ATSC Implementation Team Document
ATSC 3.0 Advanced Emergency Information System
Implementation Guide

Doc. AEA-IT-024r31
20 February 2019

Advanced Television Systems Committee
1776 K Street, N.W.
Washington, D.C. 20006
202-872-9160

The Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards and recommended practices for digital television. ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries. Specifically, ATSC also develops digital television implementation strategies and supports educational activities on ATSC standards. ATSC was formed in 1983 by the member organizations of the Joint Committee on Inter-society Coordination (JCIC): the Electronic Industries Association (EIA), the Institute of Electrical and Electronic Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable Telecommunications Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE). For more information visit www.atsc.org.

Revision History

Version	**Date**
v0.9 approved for release to ATSC, AWARN and CTA	July 17, 2018
V1.0 approved for release	February 22, 2019

Table of Contents

Index of Figures and Tables

ATSC Implementation Team Document
ATSC 3.0 Advanced Emergency Information System
Implementation Guide v1.0

1. ADVANCED EMERGENCY ALERT IMPLEMENTATION TEAM (AEA-IT)

Advanced Emergency Information, as a key element of the next-generation ATSC 3.0 broadcast standard, promises to create new significant value for viewers, consumer electronics manufacturers, broadcasters and various emergency message origination authorities. The addition of advanced emergency messaging capability and the accompanying rich-media emergency information represents a compelling application for ATSC 3.0.

The AEA-IT provides a venue for industry discussions of issues related to implementation of emergency messaging. The AEA-IT may address business, regulatory and technical requirements for the successful inclusion of emergency messaging and the successful commercial rollout of ATSC 3.0.

This Guide was authored by the AEA-IT. It is not an ATSC Standard or Recommended Practice. As such, this Guide was not subject to the ATSC procedures that govern the development of ATSC Standards and Recommended Practices. However, the information contained herein represents the consensus agreement of the members of the AEA-IT, which comprise a variety of stakeholders within the ATSC 3.0 AEA ecosystem, including broadcasters, consumer electronics manufacturers, and equipment and technology vendors.

2. SCOPE AND BACKGROUND

This document describes methods and examples for implementing the ATSC 3.0 Advanced Emergency informAtion (AEA[1]) system features. The present version of this document focuses on AEA implementations in North America.

This ATSC 3.0 AEA system enables broadcasters to deliver timely, in-depth emergency-related information to their viewers, which can strengthen the connection between the audience and the station and provide critical information in times of need.

AEA information is not intended to replace current FCC emergency messaging regulations. It is expected that stations will fulfill their obligations regarding EAS in the same way as with ATSC 1.0, and stations that employ "burned in" banners and audio for non-EAS emergency messages may continue with that practice as with ATSC 1.0. The ATSC 3.0 AEA system enables broadcasters to provide a rich set of supplemental information.

The ATSC 3.0 AEA system includes a "wake-up" function that allows receivers in stand-by mode to detect when an emergency message has been initiated by a station. It provides a mechanism for delivering rich media via broadcast and/or broadband, such as evacuation maps, images associated with AMBER alerts, weather radar maps, user-generated videos, etc. It defines video and audio watermarks that are capable of enabling receivers that do not have access to the

[1] Note that the acronym "AEA" refers to Advanced Emergency informAtion. When AEA is used in the context of "AEA-IT", the acronym refers to Advanced Emergency Alert Implementation Team. ATSC may align the interpretation of "AEA-IT" with that of "AEA"; i.e., both referring to Advanced Emergency informAtion. The AEA-IT has found that Advanced Emergency informAtion better describes the intended capabilities of the ATSC 3.0 AEA system.

full broadcast signaling tables, e.g., those connected to pay-service set-top boxes, to access AEA rich media via broadband or a subset of AEA information directly in the watermark.

2.1 Public and Private AEA Messages

The ATSC 3.0 AEA system is capable of sending public-facing AEA messages intended for consumers, and non-public-facing messages, intended for first responders or other restricted audiences. The present version of this document is focused on using the system for public-facing AEA messages.

