ATSC Standard:
A/300:2024-04, ATSC 3.0 System

Doc. A/300:2024-04
3 April 2024

Advanced Television Systems Committee
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Implementers with feedback, comments, or potential bug reports relating to this document may contact ATSC at https://www.atsc.org/feedback/.

Revision History

Version	Date
A/300:2017 Standard approved	19 October 2017
A/300:2019 Standard approved	17 September 2019
A/300:2020 Standard approved	15 May 2020
A/300:2021 Standard approved	7 July 2021
A/300:2022-04 Standard approved	9 April 2022
A/300:2023-03 Standard approved	28 March 2023
A/300:2024-04 Standard approved	3 April 2024

Note: Services and devices conformant to an earlier version of the ATSC 3.0 Standard suite, as defined by a previous revision of the A/300 System Standard (listed in the table above), may remain in use for some time. Unless otherwise specified, these legacy services and devices will remain compatible with the latest version of the ATSC 3.0 Standard defined by the latest edition of A/300, although they may not support all features defined therein. See Table A.1.1 for detailed listing of previous A/300 versions' contents.

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ATSC Standard: A/300:2024-04, "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-backward-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 elements of the system to be revised or extended without affecting other elements.

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.

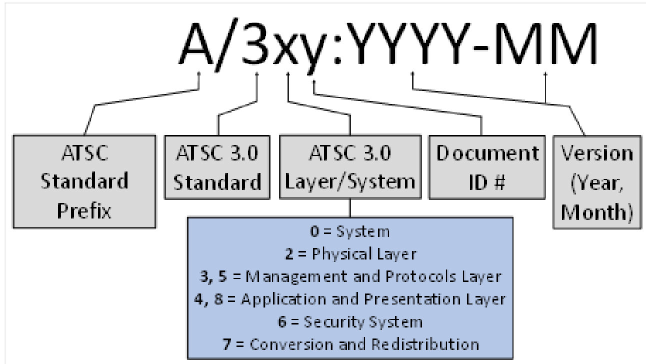

Figure 1.1 ATSC 3.0 Standard and Recommended Practice naming scheme.

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 – Presents a system overview.
- Section 5 – Presents the ATSC 3.0 specification, with subsections addressing each of the ATSC 3.0 suite of Standards documents, and how they interrelate.
- Section 6 – Details how the Standard addresses redistribution of ATSC 3.0 signals.
- Section 7– Provides information about regionalization of aspects of the ATSC 3.0 system.
- Annex A – Shows which versions of ATSC 3.0 documents are included in each previous version of A/300.

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/321:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[3] ATSC: "ATSC Standard: Physical Layer Protocol," Doc. A/322:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[4] ATSC: "ATSC Standard: Dedicated Return Channel for ATSC 3.0," Doc. A/323:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[5] ATSC: "ATSC Standard: Scheduler / Studio to Transmitter Link," Doc. A/324:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[6] ATSC: "ATSC Standard: Link Layer Protocol," Doc. A/330:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[7] ATSC: "ATSC Standard: Signaling, Delivery, Synchronization, and Error Protection," Doc. A/331:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[8] ATSC: "ATSC Standard: Service Announcement," Doc. A/332:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[9] ATSC: "ATSC Standard: Service Usage Reporting," Doc. A/333:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[10] ATSC: "ATSC Standard: Audio Watermark Emission," Doc. A/334:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[11] ATSC: "ATSC Standard: Video Watermark Emission," Doc. A/335:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[12] ATSC: "ATSC Standard: Content Recovery in Redistribution Scenarios," Doc. A/336:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[13] ATSC: "ATSC Standard: Application Signaling," Doc. A/337:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[14] ATSC: "ATSC Standard: Companion Device," Doc. A/338:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[15] ATSC: "ATSC Standard: Video – HEVC," Doc. A/341:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[16] ATSC: "ATSC Standard: Audio Common Elements," Doc. A/342-1:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[17] ATSC: "ATSC Standard: AC-4 System," Doc. A/342-2:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[18] ATSC: "ATSC Standard: MPEG-H System," Doc. A/342-3:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[19] ATSC: "ATSC Standard: Captions and Subtitles," Doc. A/343:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[20] ATSC: "ATSC Standard: ATSC 3.0 Interactive Content," Doc. A/344:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[21] ATSC: "ATSC Standard: ATSC 3.0 Security and Service Protection," Doc. A/360:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.
[22] IETF: "The 'tag' URI Scheme," Doc. RFC 4151, Internet Engineering Task Force, Fremont, CA, October 2005.
[23] ATSC: "ATSC Standard: Regional Service Availability," Doc. A/200:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

