opportunity to educate members around standards efforts.

Since the CTVC is in hiatus, PT-3 feels there is no further review necessary on CTVC's standards efforts. However, should work within CTVC revive, ATSC may want to set up a liaison effort to ensure coordination of standards efforts within both organizations.

4.4.4 Yahoo Connected TV

Yahoo Connected TV is a cross-platform product for development and distribution of connected TV applications. It was launched at CES 2009 and was integrated into retail devices in April 2009. Yahoo has distributed its platform in over 110 countries with a number of distribution partners. Yahoo's platform was presented to PT3 to provide an overview of the connected television ecosystem and lessons learned through Yahoo's deployment.

Yahoo identified a number of challenges to the connected TV market. Specifically, Yahoo noted a high proliferation of diverse platforms that make it difficult to achieve adequate scale.

[15] http://www.smpte.org/news/pr/view?item_key=2da42156b994c22137e5691f482641ab07c74caa

[16] http://www.cablelabs.com/specifications/CL-SP-SaFI-SMS-I01-090626.pdf

The lack of interoperability between these devices causes a challenge to publishers of applications, given Yahoo's determination of cross-platform distribution as being a key to success.

Although Yahoo's connected TV platform is not directly tied to any ATSC standardization efforts, Yahoo's lessons learned should be considered as PT-3 and the ATSC move forward in any future standardization or requirements-gathering efforts.

4.4.5 Open Hybrid TV

Open Hybrid TV (OHTV) is a new TV service for TV receivers with a broadband network connection [2]. The OHTV Standard is in progress under the auspices of the Korea Next Generation Broadcast Forum. OHTV considers various service scenarios using both broadcast and broadband connections. (See Figure 4.2.)

The Founding Members of OHTV are:

- Broadcasters: KBS, MBC, SBS, EBS (four Korean broadcasting companies)
- Manufacturers: LGE, Samsung, Net&TV
- Academia: Realistic Ubiquitous IPTV ITRC (Kyung Hee University)

Eight main services were determined (from a survey of all participants). The Top five of those services have been standardized in a 1st phase. Prototypes were demonstrated at the NAB 2010 Conference and the KOBA Show in 2010, incorporating the following features:

- NAB: Push VoD (NRT), IP VoD, Video Bookmark
- KOBA: Push VoD (NRT), IP VoD, Advanced EPG, Video Bookmark

Co-promotion celebrations/demonstrations by Broadcasters were held in December 2010. The OHTV specification has been approved as a draft document at TTA[17], and an OHTV Implementation Guideline will be developed in 2011.

The OHTV technology is based on ATSC and web technologies:

- Broadcast Technology : ATSC, PSIP, ATSC-NRT
- Web Technology : HTTP 1.1, W3C Widget, HTML, CE-HTML (CEA-2014), OIPF DAE (Open IPTV Forum Declarative Application Environment)

A document submitted to ATSC [2] suggests that the OHTV Standard could be incorporated into ATSC 2.0 by using the following:

- ATSC PSIP extension: a "link descriptor" describes what kinds of resources for Advanced EPG should be linked.
- Hybrid content delivery over NRT and Internet: Push-VoD content can be delivered through ATSC-NRT and HTTP to reduce the broadcaster's CDN maintenance costs.
- A Triggering event which is able to play downloaded content and activate applications on the main video (e.g., a voting application or a T-commerce application)

[17] Telecommunications Technology Association, a Korean SDO; see http://www.tta.or.kr/English/index.jsp