2.2 User Experience

This document is not intended to provide specific principles or guidelines on usability, user interface (UI) or user experience (UX) design. This document focuses on the technical aspects of implementation of the ATSC 3.0 AEA features.

3. SCOPE OF AEA MESSAGING

The AEA capability in ATSC 3.0 is highly versatile, and the scope of AEA messaging can encompass a range of valuable information to viewing audiences and their communities, as illustrated in Figure 1 and described in Table 1.

Figure 1 Scope of AEA messaging.

Table 1 Examples of Emergency Message Types

Types of Emergency Messages	Examples
"Timely Warnings" – the types of messages issued by campuses – extremely short fuse events.	School lockdowns; active shooter, etc.
Emergency Warnings – EAS, public safety and weather alerts.	Weather alerts, AMBER alerts, etc.
Emergency Information - EI is a broader category of information and instructions. EI may be issued even though there is no "alert." EI may also enhance an alert with more information on what is happening, what the response organization is doing, and what else the public should do for its safety.	Safety messages, follow-on evacuation instructions, post-emergency information, media communications from authorities, etc.
Bulletins and Advisories – information that may not fit into the category of an "alert" or "EI" but still represents information of important interest to the viewer or community.	School closing lists, major traffic/road information, list of shelters, emergency preparedness info, etc.

4. REFERENCES

All referenced documents are subject to revision. Users of this document are cautioned that newer editions might or might not be compatible. The following documents contain information that may be helpful in implementing the methods described in this Guide.

[1] ATSC: "ATSC Standard: ATSC 3.0 System," Doc. A/300:2017, Advanced Television Systems Committee, Washington, DC, 19 October 2017.

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

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

[4] ATSC: "ATSC Standard: Signaling, Delivery, Synchronization, and Error Protection," Doc. A/331:2017, Advanced Television Systems Committee, 6 December 2017.

[5] ATSC: "ATSC Standard: Audio Watermark Emission," Doc. A/334:2016, Advanced Television Systems Committee, Washington, DC, September 19, 2016.

[6] ATSC: "ATSC Standard: Video Watermark Emission," Doc. A/335:2016, Advanced Television Systems Committee, Washington, DC, September 20, 2016.

[7] ATSC: "ATSC Standard: Content Recovery in Redistribution Scenarios," Doc. A/336:2018, Advanced Television Systems Committee, Washington, DC, 24 April 2018.

[8] ATSC: "ATSC Standard: Application Signaling," Doc. A/337:2018, Advanced Television Systems Committee, Washington, DC, January 2, 2018.

[9] ATSC: "ATSC Standard: Companion Device," Doc. A/338:2017, Advanced Television Systems Committee, Washington, DC, 17 April 2017.

[10] ATSC: "ATSC Standard: Interactive Content," Doc. A/344:2017, Advanced Television Systems Committee, Washington, DC, 18 December 2017.

[11] ATSC: "ATSC Standard: ATSC 3.0 Security and Service Protection," Doc. A/360:2018, Advanced Television Systems Committee, Washington, DC, 09 January 2018.

5. DEFINITION OF TERMS

5.1 Acronyms and Abbreviations

The following acronyms and abbreviations are used within this document.

AEA Advanced Emergency informAtion
AEA-IT ATSC Advanced Emergency Alert Implementation Team
AEAT Advanced Emergency informAtion Table
API Application Program Interface
ATSC Advanced Television Systems Committee
BA Broadcaster Application (App)
CAP Common Alert Protocol
EAN Emergency Alert Notification (aka "Presidential Alert")
EAS Emergency Alert System
EFDT See A/331 [4]
EI Emergency Information
FIPS Federal Information Processing Code
IANA Internet Assigned Numbers Authority

LLS Low Level Signaling
NPT National Periodic Test
NRT Non-real Time (file)
OSN On Screen Notification
OTA Over the Air (i.e., via digital terrestrial broadcast)
PLP Physical Layer Pipe
RA Receiver Application (App)
RMT Required Monthly Test
RWT Required Weekly Test
SAME Specific Area Message Encoding
SLT Service List Table
WEA Wireless Emergency Alert

5.2 Terms

The following terms are used within this document.

