ATSC Standard:
A/107 – ATSC 2.0 Standard

A/107:2015
15 June 2015

Advanced Television Systems Committee
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Washington, D.C. 20006
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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.

Note: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith. One or more patent holders have, however, filed a statement regarding the terms on which such patent holder(s) may be willing to grant a license under these rights to individuals or entities desiring to obtain such a license. Details may be obtained from the ATSC Secretary and the patent holder.

Revision History

Version	Date
Candidate Standard approved	25 February 2014
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1. SCOPE

This document is a top-level specification of the ATSC 2.0 fixed-broadcast digital television services, which augment the digital television services defined in ATSC A/53 [1]. As a top-level document this standard references other ATSC standards as well as standards developed by other organizations.

1.1 Introduction and Background

ATSC 2.0 is designed to take the experience of television-watching on fixed receivers to the next level by introducing a number of enhanced features based on newly-developed standards and focused application of existing standards. Internet-connected consumer devices enable new distribution and consumption models for television entertainment programming and information.

Many consumer electronics products such as video game consoles, Blu-ray™ disc players, and personal computers can be connected to the Internet, allowing them to receive content and services from Internet-based service providers. Televisions can also be connected to the Internet.

Other more fundamental developments in video technology, incorporated in ATSC 2.0, significantly improve the operation of TV systems. Since the first widely-deployed video compression technology, MPEG-2, was introduced decades ago, the AVC (H.264) video codec is now widely used for high-quality high-efficiency video distribution; it is found in Internet streaming services and also in the ATSC Mobile DTV standard. New high efficiency audio codecs are also found in the most modern video services.

ATSC 2.0 is designed to be in-band backward compatible, which means that, although ATSC 2.0 services are not expected to run on current ATSC receivers, the inclusion of ATSC 2.0 services in a transmission are designed to be compatible with current ATSC receivers' ability to receive current ATSC services in that transmission.

1.2 Organization

This document is organized as follows:

- Section 1 – Outlines the scope of this standard and provides a general introduction.
- Section 2 – Lists references and applicable documents.
- Section 3 – Provides a definition of terms, acronyms, and abbreviations for this standard.
- Section 4 – Overview of the ATSC 2.0 system.
- Section 5 – System specification
- Annex A – Stream Info Details for AAC Audio Codec Family
- Annex B – Stream Info Details for DTS-HD Audio

2. REFERENCES

All referenced documents are subject to revision. Users of this Standard are cautioned that newer editions might or might not be compatible.

2.1 Normative References

The following documents, in whole or in part, as referenced in this document, contain specific provisions that are to be followed strictly in order to implement a provision of this Standard.

[1] ATSC: "ATSC Digital Television Standard, Part 1 – Digital Television System," Doc. No A/53 Part 1:2013, Advanced Television Systems Committee, Washington, D.C., August 2013.

[2] ATSC: "ATSC Digital Television Standard: Part 3 – Service Multiplex and Transport Subsystem Characteristics," Doc. No A/53 Part 3:2013, Advanced Television Systems Committee, Washington, D.C., 7 August 2013.

[3] ATSC: "Digital Television Standard: Part 4 – MPEG-2 Video System Characteristics," Doc. A/53 Part 4:2009, Advanced Television Systems Committee, Washington, D.C., 7 August 2009.

[4] ATSC: "Digital Television Standard: Part 5 – AC-3 Audio System Characteristics," Doc. A/53 Part 5:2014, Advanced Television Systems Committee, Washington, D.C., 28 August 2014.

[5] ATSC: "Digital Television Standard: Part 6 – Enhanced AC-3 Audio System Characteristics," Doc. A/53 Part 6:2013, Advanced Television Systems Committee, Washington, D.C., 7 August 2013.

[6] ATSC: "Program and System Information Protocol for Terrestrial Broadcast and Cable," Doc. A/65:2013, Advanced Television Systems Committee, Washington, D.C., 7 August 2013.

[7] ATSC: "ATSC Standard: Parameterized Services Standard," Doc. A/71:2012, Advanced Television Systems Committee, Washington, D.C., 3 December, 2012.

[8] ATSC: "ATSC Standard: Video System Characteristics of AVC in the ATSC Digital Television System," Doc. A/72 Part 1:2014, Advanced Television Systems Committee, Washington, D.C., 18 February 2014.

[9] ATSC: "ATSC Standard: AVC Video Transport Subsystem Characteristics," Doc. A/72 Part 2:2014, Advanced Television Systems Committee, Washington, D.C., 18 February 2014.

[10] ATSC: "ATSC Data Broadcast Standard," Doc. A/90:2013, Advanced Television Systems Committee, Washington, D.C., 28 October, 2013.

[11] ATSC: "ATSC Standard: Software Download Data Service," Doc. A/97, Advanced Television Systems Committee, Washington, D.C., 16 November, 2004.

[12] ATSC: "ATSC Standard: Interactive Services," Doc A/105:2015, Advanced Television Systems Committee, Washington, D.C., 29 October 2015.

[13] ATSC: "ATSC Standard: Non-Real-Time Content Delivery," Doc. A/103:2014, Advanced Television Systems Committee, Washington, D.C., 25 July 2014.

[14] ATSC: "ATSC Standard: Security and Service Protection," Doc. A/106:2015, Advanced Television Systems Committee, Washington, D.C., Candidate Standard, 28 September 2015.