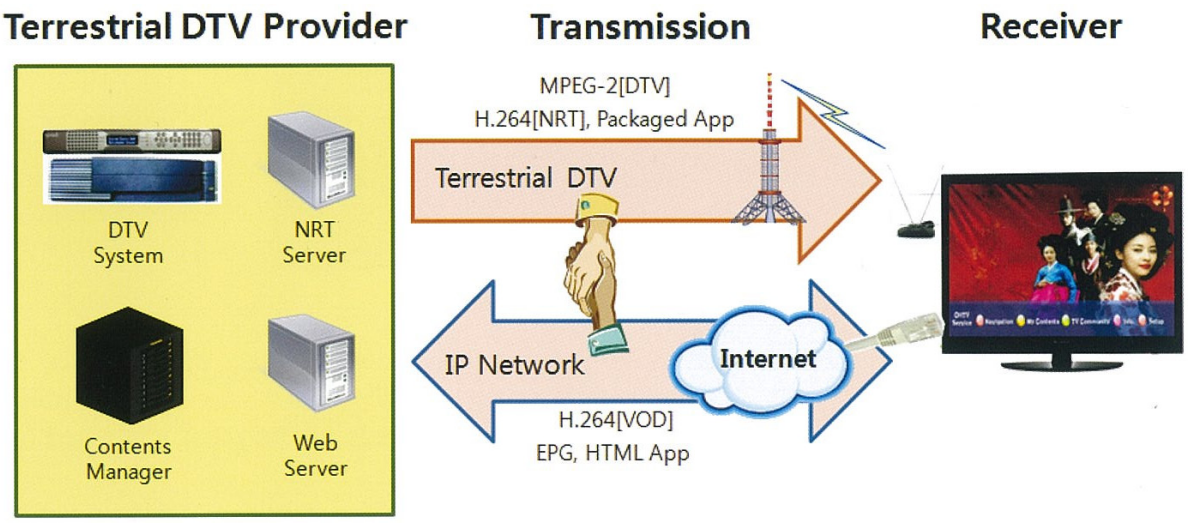

Figure 4.2 The OHTV system [2].

4.4.6 The Open IPTV Forum

The Open IPTV Forum (OIPF) is a pan-industry initiative with the purpose of producing end-to-end specifications for IPTV to take the next generation of IPTV into the mass market. The Forum, which is open to participation from the communications, entertainment and other relevant industries, focuses on the development of open standards that help streamline and accelerate deployment of IPTV technologies, and maximize the benefits of IPTV for consumers, network operators, content providers, service providers, consumer electronics manufacturers and home and network infrastructure providers.

Of particular relevance to ATSC are the components of OIPF that address broadcast television service integration. Nevertheless, the full scope of OIPF is summarized herein, including some areas that may not be pertinent to ATSC's investigation of Internet-Enhanced Television.

The members of OIPF include BBC, BT, RT, RAI, DTS, Dolby, Technicolor, Samsung, LGE, Sony, Sun, Cisco, Ericsson, and Nagravision.

To support the various business models, OIPF profiles its technology:

- An Open Internet Profile (OIP). This profile is intended for "over-the-top" services that do not utilize any QoS provision or terminal management features.
- A Baseline Managed Profile (BMP). This profile adds support for the Scheduled Content and Streamed CoD services making use of certain managed-network capabilities for content delivery, compared to the OIP.
- An Enhanced Managed Profile (EMP). This profile adds native support for advanced managed-network features like IMS, Broadband Content Guide, and TR-069 based remote management.

OIPF has six specifications (Volumes 2–7, detailed below) referencing technologies from MPEG, ITU, CEA, DLNA, W3C, IETF, 3GPP, UPnP, OMA, Broadband Forum, and more, to avoid duplicating work and to leverage existing technologies:

- **Volume 2** : Media Format
  - Volume 2 specifies the complete set of media formats adopted in Release 2, including audio, video and systems layers, also ancillary content like subtitles and resources

used by other parts of the Solution, namely graphics and audio clip formats for interactive application environments.

- **Volume 3**: Content Metadata
  - Volume 3 specifies all aspects of content metadata, including service provider information and metadata delivery.
  - Two levels of service and content discovery and selection are defined, mirroring the DVB specifications, standardized by ETSI, for Service Discovery and Selection (SD&S), and Broadband Content Guide (BCG).
  - Subset of W3C specifications & image formats
- **Volume 4** : Protocols
  - Volume 4 brings together the specification of a complete set of protocols for the Multimedia delivery covering the interfaces below.
    - The interfaces between the network or service provider domains and the consumer domain:
      - The interfaces between the functional entities in the consumer network domain.
      - The interfaces between the functional entities in the network and service provider domains.
      - Interfaces to external systems, e.g. the DLNA home network.
- **Volume 5** : Declarative Application Environment
  - Volume 5 specifies the browser-based Declarative Application Environment (DAE) that runs in the device.
  - The DAE enables web technologies to be used to provide access to services deployed via both managed networks and the open Internet.
  - The starting point for the DAE specification is CEA-2014, also known as CE-HTML.
  - The CEA-2014 specification makes a selection from among the various available web technologies, namely XHTML 1.0 transitional or strict; DOM level 2 core, style, events and a subset of the HTML DOM; CSS TV 1.0; ECMA-262 Java-script and W3C (working draft) XMLHttpRequest.
  - Both CEA-2014 and the DAE specification define more detail on these including exactly which parts are required and which are optional.
- **Volume 6** : Procedural Application Environment
  - Volume 6 specifies the Java-based Procedural Application Environment (PAE) that runs in the Application Gateway (AG) functional entity.
  - The PAE is based on DVB's IPTV profile of GEM – Globally Executable Multimedia Home Platform. This is a powerful open Java execution environment that can allow multiple applications to run in parallel on the host device.
  - The GEM platform provides a set of Java APIs that define a common core of TV-specific functionality for various markets.
  - This includes user interface, access to content metadata, media (also TV-specific) decoding and rendering control.
- **Volume 7** : Authentication, Content Protection and Service Protection
  - Volume 7 specifies the set of tools and methods to protect services and content, and for User authentication.