Advanced Emergency Information (AEA) system – A capability within ATSC 3.0 for transmitting urgent notices related to emergency information, with messages structured in a specific Advanced Emergency Information Message Format, and transmitted in an Advanced Emergency Information Table (AEAT) as a Low Level Service (LLS).

Advanced Emergency Information (AEA) Message – Urgent notice regarding a broad range of emergency-related information, including urgent bulletins, advisories, all-hazard warnings and other urgent information over an ATSC 3.0 system. An AEA message is formatted in the Advanced Emergency Information Message Format (AEA-MF) structure. One or more AEA messages are contained in an Advanced Emergency Information Table (AEAT).

Advanced Emergency Information Table (AEAT) – One of the instances of LLS information in ATSC 3.0. The AEAT is composed of one or more AEA (Advanced Emergency Information) messages.

Advanced Emergency Information Message Format (AEA-MF) – An XML-based digital message format for ATSC 3.0 related emergency message transmission.

Broadcaster Application (App) – See A/344 [10].

Emergency Alert System (EAS) – A national public warning system governed by Federal Communication Commission (FCC) rules that requires broadcasters, cable television systems, wireless cable systems, satellite digital audio radio service (SDARS) providers, and direct broadcast satellite (DBS) providers to supply the communications capability to the President to address the American public during a national emergency. EAS is also used by the National Weather Service to relay weather-related warnings, and may also be used by state and local authorities to deliver important emergency information about other types of hazardous situations. (Note that EAS is a subset of Emergency Information; Emergency Information messages can include EAS information.)

Emergency Communications – Urgent notices regarding matters that affect the health and safety of people and/or property in a community; emergency communications may span the spectrum of emergency information content.

Emergency Information – Accurate, timely, and useful information that may be available and disseminated to the general public or to specific communities; any text, voice, video, or other

information provided by an authorized official and includes both general information and crisis and emergency risk communication activities; accurate, timely, and useful information and instructions that may be available and disseminated throughout the emergency period. (Note that Emergency Information encompasses a broader range of information and information sources than EAS.)

Federal Information Processing System (FIPS) Codes – A standardized set of numeric or alphabetic codes issued by the National Institute of Standards and Technology (NIST) to ensure uniform identification of geographic entities. The entities covered include: states, counties, American Indian and Alaska Native areas, etc. FIPS codes are used by in the EAS system and in Integrated Public Alert & Warning System (IPAWS) as one method to specify geographic warning areas.

Receiver Application (App) – A software program which is native to a receiving device that enables the device to render AEA material.

Specific Area Message Encoding (SAME) – The protocol used to encode the Emergency Alert System (EAS) and NOAA Weather Radio (NWR) in the U.S. and Weatheradio Canada in Canada. The header code in a SAME protocol message will consist of a preamble, originator code, event code, location code (see FIPS), message duration time, message issuance time, and call-sign identification.

Timely Warning (Clery Timely Warning Notices) – Notifications that are specifically related to compliance with the federal Clery Act, which requires colleges and universities to notify students and employees whenever there is a threat that a serious crime is ongoing or may be repeated so that campus community members can protect themselves from harm.

Wake-up Field – Two bits in the bootstrap signal are allocated to indicate to receivers that are in stand-by mode that "wake up" function is requested. The two bits used together are referred to as the Wake-up Field.

6. ATSC 3.0 AEA FUNCTIONS AND METHODS

This section provides a summary of ATSC 3.0 AEA capabilities and features. Functions related to emergency information appear in several documents within the ATSC 3.0 suite of standards. A/300 [1] includes a list of the relevant ATSC 3.0 Standards and the areas each covers.

6.1 Wake-up Signaling

The ATSC 3.0 physical layer includes signaling that a receiver can monitor with minimum power consumption while in stand-by mode. There are two bits allocated to this wake-up function, which together comprise the Wake-up Field. The Wake-up Field enables a broadcaster to indicate the presence of a new or updated wake-up event. See A/321 [2] for details.