[15] IEEE: "Use of the International Systems of Units (SI): The Modern Metric System," Doc. SI 10-2002, Institute of Electrical and Electronics Engineers, New York, N.Y.

[16] ISO/IEC: "Information technology – Coding of audio-visual objects – Part 3: Audio," ISO/IEC 14496-3:2009 (E), International Organization for Standardization and International Electrotechnical Commission, 1 September 2009 with Amendments 1, 2, 3 and 4 thereto.

[17] SCTE: "MPEG-4 AAC Family Audio System – Part 1: Coding Constraints for Cable Television," Doc. ANSI/SCTE 193-1 2014, Society of Cable Telecommunications Engineers, Exton, PA, 2014.

[18] SCTE: "MPEG-4 AAC Family Audio System – Part 2: Constraints for Carriage over MPEG-2 Transport," Doc. ANSI/SCTE 193-2 2014, Society of Cable Telecommunications Engineers, Exton, PA, 2014.

[19] SCTE: "DTS-HD Audio System – Part 1: Coding Constraints for Cable Television," SCTE 194-1 2013, Society of Cable Telecommunications Engineers, Exton, PA.

[20] SCTE: "DTS-HD Audio System – Part 2: Constraints for Carriage over MPEG-2 Transport" SCTE 194-2 2014, Society of Cable Telecommunications Engineers, Exton, PA.

2.2 Informative References

The following documents contain information that may be helpful in applying this Standard.

[21] ITU: ITU-T Rec. H.222.0 | ISO/IEC 13818-1:2013, Information Technology – Generic coding of moving pictures and associated audio – Part 1: systems, 15 June 2013.

[22] ATSC: "Digital Audio Compression (AC-3, E-AC-3) Standard," Doc. A/52:2012, Advanced Television Systems Committee, Washington, D.C., 17 December 2012.

3. DEFINITION OF TERMS

With respect to definition of terms, abbreviations, and units, the practice of the Institute of Electrical and Electronics Engineers (IEEE) as outlined in the Institute's published standards [13] shall be used. Where an abbreviation is not covered by IEEE practice or industry practice differs from IEEE practice, the abbreviation in question will be described in Section 3.3 of this document.

3.1 Compliance Notation

This section defines compliance terms for use by this document:

shall – This word indicates specific provisions that are to be followed strictly (no deviation is permitted).

shall not – This phrase indicates specific provisions that are absolutely prohibited.

should – This word indicates that a certain course of action is preferred but not necessarily required.

should not – This phrase means a certain possibility or course of action is undesirable but not prohibited.

3.2   Treatment of Syntactic Elements

This document contains symbolic references to syntactic elements used in the audio, video, and transport coding subsystems. These references are typographically distinguished by the use of a different font (e.g., restricted), may contain the underscore character (e.g., sequence_end_code) and may consist of character strings that are not English words (e.g., dynrng).

3.2.1   Reserved Elements

One or more reserved bits, symbols, fields, or ranges of values (i.e., elements) may be present in this document. These are used primarily to enable adding new values to a syntactical structure without altering its syntax or causing a problem with backwards compatibility, but they also can be used for other reasons.

The ATSC default value for reserved bits is '1'. There is no default value for other reserved elements. Use of reserved elements except as defined in ATSC Standards or by an industry standards setting body is not permitted. See individual element semantics for mandatory settings and any additional use constraints. As currently-reserved elements may be assigned values and meanings in future versions of this Standard, receiving devices built to this version are expected to ignore all values appearing in currently-reserved elements to avoid possible future failure to function as intended.

3.3   Acronyms and Abbreviation

The following acronyms and abbreviations are used within this document.

AAC – Advanced Audio Coding
ACR – automatic content recognition
ATSC – Advanced Television Systems Committee
AVC – Advanced Video Codec
DO – Declarative Object
DRM – Digital Rights Management
DTV – Digital Television
EPG – Electronic Program Guide
HTTP – Hypertext Transfer Protocol
IEC – International Electrotechnical Commission
ISO – International Standards Organization
ITU – International Telecommunication Union
LAN – Local Area Network
MPEG – Moving Picture Experts Group
NRT – non-real-time
OTT – Over the Top
PAT – Program Association Table
PMT – Program Map Table
SCTE – Society of Cable Telecommunications Engineers
TVCT – Terrestrial Virtual Channel Table
UPnP – Universal Plug and Play
VCT – Virtual Channel Table
VOD – Video on Demand
XML – eXtensible Markup Language

3.4   Terms

The following terms are used within this document.
reserved – Set aside for future use by a Standard.

3.5 Extensibility

This Standard is designed to be extensible via both backward compatible mechanisms and by replacement syntactical mechanisms that are not backward compatible. It also establishes means to explicitly signal collections of components to establish services with various characteristics. The enumeration of the set of components that can be used to present a service is established to

enable different combinations of the defined components to be offered without altering this standard.

The backward compatible mechanisms are:

Table length extensions – Future amendments to this Standard may include new fields at the ends of certain tables. Tables that may be extensible in this way include those in which the last byte of the field may be determined without use of the section_length field. Such an extension is a backwards compatible addition.

Definition of reserved values – Future amendments to this Standard may establish meaning for fields that are asserted to be "reserved" in a table's syntax, semantic or schema in the initial release. Such an extension is a backwards compatible addition due to the definition of "reserved."