OIPF is referenced by HbbTV and DTG as the base specification for Internet Enabled TV. As such, it is worthwhile considering a relevant OIPF technology as part of the solution for Internet-Enhanced TV in ATSC. ATSC management might also consider establishing a formal liaison with OIPF.

4.4.7 MPEG Media Transport

In 2010, MPEG launched a new standardization work item, called MPEG Media Transport (MMT). The main objectives of MMT is the efficient delivery of media in an adaptive fashion over various networks, with the main emphasis on IP-based networks, including terrestrial, satellite and cable broadcast networks. The standard will enable building interoperable solutions for delivery and consumption of media in this context.

MMT also enables the use of cross-layer designs to improve the Quality of Service/Experience (QoS/QoE). By incorporating QoS/QoE-related information from different layers, the delivery and consumption of media would be optimized.

The specification will provide the capability of seamless and efficient use of heterogeneous network environments, including broadcast, multicast, storage media and mobile networks, and enable bi-directional, low-delay services and applications, such as online gaming and conversational services.

It is also intended to enable efficient signaling, delivery and utilization of multiple content protection and rights management tools, as well as efficient content forwarding and relaying efficient one-to-many delivery, and a means for error immunity, including burst errors.

MMT can be divided into three functional areas, namely: Encapsulation, Delivery and Control. Encapsulation will define the format to encapsulate encoded media data either to be stored on some storage device or to be carried as a payload of delivery protocols. Delivery provides functionalities that are required for transferring encapsulated media data from one network entity to another. Control provides functionalities to control the media delivery and consumption.

A document supplied to ATSC PT-3 remarks that "ATSC needs to follow if this MPEG technology can satisfy what ATSC needs for Internet Enabled TV, and should consider it for one of candidate technologies for Internet Enabled TV if the timeline is aligned." [3]

4.4.8 NHK Hybrid-Cast

NHK's Hybrid-Cast is a system that combines Internet features and broadcast content [4]. To make the system work, there needs to be close synchronization between broadcast and broadband content. The concept of Hybrid-Cast is illustrated in Figure 4.3.