6.2 Advanced Emergency Information Table (AEAT)

The AEAT enables broadcasters to signal details about an emergency, including location, priority level, intended audience, and more.

ATSC 3.0 enables broadcasters to deliver AEA-related rich media files via either broadcast or broadband. The AEAT provides a mechanism to associate the rich media files with a given emergency message (e.g., evacuation maps, videos of traffic on evacuation routes, or other types of files) and an indication of a channel that is currently presenting live coverage of the event. See A/331 [4] for details.

The AEAT can be parsed by a receiver that has implemented AEA features natively or by a broadcaster application that is running on a receiver that has implemented the interactive runtime environment. The interactive runtime environment is described in A/344 [10].

6.3 OnScreenNotification (OSN)

The OSN is a Boolean signaling mechanism that enables broadcasters to convey to receivers that something is in the A/V broadcast that should not be obscured by visual or audible "overlays" generated at the receiver. One use case for the OSN is when a "burned-in" emergency crawl and its corresponding audio is present in the audio/visual (A/V) portion of the broadcast. If the OSN is "on" then the receiver can suppress receiver-generated graphics and sound until the OSN is "off." In this way, the broadcaster can indicate a preference that the burned-in crawl be allowed to conclude before the receiver or a broadcaster app presents AEA material. The OSN is described in detail in A/331 [4].

6.4 Audio and Video Watermarks

ATSC 3.0 receivers in homes that get television service from a Multichannel Video Programming Distributor (MVPD) may be connected to a set-top box (STB) that delivers uncompressed audio and video. Such receivers would not receive the ATSC 3.0 service signaling and thus may not receive the AEAT, the OSN or file-based content that would be available to receivers getting the signal over the air (OTA). Audio and video watermarks are designed to enable these receivers to "recover" information that was in the OTA broadcast but is not in the uncompressed A/V signal coming from a STB. Use of ATSC 3.0 watermarks might be subject to business discussions between broadcasters and their MVPD partners.

The audio watermark is capable of delivering 50 bits of data per every 1.5 seconds via the audio portion of a service. The video watermark is capable of delivering up to 60 Bytes of data per video frame via the video portion of a service. Both watermarks are designed to be resilient to various content transformations such as transcodes, frame rate conversions, etc. As such it can be expected that an ATSC 3.0 receiver that has watermark detection capability could recover data found in a watermark, even if the content arrives uncompressed via an interface such as an HDMI cable.

The audio watermark requires a broadband connection to function. The small payload is used to enable a receiver to use a broadband connection to retrieve content such as an AEAT, AEA rich media and other content and signaling from a remote server.

The video watermark is capable of conveying a larger amount of data such as a subset of the AEAT information directly, with no broadband connection needed. It also enables a receiver to use a broadband connection to retrieve additional data in a similar manner to the audio watermark.

Information about the audio and video watermark construction can be found in A/334 [5] and A/335 [6], respectively. Details about the watermark payload and payload use are found in A/336 [7].

6.5 Runtime Environment

ATSC 3.0 includes an interactive application standard which enables a broadcaster application (BA) to perform a wide variety of functions using media files, JavaScript logic, and more on receivers that have the runtime environment implemented. See A/344 [10] for details. One of the functions of a BA can be to present AEA material to a viewer by accessing and parsing the AEAT. See Section 6.5 for more details.

BAs can perform a wide variety of functions, such as offering play-along interactivity, showing sports stats and weather updates, inserting targeted ads, etc. The majority of these actions are opaque to the receiver; i.e., the receiver does not know the nature of the media the BA is presenting at any given time. Thus, it is possible for a BA to present AEA material and the receiver to be unaware of this. This situation should be avoided so that the receiver does not also attempt to render AEA material at the same time. The method by which a BA informs a receiver of its intent to render AEA material is via the Subscribe AEAT API (see A/344 [10]). Note that if the broadcaster creates BA functions that render AEA material without also subscribing to the AEAT, the receiver might also try to render the same AEA material, which might be confusing to the viewer. See also Section 10.

