ATSC Standard: ATSC 3.0 System

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ATSC Standard: ATSC 3.0 System

1. SCOPE

This Standard describes the ATSC 3.0 digital television system. ATSC 3.0 is a suite of voluntary technical Standards and Recommended Practices that is fundamentally different from predecessor ATSC systems and is therefore largely incompatible with them. This divergence from earlier design is intended to allow substantial improvements in performance, functionality and efficiency sufficient to warrant implementation of a non-backwards-compatible system. With higher capacity to deliver Ultra High-Definition services, robust reception on a wide range of devices, improved efficiency, IP transport, advanced emergency messaging, personalization features and interactive capability, the ATSC 3.0 Standard provides much more capability than previous generations of terrestrial broadcasting.

This document describes the complete ATSC 3.0 Standard, which encompasses a set of individual standards documents (see Section 2.1 and Figure 5.1), the interworking of which is described below.

1.1 Introduction and Background

In the fall of 2011, ATSC formed Technology Group 3 (TG-3) to design a next-generation broadcast system. TG-3 issued a Call for Input to solicit requirements for the system from a broad, international base of interests and organizations. Using this input, thirteen Usage Scenarios were developed, from which were derived a comprehensive set of system requirements. The system requirements established the capabilities of the overall system and thereby served as a guide in the preparation of the ATSC 3.0 suite of standards.

The ATSC 3.0 Standard uses a layered architecture, as shown in Figure 4.1 below. Three layers are defined: *Physical*, *Management and Protocols*, and *Application and Presentation*. To facilitate flexibility and extensibility, different elements of the system are specified in separate Standards. The complete list and structure of these Standards is provided in Section 5 and Figure 5.1 below. Each ATSC 3.0 Standard document is numbered according to the scheme shown in Figure 1.1.

1.1.1 Flexibility

Each ATSC 3.0 Standard is designed for maximum flexibility in its operation, and is extensible to accommodate future adaptation. As a result, it is critical for implementers to use the most up-to-date revision of each Standard, as referenced herein.[1] The overall documentation structure also enables individual components of the system to be revised or extended without affecting other components.

In some cases, multiple, fully parallel options are specified for certain operations, from which broadcasters can choose whichever method is more suitable to their operations or preferences. Examples include the use of either the MMT or ROUTE transport protocol [7], or the use of either the AC-4 or MPEG-H 3D Audio system [16].

[1] While new or revised *individual* ATSC 3.0 Standards may be published from time to time, the proper interoperability of the entire set is not verified until it appears in this document. The most recent A/300 Standard (indicated by its date of publication) therefore establishes by reference the complete set of Standards documents comprising the current ATSC 3.0 Suite.

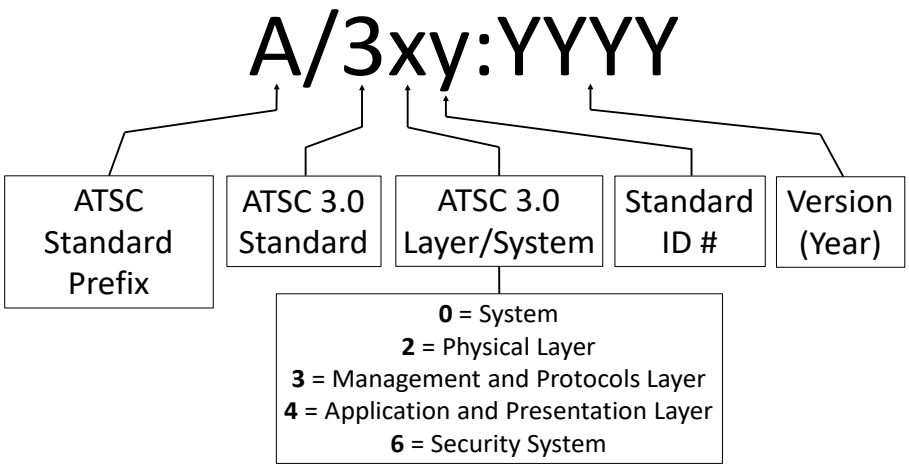

Figure 1.1 ATSC 3.0 Standard naming scheme.

1.2 Organization

This document is organized as follows:

- Section 1 – Outlines the scope of this document and provides a general introduction.
- Section 2 – Lists references and applicable documents.
- Section 3 – Provides a definition of terms, acronyms, and abbreviations for this document.
- Section 4 – System overview
- Section 5 – Specification, with subsections addressing each of the ATSC 3.0 suite of Standards documents, and how they interrelate.
- Section 6 – Provides information about regionalization of aspects of the ATSC 3.0 system.
- Annex A– ATSC 3.0 Service Conceptual Model

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

[2] ATSC: "ATSC Standard: System Discovery and Signaling," Doc. A/321:2016, Advanced Television Systems Committee, Washington, DC, 23 March 2016.

[3] ATSC: "ATSC Standard: Physical Layer Protocol," Doc. A/322:2018, Advanced Television Systems Committee, Washington, DC, 26 December 2018.

[4] ATSC: "ATSC Standard: Dedicated Return Channel for ATSC 3.0," Doc. A/323:2018, Advanced Television Systems Committee, Washington, DC, 7 December 2018.

[5] ATSC: "ATSC Standard: Scheduler / Studio to Transmitter Link," Doc. A/324:2018, Advanced Television Systems Committee, Washington, DC, 5 January 2018.

[6] ATSC: "ATSC Standard: Link Layer Protocol," Doc. A/330:2019, Advanced Television Systems Committee, Washington, DC, 3 May 2019.
[7] ATSC: "ATSC Standard: Signaling, Delivery, Synchronization, and Error Protection," Doc. A/331:2019, Advanced Television Systems Committee, Washington, DC, 20 June 2019.
[8] ATSC: "ATSC Standard: Service Announcement (A/332)," Doc. A/332:2017, Advanced Television Systems Committee, Washington, DC, 6 December 2017.
[9] ATSC: "ATSC Standard: Service Usage Reporting," Doc. A/333:2017, Advanced Television Systems Committee, Washington, DC, 4 January 2017.
[10] ATSC: "ATSC Standard: Audio Watermark Emission," Doc. A/334:2016, Advanced Television Systems Committee, Washington, DC, 19 September 2016.
[11] ATSC: "ATSC Standard: Video Watermark Emission," Doc. A/335:2016, Advanced Television Systems Committee, Washington, DC, 20 September 2016.
[12] ATSC: "ATSC Standard: Content Recovery in Redistribution Scenarios," Doc. A/336:2018, Advanced Television Systems Committee, Washington, DC, 11 December 2018.
[13] ATSC: "ATSC Standard: Application Signaling," Doc. A/337:2019, Advanced Television Systems Committee, Washington, DC, 30 April 2019.
[14] ATSC: "ATSC Standard: Companion Device (A/338)," Doc. A/338:2017, Advanced Television Systems Committee, Washington, DC, 17 April 2017.
[15] ATSC: "ATSC Standard: Video – HEVC," Doc. A/341:2019, Advanced Television Systems Committee, Washington, DC, 14 February 2019.
[16] ATSC: "ATSC Standard: Audio Common Elements," Doc. A/342 Part 1:2017, Advanced Television Systems Committee, Washington, DC, 24 January 2017.
[17] ATSC: "ATSC Standard: AC-4 System," Doc. A/342 Part 2:2017, Advanced Television Systems Committee, Washington, DC, 23 February 2017.
[18] ATSC: "ATSC Standard: MPEG-H System," Doc. A/342 Part 3:2017, Advanced Television Systems Committee, Washington, DC, 3 March 2017.
[19] ATSC: "ATSC Standard: Captions and Subtitles," Doc. A/343:2018, Advanced Television Systems Committee, Washington, DC, 10 October 2018.
[20] ATSC: "ATSC Standard: ATSC 3.0 Interactive Content," Doc. A/344:2019, Advanced Television Systems Committee, Washington, DC, 2 May 2019.
[21] ATSC: "ATSC Standard: ATSC 3.0 Security and Service Protection," Doc. A/360:2019, Advanced Television Systems Committee, Washington, DC, 20 August 2019.
[22] IETF: "The 'tag' URI Scheme," Doc. RFC 4151, Internet Engineering Task Force, Fremont, Calif., October 2005.

2.2 Informative References

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

[23] ATSC: "ATSC Candidate Standard: Regional Service Availability," Doc. A/200, Advanced Television Systems Committee, Washington, DC, 26 April 2018.
[24] ATSC: "ATSC Code Point Registry," Advanced Television Systems Committee, Washington, DC, http://atsc.org/techdoc/code-point-registry /
[25] W3C Date and Time Formats, Misha Wolf, Charles Wicksteed, August 27, 1998
[26] IETF: RFC 5905 Network Time Protocol Version 4: Protocol and Algorithms Specification, D. Mills, J. Martin, J. Burbank, W. Kasch, June 2010.

[27] "Accurate Time and Frequency Transfer During Common-View of a GPS Satellite," David W. Allan and Marc A. Weiss, Proceedings of the 34th Annual Frequency Control Symposium, National Bureau of Standards, Boulder, CO, May 1980.

[28] "International Atomic Time," International Bureau of Weights and Measures, retrieved 22 February 2013.

[29] "The Role of the IERS in the Leap Second," Brian Luzum, (available at https://www.iers.org/SharedDocs/Publikationen/EN/IERS/Documents/IERS_Leap_Seconds.pdf?__blob=publicationFile&v=1), retrieved 2013.

[30] ITU-R: "Standard-Frequency and Time-Signal Emissions," ITU Recommendation TF.460-6 (2002) (available at https://www.itu.int/rec/R-REC-TF.460/en).

[31] ISO/IEC 23008-1, MPEG-H Part 1, MPEG media transport (MMT), International Organization for Standardization/International Electrotechnical Commission, Geneva Switzerland.

[32] ISO/IEC 23008-2, MPEG-H Part 2, High efficiency video coding, International Organization for Standardization/International Electrotechnical Commission, Geneva Switzerland.

[33] ATSC: "ATSC Standard: Digital Audio Compression (AC-3) (E-AC-3) Standard," Doc. A/52:2015, Advanced Television Systems Committee, Washington, DC, November 24, 2015.

[34] ATSC: "ATSC Standard: ATSC Digital Television Standard," Doc. A/53 Parts 1 through 6, Advanced Television Systems Committee, Washington, DC, various dates.

[35] ISO/IEC 23009-1:2017 Information technology, Dynamic adaptive streaming over HTTP (DASH), Part 1: Media presentation description and segment formats, International Organization for Standardization/International Electrotechnical Commission, Geneva Switzerland.

[36] ATSC: "TG3/S32 Lab Performance Test Plan," Doc. A/325:2018, Advanced Television Systems Committee, Washington, D.C., 10 December 2018.

[37] ATSC: "ATSC 3.0 Field Test Plan," Doc. A/326:2017, Advanced Television Systems Committee, Washington, D.C., 22 February 2017.

[38] ATSC: "Guidelines for the Physical Layer Protocol," Doc. A/327:2018, Advanced Television Systems Committee, Washington, D.C., 2 October 2018.

[39] ATSC: "ATSC Recommended Practice: Audio Watermark Modification and Erasure," Doc. A/339:2017, Advanced Television Systems Committee, Washington, D.C., 4 December 2017.

[40] ATSC: "ATSC Recommended Practice: Guide to the Link-Layer Protocol (A/330)," Doc. A/350:2019, Advanced Television Systems Committee, Washington, D.C., 19 July 2019.

[41] ATSC: "ATSC Recommended Practice: Techniques for Signaling, Delivery and Synchronization," Doc. A/351:2019, Advanced Television Systems Committee, Washington, D.C., 28 August 2019.

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 [1] are observed in the suite of ATSC 3.0 standards. 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

The ATSC 3.0 Standards referenced herein may contain 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 ATSC 3.0 Standards. 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 the ATSC 3.0 Standards referenced herein, 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 Abbreviations

The following acronyms and abbreviations are used within this document.