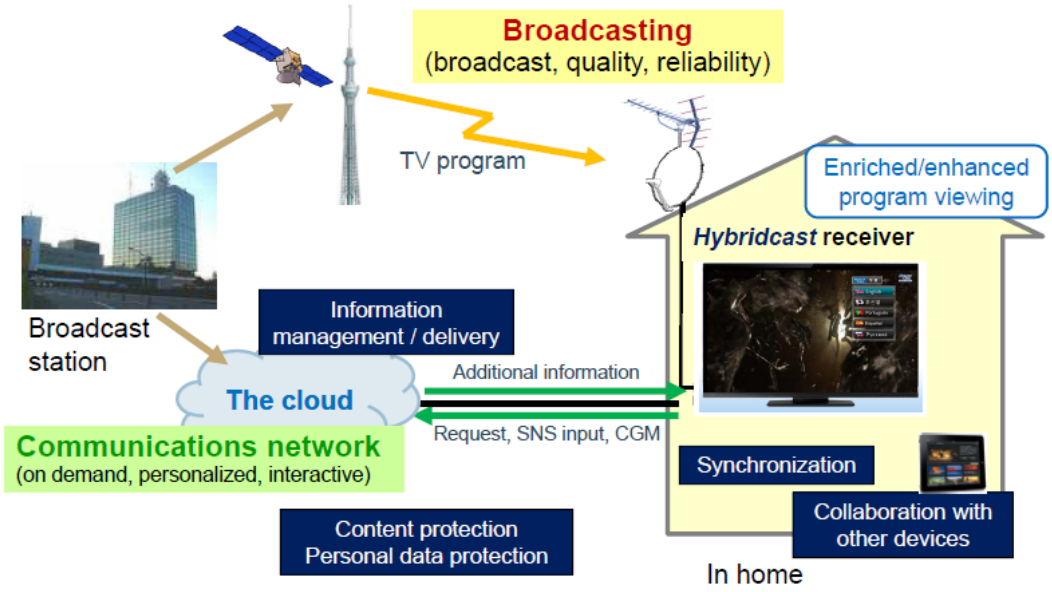

Figure 4.3 Hybrid-Cast concept (©NHK) [4].

Interaction with the program content is the motivation. For instance, while watching a movie the user can text a comment about a certain actor in the film. Hybrid-Cast receivers can then pull up all movies in which the actor appears, and list them in a recommendation area for user browsing. Other envisioned services include program customization, social TV, program recommendation, and multi-device linking. System specifications are now being defined, and a prototype set-top box receiver is under development at NHK.

4.4.9 Sony Media Fusion

Sony presented its concept for converged media integration that integrates different types of media (broadcast, IP networks, cell-phones, etc.) [5]. Four service use cases were identified as becoming possible through combining such media, or enabling communication between them:

1) Fixed/ Mobile Device Interaction
2) Targeted Ad switching
3) Interactive Video Portals to the internet
4) Free-Viewpoint Service (i.e.. user-defined angles of viewing)

Fixed/ Mobile device interaction could allow mobile devices to control stationary TVs and/or TV content, via display of an Electronic Program Guide (EPG) on the mobile device. Targeted Ad switching enables region- or product-specific advertisements, such that these ads are displayed only to most likely interested consumers. Internet access from a TV is enabled through an Interactive Video Portal. Another example of such converged media is user-defined viewing angles being generated with a Free-Viewpoint Service.

4.4.10 Open Connected TV project

Open Connected TV (OCTV) is a wide-ranging, European-based project (a recent addition to the Digital Media Project [DMP], led by Leonardo Chariglione).[18] It has begun work toward standards development in the connected TV area [11], but seems to be solely focused on Internet

[18] http://p212.dmpf.org/index.html

TV (OTT) services, and is therefore out of scope for PT-3's further examination at this time. Nevertheless, OCTV should continue to be monitored for the possibility that it might add a broadcast-television Internet-enhancement component.

4.4.11 Syncbak

Syncbak is a private company that has developed a proprietary technology that creates a closed transmission path that ensures broadcast content streamed over the web is distributed only to those viewers who can receive it over-the-air. It has been proposed as an authentication method with sufficient robustness to guarantee territorial exclusivity in online distribution, where broadcasters' program distribution agreements require such constraints.

The methodology employed involves a small, uniquely identifiable ATSC receiver (suggested form factor is a "wall-wart" device) that also includes WiFi connectivity, called the *Syncbox* (see Figure 4.4). Upon successfully receiving one or more local DTV transmissions, the device communicates with a central server, identifying the user's household (and devices registered on the user's home network) as authenticated to receive those broadcast stations' online streams.