Descriptor length extensions – Future amendments to this Standard may include new fields at the ends of certain descriptors. Descriptors extensible in this way include those in which the last byte of the last currently defined field may be determined without the use of the descriptor_length field.

New descriptor types – Future amendments to this Standard may define new types of descriptors not recognized or supported by existing receiving devices. A descriptor whose descriptor_tag identifies a type not recognized by a particular receiver is expected to be ignored. Descriptors can be included in certain specified places within tables, subject to certain restrictions. Descriptors may be used to extend data represented as fixed fields within the tables. They make the protocol very flexible since they can be included only as needed. New descriptor types can be standardized and included without affecting receivers that have not been designed to recognize and process the new types.

3.5.1 Non-backward Compatible Extensions

Tables and schema that can be changed in a non-compatible manner each contain a field labeled major version (or major_version) in order to explicitly signal their syntax. More than one instance (each with a different major version) can be expected to be present wherever such tables or schema are used.

3.5.2 Extensions with Unknown Compatibility

This standard establishes a general signaling approach that enables new combinations of components to be transmitted that define a new or altered service offering. They, of course, are not "ATSC 2.0," even though they are enabled by the service signaling in this standard. Receiver support for such sets is unknown and labeling of such sets of extensions to the service signaling established herein is the responsibility of the document establishing a given set of capabilities.

3.5.3 Descriptor Processing Considerations

The descriptors used in "descriptor loops" in tables in this Standard have the format: type (descriptor_tag), length (descriptor_length), and data, as specified in the MPEG-2 Systems Standard ISO/ITU 13818-1 [21]. These "descriptor loops" indicate that zero, one or more descriptors are carried in that position in the stream. For many descriptor loops, certain descriptors are required and others are optional. However, these requirements specify descriptors which are required to or optionally may be carried in a particular descriptor loop. There are a large number of reserved and user-defined descriptor types which may be in private usage, or may be standardized in later versions of a standard referenced by this standard or this standard itself.

3.5.3.1 Processing Descriptor Loops

Descriptor loops are collections of descriptors. In order to parse the transport stream, it is necessary to parse the descriptor_tag and descriptor_length, and subsequently either process the content of the descriptor or discard the number of bytes indicated by the descriptor_length field from the transport stream and proceed with the next entry in the descriptor loop (if any).

3.5.3.2 Treatment of Descriptor Length

The length of each descriptor in a descriptor loop is *exclusively* described by the descriptor_length field. There are certain descriptors that have multiple allowable lengths. There are descriptors with descriptor_length of zero. Receivers are expected to be able to parse (or skip, as appropriate) descriptors of zero length. Receivers are expected to be able to parse (or skip, as appropriate) descriptors with varying length. Receivers are expected to be able to parse (or skip, as appropriate) descriptors with nonzero, but unexpected length (where length is either larger or smaller than expected).

3.5.3.3 Treatment of Unrecognized Descriptor Types

For the reason discussed above, descriptors have a common header (descriptor_type and descriptor_length) which devices can use to identify descriptors and process them (if they are a known type). However, unrecognized descriptors (either unrecognized in the location found or otherwise) *are not errors*. Emission, processing and reception devices are expected to silently ignore descriptors that they do not process.

3.5.3.4 Descriptor Order within a Descriptor Loop

The collection of descriptors carried in a descriptor loop is an unordered set. *No information is provided* by the fact that a particular descriptor is placed before or after another within a descriptor loop.

3.5.4　　　Schema Revision and Extension Considerations

The XML schema name spaces used in this standard enable addition of backward compatible extensions to the schema. Non-backward compatible schema changes are signaled by altering the major version designation of the schema. For example, consider the namespace:

http://www.atsc.org/XMLSchemas/nrt-sg-1

The number 1 at the end of the namespace designation indicates that the major version number of the schema is 1. The "schema" element in the XML schemas created by ATSC are defined to contain a "version" attribute set to the value "1.0" to start; indicating that the major version number of the schema is 1, and the minor version number of the schema is 0. The version attribute would contain 1.1 for the first backward compatible extension, and the extended schema would use the same XML namespace as the 1.0 version.

For each non-backwards compatible change, the namespace number would be incremented along with the version attribute increment. For the example here, the value of the "version" attribute would become "2.0" and the name space would bear the number "2" as shown below:

http://www.atsc.org/XMLSchemas/nrt-sg-2

Extensions that might be added by establishing optional attributes in schemas defined by other standards bodies are not managed by using this extension approach. Their namespace design is not under ATSC control.

4. SYSTEM OVERVIEW

ATSC 2.0 is designed to provide a comprehensive set of tools and features to enhance and extend the current ATSC A/53 Standard while maintaining backward compatibility. The following is a synopsis of ATSC 2.0 features.

Extensibility. ATSC 2.0 has provisions to enable extensible, backward-compatible features and also, through replacement of syntactical mechanisms, to provide new features that are not usable by existing receivers but are not expected to negatively impact their performance.

Internet Connectivity. Many features and capabilities of ATSC 2.0 are enhanced or enabled through an Internet connection. An Internet connection capability can be utilized by ATSC 2.0 receivers to provide streaming Internet media, other ATSC non-real-time services and interactive signaling. Security can be provided through authorizations and other exchanges via the internet connection, and service measurement can be enabled via the internet.