6.6 Companion Devices

ATSC 3.0 includes a document describing Companion Device (aka Second Screen) features of ATSC 3.0, which includes AEA-related functions. A/338 [9] covers this topic.

7. STATION OPERATIONS AND WORKFLOW

A high-level diagram of an example ATSC 3.0 AEA system is described below and illustrated in Figure 2.

- Emergency messages can be generated by the National Weather Service, FEMA, local or state emergency managers (EMs), other content providers, or the station itself
- Emergency messages enter the station AEA system workflow
- Rich media can also be generated by any entity: national, state, local, or the station itself
- The emergency message is processed into a standard format usable by the AEA system
- Wake-up priority is set based upon station policy and current state of series of AEA messages
- `OnScreenNotification` is appropriately set in accordance with UX design principles (which are outside the scope of this document) and in coordination with state of any existing "burned in" EAS crawl in the main A/V feed
- A Broadcaster Application can also be supplied by the broadcaster and can be responsible for handling AEA messages and associated rich media
- The rich media elements are associated with the emergency message and are input into the AEA signal flow
- The AEA components (application, messages and rich media) are then broadcast and also can be made available for broadband delivery

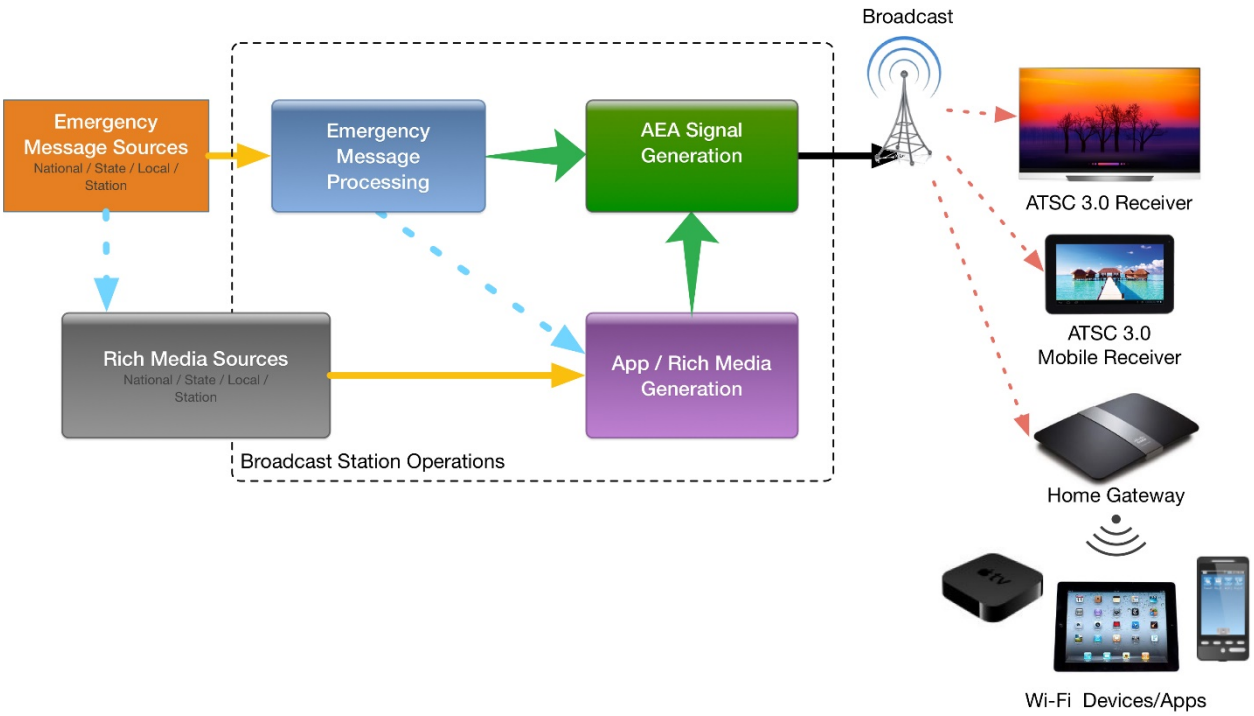

Figure 2 Example AEA signal flow.