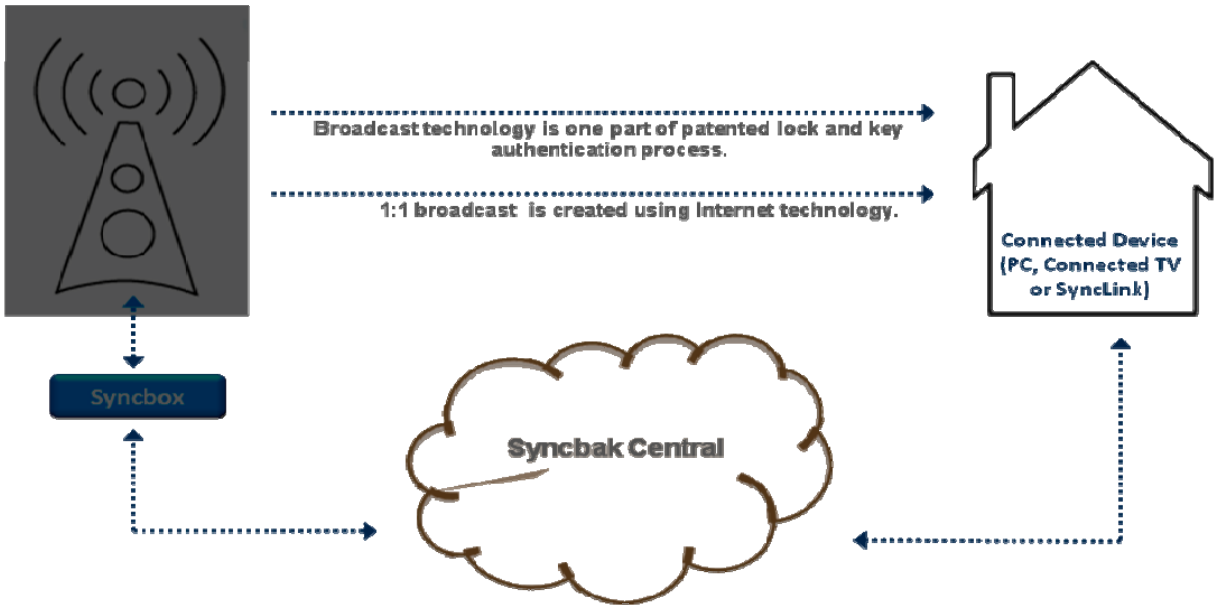

Figure 4.4 Syncbak's Connected Broadcast Platform [6].

While PT-3 does not propose any specific or proprietary implementation of over-the-web delivery of broadcast television, it does suggest that the ATSC should continue to monitor proposals enabling this capability and their potential impact on future standards work. Where applicable, this may be incorporated within the framework of ATSC 2.0 or ATSC 3.0.

4.4.12 Open Authentication Technology Committee

Open Authentication Technology Committee (OATC) is an industry forum of television programmers, content distributors and technology suppliers. It was formed to establish specifications enabling TV Everywhere functionality.

As defined by OATC, *TV Everywhere* is a method to provide consumers with multi-screen and multi-platform access to content. This enablement is a two-step process of authentication and authorization. The authentication validates that a consumer is a current subscriber to a content

distributor, and the authorization validates the consumer has been granted access to the content. Through the authentication and authorization method, TV Everywhere determines a user's permission to view content by virtue of an existing, valid subscription with a content distributor.

PT-3 suggests that ATSC continue to monitor activities of this group and assess any future requirements that maybe applicable for broadcast television and TV Everywhere functionality.

4.4.13 UltraViolet

UltraViolet is the digital locker system proposed by the Digital Entertainment Content Ecosystem (DECE). DECE is a consortium comprised of film and television studios, consumer electronic manufacturers, retailers, technology suppliers, internet service providers, and content distributors.

UltraViolet enabled content can be downloaded or streamed utilizing a common file format which utilizes a common encryption technology. UltraViolet has approved 5 DRM technologies.

It is the understanding of PT-3 that DECE has been approved as a normatively referenceable organization within ATSC. PT-3 suggests that areas within scope of ATSC 2.0 and ATSC 3.0 that require content protection or digital rights management review the technical details for UltraViolet to determine any possible synergies.

5. INTERNET TV PRINCIPLES

A number of broadcasters, copyright owners, and technology companies have collaborated to establish "Internet TV Principles" in the hopes of fostering an online environment that promotes the promises and benefits of Internet-connected televisions, while protecting the devices, the viewing experience, and the rights of copyright owners and rights holders. In coming together, these stakeholders recognize that they share several important objectives: 1) the need to create "roadblocks" limiting the ability of connected TVs to enable copyright infringement; 2) the need to respect the "content integrity" of the broadcaster's programming, and thereby minimize viewer confusion as to the source of content; and 3) the need to protect the connected TV from Internet-borne problems in order to preserve an enjoyable viewing experience. These principles were endorsed by the North American Broadcasters Association (NABA) on 5 June 2010.

Stimulated by the NABA work, the World Broadcasting Union (WBU, of which NABA is a member organization) has created a discussion paper on hybrid and Internet television [7]. The paper provides the WBU's perspective on four major areas:

- Issue 1: Content Enhancement Standards
- Issue 2: How can we ensure respect for broadcasting regulations and safeguard the safety of the HBB viewing environment?
- Issue 3: How can we preserve the viewing experience?
- Issue 4: How can we reduce risks from viruses, malware, and piracy?