ALP − ATSC 3.0 Link-Layer Protocol

ASL – American Sign Language

ATSC − Advanced Television Systems Committee

CAP − Common Alerting Protocol

CC – Closed Captions

CSS – Cascading Style Sheets

CTA – Consumer Technology Association

DASH – Dynamic Adaptive Streaming over HTTP

DASH-IF – DASH Industry Forum

DNS – Domain Name System

DSL – Digital Subscriber Line

EAS – Emergency Alert System

ESG – Electronic Service Guide

GHz – Gigahertz
GPS – Global Positioning System
HD – High Definition
HDMI – High-Definition Multimedia Interface
HEVC − High Efficiency Video Coding
HTML – Hyper-Text Markup Language
HTTP – Hyper-Text Transfer Protocol
Hz – Hertz
ID – Identifier
IEEE − Institute of Electrical and Electronic Engineers
IERS – International Earth Rotation and Reference Systems Service
IETF – Internet Engineering Task Force
IMSC1 − Internet Media Subtitles and Captions 1.0
IP − Internet Protocol
IR − Infra-Red
ISO/IEC − International Organization for Standardization / International Electrotechnical Commission
ITU-R − International Telecommunication Union – Radiocommunication Sector
ITU-T − International Telecommunication Standardization Sector
LAN − Local Area Network
MHz − Megahertz
MMT − MPEG Multimedia Transport
MPEG − Moving Picture Experts Group
MVPD − Multichannel Video Programming Distributor
NRT − Non-Real Time
NTP − Network Time Protocol
OSD − On-Screen Display
OSI − Open Systems Interconnection
PIP − Picture-in-Picture
PSIP − Program and System Information Protocol
QoS − Quality of Service
RF − Radio Frequency
RFC – Request for Comments
ROUTE − Real-time Object delivery over Unidirectional Transport
ROUTE-DASH − Real-time Object delivery over Unidirectional Transport / Dynamic Adaptive Streaming over HTTP
RT – Real Time
SDO − Standards Development Organization
SEI − Supplemental Enhancement Information
SFN − Single Frequency Network
SMPTE − Society of Motion Picture and Television Engineers
SNR − Signal-to-Noise Ratio

STL − Studio-to-Transmitter Link
TAI − International Atomic Time
TG-3 − Technology Group 3
TS − Transport Stream
TTA – Telecommunication Technology Association
TTML − Timed Text Markup Language
TV − Television
UHD − Ultra High Definition
UHF − Ultra High Frequency
U/L − Uplink
URI − Uniform Resource Identifier
URN − Uniform Resource Name
US − United States
UTC − Coordinated Universal Time
VDS − Video Description Service
VHF − Very High Frequency
W3C − World Wide Web Consortium
XML − eXtensible Markup Language

Note that each of the referenced documents in Section 5.1 includes its own set of defined acronyms that apply to its contents.

3.4 Terms

The following terms are used within this document.

ATSC 3.0 Bootstrap – The ATSC 3.0 Bootstrap provides a universal entry point into a broadcast waveform. [2]

ATSC Physical Layer Time (clock) – The ATSC Physical Layer Time is the time-scale described by the emitted ATSC Physical Layer Time samples, and corresponds exactly in rate with International Atomic Time (TAI) [27].

ATSC Physical Layer Time (sample) – A sample time for ATSC Physical Layer Time is transmitted in some or all preambles. This data indicates the moment when the start of the first symbol of the immediately preceding bootstrap was emitted.

reserved – Set aside for future use by a Standard.

Note that each of the referenced documents in Section 5.1 includes its own set of defined terms that apply to its contents.

3.5 Symbols, Abbreviations, and Mathematical Operators

The definitions given in this section apply throughout the suite of ATSC 3.0 standards when these items are used. The symbols, abbreviations, and mathematical operators listed here have been adopted for use in other SDOs and are similar to those used in the "C" programming language. However, integer division with truncation and rounding are specifically defined. The bitwise operators are defined assuming two's-complement representation of integers. Numbering and counting loops generally begin from 0.

3.5.1 Arithmetic Operators

+	Addition.
–	Subtraction (as a binary operator) or negation (as a unary operator).
++	Increment.
- -	Decrement.
* or ×	Multiplication.
^	Power.
/	Integer division with truncation of the result toward 0. For example, 7/4 and –7/–4 are truncated to 1 and –7/4 and 7/–4 are truncated to –1.
//	Integer division with rounding to the nearest integer. Half-integer values are rounded away from 0 unless otherwise specified. For example, 3//2 is rounded to 2, and –3//2 is rounded to –2.
DIV	Integer division with truncation of the result towards –∞.
%	Modulus operator. Defined only for positive numbers.
Sign( )	Sign(x) = 1 $x > 0$ = 0 $x == 0$ = –1 $x < 0$
NINT ( )	Nearest integer operator. Returns the nearest integer value to the real-valued argument. Half-integer values are rounded away from 0.
Sin	Sine.
Cos	Cosine.
Exp	Exponential.
√	Square root.
Log_{10}	Logarithm to base ten.
Log_e	Logarithm to base e.

3.5.2 Logical Operators

||	Logical OR.
&&	Logical AND.
!	Logical NOT.

3.5.3 Relational Operators

>	Greater than.
≥	Greater than or equal to.
<	Less than.
≤	Less than or equal to.
==	Equal to.
!=	Not equal to.
Max [,...,]	The maximum value in the argument list.
Min [,...,]	The minimum value in the argument list.

3.5.4 Bitwise Operators

&	AND.
|	OR.

>> Shift right with sign extension.
<< Shift left with 0 fill.

3.5.5 Assignment

= Assignment operator.

3.5.6 Mnemonics

The following mnemonics are defined to describe the different data types used in the coded bit stream.

bslbf Bit string, left bit first, where "left" is the order in which bit strings are written in the Standard. Bit strings are written as a string of 1s and 0s within single quote marks, e.g. '1000 0001'. Blanks within a bit string are for ease of reading and have no significance.

uimsbf Unsigned integer, most significant bit first.

The byte order of multi-byte words is most significant byte first.

3.5.7 Constants

π 3.14159265359...
e 2.71828182845...

3.5.8 Numeric Representation

Conventional numbers denote decimal values, numbers preceded by 0x are to be interpreted as hexadecimal values, and numbers within single quotes (e.g., '10010100') are to be interpreted as a string of binary digits.

3.5.9 Method of Describing Bit Stream Syntax

Each data item in the coded bit stream described below is in bold type. It is described by its name, its length in bits, and a mnemonic for its type and order of transmission.

The action caused by a decoded data element in a bit stream depends on the value of that data element and on data elements previously decoded. The decoding of the data elements and definition of the state variables used in their decoding are described in the clauses containing the semantic description of the syntax. The following constructs are used to express the conditions when data elements are present, and are in normal type.

Note this syntax uses the "C" code convention that a variable or expression evaluating to a non-zero value is equivalent to a condition that is true.

while (*condition*) {
data_element
. . .
}
	If the *condition* is true, then the group of data elements occurs next in the data stream. This repeats until the condition is not true.

do {
data_element
. . . }
while (*condition*)
	The data element always occurs at least once. The data element is repeated until the *condition* is not true.

if (*condition*){
data_element
. . .
}
	If the *condition* is true, then the first group of data elements occurs next in the data stream.

else {
data_element
. . .
}
	If the condition is not true, then the second group of data elements occurs next in the data stream.

for (i = 0; i<*n*; i++) {
data_element
. . .
}
	The group of data elements occurs *n* times. Conditional constructs within the group of data elements may depend on the value of the loop control variable *i*, which is set to zero for the first occurrence, incremented to 1 for the second occurrence, and so forth.

switch (*expression*) {
case *value1*:
data_element1
…
break;
case *value2*:
data_element2
…
break;
case *value3*:
data_element3
…
break;
...
default:
data_element
…
}
	The data element(s) to occur next in the data stream depends on the value of *expression*. If the value of *expression* is equal to *value1*, then the data elements given for the *value1* case appear next. If the value of *expression* is equal to *value2*, then the data elements given for the *value2* case appear next, etc. If the value of *expression* does not match any of the given cases, then the data elements given for the default case appear next in the data stream.

As noted, the group of data elements may contain nested conditional constructs. For compactness, the {} are omitted when only one data element follows.

data_element [ ]	data_element [ ] is an array of data. The number of data elements is indicated by the context.
data_element [n]	data_element [n] is the n+1th element of an array of data.
data_element [m] [n]	data_element [m] [n] is the m+1,n+1 th element of a two-dimensional array of data.
data_element [l] [m] [n]	data_element [l] [m] [n] is the l+1,m+1,n+1 th element of a three-dimensional array of data.
data_element [m..n]	data_element [m..n] is the inclusive range of bits between bit m and bit n in the data_element.

3.6 URI Usage

Syntactic elements requiring a URI (including URN) identifier or field value that are defined by ATSC shall use the `tag:` URI scheme as defined in RFC 4151 [22]. The `authorityName` shall be "atsc.org" (note lower case). The `date` is composed of only the `year` of initial publication of the controlling standard, e.g. "2016". The `date` does not include the `month` and `day`. The `date` is not used for version control, but is used for scope of the DNS registration of the `authorityName`.

The remaining syntax and semantics shall conform to RFC 4151 [22], which includes:

1) The strings are case-sensitive.
2) Tags are simply strings of characters and are considered equal if and only if they are completely indistinguishable in their machine representations when using the same character encoding.
3) Characters can be % escaped, but are not intended to be defined that way.
4) Query and fragment identifiers are permitted.
5) There is no resolution mechanism of tag: URIs to resources.

The constant string portion of any tag: URI published in any ATSC, or ATSC-sanctioned (e.g. DASH-IF), specification is published in the ATSC Code Point Registry [24].

4. SYSTEM OVERVIEW

4.1 System Architecture

The ATSC 3.0 System is designed with a "layered" architecture due to the many advantages of such a system, particularly pertaining to upgradability and extensibility. A generalized layering model for ATSC 3.0 is shown in Figure 4.1 below. Note that the middle two system layers are grouped into a single organizational layer, which is entitled the "Management and Protocols" Layer.

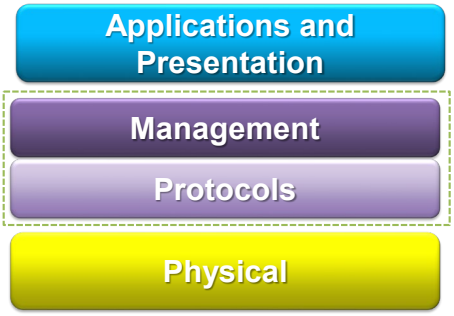

Figure 4.1 ATSC 3.0 layered architecture.

4.2 Conceptual Model of Services

ATSC 3.0 enables traditional linear programming, enhanced linear programming and application-based services. Enhanced linear programming can include a variety of different content components such as multiple video, audio and caption streams that can be selected and synchronously combined for presentation at the receiver. Linear programming services can be enhanced by applications, such as interactive games or targeted ad insertion. Application-based services are also possible, in which an application serves as a launching point of the service, and the service is consumed from within the application. An example of an application-based service could be an on-demand service that allows a viewer to access and manage a library of on-demand content and play selected titles. See Annex B for details about the Service Conceptual Model that ATSC 3.0 enables.

4.3 Redistribution Scenarios

The ATSC 3.0 signal is expected to be redistributed by MVPDs. In the event that a portion of the ATSC 3.0 signaling and components of a given service is not redistributed by a given service provider, the system enables recovery of those signals, and by extension those components, via a broadband connection using a video or audio watermark or fingerprints. The system employs automatic content recognition technologies along with methods for requesting and receiving signaling tables. Automatic content recovery technologies include audio watermarks, video watermarks and fingerprints.

Further information on these technologies is provided in Sections 5.1.9, 5.1.10 and 5.1.11.

4.4 Regional Service Availability

The Regional Service Availability Table (RSAT), as defined in A/200 [23] and signaled in SLS per A/331 [7], specifies information describing the availability of broadcast services over time within a broadcast region. Broadcast receivers may use this information to help maintain a list of services that may be available to them. Additionally, the information provides a schedule that allows receivers to maintain an up-to-date service list as broadcast changes are made. This document describes how the information may be distributed using either an ATSC 1.0 broadcast (or any MPEG-2 transport stream), ATSC 3.0 broadcast, or over broadband.

5. SPECIFICATION

The ATSC 3.0 System is described in a number of separate documents, which together comprise the full Standard. The documents were divided in this manner to support the independent evolution of the different aspects of the Standard.

Figure 5.1 below is an illustration showing the various documents and the topics to which they pertain. It should be noted that some topics span more than one document, for example, accessibility and emergency messages. In these cases, guidance is provided in the sections below to aid the reader in identifying the various parts of the Standard that apply to the topic and how those parts are intended to be used together.