2.2 Informative References

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

[24] ATSC: "ATSC 3.0 Code Point Registry," Advanced Television Systems Committee, Washington, DC.
https://www.atsc.org/documents/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. 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).
https://www.itu.int/rec/R-REC-TF.460/en.

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

[32] ATSC: "ATSC Standard: Digital Audio Compression (AC-3) (E-AC-3) Standard," Doc. A/52:2018, Advanced Television Systems Committee, Washington, DC, 25 January 2018.

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

[34] ATSC: "ATSC 3.0 PHY Lab Performance Test Plan," Doc. A/325:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[35] ATSC: "ATSC 3.0 Field Test Plan," Doc. A/326:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[36] ATSC: "Guidelines for the Physical Layer Protocol," Doc. A/327:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[37] ATSC: "ATSC Recommended Practice: Audio Watermark Modification and Erasure," Doc. A/339:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[38] ATSC: "ATSC Recommended Practice: Guide to the Link-Layer Protocol," Doc. A/350:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[39] ATSC: "ATSC Recommended Practice: Techniques for Signaling, Delivery, and Synchronization," Doc. A/351:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[40] ATSC: "ATSC Recommended Practice: Security and Content Protection," Doc. A/361:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[41] ATSC: "ATSC Recommended Practice: Digital Rights Management (DRM)," Doc. A/362:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[42] ATSC: "ATSC Recommended Practice: Conversion of ATSC 3.0 Services for Redistribution," Doc. A/370:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[43] ATSC: "ATSC Technology Group Report: ATSC 3.0 Launch – DASH Timeline and IMSC1," Doc. T/300, Advanced Television Systems Committee, Washington, DC, 9 October 2020.

[44] ATSC: "ATSC Technology Group Report: ATSC 3.0 Initial AC-4 Implementation," Doc. T/301, Advanced Television Systems Committee, Washington, DC, 24 May 2019.

[45] ATSC: "ATSC Implementation Team Guide: ATSC 3.0 Advanced Emergency Information System Implementation Guide," Advanced Television Systems Committee, Washington, DC, 22 February 2019.

[46] ATSC: "ATSC Recommended Practice: Haptics for ATSC 3.0," Doc. A/380:2024-04, Advanced Television Systems Committee, Washington, DC, 3 April 2024.

[47] NABA: "HDR Emissions Format," North American Broadcasters Association, Toronto, ON, Canada, 3 August 2021.

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.

AD– Audio Description

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
EAS – Emergency Alert System
ESG – Electronic Service Guide
GHz – Gigahertz
GPS – Global Positioning System
HDMI – High-Definition Multimedia Interface
HDR – High Dynamic Range
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
ISO/IEC − International Organization for Standardization / International Electrotechnical Commission
ITU-R − International Telecommunication Union – Radiocommunication Sector
MHz − Megahertz
MMT − MPEG Multimedia Transport
MPEG − Moving Picture Experts Group
NRT − Non-Real Time
NTP − Network Time Protocol
OSI − Open Systems Interconnection
PIP − Picture-in-Picture
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
SDO − Standards Development Organization
SEI − Supplemental Enhancement Information
SFN − Single Frequency Network

SMPTE − Society of Motion Picture and Television Engineers
STL − Studio-to-Transmitter Link
TAI − International Atomic Time
TG-3 − Technology Group 3
TTA – Telecommunication Technology Association
TTML − Timed Text Markup Language
TV − Television
URI − Uniform Resource Identifier
URN − Uniform Resource Name
UTC − Coordinated Universal Time
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.