Similarly, the European Broadcasting Union has published "Principles for Internet Connected and Hybrid Television," which was released on 15 April 2011 [8]. These principles focus on linkage between broadcast and broadband, content integrity and display of broadcast signal on the screen, access to broadcasters' content, preservation of a safe viewing environment (including the protection of minors), copyright/IPR, piracy and data protection.

As Internet-connected television platforms continue to evolve, the ATSC should monitor the situation and take action as consensus dictates.

6. SUMMARY OF OBSERVATIONS

Internet-Enhanced Television offers the unique opportunity for a consumer to access value-added content that can enhance the viewer experience. PT-3 has identified and explored components of this environment, many of which should be considered by ATSC and the broadcast ecosystem at large, and some of which may warrant or benefit from future standardization activity at ATSC.

6.1 Single-screen Interactivity

Two such areas rise to primary importance for immediate consideration. The first is the *interactive in-video experience*, which is displayed on the main television screen where traditional broadcast content is viewed. In some cases this experience is referred to as a *television application* or *widget*, and within the ATSC 2.0 context, it is specified as a *Triggered Declarative Object* (TDO). While most of the requirements documented in ATSC 2.0 appear synchronized with the use cases presented in PT-3 deliberations, the ATSC 2.0 initiative should pay special attention to real-time synchronization of the TDO to broadcast content, where content associated with the TDO is delivered via an Internet connection. In addition, to the extent possible, it is desirable that TDO's designed and utilized in conjunction with over the air broadcasting are interoperable with alternate real time video delivery services such as cable or satellite distribution.

Further review of industry efforts toward standardization of "hybrid schemes" for Internet-Enhanced Television also would be of value, in PT-3's view. (PT-3 can provide all documentation reviewed during its information sessions to the designated party if desired for this purpose.)

6.2 Two-screen Applications

The second key component is the so-called *two-screen experience*. In today's world, consumers frequently and increasingly engage with multiple media simultaneously. Watching TV while doing a Facebook update and text-messaging among friends to discuss the TV program is a common example. This is nothing less than having a virtual living room for TV viewers across the country. There is, therefore, real value to consumers if broadcast content can be more closely coupled to such a virtual living room.

For instance, a viewer could be enabled to automatically discover members of his/her social network who are currently watching the same content as the viewer. One method of providing such a "social TV" scenario is the ability of a device, such as a television, to be automatically aware of the content it is displaying. The device then sends the extracted viewing information (with appropriate privacy protections and requisite opt-ins) to a remote database to discover other such viewers and potentially establish connections among them via the appropriate social media sites. Additional content and/or data could then be provided to these viewers that further enhances the value of the content currently being commonly viewed.

7. RECOMMENDATIONS

PT-3 recommends that ATSC take the following actions with regard to Internet-Enhanced Television at this time:

1) ATSC should continue its exploration of hybrid broadcast/online delivery models. Given the still early and developing nature of this area, TG1/S11 and TG3 should continue to monitor the output of the already identified organizations developing hybridcasting

standards or recommendations, and remain ready to subsequently investigate any new bodies that may be formed for similar purposes.

2) Among existing initiatives, PT-3 recommends that ATSC pay particular attention going forward to EBIF, OIPF, OHTV and HbbTV.
3) ATSC should remain open to the near-term establishment of work toward any necessary standards or recommended practices regarding Internet-Enhanced Television. Currently PT-3 sees no explicit need for immediate new work in this area, but regards the existing efforts underway within the ATSC 2.0 and ATSC 3.0 initiatives as adequate to the task. (Specifically, PT-3 encourages the ATSC 2.0 initiative to provide leadership in developing any necessary technical specifications or recommended practices that can enable a healthy development of the *interactive in-video* and *two-screen* experiences for broadcast television described in this report.)

Regarding process, PT-3 recommends that all reference documentation it has collected be provided to the appropriate specialist groups in TG-1 involved in ATSC 2.0 developments, where the material falls within that initiative's scope. Any item PT-3 reviews that does not fall within scope for ATSC 2.0 should be considered for review by TG-3 in its planning for ATSC 3.0.

Finally, PT-3 recommends that its work be concluded following the acceptance of this Final Report. All findings from PT-3 would be available to the ATSC Board, TG1 and TG3, as needed.

8. REFERENCES

[1] "HbbTV Status," presentation by Ludovic Pierre, OpenTV, and Robin Wilson, Nagravision, to ATSC PT-3 on 2 September 2010: http://members.atsc.org/apps/org/workgroup/pt-3/download.php/16998/HbbTV_ATSC_30Aug10.pdf.