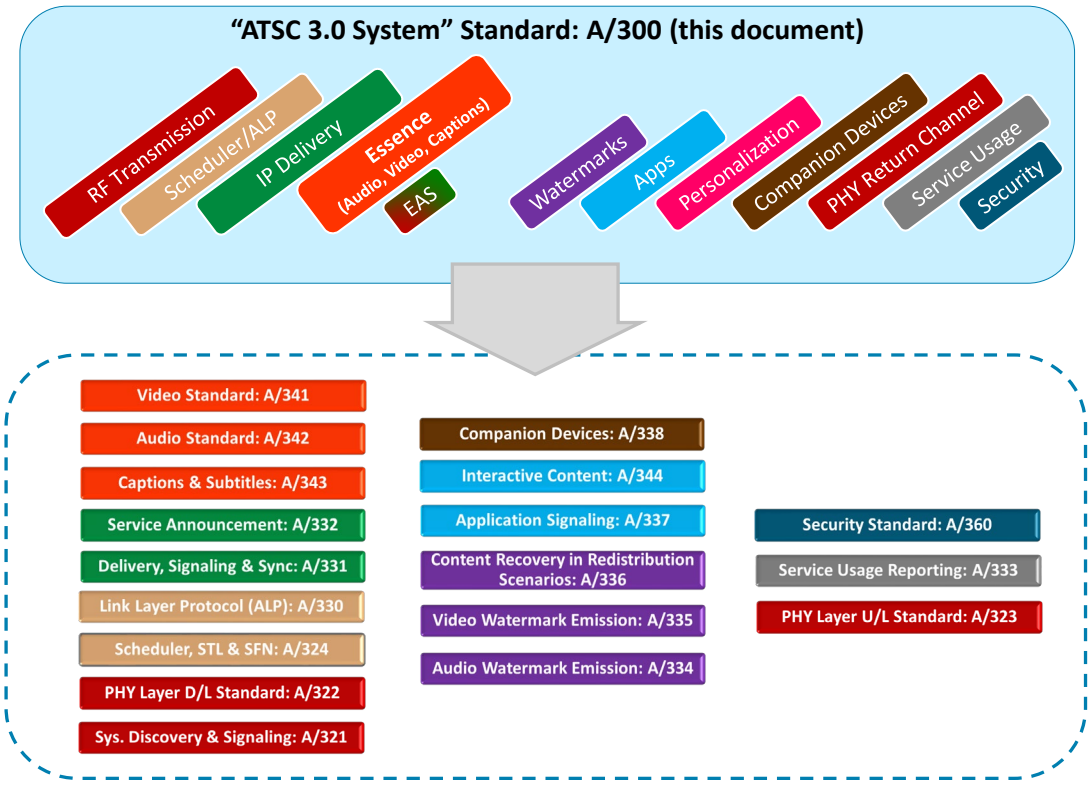

Figure 5.1 ATSC 3.0 standards set and structure.

5.1 Description of the ATSC 3.0 Standard

This section provides a brief description of each general function provided by the ATSC 3.0 System. In most cases, a separate standard specifies the details of the function's operation, and these standards are referenced below. (Informative ATSC 3.0 *Recommended Practice* documents are also available for certain elements of the Standard, and these are noted in the text where appropriate.)

5.1.1 System Discovery and Signaling

A process has been defined that describes the system discovery and signaling architecture for the ATSC 3.0 physical layer. The mechanism for carrying such information is called the ATSC 3.0 "bootstrap", and it provides a universal entry point into the ATSC 3.0 broadcast waveform. The "bootstrap" also includes the mechanism for signaling a device in stand-by mode to "wake-up", in the event of an emergency. (See Section 5.2.1.) This System Discovery and Signaling shall be performed as specified in ATSC Standard A/321 [2].

5.1.2 Physical Layer Protocol

A protocol has been defined that describes the downlink (i.e., from broadcast transmitter to consumer receiver) baseband transmission system of the ATSC 3.0 physical layer waveform, modulation, and coding. The downlink Physical Layer Protocol for ATSC 3.0 shall be as defined in ATSC Standard A/322 [3]. In addition, ATSC Recommended Practice A/327, "Guidelines for the Physical Layer Protocol" [38] provides informative guidance on use of A/322. Further, two other Recommended Practices, A/325 and A/326 [36] [37] provide informative guidance on lab and field testing, respectively, of equipment implementing the A/322 Standard.

5.1.3 Dedicated Return Channel

A Dedicated Return Channel (DRC) system for the ATSC 3.0 next generation broadcast standard has been defined, including both a physical layer specification and a Media Access Control (MAC) layer specifications. If a DRC is used, it shall be as specified in ATSC Standard A/323 [4].

5.1.4 Scheduler / Studio to Transmitter Link

An interface between the Transport Layer and the Physical Layer of the ATSC 3.0 System has been defined, which consists of standard protocols to transport ATSC 3.0 Link-Layer Protocol (ALP) packets and Studio-to-Transmitter Link (STL) packets, along with necessary timing and control information. The functions of a Scheduler also have been defined to provide control of the emissions of the transmitter(s), along with requirements for buffering, signaling and error correction for the STL protocol. The various protocols shall be as specified in ATSC Standard A/324 [5].

5.1.5 Link-Layer Protocol

An ATSC 3.0 Link-Layer Protocol (ALP) has been defined, which corresponds to the data link layer in the OSI 7-layer model. It provides efficient encapsulation of IP, link-layer signaling and MPEG-2 Transport Stream (TS) packets, as well as overhead reduction mechanisms and extensibility. ALP shall be as specified in ATSC Standard A/330 [6]. In addition, ATSC Recommended Practice A/350, "Guide to the Link-Layer Protocol (A/330)" [40] provides informative guidance on use of A/330.

5.1.6 Signaling, Delivery, Synchronization, and Error Protection

The technical mechanisms and procedures for service signaling and IP-based delivery of ATSC 3.0 services and contents over broadcast, broadband and hybrid broadcast/broadband networks,

along with the mechanism to signal the language(s) of each provided Service, including audio, captions, subtitles (if present), and any emergency Service shall be as specified in ATSC Standard A/331 [7].

5.1.7 Service Announcement

The method for announcement of services in an ATSC 3.0 broadcast shall be as specified in ATSC Standard A/332 [8].

5.1.8 Service Usage Reporting

The method for service usage reporting for ATSC 3.0 services shall be as specified in ATSC Standard A/333 [9].

5.1.9 Audio Watermark Emission

The VP1 audio watermark technology is used for content recovery within ATSC 3.0 broadcasts, and shall be as specified in ATSC Standard A/334 [10]. In addition, ATSC Recommended Practice A/339, "ATSC Recommended Practice: Audio Watermark Modification and Erasure," [39] provides informative guidance on how to modify and erase watermarks generated under A/334.

5.1.10 Video Watermark Emission

The video watermark technology used for content recovery within ATSC 3.0 broadcasts shall be as specified in ATSC Standard A/335 [11].

5.1.11 Content Recovery in Redistribution Scenarios

The payload formats for video and audio watermarks, the protocols for use of those payloads, the fingerprint automatic content recognition method, and the methods for requesting and recovering service signaling associated with ATSC 3.0 broadcast content via broadband shall be as specified in ATSC Standard A/336 [12].

5.1.12 Application Event Delivery

Delivery of application events in the ATSC 3.0 System shall be as specified in ATSC Standard A/337 [13]. (Signaling of application events shall be as specified in ATSC Standard A/331 [7].)

5.1.13 Companion Device

A communication protocol has been defined between an ATSC primary receiver and an ATSC companion device. The companion device communicates with the primary device to present related, supplementary content to (or even the same content as) that being presented on the primary device. This communications protocol shall be as defined in ATSC Standard A/338 [14].

5.1.14 Video - HEVC

ATSC 3.0 can support multiple video coding technologies. When ITU-T Recommendation H.265 / International Standard ISO/IEC 23008-2 ("HEVC") video compression [31] is used with the ATSC 3.0 Digital Television System, coding constraints shall be as specified in ATSC Standard A/341 [15].

All ATSC 3.0 terrestrial and hybrid television services emitted within a given region should use one High Dynamic Range (HDR) system selected for that region from those defined in A/341.

5.1.15 Audio

Part 1 of ATSC Standard A/342 [16] defines a common framework that shall be used for all audio systems in ATSC 3.0 broadcasts. Subsequent Parts of the standard [17] [18] define the audio systems and associated constraints on coding to be used within the framework defined in Part 1.

All ATSC 3.0 terrestrial and hybrid television services emitted within a given region shall use one audio system selected for that region from those defined in A/342 Parts 2 and higher.[2] For example, broadcast organizations in North America have selected the audio system defined in A/342, Part 2 as the audio system for use in Mexico, Canada and the U.S., and the Telecommunication Technology Association (TTA) has selected the audio system defined in A/342, Part 3 for use in the Republic of Korea.

5.1.16 Captions and Subtitles

Technology is defined for carriage of closed caption and subtitle tracks over both the ROUTE-DASH and MMT transports of ATSC 3.0. This definition includes the caption/subtitle content essence, its packaging and timing, and its transport-dependent signaling. The mechanisms used for such functionality in ATSC 3.0 broadcasts shall be as specified in ATSC Standard A/343 [19].

5.1.17 Interactive Content

An Interactive Content environment has been defined for ATSC 3.0. It shall be as specified in ATSC Standard A/344 [20].

5.1.18 Security and Service Protection

Security and Service Protection functions in ATSC 3.0 shall be as specified in ATSC Standard A/360 [21].

5.2 Emergency Messaging

Functions related to emergency messaging appear in several documents within the ATSC 3.0 suite of standards. This section describes which documents contain emergency message functionality and how those functions work together in the system.

Documents containing ATSC 3.0 emergency messaging information include:

- ATSC Standard: A/321, System Discovery and Signaling [2]
  - defines syntax for signaling that enables a device wake-up function
- ATSC Standard: A/324, Scheduler/Studio-to-Transmitter Link [5]
  - describes mechanisms for quickly delivering wake-up signaling to transmitters
  - defines methods to bypass certain buffers and reduce latency of wake-up signals
- ATSC Standard: A/331, Signaling, Delivery, Synchronization, and Error Protection [7] describes the semantics of the wake-up signaling defined in A/321 [2]
  - defines signaling that indicates the presence and location of emergency-related content in the broadcast stream or available via broadband
  - defines how emergency-related content is delivered via broadcast
- ATSC Standard: A/336, Content Recovery in Redistribution Scenarios [12]
  - defines mechanisms to recover over-the-air signaling when that signaling is not available to the receiver, such as in a redistribution scenario
- ATSC Standard: A/338, Companion Devices [14]
  - defines mechanisms for a primary receiving device, such as a television, to communicate emergency information to a companion device, such as a smartphone or a tablet

[2] Exceptions are permitted for custom purposes in support of broadband delivery services requiring other codecs.

- ATSC Standard: A/342-1, Audio Common Elements [16]
  - defines a mechanism for delivering an aural rendering of an emergency-related video text crawl
- ATSC Standard: A344, Application Runtime Environment [20]
  - defines the interactive application runtime environment; broadcasters may author interactive applications that can be used to render supplemental emergency content delivered via broadcast or broadband

5.2.1 Wake-up Function

The ATSC 3.0 suite of standards includes a wake-up function which enables a receiving device in "sleep" or "stand-by" mode to recognize the presence of an emergency message and wake up to present the message to the consumer.

There are two bits in the bootstrap assigned to the wake-up function, which are defined in A/321 [2]. The meaning of the settings of the two bits is described in A/331 [7].

5.2.2 Emergency Message Content Signaling and Delivery

It is expected that broadcasters will continue to provide "burned in" text crawls relating to emergencies. The mechanism for overlaying a text crawl onto the video of the main program is out of scope of the ATSC standards. It is also expected that broadcasters will continue to provide an aural version of the message in conformance with regulatory requirements in the United States, Canada, and other countries. The mechanism for including the aural text crawl in the audio content is defined in A/342 [16].

In addition to the "burned in" visual and aural text crawl, ATSC 3.0 enables broadcasters to deliver supplementary emergency-related content such as evacuation maps, web pages, and more. A/331 [7] describes how such files are delivered in non-real time via broadcast and how the presence and location are signaled for such files that may be available in the broadcast stream or via broadband or both. A/336 [12] describes how this signaling can be retrieved by receivers that do not have access to all the signaling delivered within the broadcast. For example, receivers connected to a set-top box via HDMI that are receiving uncompressed audio and video may not have access to the full signaling offered in the broadcast. A/336 provides mechanisms for such receivers to recover the signaling and subsequently access the supplemental emergency content. A/344 [20] provides mechanisms for emergency-related data to be passed to a broadcaster application for presentation.