Deploying AEA requires the addition of software or a server with software to the ATSC 3.0 broadcast system and the interfacing of the EAS system to the station's existing EAS receiver/processor.

Note in most cases approved EAS receivers (e.g., DASDEC™ or similar systems) are utilized as the connection to IPAWS and therefore no additional authorization is required for AEA.

7.1 AEA Station Policy

One of the benefits of AEA is its flexibility. Broadcasters can develop policies for use of the AEA system, and might work together with the emergency management community as these policies are considered. For example, an AEA message about an imminent threat may be auto-forwarded through the station to the air, or may be curated in the station by station news/weather personnel.

Many broadcasters may already have a policy in place for the current EAS system. Similarly, when deploying AEA, existing policies and procedures may be extended to direct the usage of the AEA System. Procedures already in place covering given types of events (Weather, AMBER Alert, Emergency information, Public information), the severity of the event (warning, watch), and the geographical areas covered by the station's broadcast transmission will have to be considered.

Additionally, AEA will allow for more robust messaging and "opt in" messaging by the user so that additional information can be provided. This could be information that a station would not necessarily put on a crawl over programming. For example, an event might be simply a thunderstorm watch, which might only warrant a TV crawl every 5–10 minutes, but with AEA a great amount of rich media showing a developing storm could be provided.

The AEA system provides a much more informative user experience. Figure 3 provides an example decision tree that station personnel may use to determine the best use of the system for a given situation. Below is a description of the example decision tree.

- The Advanced Emergency Information can be triggered by one of three events highlighted at the top of the diagram. First by an Emergency Alert or CAP Alert received by the station decoder, second due to a "news or weather" event and finally by a change of an existing event.
- During an EAS or CAP alert the first test is to ensure the alert pertains to the coverage area. Second is whether the alert is a required alert or an optional alert (e.g., alert from National Weather Service). In the case of required alert, such as a required monthly or weekly EAS test (RMT, RWT), the alert would simply be logged and would not generate an AEAT.
- A National Periodic Test may produce an AEAT if the broadcaster wanted to supply detailed information to assure the public that this was a test and not an actual emergency. Finally, an actual Emergency Action Notification (EAN) would generate an AEAT of the highest priority based on the priority table in A/331 [4].
- The Advanced Emergency Information system is a powerful tool for public authorities and broadcasters that can provide news and weather and is triggered by either a news or weather event or change of existing event as described at the top of the figure. The wake-up field would be handled in accordance with Section 7.2 below. Finally, any change to the AEA priority or status would be sent over the broadcast chain to the associated receivers.