[2] "Open Hybrid TV Standard (Korea Next Generation Broadcast Forum)," presentation by Gomer Thomas, LG Electronics, to ATSC PT-3 on 24 January 2011: http://members.atsc.org/apps/org/workgroup/pt-3/download.php/18277/KNGBF%20OHTV%20Standard%20r1%200%20(ATSC-PT3).ppt.

[3] "Introduction of MPEG Multimedia Transport," presentation by Sung Oh Hwang, Samsung Electronics, to ATSC PT-3 on 22 February 2011: http://members.atsc.org/apps/org/workgroup/pt-3/download.php/18614/MMT_Introduction_V2.pdf.

[4] "Toward the Construction of Hybrid-Cast™," Kinji Matsumura, Yasuaki Kanatsugu, and Hisakazu Katoh, NHK Science and Technology Research Laboratories, Tokyo, Japan, *ATSC Symposium on Next Generation Broadcast Television*,.19 October 2010: http://members.atsc.org/apps/org/workgroup/pt-2/download.php/17390/Kinji-Matsumura-Hybridcast.pdf (slides) http://members.atsc.org/apps/org/workgroup/pt-2/download.php/17313/TowardTheConstructionOfHybridcast_NHK.pdf (manuscript).

[5] "A Revolutionary Digital Broadcasting System: Achieving Maximum Possible Use of Bandwidth," Naohisa Kitazato, Yoshiharu Dewa, Robert Blanchard, and Mark Eyer, Sony Corporation, San Diego, CA, *ATSC Symposium on Next Generation Broadcast Television,* 19 October 2010:

http://members.atsc.org/apps/org/workgroup/pt-2/download.php/17328/A%20Revolutionary%20Digital%20Broadcasting%20System-%20Sony%2010-7-2010.pdf (manuscript)
http://members.atsc.org/apps/org/workgroup/pt-2/download.php/17674/Naohisa-Kitazato-Next-Generation-Broadcast.pdf (slides).

[6] "Syncbak Overview," presentation by Steve Maher of Syncbak to ATSC PT-3 on 14 June 2011: http://members.atsc.org/apps/org/workgroup/pt-3/download.php/19615/ATSC%20Briefing%202011-06-14.pptx.

[7] "Hybrid and Internet Television – A discussion paper prepared by the World Broadcasting Unions," WBU, c/o NABA. January, 2011: http://www.nabanet.com/wbuarea/library/Docs/TC/Final%20WBU%20Hybrid%20Internet%20TV%20Jan%202011-02-04.pdf .

[8] "Principles for Internet Connected and Hybrid Television in Europe," European Broadcasting Union, 15 April 2011: http://www.ebu.ch/CMSimages/en/Annex%20PR_15.04.2011_Principles%20for%20Internet%20Connected%20and%20Hybrid%20Television%20in%20Europe_tcm6-71718.pdf .

[9] "CEA July 2010 Forecast Report," *2009-2014 Extended Forecast Module* (*January 2011*), Consumer Electronics Association, Arlington, VA. January 2011.

[10] "CEA August 2010 US Consumer Survey," *Interactive TV: Engaging Viewers, Enriching Content*, Consumer Electronics Association, Arlington, VA, 8 April 2010.

[11] "Draft Core OCTV Specification," (DMP 1312/OCTV), Open Connected TV (OCTV), 3 April 2011: http://open.dmpf.org/dmp1312.doc.

Annex A: Data Tables

A.1 INTERNET TV-RELATED RESEARCH DATA

Table A1 TV Sales Forecast
(Source: CEA July-2010 Forecast for CE Devices)

Unit Sales to Dealers (000's)	2009	2010[1]	2011[2]	2012[2]	2013[2]	2014[2]	Percent Changes				
							2010	2011	2012	2013	2014
Total digital displays	34,799	35,591	36,296	36,994	37,532	38,041	2%	2%	2%	1%	1%
Total DTV that are HD	29,662	31,145	32,390	33,686	34,697	35,738	5%	4%	4%	3%	3%
Total DTV with integrated ATSC tuner	32,802	34,114	35,479	36,188	36,912	37,281	4%	4%	2%	2%	1%
Full HD (1080p)	13,403	15,950	18,820	20,514	21,335	21,975	19%	18%	9%	4%	3%
Total DTV that are Ethernet enabled[3]	3,029	8,233	13,438	19,075	24,607	28,298	172%	63%	42%	29%	15%
Total DTV that are widget enabled[4]	1,840	3,795	6,795	8,993	12,133	15,843	106%	79%	32%	35%	31%