5.2.3 Supplemental Emergency Content Rendering

Signaling the presence and location of supplemental emergency-related files enables such content to be accessed by a receiver or a broadcaster-authored interactive application. The receiver and/or the application are able to offer a user interface so that the consumer can view and manage the content. A receiver function that enables a viewer to access supplemental emergency content is out of scope for ATSC. The environment enabling broadcaster-authored interactive applications is described in A/344 [20]. This environment is a generic platform for all types of applications, and one such use can be to provide an emergency information application.

Emergency information can also be communicated from a primary viewing device, such as a television, to a companion device, such as a smartphone or tablet. A/338 [14] defines the mechanisms and the emergency-related messages and content that may be passed between a primary and companion device.

5.3 Accessibility

5.3.1 Video Description Service

Video Description Service (VDS) is an audio service carrying narration describing a television program's key visual elements for the visually impaired. These descriptions are inserted into natural pauses in the program's dialog. Video description makes TV programming more accessible to individuals who are blind or visually impaired.

VDS may be provided by sending a collection of audio components; for example, a "Music and Effects" component, a "Dialog" component, and an appropriately labeled "Video Description" component, which are mixed at the receiver. Alternatively, a Video Description Service component may be provided as a single component that is a complete mix with the appropriate label identification, or mixed with just the same-language "Dialog" component.

With ATSC 3.0 visually impaired individuals can receive VDS along with a full surround or immersive mix due to advances in Next Generation Audio as described in A/342 [16].

5.3.2 Emergency Information

Television broadcasters often provide emergency-related information visually in programming that is neither a regularly scheduled newscast nor a newscast that interrupts regular programming. For accessibility purposes, this content includes an aural presentation of that information on a separate audio component, called Emergency Information. An aural tone on the main program audio alerts viewers that visual emergency information is being displayed and that aural information is available on the additional accessibility audio stream. This audio track is neither an Emergency Alert per se nor CAP rich media audio. It is an audio transcription of an on-screen text crawl or banner.

Emergency Information for the purposes of this requirement is defined as information, about a current emergency, that is intended to further the protection of life, health, safety, and property, i.e., critical details regarding the emergency and how to respond to the emergency.

Aural Emergency Information may be provided by sending a collection of audio components: "Music and Effects" component, a "Dialog" component, and an appropriately labeled "Emergency Information" component, which are mixed at the receiver. Alternatively, an Emergency Information component may be provided as a single component that is a complete mix with the appropriate label identification, or mixed with just the same-language "Dialog" component.

Signaling is provided for Emergency Information to support a separate audio component provided by the broadcaster during the Emergency Information crawl. This signaling enables the capabilities in a receiver to allow a visually impaired viewer to manually select the Emergency Information audio component into the decoded output and/or allow a user preference setting so that a receiver could retain and act on said user preference.

5.3.3 Dialog Enhancement

Dialog Enhancement in ATSC 3.0 can improve dialog intelligibility for those with minor hearing impairment, within noisy environments and for other situations when dialog may be difficult to discern.

Next generation audio systems provide user-controlled enhancement of the dialog during decoding. Dialog Enhancement is accomplished by attenuation of the main program music and effects to improve intelligibility of the associated dialog. This is possible whether the audio elements are sent as separate elements or dialog that has been pre-mixed with other elements. In the latter case this is not a separate audio mix with higher dialog level.

Prior to ATSC 3.0 this process has been limited by the number of channels carried along with a video service and the inability to distinguish the individual audio components within the receiver.

5.3.4 Closed Captions

Closed captions and subtitles are processes of displaying text on a television, computer monitor or other devices such as a tablet or phone. Both are typically used as a transcription of the audio portion of a program as it occurs or is presented to viewer. The term "closed" means that the text is hidden until requested by the viewer (in contrast, Open Captions are always visible). Closed Captions, in addition to a transcription of the audio portion of a television program, includes non-speech sounds as text on the TV screen. This provides a critical link to news, entertainment and information for individuals who are deaf or hard-of-hearing. This service is regulated to ensure broadcasters, satellite distributors and other multi-channel video programming distributors close caption their TV programs. Subtitles are typically used for language translation and need not contain non-speech elements.

In ATSC 3.0 captions are required to be provided as a separate component using W3C's TTML Text and Image Profiles for Internet Media Subtitles and Captions (IMSC1) standard, which can be transmitted though both broadcast and broadband as described in A/343 [19]. This format was selected since it supports a world-wide language and symbol table and has been used successfully by other industry segments. It also supports regulatory requirements and is U.S. safe harbor for IP delivery.

In addition to the required IMSC1 component, the broadcaster may optionally supply CTA 708 captions carried as supplemental enhancement information (SEI) within the video stream as described in A/341 [15].

5.3.5 Closed Signing

For many born deaf in the U.S., American Sign Language (ASL) is their primary language. ASL is not just signing American English word-for-word, but has a different sentence structure that has meaning for ASL users. For this reason, many deaf television viewers prefer a live ASL interpreter in a PIP window to closed captions because ASL is much more akin to their normal communication processes.

It is also important to recognize that ASL (and any native sign language) is a visual language, so the image of the live interpreter needs to be very clear. Much of the grammar communicated in ASL is done through the facial expressions of the people signing. For example, one can be either pleasantly or unpleasantly surprised, and the respective facial expressions will be very different.

The video stream for carrying this content therefore requires the capacity to carry a relatively high resolution image of the interpreter to ensure motion and expression are clearly communicated to the deaf viewer.

Such Closed Signing can be accomplished in ATSC 3.0 by the broadcaster providing a separate video component of an ASL interpretation (or native sign language). If utilized, the receiver overlays this video component on the main feed as a PIP experience.

5.4 System Time

5.4.1 Concept and Practice of System Time

All media time synchronization in ATSC 3.0 is accomplished using Coordinated Universal Time (UTC) [24]. The media components and IP stack of the system can utilize the NTP 32b short format of UTC [25] for wall clock.

UTC includes leap seconds that allow wall clock to stay synchronized with the earth's rotation, which is slowing. When a leap second occurs, it is on the last second of the month, i.e., UTC midnight, typically in December or June [28] [29].

The synchronization of a physical layer to a common source of time/frequency is required in order to support a Single Frequency Network (SFN). ATSC 3.0 supports SFN, therefore the system requires a common source of time/frequency at each transmitter. Global Positioning Satellite (GPS) derived time is a suitable method in terms of accuracy and stability for establishment of time for ATSC 3.0 infrastructure [26].

The ATSC 3.0 physical layer [3] utilizes ATSC Physical Layer Time, which corresponds exactly in rate with International Atomic Time (TAI) [27] and GPS time. TAI is ahead of GPS by a static 19 seconds [29]. These three formats do not include leap seconds.

The ATSC 3.0 physical layer carries time metadata which includes ATSC Physical Layer Time samples that enable recovery of the ATSC Physical Layer Time clock in the receiver [3]. The format of this metadata is the 32 least-significant bits of the number of seconds plus the fraction of a second elapsed since midnight, January 1, 1970. See Section 9.3 of [3] for format details.

The scheduling of media into the ATSC physical layer frames [5] is organized such that the boundaries of DASH Media Segment delivery can be constrained to be within DASH Period time boundaries [34]. This allows ad insertion by switching among media streams that share a common time source.

The availability of ATSC Physical Layer Time from the physical layer allows for the generation of UTC within a receiver that is tightly synchronized to the ATSC infrastructure. UTC is used for media synchronization in order to support, for example, hybrid services which deliver linear media service components concurrently via broadcast and broadband. The calculation of UTC from ATSC Physical Layer Time is accomplished utilizing the metadata supplied in the System Time fragment of the Low Level Signaling (LLS) [7].

Figure 5.2 depicts the locations within the ATSC infrastructure that require a synchronized time source.

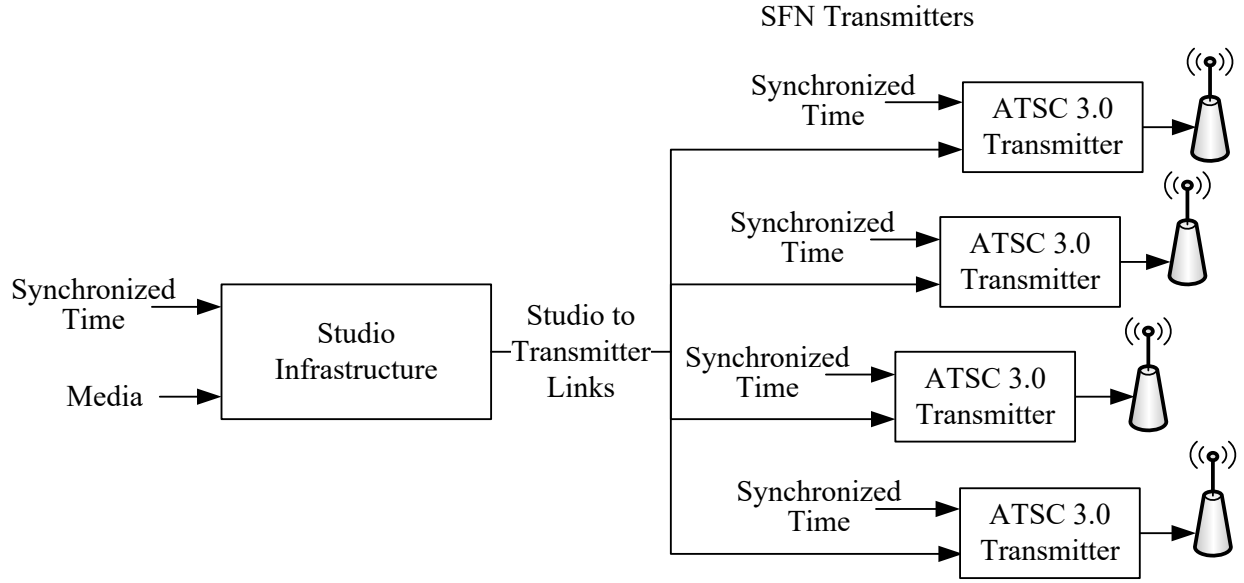

Figure 5.2 System locations requiring synchronized time.

5.5 Personalization

Functions related to personalization of ATSC 3.0 content by viewers appear in several documents within the ATSC 3.0 suite of standards. This section describes which documents contain personalization functionality and how those functions work together in the system.

There are two main aspects to personalization in ATSC 3.0: personalization related to audio and personalization related to interactive capabilities.

5.5.1 Audio Personalization

Audio personalization pertains to the ability to choose one audio track over another. Examples include alternate languages, home team vs. visitor team sports commentary, and many more. It also pertains to accessibility such as dialog enhancement and video description services.

Documents containing ATSC 3.0 audio personalization information include the following:

- ATSC Standard: A/342-1, Audio Common Elements [16]
  - describes user control of certain aspects of audio rendered from the encoded representation
  - describes how user-selectable alternative audio elements delivered via broadcast or broadband, in real time or non-real time, can be used to replace or augment main audio elements
  - describes how users can adjust dialog level relative to other sound elements
- ATSC Standard: A/342-2, AC-4 System [17]
  - defines how personalized audio elements are presented and constrained in the AC-4 system
- ATSC Standard: A/342-3, MPEG-H System [18]
  - defines how personalized audio elements are presented and constrained in the MPEG-H system

5.5.2 Interactivity Personalization

Interactivity personalization pertains to the ability to tailor content enabled by interactive runtime environment to the viewer. Examples include addressable advertising, home vs. away team statistics in graphics overlays, language of an interactive application, and many more. These capabilities are enabled using Filter Codes and various APIs between a broadcaster application and the receiver.

Filter Codes are integers created by broadcasters to represent personalization categories as defined by individual broadcaster entities. For example, different Filter Code values may be assigned to categories such as truck owner, sustaining member, or a zip code. Filter Codes can be associated with application-related files. In addition, the receiver can have internally-stored Filter Code values provided by broadcaster applications. In this way, Filter Codes associated with files can be compared with internally-stored Filter Codes to help determine whether a given file is relevant to a particular device.

Documents containing ATSC 3.0 interactivity personalization information include the following:

- ATSC Standard: A/331, Signaling, Delivery, Synchronization, and Error Protection [7]
  - defines the mechanism for associating Filter Codes with application-related files delivered via the ROUTE/DASH protocol. This enables a receiver to determine which of the available files are relevant with respect to personalization.

  - defines the mechanism for associating Filter Codes with a Distribution Window, which is a scheduled time block during which application-related files will be available in a given service. This enables a receiver to determine whether to participate in a given Distribution Window.
- ATSC Standard: A/344, Interactive Content [20]
  - defines a W3C-based interactive content environment that enables the interactive content to use cookies and other browser-like persistent storage to maintain user preferences and personalization data.
  - specifies receiver interfaces that provide preferences and device configuration details that the interactive content may use to personalize its behavior. For example, language, caption display and audio accessibility preferences are all available through the receiver interfaces.
  - defines the mechanism for a broadcaster application to store Filter Codes that are associated with a given device. This enables a receiver to compare the Filter Codes that are set by the broadcaster application with those of the files available in the broadcast stream so that it can determine which of the available files are relevant with respect to personalization.