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.

App-based Feature –Component consisting of an application, optional files to be used by the application, and optional notifications directing the application to take particular actions at particular times.

App-based Service – Service consisting entirely of app-based features, which provide the user interface for the Service.

ATSC 3.0 Application – Application conforming to the ATSC 3.0 Interactive Content standard [20].

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) [28].

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.

Audio Description – As defined in A/342 Part 1 [16], "Audio Description" is the insertion of audio narrated descriptions of a television program's key visual elements into natural pauses between the program's dialog.

Audio Emergency Information – As defined in A/342 Part 1 [16], "Emergency Information" is data to be presented aurally, such as the reading of a text crawl, and is distinct from Emergency Alert System (EAS) data and audio.

Component -- Single media coding sequence of segments of, e.g., video, audio, or captions.

Linear Service – A Service where the primary content consists of Components that are delivered according to a schedule and time base defined by the broadcast.

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.

Locally Cached File – File that is delivered in non-real-time and stored on the device for later consumption; a Locally Cached File is typically not consumed or presented until it has been fully received and cached; Locally Cached files can be delivered via broadcast or broadband.

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.

reserved – Set aside for future use by a Standard.

Service – A collection of Components presented to the user in aggregate; Components can be of multiple media types; a Service can be either continuous or intermittent.

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( )	$\text{Sign}(x) = 1 \quad x > 0$ $= 0 \quad x == 0$ $= -1 \quad x < 0$

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.

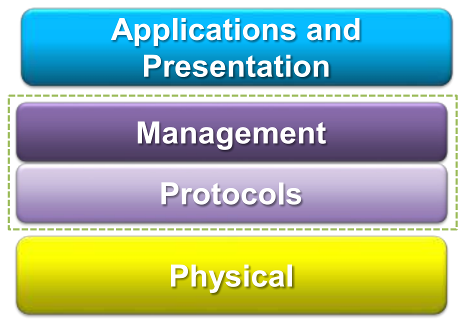

Figure 4.1 ATSC 3.0 layered architecture.

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 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.

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.