Advanced Video and Audio Codecs. ATSC 2.0 has enabled the use of extensible features to deploy advanced video and audio codecs enabling a higher quality user experience, such as 1080p60 video and up to 7.1 channels of audio. These features are defined for real-time and non-real-time broadcast services. Advanced codecs currently supported for ATSC 2.0 are AVC for video and include E-AC-3, HE-AAC v2, and DTS-HD for audio.

Second Screen. ATSC 2.0 provides support for the integration of second-screen devices complementing television services. In this context, the television receiver is the first screen device, and the second screen device is a personal device that is used by a viewer while watching a first-screen device. Additionally, multiple second screen devices can be linked to a TV receiver at the same time. Examples of second screen devices are tablets, smart phones, laptop computers or any other device that can present services that integrate with television service. ATSC 2.0 also makes use of Universal Plug and Play (UPnP) services that allow an application running on a second screen device to communicate with a TV, typically over the home local area network (LAN).

Service Usage Data Gathering and Reporting. ATSC 2.0 includes the capability for a receiver to provide data about the consumption of services or components of services. The capabilities include gathering and storing defined data elements for services or components of services that are consumed at the same time they are received, and for those that are consumed sometime after receipt.

Personalization. ATSC 2.0 provides for personalization of the user's interests and preferences. The viewer has the option of providing information for their viewing preferences and the standard defines a standardized format for downloadable questionnaires with various answer formats, with examples such as yes/no or true/false, text string, multiple choice, integer, and checklist. ATSC 2.0 receivers are expected to offer users a setup screen where the answers to the questions may be provided.

4.1 Non real-time Services

The A/103 [13] non real-time (NRT) standard describes standardized signaling, announcement, and transport of NRT essence.

Non-Real-Time services for fixed broadcast are delivered within IP subnets; the particular IP subnets associated with a given virtual channel are identified by references in the Terrestrial Virtual Channel Table (TVCT) and associated PAT/PMT tables.

There are seven consumption models identified by the NRT standard.

4.2 Interactive Services

The ATSC A/105 Interactive Services Standard [12] system allows broadcasters to connect broadcast programming with additional services related to that programming. Central to this system are Declarative Objects (DOs) providing the user's interactive experience. Changes to the life-cycle state of Declarative Objects (for example to launch or kill a DO) can be initiated and changed by both broadcasters and viewers. The system provides for the extension of these services to second screens and provides for delivery of needed resources via the Internet path.

In addition to services already part of traditional terrestrial broadcast television, services described in the Interactive Services standard include:

- Personalization
- Service usage reporting
- Receiver access to web-based servers
- Support for automatic content recognition.

Three contexts for interactivity are supported in the Interactive Services Standard and related ATSC standards:

- Triggered interactive adjunct data services (defined in Section 5.1 of A/105 [12])
- Other interactive NRT services
- Interactive applications not bound to a service

In each case the interactivity is provided by Declarative Objects (DOs) that conform to the specifications in Sections 6 and 1.1 of the Interactive Services Standard [12].

4.3 Features and Capabilities

4.3.1   Advanced Video/Audio Codecs

The use of advanced video and audio codecs enables delivery of content at lower bit rates than current codecs while maintaining equivalent or improved quality. This provides the opportunity for more program services in available bandwidth and/or quality enhancements. Additional features are also supported by the audio codecs.

For example, the improved efficiency of the video codec enables carriage of 1080p60 video in a broadcast channel.

For audio codecs, not only is the efficiency improved, but capability for up to 7.1 audio channels and supplemental services such as video description can be implemented within a single stream and single decoder.

Use of advanced codecs is defined for real-time broadcast services, Internet streaming media delivery, and file download (non-real-time) broadcast services.

Advanced codecs for ATSC 2.0 are AVC for video and include E-AC-3, HE AAC v2, and DTS-HD for audio.

4.3.2   Interactivity System Overview

The ATSC 2.0 Interactive Services system makes use of new data structures to connect broadcast programming with additional services. In addition to services already part of broadcast, these services enable personalization, service usage reporting, broadcaster notification via the internet, and web site access. Central to this system are Declarative Objects containing information and instructions for the additional services. The Declarative Objects have a number of states (ready, active, etc.) which can be initiated and changed by both broadcasters and viewers. The system provides for the extension of these services to second screens.

4.3.3 Non-Real-Time Services

NRT services provide support for delivery of content in advance of use (i.e., not real time streaming content), carried in DTV broadcast multiplexes. NRT content can include both "traditional" TV fare (video/audio entertainment programming, news, weather, sports, etc.), as well as information not aimed at the TV at all, including content targeted to PCs, handheld media players or even commercial platforms. In addition, NRT content can be presented in a customized and non-traditional way on various devices.

Typical applications for NRT services include:

- Push VOD (content ranging from short-form video clips to feature length movies)
- News, information and weather services
- Personalized TV channels
- Music distribution
- Reference information on a wide range of topics

Delivery of Non-Real-Time services allows broadcasters to efficiently deliver regionally-localized content wirelessly to devices.