6. REGIONALIZATION

The ATSC 3.0 Standard anticipates application in different regions of the world, and is therefore designed to intrinsically accommodate regional variations. These include the following:

- The Physical Layer's design that allows operation in television channelization schemes using 6, 7 or 8 MHz bandwidths [3], and electrical power service of either 50 or 60 Hz frequency.
- The Application and Presentation Layer's inclusion of 25, 50, and 100 Hz video frame rates for use in some regions (e.g., Europe), and 24, 30, 60 and 120 Hz framerates (integer and fractional) for use in other regions (e.g., United States) [15].
- The Application and Presentation Layer's regional flexibility for High Dynamic Range Video (see Section 5.1.14) and Next Generation Audio (see Section 5.1.15).

Note that this document considers only the approved, current version of the Standard as defined by the ATSC. The reader should be aware that other variations of ATSC 3.0 may be in concurrent use in different regions of the world.

Annex A: Service Conceptual Model

A.1 DESCRIPTION OF CONCEPTUAL MODEL OF SERVICES

This Annex describes the conceptual model of ATSC 3.0 services. It describes the composition of elements of a service into a complete service, as a logical model. This model gives an abstract description of the elements that are realized by the signaling, guide information, presentation information and other normative elements of this Standard. For example, this model includes the components of services, but it does not include information about the source of service components (i.e., how they are delivered), which can be found in normative text about service delivery elsewhere in the Standard.

A.1.1 Structural Types and Roles of Components

Given the complexity of the service model necessitated by the ATSC 3.0 requirements, it is useful to introduce certain new concepts related to the structural types and roles of components in order to describe the service model. Section A.1.1 defines these concepts. Sections A.1.2 through A.1.6 use these concepts in describing the service model.

A.1.1.1. Definitions

The definitions in Table A.1.1 below are used in this document.

Table A.1.1 Component Structure and Role Definitions

Continuous Component	A Content Component that is presented in a continuous stream (e.g., audio, video or closed captioning).
Elementary Component	A Continuous Component that is a single encoding (e.g., a single encoding of a sound sequence, or a single encoding of a picture sequence, or a single closed caption track).
Composite Component	A Content Component that consists of a collection of Continuous Components which have the same Content type[3], and which represent the same scene, and which are to be combined in some combination to produce a presentation (e.g., music, dialog and effects audio components that are to be mixed to give complete audio, or left and right 3D views that are to be combined to give 3D pictures).
PickOne Component	A Content Component that consists of a collection of Continuous Components which have the same Content type, and which represent the same scene, and exactly one of which is to be selected to produce a presentation (e.g., a set of audio components encoded from the same sound sequence with different bitrates, or a set of video components encoded from the same picture sequence with different bit rates, or a regular closed caption track and an “easy reader” closed caption track for the same dialog).
Complex Component	Either a Composite Component or a PickOne Component
Presentable Component	A Continuous Component that is intended for presentation to the user. Such a component can be an Elementary Component or a Complex Component.

[3] The term “Content type” means high level content type, such as “video”, “audio”, “closed captions”, “interactive applications”, “images”, etc. This is not the same as the term Content-Type as defined in IETF-RFC-2616.

Locally Cached File	File that is delivered in non-real-time and stored on the device for later consumption; Locally Cached File is typically not consumed or presented until it has been fully received and cached; Locally Cached file can be delivered via broadcast or broadband.
Locally Cached Content Item	A collection of one or more Locally Cached Files which are intended to be consumed as an integrated whole; a Locally Cached Content Item is typically not consumed or presented until the requisite Locally Cached Files have been fully received and cached.
Network Content Item	A Continuous Component (e.g., an audio/video clip) or a collection of one or more files (e.g., a slide show or a set of inter-linked HTML pages) that is intended to be consumed as an integrated whole, and that is delivered on demand for immediate presentation. Network Content Items are delivered via broadband and are normally progressively presented prior to receiving the entire file(s).
Notification Stream	A stream of messages intended to be consumed by one or more Applications; the messages may instruct and notify the Application(s) to perform some action(s) at particular time(s) such as fetch updated sports stats, insert personalized content, etc.
Application or App	A collection of documents constituting a self-contained enhanced or interactive service. The documents of an application can include HTML, JavaScript, CSS, XML and multimedia files. An application can access other data that are not part of the application itself. An Application is a special case of a Locally Cached Content Item.
ATSC 3.0 Application	Application conforming to the ATSC 3.0 Application Runtime Environment Specification.
Linear Service	A Service where the primary content consists of Continuous Components that are delivered according to a schedule and time base defined by the broadcast.
App-based Service	A Service that consists of one or more App-based Features.
App-based Feature	One or more Applications with zero or more Notification Streams, and zero or more Locally Cached Content Items and/or Network Content Items, intended to enhance a Linear Service or form the basis of an App-based Service.
Data Service	A Service that is not directly visible to viewers where the primary content consists of Non-Continuous Components delivered in non-real time and signaled in a standardized way such that a receiving device may utilize the Components in a meaningful way. (Note that there are currently two types of Data Services defined: delivering Electronic Service Guide (ESG) data and Emergency Alert System (EAS) data.)

Content Components that are contained in a Complex Component are not necessarily Elementary Components. Some or all of them may themselves be Complex Components.

An Elementary Component is not necessarily suitable for presentation by itself. It may need to be combined with other Content Components for a meaningful presentation. An example of this would be an enhancement layer of a scalable video encoding.

A component can be a Presentable Component by itself and can also be a member of a Complex Component. For example, a Service can have a video encoding that is intended to be presented either by itself as an elementary 2D video component or as one view of a complex 3D video component.

One can think of a Composite Component as a list of Content Components with a check box next to each one. A receiver can select a subset of these Content Components to combine for producing a presentation. Similarly, one can think of a PickOne Component as a list of Content Components with a radio button next to each one. A receiver must select exactly one of these Content Components to use for producing a presentation. (This analogy is not exact. There can be restraints on the combinations of check boxes that can be checked in a Composite Component. For example, consider a scalable video coding that has a base layer and two enhancement layers. The possible choices are the base layer alone, the base layer plus the first enhancement layer, or all three layers.)

In the remainder of this document the term "component" will often be used as shorthand for "Content Component".

A.1.1.2. Examples

Figure A.1.1 below shows an example of a PickOne Video Component containing a 2D encoding and a 3D "side-by-side" encoding of the same video scene. (Such a 3D side-by-side encoding consists of the left 3D view and the right 3D view each squeezed down to half their normal width, juxtaposed side by side, and encoded as a single picture. Receivers decode the picture, stretch each half back to its normal size, and feed these into their 3D display circuitry as the left view and right view.)

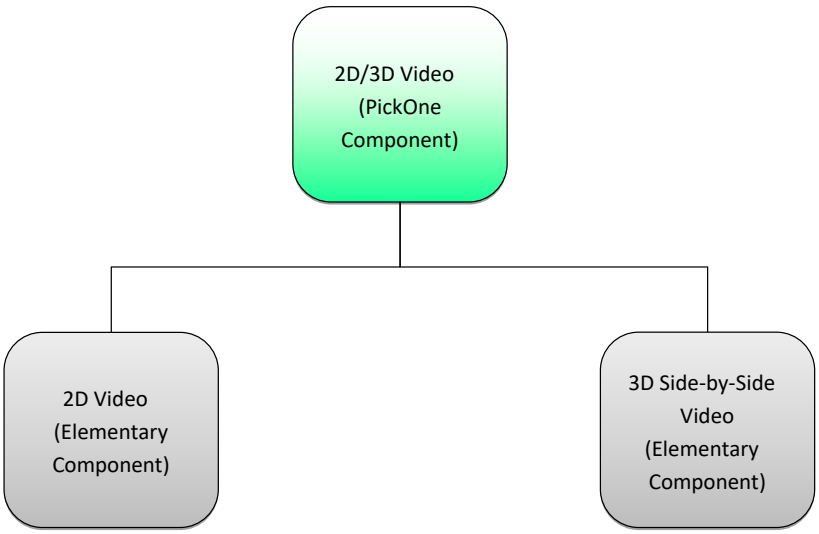

Figure A.1.1 2D/3D PickOne video component example.

Depending on its capabilities, a receiver can pick the 2D encoding and present it as a 2D picture, or it can pick the 3D encoding and present it as a 3D picture.

With these definitions, a Service can be described in terms of the Presentable Components it contains. If any of these Presentable Components are Complex Components, they can be described in terms of their members (and so on, recursively, if necessary). Each presentable audio component represents sound for a particular scene in a particular language, and each presentable video component represents pictures for a particular scene with a particular camera angle. In the simple case, such as in ATSC 1.0, these would be Elementary Components.

As a more complicated example of a complex component, a presentable video component could be a Composite Component that contains a left view component and a right view component of a 3D video. Each of these view components could in turn be PickOne Components that contain encodings at different resolutions. Figure A.1.2 below illustrates this example.

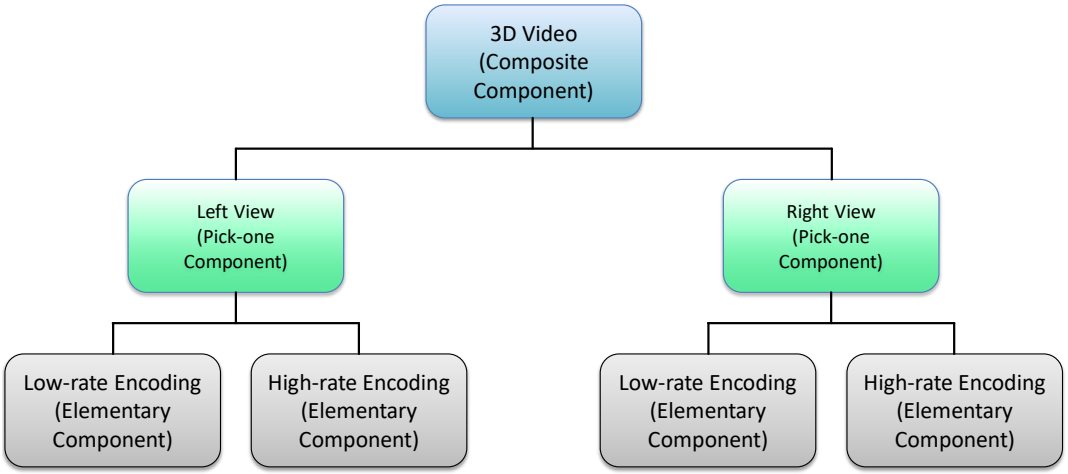

Figure A.1.2 Complex video component example.

Similarly, a presentable audio component could be a PickOne Component that contains a complete main component (as that term is used in ATSC A/52 [33] and A/53 [34]) and a component that contains music, dialog and effects tracks that are to be mixed. The complete main audio component and the music component could be PickOne Components that contain Elementary Components consisting of encodings at different bitrates, while the dialog and effects components could be Elementary Components. Figure A.1.3 below illustrates this example.

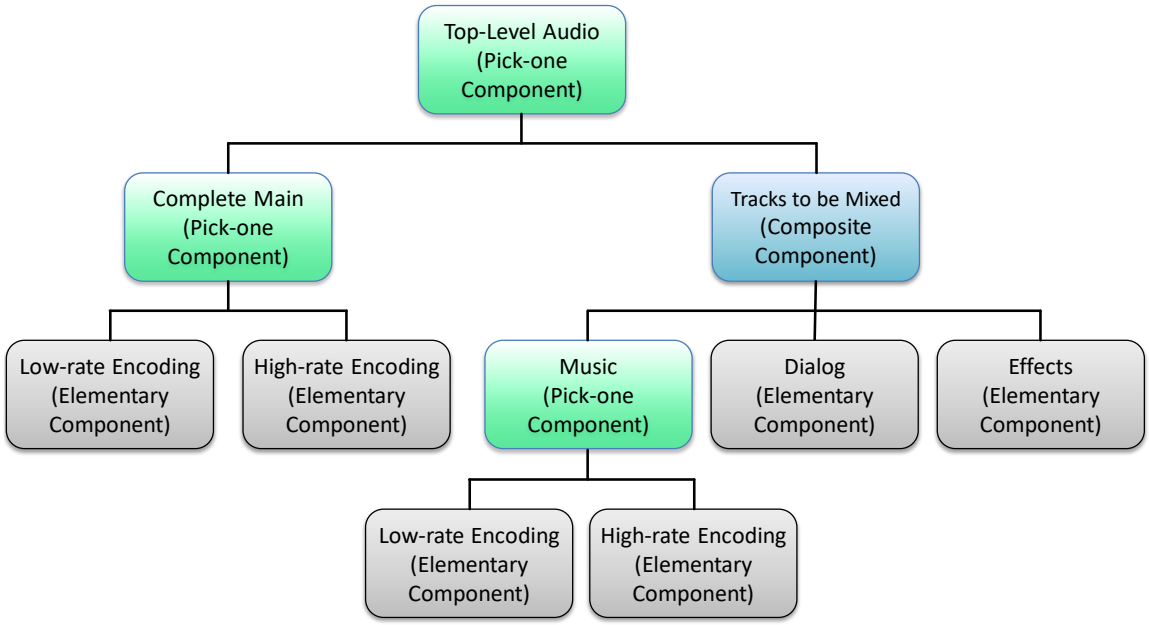

Figure A.1.3 Complex audio component example.