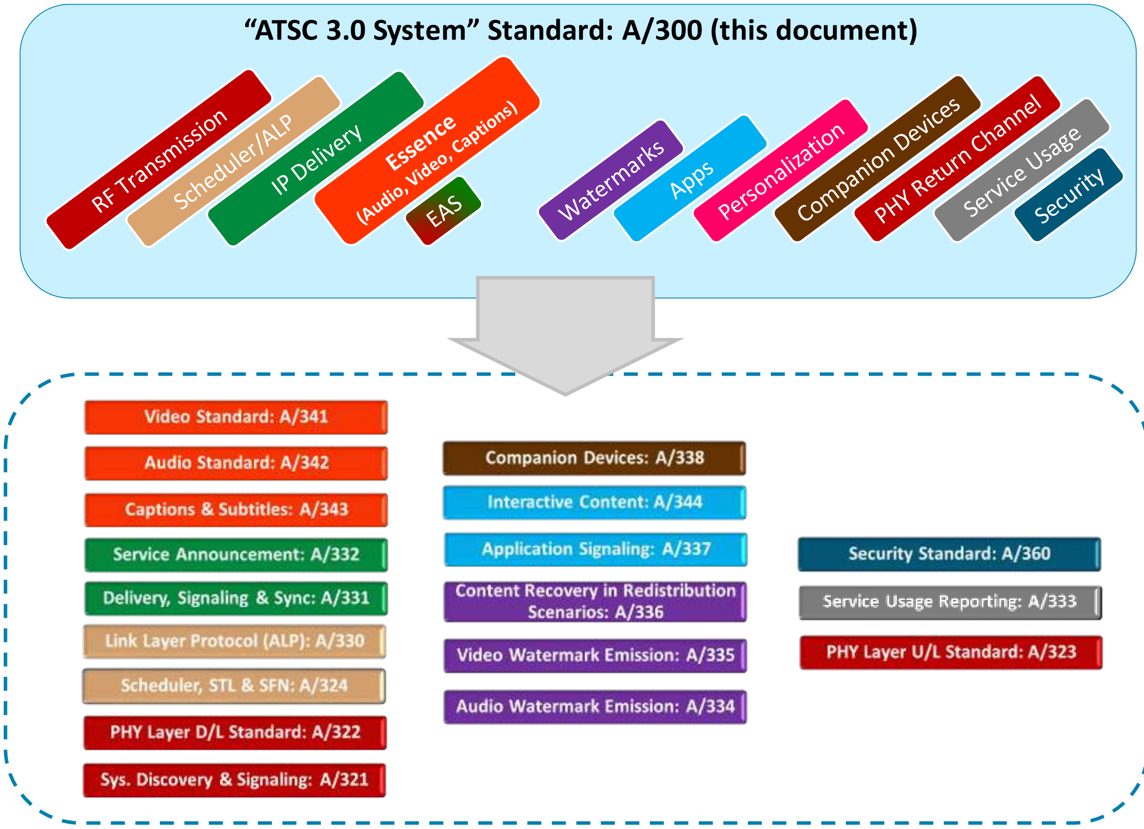

Figure 5.1 ATSC 3.0 Standards set and structure.

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" [36], provides informative guidance on use of A/322. Further, two other Recommended Practices, A/325 [34] and A/326 [35], 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 specification. If a DRC is used, it shall be as specified in ATSC Standard A/323 [4].

5.1.4 Scheduler / Studio to Transmitter Link

A set of interfaces between the Transport Layer and the Physical Layer and within the Physical Layer of the ATSC 3.0 System has been defined. It consists of standard protocols to transport content from data sources to generators of the ATSC Link-Layer Protocol (ALP), to transport ALP packets, and to transport Studio-to-Transmitter Link (STL) packets, all along with necessary timing and control information. All three protocols contain provisions for error correction coding and security measures that can be applied during transport. The functions of a Scheduler also have been defined to provide control of the emissions of the transmitter(s) and preparation of the signaling necessary to set the Physical Layer operating parameters for both transmitters and receivers. Support for operation of Single Frequency Networks (SFNs) is provided, as is support for operation of neighboring co-channel stations or networks, transmitting with parameters yielding low SNR thresholds, with similar or identical configurations, while minimizing interference between them. 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)" [38] 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]. In addition, ATSC Recommended Practice A/351, "Techniques for Signaling, Delivery and Synchronization" [39], provides informative guidance on use of A/331.

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, "Audio Watermark Modification and Erasure" [37], 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 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 [14].

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 (i.e., PQ or HLG). Emission of SL-HDR1 derived from a PQ source is considered to be based on an underlying PQ transfer function.

The North American Broadcasters Association (NABA) has recommended [47]: "That systems based on an underlying PQ-based HDR transfer function (SMPTE ST 2084) with optional static (SMPTE ST 2086) and/or dynamic metadata (SMPTE ST 2094) be used for ATSC 3.0 program emission in North America."[2]

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.[3] 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

[2] This is a non-binding recommendation of a trade association.

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

A/342, Part 3 for use in the Republic of Korea. In addition, for regions implementing A/342, Part 2, ATSC Technology Group Report T/301, "ATSC 3.0 Initial AC-4 Implementation" [44], provides informative guidance on early implementations of the AC-4 audio system.

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]. In addition, ATSC Technology Group Report T/300, "ATSC 3.0 Launch – DASH Timeline and IMSC1" [43], provides informative guidance on interoperability of the ATSC 3.0 IMSC1 Component.

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]. In addition, ATSC Recommended Practice A/380, "Haptics for ATSC 3.0" [46], provides guidance for adding haptics functionality (i.e., the generation of touch-related sensations in a device or interface to provide touch-based feedback to users) to ATSC 3.0 broadcast and broadband content when viewed on mobile devices with built-in haptic actuators, such as smartphones and tablets.