Notes:

1 Estimate

2 Forecast

3 Ethernet Enabled = any DTV that has LAN ports or USB ports that can be connected LAN or Integrated WiFi.

4 Widget Enabled = any DTV that has a framework/platform onto which external 3rd party apps can be loaded by the consumer

Table A2 Internet TV Viewing Trends
(Source: CEA August 2010 US Consumer Survey)

Query	Result
Over the past 12 months have cut back on the number of channels paid to access through a television service provider such as cable or satellite	23%
Are using online streaming video services to watch movies or TV shows instead of watching movies or TV shows on physical media, such as DVD, Blu-ray or VHS	27%
Would consider cancelling current subscription to television service provider, such as cable or satellite, if they could watch equal quality broadcast television programming on their TV via an Internet connection	46%
Watched Internet-sourced video content, such as movies, TV shows or video clips from sources such as Netflix, Amazon On-Demand, Hulu, Vudu, CNN, YouTube, etc., on a daily or several times a week basis	23%
Watched full episodes of a TV shows online in the past 12 months - responses of all-ages / 18-24 ages	36% / 75%
Watched full length movies online in the past 12 months - responses of all-ages / 18-24 ages	20% / 46%

Table A3 TV Usage Trends
(Source: CEA August 2010 US Consumer Survey)

How, often, if at all, are the televisions in your home used to do each of the following? Would you say daily or several times a week?	Daily	Several times a week
Watch television programming through a service provider, such as cable, satellite, or fiber to the home	73%	82%
Watch television programming recorded using a digital video receiver or DVR	23%	33%
Play video games	18%	32%
Watch movies or TV shows on DVD, VHS or Blu-ray disc	16%	29%
Watch Internet-sourced video content, such as movies, TV shows or video clips from sources such as Netflix, Amazon On-Demand, Hulu, Vudu, CNN, YouTube, etc.	14%	23%
Watch On Demand movies or TV shows FOR FREE through a TV service provider	11%	20%
Watch Pay-per-view or On Demand movies or TV shows PURCHASED through a TV service provider	3%	5%

Table A4 Methods of Internet TV Viewing
(Source: CEA August 2010 US Consumer Survey)

In which of the following ways, if any, are you able to view Internet-sourced video content, such as movies, TV shows, video clips, through a home television set? Do you use a...	% US Viewers
Home component such as an Internet enabled Blu-Ray or DVD player connected to the TV	43%
Internet-connected video game system connected to the TV	39%
Internet-connected desktop or laptop computer connected with wires or wirelessly to the TV	37%
Widgets accessible through your television service provider's set-top box	18%
Widgets built into an Internet connected TV	6%
Portable MP3 or media player connected to the TV	15%
Internet-connected set-top box, such as Roku or Apple TV, connected with wires or wirelessly to the TV	12%
Some other way	8%

Table A5 TV "Cord-cutting" Trends
(Source: CEA August 2010 US Consumer Survey)

Which of the following statements, if any, apply to you?	Yes
You are aware which, if any, of your TVs have a built-in digital tuner	51%
You would consider cancelling your current subscription to a television service provider, such as cable or satellite, if you could watch equal quality broadcast television programming on your TV via an Internet connection	46%
You are using online streaming video services to watch movies or TV shows instead of watching movies or TV shows on physical media, such as DVD, Blu-ray or VHS	27%
Over the past 12 months you have cut back on the number of channels you pay to access through a television service provider, such as cable or satellite	23%

Table A6 Interest in Internet TV Access
(Source: CEA August 2010 US Consumer Survey)

Given that Internet-sourced video content comes from sources such as Netflix, Amazon On-Demand, Hulu, Vudu, CNN, CinemaNow, Blockbuster On-Demand, YouTube and more, how interested or uninterested are you in being able to do each of the following? Are you very interested or interested?	**Very Interested/ Interested**
Purchasing devices, such as TVs, computer, set-top box, that will allow you to watch Internet-sourced video content on a TV	21%
Watch Internet-sourced video content on a TV using Widgets built into the TV	18%
Watch Internet-sourced video content on a TV using Widgets accessible through a television service provider via their set-top box	14%