A model based on the definitions above can capture all the features in the ATSC 3.0 requirements. The model is very simple in simple situations, and it has a straightforward hierarchical structure in more complicated situations.

To restrict the possible unbounded recursion of the component model, the following restriction is imposed: Any Continuous Component must fit into a three-level hierarchy, where the top level consists of PickOne Components, the middle level consists of Composite Components, and the bottom level consists of PickOne Components. Any particular Continuous Component can contain all three levels or any subset thereof, including the null subset where the Continuous Component is simply an Elementary Component. (See Figure A.1.1.)

A.1.2 Service Properties

The following three types of ATSC 3.0 services are defined in this model, with their currently defined presentable Content Components as indicated. Other service types and components could be defined in the future.

- Linear Service – Service where the primary content consists of Continuous Components that are consumed according to a schedule and time base defined by the broadcast (except that various types of time-shifted viewing mechanisms can be used by consumers to shift the consumption times). Components of a Linear Service can include:
  - One or more continuous components which can include:
    - Video
    - Audio
    - Closed captions
    - A time base that is used to synchronize the components
    - Zero or more app-based features. Components of such a feature can include:
      - One or more Applications
      - Zero or more Notification Streams
      - Zero or more Locally Cached Content Items
      - Zero or more Network Content Items

    Optionally, one of the Applications in an app-based feature can be designated as the "Primary App". If there is a designated Primary App, it is activated as soon as the underlying service is selected.
- App-based Service – Non-linear service based on applications that provide the User Interface and functionality of the service. Components of an App-based Service can include:
  - One or more App-Based features, with the restriction that at least one of the App-Based features in an App-Based Service must contain a designated Primary App.
  - Optional Time Base that can be used to support timed actions
  - Zero or more Notification Streams
- Data Service – A Service where the primary content consists of locally cached content items and/or network content items, signaled in a standardized way such that a receiving device may utilize the items in a meaningful way. Note that a Downloadable App may also be capable of utilizing the data in such a data service. Two examples of Data Services are Electronic Service Guide (ESG) and Emergency Alert System (EAS) services. Components of a Data Service can include:
  - Zero or more locally cached content items
  - Zero or more network content items

Components can be shared among multiple services.

Detailed properties of these two types of ATSC 3.0 services are defined in the Service Object Model in A.2 of this document.

A.1.3 Continuous Component Properties

Continuous Components can have four broad categories of properties;

- Basic Continuous Component Properties
  These properties apply to all Continuous Components. They include a unique content identifier, content structure (Elementary, Composite, PickOne) and content type (audio, video, closed caption, etc.).
- Elementary Component Properties
  These properties apply only to Elementary Components. They include basic features of the component encoding, such as the number of audio channels or the video resolution.
- Complex Component Properties
  These properties apply only to Complex Components. They include the members of the Complex Component and their roles, such as dialog track for audio or left view for 3D video.
- Presentable Component Properties
  These properties apply only to Presentable Components. These include such things as targeting properties or content advisory ratings.

Continuous Components can be streamed via broadcast or broadband for immediate consumption as part of a linear service and/or they can be delivered via broadcast or broadband in non-real time and stored on the device as Locally Cached Content Items, and/or they can be streamed via broadband as Network Content Items. Viewers generally access both Locally Cached and Network Content Items via a user interface provided by an App-Based feature (e.g., in an App-Based Service that provides content-on-demand) or via a user interface provided by a receiver in the case of a Data Service.

Detailed definitions of these properties for the various types of components appear in the Service Object Model in A.2 of this document.

A.1.4 Properties of Locally Cached and Network Content Items

Detailed definitions of the properties of Locally Cached and Network Content Items appear in the Service Object Model in A.2 of the present document.

Locally Cached Content Items and Network Content Items are intended to be consumed by an App-based feature (in either a Linear Service or an App-based Service) or, in the case of Content Items delivered in a Data Service, by a receiver function.

Locally Cached Content Items may be delivered via broadcast or broadband and are typically fully received and cached locally prior to beginning presentation.

Network Content Items are accessed via broadband from a remote server and may be available for immediate presentation to the viewer, i.e., the presentation of a continuous Network Content Item begins as soon as there is enough media to avoid underflow, and the presentation of a Network Content Item consisting of a collection of files begins as soon as enough files are acquired for a coherent presentation.

An app-based service that offers content on-demand might offer Locally Cached Content Items or Network Content Items or a combination of the two.

A.1.5 Properties of Applications

Properties of Applications are specified in the ATSC 3.0 Application Runtime Environment specification, A/344 [20].

A.1.6 Programs and Segments

A Program is a temporal section of a Linear Service with a scheduled start time and duration, which is intended by the broadcaster to be treated as a single programming unit from a consumption standpoint. Such "Programs" within a Linear Service are typically disjoint in time (although temporal overlap could occur, for example, if the credits of a concluding program are "squeezed back" to be displayed concurrently with the opening of the next program).

The term Program can also refer to a Locally Cached or Network Content Item that has the same structure as a Program in a Linear Service, but which is not consumed at a scheduled time and does not have a time base defined in the broadcast.

Each Program can be considered to have an associated "Show" which consists of the primary content of the Program (from a consumer standpoint). Many properties that are often considered properties of a Program (such as textual description, actors/actresses or release date) are actually properties of the Show. Other properties such as the identifier of the Service containing the Program and the start time of the Program (for Programs contained in a Linear Service) are properties of the Program. They can differ for different Programs based on the same Show.

Detailed definitions of Show and Program properties appear in the Service Object Model in A.2 of this document.

A Program can consist of one or more time intervals during which a portion of the Show is played out and zero or more time intervals during which other "interstitial" material is played out (e.g., ads or public service announcements). These time intervals are called "Segments", or more particularly "Show Segments" and "Interstitial Segments", respectively.

Detailed definitions of Segment properties appear in the Service Object Model in A.2 of this document.

Segments that are part of a Program may have a specified start time and duration, such as for pre-recorded content, or they may not have a particular start time or duration within the program in advance such as for live news or sports content. Segments may also not be assigned to a particular Program or a particular start time within a Program, as for a targeted ad that has been delivered to a receiver for insertion into Programs, but no decision has been made yet as where it will be inserted – i.e., into which ad slot(s) of which program(s) it will be inserted.

A.2 OBJECT MODEL FOR SERVICES

This section defines an object model for ATSC 3.0 services.

A.2.1 Introduction

The object model defined here includes classes, inheritance relationships between classes, containment relationships between classes, and other relationships among classes. It is a high-level design model, not a deployment model. As such, it does not include the data types of class attributes. These are defined in the normative text of the ATSC 3.0 standard, taking into account the semantics of the attributes and the best way to represent these semantics in the delivered signaling. It also does not include any operations, since the ATSC 3.0 Service Conceptual Model is purely a structural model of services, not an operational model of how receivers would access and present the services.

Section A.2.2 contains figures giving graphical representations of relationships among the classes in the object model, to give some high-level insight into the overall structure of the model.

Section A.2.3 contains the definitions of the individual classes.

A.2.2 Graphical Representation of Relationships between Classes

In the interests of simplicity, most of the attributes are omitted from the diagrams in this section.

Figure A.2.1 below shows the different service types, along with the types of components contained in each type of service.

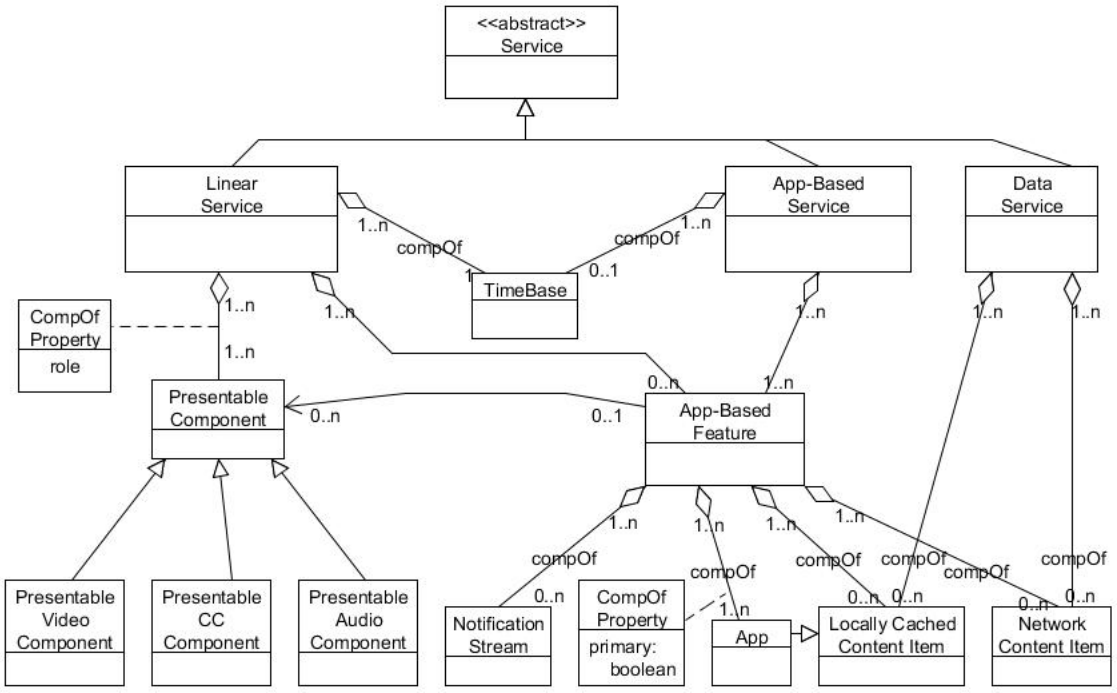

Figure A.2.1 Service Types and their Component Types.

Properties of Services and their Components can be found in Section A.1.2 through Section A.1.5 above.

Figure A.2.2 below shows the containment relationships among the different types of Continuous Component classes and how they fit into a 3-layer model.

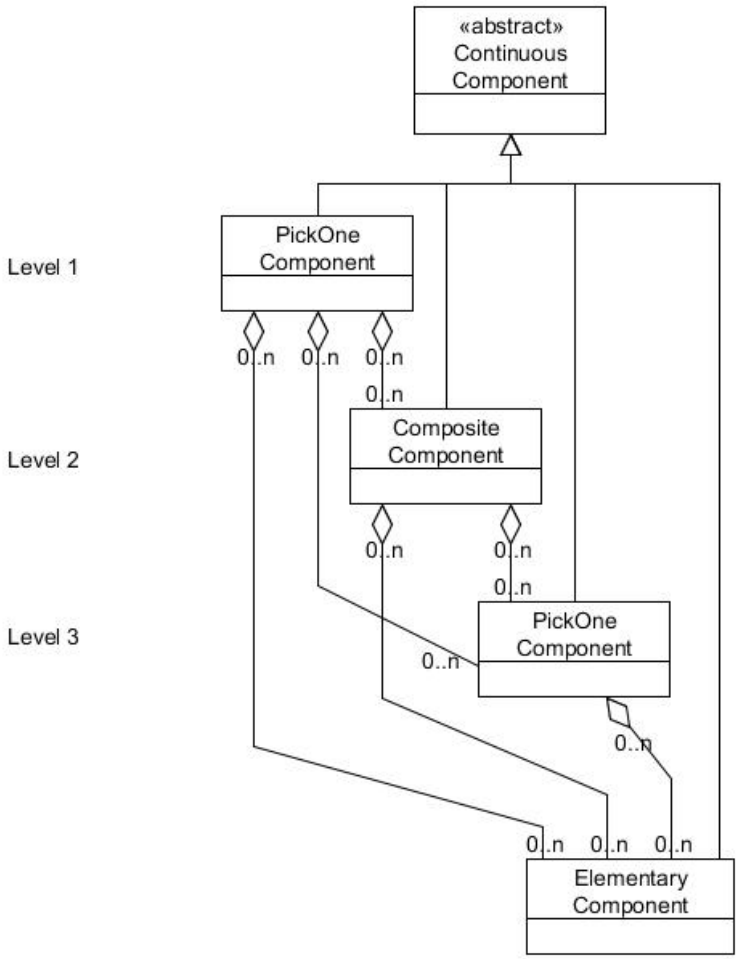

Figure A.2.2 Component hierarchy and inclusion relationships.