4.3.4 Access Control/DRM

Access control (or conditional access) is the protection of content by requiring certain criteria to be met before granting access to the content. This is typically accomplished by encrypting the content (sometimes encrypting content is called scrambling), and providing the decryption keys only when the access criteria has been met. Digital Rights Management (or DRM) is a form of access control which includes the secure delivery of usage rights rules. Receivers then only permit the usage which is permitted by the usage rights rules, which may include restrictions on the number of copies which may be made.

4.3.5 Service Usage Data Gathering and Reporting

The capability for a receiver to provide data about the consumption of services or components of services is enabled through the normative definition of a set of capabilities in a "Usage Reporting-Capable Receiver" as defined in Section 11 of ATSC Interactive Services [12]. The capabilities include gathering and storing defined data elements for services or components of services that are consumed at the same time they are received and for those that are consumed sometime after receipt.

The capabilities also include means for establishing a communications path to enable forwarding consumption records to designated locations on the Internet. While the data communication process is addressed by Interactive Services [12], the management of the collection, post-processing, analysis and reporting of audience measurement information bases upon the data is not addressed.

4.3.6 Second Screen

ATSC 2.0 provides support for the integration of second-screen devices with television services. ATSC 2.0 defines Universal Plug and Play (UPnP) services that allow an application running on a second screen device to communicate with a TV, typically over the home local area network (LAN). The supported communications enable:

- Receiving triggers on second screen devices, whether those triggers be obtained from the broadcast stream or via ACR.

- Communication between an application running on the first screen device and applications running on second screen devices.
- Chaining applications on second screen devices.

These facilities allow television service providers to create hybrid user experiences that take advantage of the television screen and smaller, personal screens to create a synchronized, coordinated, personalized viewer experience.

4.3.7　　Internet Connectivity

Many of the features and capabilities of ATSC 2.0 are enhanced or enabled through an Internet connection. Some ATSC 2.0 applications function even without a continuous Internet connection, while other applications require a continuous connection. Non-real-time (NRT) file delivery via broadcast can be enhanced through the use of an Internet connection, as well as the delivery itself can occur directly via the Internet connection. Security can be enhanced through authorizations or other exchanges via the Internet connection. Service measurement reporting requires that some form of interaction channel is available such as what an Internet connection would provide.

4.3.8　　Personalization

A user's experience of ATSC 2.0 services may be enhanced when content is tailored to that user's individual interests and preferences. Through the personalization function in ATSC 2.0 for example, the viewer can receive content suitable for those living in his or her geographic area while viewers living in a different area receive different content. Likewise, since some viewers may be more interested in sports broadcasting while others prefer cooking shows, content more closely matching the viewer's indicated interests can be offered for download.

The ATSC 2.0 standard defines a standard format for downloadable questionnaires with various answer formats including yes/no or true/false, text string (with maximum length), multiple choice, integer (with range limits), and checklist. ATSC 2.0-capable receivers are expected to offer users a setup screen where the answers to the questions may be provided. The standard defines APIs to allow the authors of interactive content to access the answers to these questions, and thus customize the behavior of scripts (and thus alter the user's experience of the channel) based on the user's responses.

4.3.9　　Delivery by other interfaces (ACR, Home Network)

The ATSC 2.0 standard defines formats for multiple delivery channels. In addition to conventional audio-visual program services such as traditional linear TV service delivery over linear broadcast TV channels, data delivery services are specified for delivery over linear TV channels, and over separate, independent, IP channels. The TV services, as well as the data services may be separate and independent of each other, or they may be used in concert to provide an enhanced ATSC 2.0 TV viewing experience. To facilitate such services, the ATSC 2.0 standard defines Triggers that enable the coupling of data on the data channel to the audio-visual program content.

The standard supports two methods of transmitting the Triggers: as part of the linear TV AV service content, or via automatic content recognition (ACR) methods by the ATSC 2.0 receivers. While the standard does not specify nor mandate use of any particular ACR technology, the standard does specify the protocols to be used by the ACR-enabled ATSC 2.0 receiver to establish a IP connection with the proper ACR content servers so that synchronous auxiliary data may be delivered to the ACR-enabled ATSC 2.0 receiver.

4.3.10   Bookmarks

"Bookmarks" represent a feature in ATSC 2.0 standard that provides convenience for consumers to store relevant information to be used by consumers at a later time to obtain additional detail about the TV program or an NRT service. ATSC 2.0 Links and Packaged Apps are the standardized format used by ATSC 2.0 broadcasters to carry the information, which includes URL, titles, expiration date, icons, and other information that may be useful for reminding consumers about the Links. The signaling of when a particular Link is to be presented for bookmarking by consumers is done using ATSC 2.0 standard TDO.

The additional information is sent in the ATSC 2.0 Packaged App format. The delivery of the Packaged App may be via ATSC 2.0 NRT channel, or over separate and independent IP connection with the ATSC 2.0 receiver. ATSC 2.0 receiver UI designs would provide the desirable presentation to viewers/users of their previously "bookmarked" Links and Packaged Apps, and any meaningful processing thereof.

5. SYSTEM DESIGN

5.1 Service Model

ATSC 2.0 services shall conform to the specifications in A/53 [1] and A/65 [6], with extensions as specified in Sections 5.2, 5.3, 5.4 and 5.5 of this standard. ATSC 2.0 Non-Real Time (NRT) services and interactive services shall also conform to the specifications in A/103 [13] and A/105 [12], respectively.