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]. In addition, ATSC Recommended Practice A/361, "Security and Content Protection" [40], and ATSC Recommended Practice A/362, "Digital Rights Management" [41], provide informative guidance on use of A/360.

5.1.19 Regional Service Availability

The Regional Service Availability Table (RSAT) 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. Regional Service Availability in ATSC 3.0 shall be as specified in ATSC Standard A/200 [23] and signaled in Service Layer Signaling (SLS) per A/331 [7]. A/200 describes how the information may be distributed using either an ATSC 1.0 broadcast (or any MPEG-2 transport stream), an ATSC 3.0 broadcast, or over broadband.

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
- ATSC Standards: A/342-1, Audio Common Elements [16]; A/342-2, AC-4 System [17]; A/342-3, MPEG-H System [18]
  - define mechanisms for delivering aural renderings of emergency-related video text crawls
- ATSC Standard: A/344, 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
- ATSC Implementation Team Guide: ATSC 3.0 Advanced Emergency Information System Implementation Guide [45]
  - provides informative guidance to assist in understanding and implementing the emergency-related capabilities of the ATSC 3.0 suite of Standards

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 Audio Description

Audio Description (AD) 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. Audio description makes TV programming more accessible to individuals who are blind or visually impaired.

AD may be provided by sending a collection of audio Components; for example, a "Music and Effects" Component, a "Dialog" Component, and an appropriately labeled "Audio Description" Component, which are mixed at the receiver. Alternatively, an Audio Description 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 AD along with a full surround or immersive mix due to advances in Next Generation Audio as described in A/342 [16].

5.3.2 Audio 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 Audio Emergency Information. As defined in A/342 Part 1 [16], Audio Emergency Information is "Emergency Information" data to be presented aurally, such as the reading of a text crawl, which is distinct from Emergency Alert System (EAS) data and audio.

Audio 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.

Audio Emergency Information may be provided by sending a collection of audio Components: "Music and Effects" Component, a "Dialog" Component, and an appropriately labeled "Audio Emergency Information" Component, which are mixed at the receiver. Alternatively, an Audio 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 Audio 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 Audio Emergency Information Component in the decoded output and/or allow a user preference setting so that a receiver could retain and act on said user preference.

For regions implementing A/342-2, AC-4 System [17], Audio Emergency Information shall be signaled in compliance with the requirements defined in A/342-2, Section 5.4 (“Personalized Audio Constraints”). For regions implementing A/342-3, MPEG-H System [18], Audio Emergency Information shall be signaled in compliance with A/342-3, Section 5.4 (“Audio Emergency Information”).

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 through 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 [14].

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 Picture-in-Picture (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) [25]. The Components and IP stack of the system can utilize the NTP 32b short format of UTC [26] 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 [29] [30].

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 [27].

The ATSC 3.0 physical layer [3] utilizes ATSC Physical Layer Time, which corresponds exactly in rate with International Atomic Time (TAI) [28] and GPS time. TAI is ahead of GPS by a static 19 seconds [30]. 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 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 that deliver Linear Services 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.