Every Continuous Component must have a structure that fits into the 3-level component hierarchy shown in Figure A.2.2.

A Continuous Component can be a PickOne Component, a Composite Component or an Elementary Component.

A PickOne Component at Level 1 in a component hierarchy can contain zero or more Composite Components, zero or more PickOne Components and zero or more Elementary Components, with the overall restriction that it must contain at least two components. A PickOne Component at Level 1 in the hierarchy cannot be contained in any Complex Component.

A Composite Component can contain zero or more PickOne Components and zero or more Elementary Components, with the restriction that it must contain at least two components. A Composite Component can be contained in zero or more PickOne Components that are at Level 1 in the hierarchy.

A PickOne Component at Level 3 in a component hierarchy can contain two or more Elementary Components. A PickOne Component at Level 3 in a component hierarchy can be contained in zero or more PickOne Components and zero or more Composite Components.

Although not shown in this diagram, an Elementary Component can be an Elementary Video Component, an Elementary Audio Component or an Elementary Closed Caption (CC) Component.

Figure A.2.3 below shows the containment relationship between the Locally Cached Content Item class and the Locally Cached File class.

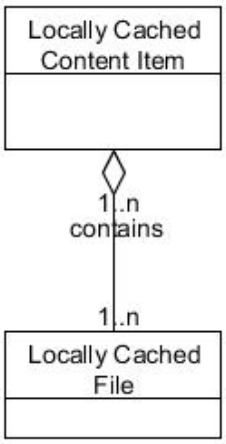

Figure A.2.3 File-based components.

A Locally Cached Content Item contains one or more Locally Cached Files, and a Locally Cached File can belong to one or more Locally Cached Content Items. Locally Cached Content Items are intended for consumption by App-Based Services or Features or, in the case of a Data Service, by the receiver.

One way to look at these classes is that a Locally Cached Content Item is basically a presentable Locally Cached file-based component – i.e., a set of Locally Cached files that can be consumed without needing to be combined with other files – and a Locally Cached file is basically an elementary Locally Cached file-based component – i.e., a component that is an atomic unit.

Figure A.2.4 below shows the association relationships between the Presentable Video Component class and the Presentable Audio Component and Presentable CC Component classes in a Service that contains video.

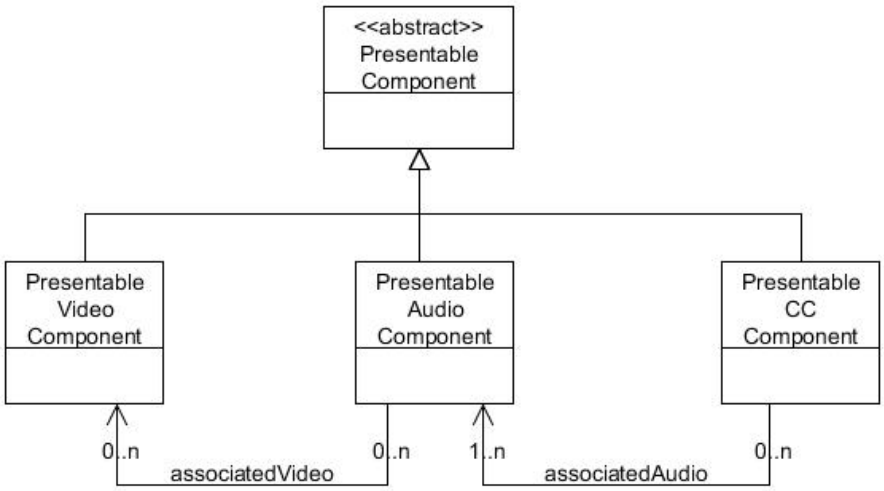

Figure A.2.4 Presentable Component Associations in a Service that contains Video.

A Presentable Component can be a Presentable Video Component, Presentable Audio Component or Presentable CC Component.

Each Presentable Video Component has zero or more associated Presentable Audio Components, and each Presentable Audio Component has zero or more associated Presentable CC Components (where "associated" in this case means that they are suitable for presentation together).

In a Service that contains any Presentable Video Components, each Presentable Audio Component must be associated with one or more Presentable Video Components.

Figure A.2.5 below shows the inheritance relationships and inclusion relationships among the Service, Program, Show and Segment classes and their sub-classes.

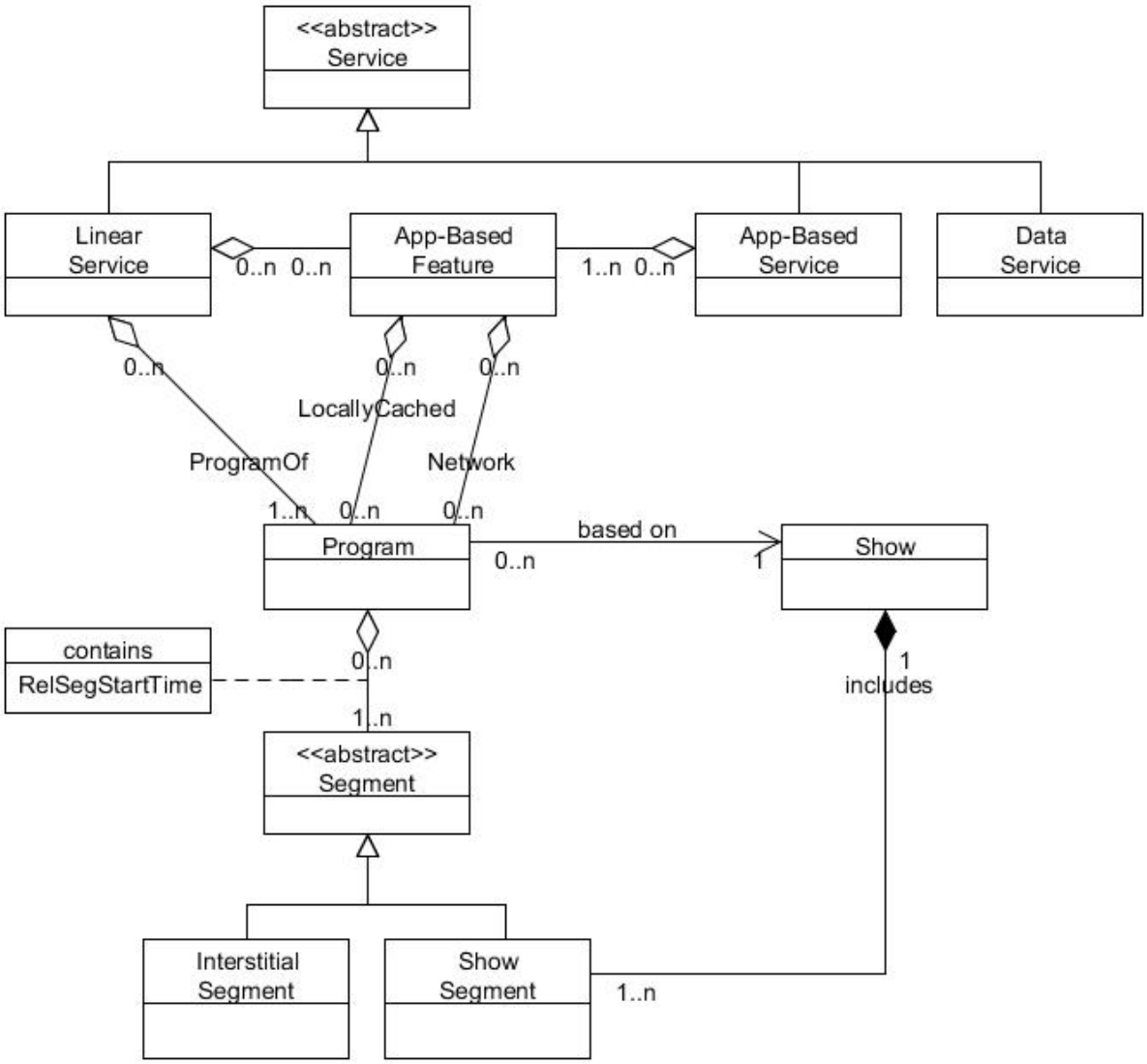

Figure A.2.5 Service, Program, Show, and Segment Class Hierarchy and Inclusion Relationships.

A Linear Service can contain one or more Programs, in the form of a temporal segment of the linear content in the Service. A Program can be contained as a temporal segment in zero or more Linear Services. A Linear Service can contain zero or more App-Based Features. An App-Based Service can contain one or more App-Based Features. An App-Based Feature can contain zero or more Programs, either in the form of Locally Cached Content Items or Network Content Items. A Program can be a Locally Cached Content Item and/or a Network Content Item in zero or more App-Based Features.

A Program can contain one or more Segments, and a Segment can be contained in zero or more Programs. Each Segment can be a Show Segment or an Interstitial Segment.

A Program is by definition based on exactly one Show. (The Show is that portion of the Program that is not considered by the service provider to be interstitial material.)

A Show can consist of one or more Show Segments.

A Program has many of the properties of a Linear Service, since a "Program" can be a temporal section of a Linear Service (a section of a Linear Service with a specified start time and duration), or it can be a Locally Cached Content Item or Network Content Item that has the same structure as such a temporal section of a Linear Service. For example, a Program contains Continuous Components, and it can contain one or more App-based Features.

A.2.3 Service Model Classes and their Attributes

The classes defined for the service object model are listed below, with their attributes and relationships. The notation [n..m] or [n] following an attribute name indicates the multiplicity of the attribute, where [n..m] means that the attribute can have between n and m values, and [n] means that the attribute must have exactly n values. Many of the classes have additional attributes that are inherited from other classes by means of the inheritance relationships defined in the class definitions.

Strictly speaking, a relationship between two classes should be listed among the relationships of both classes. However, in an implementation of an object model, it is common for one of the classes in a relationship to be viewed as "primary" and for the relationship to be represented as an attribute of that class. (In such an implementation, the values of such an attribute for a given object in that class would be some sort of identifiers of the objects in the other class that are related to the given object.) In the class definitions below, each relationship is listed only once, in the definition of the class in the relationship that would likely (but not necessarily) be considered the "primary" class in the relationship.

Continuous Component <<abstract>> represents a Continuous Component (as defined in Section A.1.3 of this document)	
Attributes	
	ComponentId [1] – unique identifier of component

Audio Component <<abstract>> represents a Continuous Component of content type audio	
Relationships	
	Sub-class relationship with Continuous Component class

Video Component <<abstract>> represents a Continuous Component of content type video	
Relationships	
	Sub-class relationship with Continuous Component class

CC Component <<abstract>> represents a Continuous Component of content type closed caption
Relationships
Sub-class relationship with Continuous Component class

Elementary Audio Component represents an Elementary Component (as defined in Section A.1.1 of this document) of content type audio	
Attributes	
Codec [1]	
Number of audio channels [1]	
Encoding bit-rate [1]	
Language [0..1]	
Mode [1] Possible values	
Complete main	
Music	
Dialog	
Effects	
Visually impaired	
Hearing impaired	
Commentary	
Other encoding parameters (possibly codec-dependent)	
Relationships	
Sub-class relationship with Audio Component class	

Elementary Video Component represents an Elementary Component (as defined in Section A.1.1 of this document) of content type video	
Attributes	
	Codec [1]
	Resolution (width x height, in pixels) [1]
	Aspect ratio [1]
	Interlaced/Progressive [1]
	Frame rate, or "still" picture mode [1]
	Other encoding parameters (possibly codec-dependent)
Relationships	
	Sub-class relationship with Video Component class

Elementary CC Component represents an Elementary Component (as defined in Section A.1.1 of this document) of content type closed caption		
Attributes		
	"Codec" (i.e., encoding format) [1]	
	Language [1]	
	Type [1] Possible values	
		Normal
		Easy-reader
Relationships		
	Sub-class relationship with CC Component class	

Composite Audio Component represents a Composite Component (as defined in Section A.1.1 of this document) of content type audio	
Relationships	
	"ContainsAudio" relationship with Audio Component class – with the restriction that for each instantiation of the relationship all of the included objects (audio components) represent the same sound scene
	Sub-class relationship with Audio Component class

Composite Video Component
represents a Composite Component (as defined in Section A.1.1 of this document) of content type video

Relationships

"ContainsVideo" relationship with VideoComponent class – with the restriction that for each instantiation of the relationship all of the contained objects (video components) represent the same video scene

Attributes of Contains Video Relationship

Role - role of the contained component in the Composite Component
Possible values

- **Enhancement layer for scalable video encoding, with level**
- **3D video left/right view**
- **3D video depth information**
- **Part of video array, (x,y) of (n,m)** (from bottom left to top right, by row)
- **Follow-Subject metadata** (name of subject, location of subject, size of subject), in the case when the "follow-subject" feature is supported by a stream of frame-by-frame metadata indicating an area of the main video component that is focused on the subject.