5.1.1   NRT and Interactive Standalone Services

Fixed-broadcast virtual channels containing exclusively non-real-time elements, otherwise known as "standalone" services, are included in the ATSC 2.0 system. Standalone NRT services are required to be signaled in the VCT as specified in Section 6.1.1 of A/103 [13]. Six consumption models are suitable for standalone NRT services:

- Browse & Download
- Push
- Portal
- Push Scripted
- Portal Scripted
- EPG

These are defined in Annex B of A/103 [13]. The consumption_model are required to be signaled in the NRT Service Descriptor defined in Section 8.2 of A/103 [13]. All other characteristics of each type of service are as specified in A/103 [13].

> Note: The scripting of Pushed Scripted and Portal Scripted services are considered "interactive" even though they are delivered via NRT in standalone NRT services.

5.1.2   NRT and Interactive Adjunct Services to Linear TV

Fixed-broadcast virtual channels carrying a linear TV service can include ancillary NRT content and signaling. Such services may be considered to include NRT "adjunct" data. Adjunct data services are signaled per Section 6 of A/103 [13].

Linear TV with NRT adjunct data services with the following characteristics are considered to be part of the ATSC 2.0 system:

- consumption_model value 0x04 indicating "Triggered" consumption model, signaled in the NRT_service_descriptor() as specified in Section 8.2 of A/103 [13]
- triggers identifying either the interactive content or the location of the TDO Parameters Table (TPT) carried per Section 7.5.1 of A/105 [12]

The linear TV service carrying the NRT adjunct data may be either regular DTV service (service_type 0x02, MPEG-2 video and AC-3 audio)[1] or the linear TV service using AVC video and audio (see Section 5.1.4 and 5.1.5 below).

5.1.3　EPG Service

The NRT data carried in a standalone service may deliver data to augment the Electronic Program Guide (EPG) functionality in the receiver. The NRT EPG service with the following characteristics is considered to be part of the ATSC 2.0 system:

- consumption_model value 0x07 indicating "EPG" consumption model, signaled in the NRT_service_descriptor() as specified in Section 8.2 of A/103 [13].

Note that the receiver does not offer the user direct access (e.g., by tuning to a virtual channel) to such an NRT EPG service; the receiver identifies the contents of the service as containing EPG data and can collect the data for use in enhancing the native EPG functionality.

5.1.4　Linear TV Services using Advanced Video Codec

In addition to linear TV services corresponding to service_type 0x02 (regular DTV service using MPEG-2 video and AC-3 audio), ATSC 2.0 includes linear TV using the AVC video codec. Services using AVC video are signaled as follows:

- service_type 0x07, indicating Parameterized Service per A/71 [7]; and
- PMT and component_list_descriptor() indicating stream_type 0x1B for the video component as specified in ISO/IEC 13818-1 [21]; and
- video encoding as specified in Section 5.2.1 below.

5.1.5　Linear TV Services using Advanced Audio Codecs

Three types of advanced audio codecs are defined for use in ATSC 2.0 linear TV services: E-AC-3, codecs in the AAC family, and DTS-HD. This section specifies requirements related to their use.

Parameterized Services per A/71 [7] shall be used whenever the structure of a service does not conform to the requirements of any of the following service_type values:

- 0x01 – Analog Television (see A/65 [6])
- 0x02 – ATSC Digital Television (see A/53 Part 3 [2])
- 0x03 – ATSC Audio (see A/53 Part 3 [2])
- 0x04 – ATSC Data Only Service (see A/90 [10])
- 0x05 – ATSC Software Download Service (see A/97 [11])
- 0x08 – Standalone Non-Real-Time Service (see A/103 [13])

Note that the definition of service_type 0x02 does not preclude the presence in the program of audio elementary stream components encoded using advanced codecs. Example service scenarios are given in Table 5.1 below.

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[1] The service_type is a parameter signaled in the Virtual Channel Table specified in A/65 [6].

Table 5.1 Example Service Structures

	Video	Audio CM #1	Audio CM #2	Associated Audio	A/71	Service Type
1.	MPEG-2	AC-3	Adv[(1)]		No	0x02
2.	MPEG-2	AC-3	-	Adv[(1)(2)]	No	0x02
3.	MPEG-2	Adv[(1)]	-	AC-3	Yes	0x07
4.	MPEG-2	Adv[(1)]	-	-	Yes	0x07
5.	AVC	AC-3	-	-	Yes	0x07
6.	AVC	Adv[(1)]	-	-	Yes	0x07
Notes:						
1 Advanced audio codecs including E-AC-3, DTS-HD, and AAC						
2 Example only: delivery of associated audio services such as Visually Impaired audio using a codec other than AC-3 May be subject to regional regulatory restrictions.						

Table 5.1 illustrates several service structures, each involving a different set of elementary stream components employing different types of codecs. Descriptions of each of these cases follow:

1) This service includes MPEG-2 video and a Complete Main AC-3 audio component and conforms to the requirements for service_type 0x02. The service includes an alternate language (second audio) service encoded using an advanced audio codec. The presence of this extra audio component is expected to have no adverse impact on legacy receivers.

2) This service includes MPEG-2 video and a Complete Main AC-3 audio component and also conforms to the requirements for service_type 0x02. It includes an associated audio elementary stream component encoded using an advanced audio codec. The presence of this extra audio component is expected to have no adverse impact on legacy receivers.