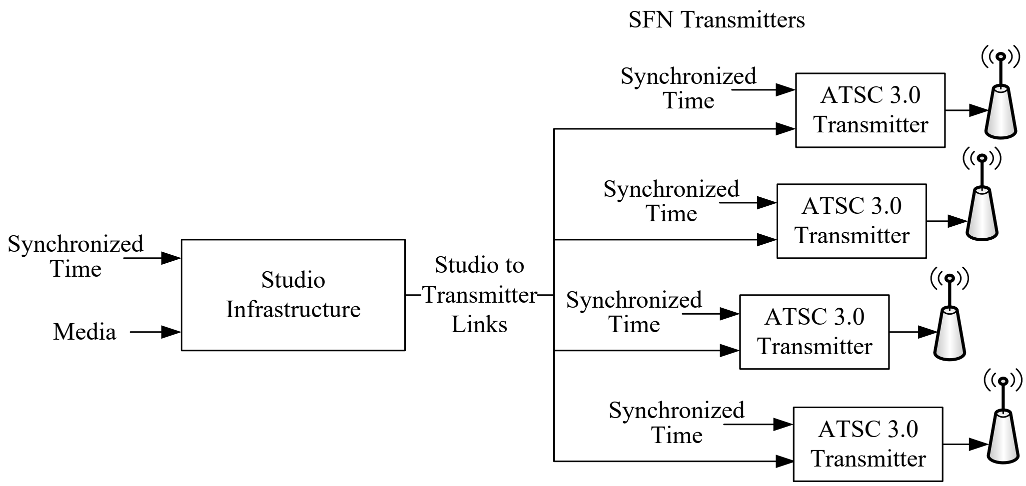

Figure 5.2 System locations requiring synchronized time.

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]
  - o describes user control of certain aspects of audio rendered from the encoded representation
  - o 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
  - o describes how users can adjust dialog level relative to other sound elements
- ATSC Standard: A/342-2, AC-4 System [17]
  - o defines how personalized audio elements are presented and constrained in the AC-4 system
- ATSC Standard: A/342-3, MPEG-H System [18]
  - o 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. REDISTRIBUTION

ATSC envisions that ATSC 3.0 services might be redistributed over non-ATSC-3.0 delivery systems. While ATSC has not produced Standards covering such delivery (preferring to leave that activity to other standards bodies native to such redistribution environments), it has produced an informative guide for *conversion* of ATSC 3.0 services to forms suitable for redistribution on ATSC 1.0-based and other legacy delivery services. This guidance is found in ATSC Recommended Practice A/370, “Conversion of ATSC 3.0 Services for Redistribution” [42].

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 ATSC 3.0 system enables recovery of those signals, and by extension, those Components, via a broadband connection. 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, as specified above in Sections 5.1.9, 5.1.10 and 5.1.11.

7. 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 frame rates (integer and fractional) for use in other regions (e.g., United States) [14].
- 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: A/300 Version Guide *(Informative)*

In June 2019, ATSC established a process (revised in December 2022) for updating the current version of the full suite of ATSC 3.0 documentation (i.e., Standards, Recommended Practices and other associated, published documents) no more frequently than on an annual basis. The mechanism for setting forth this suite of documentation is via the latest revision of the A/300 (ATSC 3.0 System) standard (this document). The process also calls for a table summarizing the contents of all previous versions of A/300 to be included in the document (see Table A.1.1). This process further acknowledges that ATSC 3.0 emissions and equipment conforming to different versions of A/300 might coexist at any given time, and that the backward compatibility requirements of ATSC 3.0 evolution ensure interoperability in such scenarios.

Table A.1.1 is provided to show which ATSC 3.0 documents (Standards, Recommended Practices, Technology Group Reports and Implementation Guides) and their respective versions (indicated by their dates) are included in each previous version of A/300. Rows with gray backgrounds indicate informative references, while all others are normative. Amended documents (or those with Corrigenda) are appended with "+A*n*" (or a "+C*n*"), where *n* = Amendment (or Corrigendum) number.

Note that a summary of substantive changes made between revisions of ATSC documents is included on the ATSC website.

It should also be noted that *Candidate Standards* of any ATSC 3.0 standard listed below may be published at any time. These are used during development of revisions, and often will evolve into the next version of a published standard. They do not represent approved technology, and are only provided to allow developers to collect, test and track possible future updates to a standard. Implementers are advised to seek out these Candidate Standards for their research and development purposes, but technologies included in any Candidate Standard should not be implemented into commercially released products until the technologies appear in a published full standard (which will, in turn, generally be adopted into the current suite of ATSC 3.0 standards through its appearance in the next revision of the A/300 standard.)