Sub-class relationship with Video Component class

PickOne Component
represents a PickOne Component (as defined in Section A.1.1 of this document)

Relationships

"Contains" relationship with Continuous Component class – with the restriction that for each instantiation of the relationship all the included components are of the same content type and represent the same video scene or audio scene

Sub-class relationship with Continuous Component class

Presentable Component <<abstract>> represents a Presentable Component, as defined in Section A.1.1 of this document
Attributes
Targeting/personalization properties
Content/Service protection properties
Target device(s) [0..n] Possible values
Primary Device
Companion Device
Inset on Primary Screen (“Picture-in-Picture”)

Presentable Video Component represents a Presentable Component of video content type – i.e., contains all objects in the Video Component class that satisfy the definition of a Presentable component
Relationships
“AssociatedAudio” relationship with Presentable Audio Component class – represents that the associated Presentable Audio Component is suitable for presentation along with the Presentable Video Component
“Associated CC” relationship with Presentable CC Component class – represents that the associated Presentable CC Component is suitable for presentation along with the Presentable Video Component
Sub-class relationship with Video Component

Presentable Audio Component represents a Presentable Component of audio content type – i.e., contains all objects in the Audio Component class that satisfy the definition of a Presentable component
Relationships
Sub-class relationship with Audio Component

Presentable CC Component represents a Presentable Component of closed caption content type – i.e., contains all objects in the CC Component class that satisfy the definition of a Presentable component
Relationships
Sub-class relationship with CC Component

Network Content Item represents a content component that is delivered on demand via broadband		
Attributes		
	NetworkContentItemId [1] – unique identifier of the Network Content Item	
	ComponentLocation [1..n] – location where the Network Content Item can be accessed	
	ComponentName [0..n] – human-readable name of the Network Content Item, possibly in multiple languages	
	PlaybackLength [0..1] – playout time of the Network Content Item (only meaningful for Network Content Items such as audio or video clips that have a defined playout time)	
	AvailabilityStart [0.1] – date and time at which Network Content Item becomes available	
	AvailablityDuration [0..1] – length of time Network Content Item remains available	
	Targeting/personalization properties	
	Content/Service protection properties	
	Accessibility Feature [0 .. n] For each feature	
		Id
		Value[]

Locally Cached Content Item represents a Locally Cached Content Item		
Attributes		
	ContentItemId [1] – unique identifier of the Locally Cached Content Item	
	ContentItemName [0..n] – human-readable name of the Locally Cached Content Item, possibly in multiple languages	
	Updatable [1] – indication whether or not the Locally Cached Content Item should be monitored for updates	
	Expiration [0..1] – date and time after which the Locally Cached Content Item should be discarded	
	ContentItemSize [1] – size of the Locally Cached Content Item, in bytes	
	PlaybackLength [0..1] – playout time of the Locally Cached Content Item (only meaningful for Locally Cached Content Items such as audio or video clips that have a defined playout time)	
	Targeting/personalization properties	
	Content/Service protection properties	
	Accessibility Feature [0 .. n] For each feature	
		Id
		Value[]
Relationships		
	"Contains" relationship with Locally Cached File class	

Locally Cached File represents a Locally Cached file		
Attributes		
	ContentLocation	
	ContentType	
	Accessibility Feature [0 .. n] For each feature	
		Id
		Value[]

App represents a Locally Cached Content Item that meets the specifications developed by S34-4 for an ATSC 3.0 application.	
Attributes	
	See A/344 [20]
Relationships	
	"Sub-class" relationship with Locally Cached Content Item class

App-Based Feature represents an App-Based Feature (as described in Section A.1.1 of this document)		
Attributes		
	Essential capabilities [0..1] – receiver capabilities needed for meaningful rendition of feature	
	Non-essential capabilities [0..1] – receiver capabilities useful for optimal rendition of feature, but not absolutely necessary for meaningful rendition of feature	
	Target device [0..n] – for App-Based Features in Linear Services only Possible values	
		Primary device
		Companion device
Relationships		
	"Contains" relationship with App class – for the applications in the App-Based Feature	
	"Contains" relationship with Locally Cached Content Item class – for Locally Cached Content Items used by the applications in the App-Based Feature	
	"Contains" relationship with Notification Stream class – for Notifications Stream that delivers notifications to synchronize the actions of the applications with an underlying Linear Time Base.	
	"Contains" relationship with Network Content Item class – for Network Content Items to be managed by the application(s).	

Time Base represents metadata used to establish a time line for synchronizing the components of a Linear Service
Attributes
Time Base ID – identifier of time base
Clock Rate – clock rate of the time base

Notification Stream represents Notification Stream used to deliver synchronized notifications of actions to be taken	
Attributes	
	Notification Stream ID – identifier of Notification Stream

Service represents a Service (as defined in the ATSC 3.0 glossary)	
Attributes	
	ServiceId [1] – unique identifier for Service
	ServiceName [0..n] – human-readable name of the service, possibly in multiple languages
	MajorChanNum [0..1] – major "channel number" of the service, for service selection
	MinorChanNum [0..1] – minor "channel number" of the service, for service selection
	Description [0..n] – textual description of the service, possibly in multiple languages
	Genre [0..n] – genre(s) of the service
	Icon [0..n] – icon used to represent the service (e.g., in ESG), possibly in multiple sizes
	Language [0..1] – primary language used in the service
	UsageReportInfo – parameters to be used for service usage reporting for this service (e.g., URL, reporting interval, etc.)
	Targeting/personalization properties – targeting properties for the service (e.g., to be used for searches, recommendations and/or user selection in the ESG) – can be overridden for individual Programs, Locally Cached Content Items, or Network Content Items
	Content/Service protection properties – service protection properties for the service – can be overridden for individual Programs, Locally Cached Content Items, or Network Content Items
	ContentAdvisoryRating [0..n] – Content advisory rating(s) for the service – can be overridden for individual Programs, Locally Cached Content Items, or Network Content items
	Essential capabilities [0..1] – receiver capabilities needed for meaningful rendition of service
	Non-essential capabilities [0..1] – receiver capabilities useful for optimal rendition of service, but not absolutely necessary for meaningful rendition

Linear Service represents a Linear Service (as described in Section A.1.1 of this document)
Relationships
“Contains” relationship with Presentable Video Component class **Attributes of**
Role of video component [1] **Possible values**
Primary (default) video
Alternative camera view
Other alternative video component
Sign language (e.g., ASL) inset
Follow subject video, with name of subject being followed, in the case when the follow-subject feature is supported by a separate video component.
“Contains” relationship with Presentable Audio Component class
“Contains” relationship with Presentable CC Component class
“Contains” relationship with Time Base class
“**Contains” relationship with App-Based Feature class**
“Sub-class” relationship with Service class

App-Based Service represents an App-Based Service (as described in Section A.1.2 of this document)
Relationships
“Contains” relationship with Time Base class
“Contains” relationship with App-Based Feature class.
“Sub-class” relationship with Service class

Data Service represents a Data Service (as described in Section A.1.2 of this document)	
Relationships	
	"Contains" relationship with Locally Cached Content Item class – for Locally Cached Content Items used by the applications in the App-Based Feature
	"Contains" relationship with Network Content Item class – for Network Content Items to be managed by the application(s).
	"Sub-class" relationship with Service class

Note that a Locally Cached Content Item Component can have the same structure as a Program, but delivered in the form of a file, rather than in streaming form. Such a Program can have an App-Based Feature associated with it, for example to provide an interactive experience while viewing it.

Program represents a Program (as described in Section A.1.6 of this document)	
Attributes	
	ProgramIdentifier [1] – unique identifier of the Program
	StartTime [1] – wall clock date and time the Program is scheduled to start
	ProgramDuration [1] – scheduled wall clock time from the start of the Program to the end of the Program
	TextualTitle [1..n] – human-readable title of the Program, possibly in multiple languages – if not present, defaults to TextualTitle of associated Show
	TextualDescription [0..n] – human-readable description of the Program, possibly in multiple languages – if not present, defaults to TextualDescription of associated Show
	Genre [0..n] – genre(s) of the Program – if not present, defaults to Genre of associated Show
	GraphicalIcon [0..n] – icon to represent the program (e.g., in ESG), possibly in multiple sizes – if not present, defaults to GraphicalIcon of associated Show
	ContentAdvisoryRating [0..n] – content advisory rating for the Program, possibly for multiple regions – if not present, defaults to ContentAdvisoryRating of associated Show
	Targeting/personalization properties – properties to be used to determine targeting, etc., of Program – if not present, defaults to Targeting/personalization properties of associated Show
	Content/Service protection properties – properties to be used for content protection and/or service protection of Program – if not present, defaults to Content/Service protection properties of associated Show
	Other properties defined in the "ESG Model" described in A/332 [8]
Relationships	

- **"ProgramOf" relationship with Linear Service class**
- **"ContentItemOf" relationship with App-Based Service class**
- **"OnDemandComponentOf" relationship with App Based Service Class**
- **"Contains" relationship with Presentable Video Component class**
  Attributes
  - **Role of video component [1]**
    Possible values
    - **Primary (default) video**
    - **Alternative camera view**
    - **Other alternative video component**
    - **Sign language (e.g., ASL) inset**
    - **Follow subject video**, with name of subject being followed, in the case when the follow-subject feature is supported by a separate video component.
- **"Contains" relationship with Presentable Audio Component class**
- **"Contains" relationship with Presentable CC Component class**
- **"Contains" relationship with App-Based Feature class**
- **"Contains" relationship with Time Base class**
- **"Based-on" relationship with Show class**
- **"Contains" relationship with Segment class**
- **Attributes of "Contains" relationship with Segment class**
  - **RelativeSegmentStartTime** – start time of Segment relative to beginning of Program

Show represents a Show, as described in Section A.1.6 of this document (i.e., the primary content of a Program from a consumer viewpoint)	
Attributes	
	ShowIdentifier [1] – unique identifier of the Show
	ShowDuration [1] – duration from the start of the Show to the end of the Show, if played without any interruptions or interstitial material
	TextualTitle [1..n] – human-readable title of the Show, possibly in multiple languages
	TextualDescription [0..n] – human-readable description of the Show, possibly in multiple languages
	Genre [0..n] – the genre(s) of the Show
	GraphicalIcon [0..n] – icon to represent the Show, possibly in multiple sizes
	ContentAdvisoryRating [0..n]
	Targeting/personalization properties – properties to be used to determine targeting, etc., of Program
	Content/Service protection properties – properties to be used for content protection and/or service protection of Program
	Other properties defined in the "ESG Model" described in A/332 [8]
Relationships	
	"Includes" relationship with Show Segment class

Segment <<abstract>> represents a Segment (as described in Section A.1.6 of this document)	
Attributes	
	SegmentId [1] – unique identifier of segment
	Duration [1] – temporal length of segment
	Targeting/personalization properties – targeting properties (to be considered when Segment is to be substituted into a Program)
	ContentAdvisoryRating [0..n] – content advisory rating for Segment (to be considered when Segment is to be substituted into a Program)

Show Segment represents a Segment of a Show	
Attributes	
	ShowSegmentRelativeStartTime – start time of Show Segment relative to beginning of Show
Relationships	
	"Sub-class" relationship with Segment class

Interstitial Segment Represents a Segment of a Program that is not a Show Segment	
Relationships	
	"Sub-class" relationship with Segment class

ContentAdvisoryRating [0 .. n] For each rating region		
	Region identifier	
	Rating Description (text)	
	Rated Dimension [1..n] For each rated dimension	
		Rating Dimension
		Rating Value

End of Document