3) This example service uses the same two audio codecs as the prior example, except the Complete Main program element is encoded with an advanced audio codec. Therefore, the requirements for use of service_type 0x02 are not met and service_type 0x07 must be used. The Parameterized Service signaling includes the description of the advanced audio codec and receiver requirements for decoding that stream.

4) In this example, MPEG-2 is used as the video codec, but an advanced codec is used for Complete Main audio. Since this service structure does not conform to the requirements outlined in A/53 [2], service_type 0x02 cannot be used. Parameterized Services are used, and the Component List Descriptor identifies the characteristics of the advanced audio codecs used.

5) In this example service, an advanced video codec (AVC) is used with the legacy AC-3 audio codec. The situation is similar to the others: Parameterized Services must be used.

6) In this example service, advanced audio and advanced video codecs are both used. Again, Parameterized Services must be used.

5.1.5.1 Linear TV Services using E-AC-3 Audio Codec

When the program consists of one or more audio program elements encoded using the E-AC-3 audio codec, the Component List Descriptor of A/71 [7], if present, shall contain an instance of stream_info_details() for stream_type value 0x87 as defined in Section 7.2.9 of A/53 Part 6 [5].

5.1.5.2 Linear TV Services using AAC Family of Audio Codecs

When the program consists of one or more audio program elements encoded using a codec in the AAC family of codecs, the Component List Descriptor of A/71 [7], if present, shall contain an instance of stream_info_details() for stream_type value 0x11 as defined in Annex A.

5.1.5.3 Linear TV Services using DTS-HD Audio Codec

When the DTS-HD audio codec is used for linear TV services, the coding constraints shall conform to SCTE 194-1 2013 [19] . The signaling and MPEG-2 transport carriage shall conform to SCTE 194-2 2014 [20], except 4.1.3:

> o The registration_descriptor() with the format_identifier set to "SCTE", as described in SCTE 194-2 [20], shall not be included.

When the program consists of one or more audio program elements encoded using DTS-HD audio codecs, the Component List Descriptor of A/71 [7], if present, shall contain an instance of stream_info_details() for stream_type value 0x88 as defined in Annex B.

5.1.5.4 Additional Constraints

When multiple audio elementary streams of the same type (CM, VI, HI, etc.) are present in the Program, the language code(s) shall be included in the descriptor associated with each such audio component.

When a service includes one or more audio elementary streams carrying two or more audio services labeled with the same language (ISO_639_language_code) and audio type (CM, VI, HI, etc.), a unique component_name_descriptor() per A65 [6] shall be placed into each descriptor loop that immediately follows ES_info_length in the TS_program_map_section() describing such audio component.

Audio components to be mixed in the receiver shall be of the same codec family.

All audio components in a program are not required to be of the same codec family.

The constraints described here are not intended to constrain or impose requirements on the capabilities of receivers.

5.2 Advanced Codecs

5.2.1   Video

When the AVC video codec is used for real-time services the coding constraints shall conform to A/72 Part 1 [8]. The signaling and MPEG–2 transport carriage shall conform to A/72 Part 2 [9].

5.2.1.1 Real-time Services

When the AVC video codec is used for real-time services the coding constraints and signaling shall conform to A/72 Part 1 [8] and A/72 Part 2 [9].

5.2.1.2 Non-Real-time Services

When the AVC video codec (as specified in A/72 [8] [9]) is used for non-real-time services the coding constraints, signaling and file formats shall conform to A/103 [13].

5.2.1.3 Interactive Services

ATSC 2.0 adds interactive services by adapting the adjunct NRT service model for fixed broadcasts specified in Section 6 of ATSC A/103 [13]. The interactive services framework is described in ATSC A/105 [12] Section 5.1. ATSC video codecs which have been defined in Section 5.1.1.4 of this standard for use in linear services also qualify for use in interactive services. This includes the linear ATSC DTV services corresponding to service_type 0x02, 0x07 and 0x09,

5.2.2   Audio

5.2.2.1   Enhanced AC-3

5.2.2.1.1   Real-time Services

When the Enhanced AC-3 (E-AC-3) audio codec (as specified in A/52 [22]) is used for real-time services, the coding constraints shall conform to A/53 Part 6 [5]. The signaling and MPEG–2 transport carriage shall conform to A/53 Part 3 [2].

5.2.2.1.2   Non-Real-time Services

When the Enhanced AC-3 (E-AC-3) audio codec (as specified in A/52 [22]) is used for non-real-time services, the coding constraints, signaling, and file formats shall conform to A/103 [13].

5.2.2.2   HE AAC v2

5.2.2.2.1   Real-time Services

When the HE AAC v2[2] audio codec is used for real-time services, the coding constraints shall conform to ANSI/SCTE 193-1 [17]. The signaling and MPEG-2 transport carriage shall conform to ANSI/SCTE 193-2 [18].

5.2.2.2.2   Non-Real-time Services

When the HE AAC v2[2] audio codec is used for non-real-time services, the coding constraints, signaling, and file formats shall conform to A/103 Non-Real-Time Content Delivery [13].

5.2.2.3   DTS-HD

5.2.2.3.1   Real-time Services

When the DTS-HD audio codec is used for real-time services, the coding constraints shall conform to SCTE 194-1 2013 [19]. The signaling and MPEG-2 transport carriage shall conform to Section 5.1.5.3.