Table A.1.1 Revisions of ATSC 3.0 Documents Included in Each Version of A/300

Document	Title	A/300 Version						
		2024	2023	2022	2021	2020	2019	2017[4]
A/321	System Discovery and Signaling	2024-04	2023-03	2022-03	2016	2016	2016	2016
A/322	Physical Layer Protocol	2024-04	2023-03	2022-03	2021	2020	2018	2017
A/323	Dedicated Return Channel for ATSC 3.0	2024-04	2023-03	2022-03	2018	2018	2018	---
A/324	Scheduler / Studio to Transmitter Link	2024-04	2023-03	2022-03	2021	2018	2018	2018
A/325	ATSC 3.0 PHY Lab Performance Test Plan	2024-04	2023-03	2022-03	2018	2018	2018	---
A/326	ATSC 3.0 Field Test Plan	2024-04	2023-03	2022-03	2017	2017	2017	---
A/327	Guidelines for the Physical Layer Protocol	2024-04	2023-03	2022-03	2021	2020	2018	---
A/330	Link-Layer Protocol	2024-04	2023-03	2022-03	2019	2019	2019	2016
A/331	Signaling, Delivery, Synchronization, and Error Protection	2024-04	2023-03	2022-03	2021 +A1	2020	2019	2017
A/332	Service Announcement	2024-04	2023-03	2022-03	2017 +A1	2017	2017	2017
A/333	Service Usage Reporting	2024-04	2023-03	2022-03	2017	2017	2017	2017
A/334	Audio Watermark Emission	2024-04	2023-03	2022-03	2016	2016	2016	2016
A/335	Video Watermark Emission	2024-04	2023-03	2022-03	2016 +A1+A2	2016 +A1	2016	2016
A/336	Content Recovery in Redistribution Scenarios	2024-04	2023-03	2022-03	2019 +A1	2019	2018	2017
A/337	Application Event Delivery	2024-04	2023-03	2022-03	2019	2019	2019	2018
A/338	Companion Device	2024-04	2023-03	2022-03	2021	2019 +A1	2017	2017
A/339	Audio Watermark Modification and Erasure	2024-04	2023-03	2022-03	2017	2017	2017	---
A/341	Video – HEVC	2024-04	2023-03	2022-03	2019 +A1	2019	2019	2017
A/342-1	Audio Common Elements	2024-04	2023-03	2022-03	2021	2017	2017	2017
A/342-2	AC-4 System	2024-04	2023-03	2022-03	2021	2017	2017	2017
A/342-3	MPEG-H System	2024-04	2023-03	2022-03	2021	2017	2017	2017
A/343	Captions and Subtitles	2024-04	2023-03	2022-03	2018 +A1	2018	2018	2017

[4] The 2017 version of A/300 is not currently published. Contact the ATSC office for access to this document.

A/344	ATSC 3.0 Interactive Content	2024-04	2023-03	2022-03	2021	2020 +C1	2019	2017
A/350	Guide to the Link-Layer Protocol	2024-04	2023-03	2022-03	2019	2019	2019	---
A/351	Techniques for Signaling, Delivery and Synchronization	2024-04	2023-03	2022-03	2021	2019 +A1	2019	---
A/360	ATSC 3.0 Security and Service Protection	2024-04	2023-03	2022-03	2019 +A1+A2	2019	2019	2018
A/361	Security and Content Protection	2024-04	2023-03	2022-03	2019	2019	---	---
A/362	Digital Rights Management (DRM)	2024-04	2023-03	2022-03	2020	2020	---	---
A/370	Conversion of ATSC 3.0 Services for Redistribution	2024-04	2023-03	2022-03	2019	2019	---	---
A/380	Haptics for ATSC 3.0	2024-04	2023-03	2022-03	2021	---	---	---
A/200	Regional Service Availability	2024-04	2023-03	2022-03	2020	CS 3-6-2019	CS 4-26-2018	---
T/300	ATSC 3.0 Launch - DASH Timeline and IMSC1	2020	2020	2020	2020	---	---	---
T/301	ATSC 3.0 Initial AC-4 Implementation	2019	2019	2019	2019	---	---	---
n/a	ATSC 3.0 Advanced Emergency Information System Implementation Guide	2019	2019	2019	2019	---	---	---

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