5.2.2.3.2   Non-Real-time Services

When the DTS-HD audio codec is used for non-real-time services, the coding constraints, and file formats shall conform to A/103 Non-Real-Time Content Delivery [13].

5.2.2.4 Interactive Services

ATSC 2.0 adds interactive services, or "non-linear services," by adapting the adjunct NRT service model for fixed broadcasts specified in Section 6 of ATSC A/103 [13]. The framework is described in ATSC A/105 [12] Section 5.1. ATSC audio codecs which have been defined in Section 5.1.1.5 of this standard for use in linear services also qualify for use in interactive services. Again this includes the linear ATSC DTV services corresponding to service_type 0x02 and AC-3 audio.

5.3 Security

5.3.1   IP Communication

When a secure IP connection is used for interaction channel communication, the communication shall be per A/106 [14], in particular Sections 5.1 and 5.4. When a secure connection for signaling between a receiver and a second screen device is used, the communication shall be per A/106 [14], in particular Sections 5.2 and 5.4.

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[2] HE AAC v2 includes a family of audio codecs, comprising Profiles for AAC, HE AAC, and HE AAC v2, with various capabilities depending on the constraints set out in the referenced standards.

5.3.2   Signed Objects

When Downloadable Objects are signed, such objects shall be signed per A/106 [14], in particular Sections 5.3 and 5.4.

5.3.3   Service Protection and Conditional Access

When service protection (conditional access) is used on the transport stream, such conditional access shall be per A/106 [14] Section 5.6. When service protection is used on streaming services in the interaction channel, such service protection shall be per A/106 [14] Section 5.7.

Annex A: Stream Info Details for AAC Audio

When a stream of stream type 0x11 (MPEG-4 AAC audio) is present in a virtual channel of service_type value 0x07 (Parameterized Service) or service_type value 0x09 (Extended Parameterized Service) the stream_info_details() defined below shall be present in the component_list_descriptor() (see ATSC A/71 [7]).

The stream_info_details() portion shall be constructed as shown in Table A.1, with the contents of the fields as defined below.

Table A.1 Stream Info Details Syntax for Stream Type 0x11 (AAC family)

Syntax	No. of Bits	Format
stream_info_details() {		
AAC_profile	4	uimsbf
AAC_ level	4	uimsbf
future_fields()	var	
}		

AAC_profile – This 4-bit unsigned integer field shall specify the profile used in the MPEG-4 AAC family encoded stream, as defined in Section 1.5.2.1 of ISO/IEC 14496-3 [16], and coded according to the following table.

Table A.2 AAC Profile

AAC_profile	Meaning
0x0	AAC (LC) Profile
0x1	HE AAC Profile
0x2	HE AAC v2 Profile
0x3-0xF	Reserved

AAC_level – This 4-bit unsigned integer field in the range 1 to 7 shall specify the AAC coding level as defined in Table 1.10, Table 1.11, or Table 1.12 of ISO/IEC 14496-3 [16] and used in the MPEG-4 AAC family encoded stream.

> Note: Per A/71 [7], the values signaled in AAC_profile and AAC_level in stream_info_details() indicate the most challenging decoding mode expected to be encountered for programming on this virtual channel.

future_fields() – This variable-length data structure is established to indicate the explicit ability to convey additional information in future versions of this standard. The value in the length_of_details which immediately precedes this instance of stream_info_details() in the component_list_descriptor() (see A/71 [7]) includes the count of the bytes in this field. In the present standard, the value of length_of_details is 1.

Note: Per A/71 [7], if an unsupported value of length_of_details is encountered, receivers are expected to conclude that the stream is not supported for decoding.

Note: Per A/71 [7], this structure will be placed in the Component List Descriptor within either a Terrestrial Virtual Channel Table or a Cable Virtual Channel Table.

Annex B: Stream Info Details for DTS-HD Audio

When a stream of stream type 0x88 (DTS-HD Audio) is present in a virtual channel of service_type value 7 (Parameterized Service) or service_type value 0x09 (Extended Parameterized Service) the stream_info_details() defined below shall be present in the component_list_descriptor() (see ATSC A/71 [7]).

The stream_info_details() portion shall be constructed as shown in Table B.1, with the contents of the fields as defined below.

Table B.1 Stream Info Details Syntax for Stream Type 0x88 (DTS-HD Audio)

Syntax	No. of Bits	Format
stream_info_details() {		
DTS-HD_profile	8	uimsbf
future_fields()	var	
}		

DTS-HD_profile – This 8-bit field shall be set to 0 to identify the DTS-HD encoded stream, coded according to SCTE 194-1 2013 [19].

future_fields() – This variable-length data structure is established to indicate the explicit ability to convey additional information in future versions of this standard. The value in the length_of_details which immediately precedes this instance of stream_info_details() in the component_list_descriptor() (see A/71 [7]) includes the count of the bytes in this field. In the present standard, the value of length_of_details is 1.

> Note: Per A/71 [7], if an unsupported value of length_of_details is encountered, receivers are expected to conclude that the stream is not supported for decoding.

> Note: Per A/71 [7], this structure will be placed in the Component List Descriptor within either a Terrestrial Virtual Channel Table or a Cable Virtual Channel Table.

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