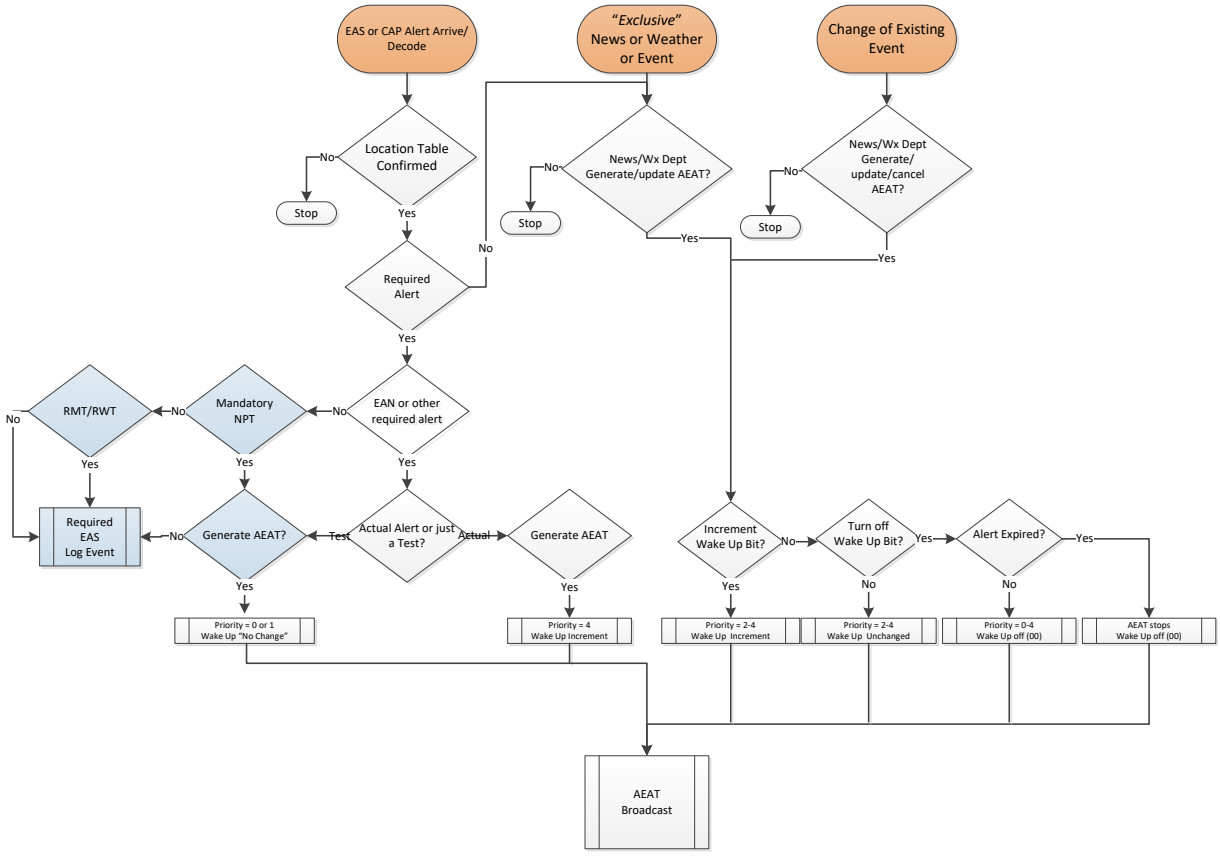

Figure 3 AEA example decision flow.

For reference, two tables from A/331 [4] have been reproduced (Table 2 and Table 3 in this document).

Table 2 Code Values for `AEAT.AEA@priority`

`priority`	**Meaning**
4	Maximum Priority ▪ Urgent or extreme message context ▪ A highest level of alert (e.g., the U.S. Emergency Action Notification/EAN) ▪ A Canadian "broadcast immediate" requirement in the source alert message ▪ Defined by station operator a time critical alert (e.g. earthquake/EQW or tornado/TOR
3	High Priority ▪ Defined by station operator for messages of an important or severe context ▪ May also be used for a "broadcast immediate" message ▪ Overrides any previous messages
2	Moderate Priority ▪ Defined by station operator for messages of a moderate but actionable priority
1	Low Priority ▪ Defined by station operator for messages of an informative nature, or of minor and non-actionable status (e.g., weather watches)
0	Minor Priority ▪ Defined by station operator for periodic or occasional messages of extremely minor context (e.g., test or administrative signals) ▪ Messages should not interrupt the user from other interactive functions
other values	ATSC Reserved

Table 3 Meaning of AEA Wake-up Field

Value	**Meaning**
'00'	No emergency to wake up devices is currently signaled
'01'	Emergency to wake up devices - setting 1
'10'	Emergency to wake up devices - setting 2
'11'	Emergency to wake up devices - setting 3

7.2 Wake-Up Policy

One of the opportunities that AEA and ATSC 3.0 enable is the concept of the Wake-up Field. This 2-bit field enables the broadcaster to indicate the presence of an AEA message to receivers in "sleep" or "stand-by" mode. When a receiver detects the presence of an active Wake-up Field, it can first parse the AEAT and use the information in the AEAT to determine whether or not to enter "active" mode. With 4 different possible values, the receiver can distinguish between a continuation of a previous wake-up event and a new wake-up event that follows directly after an old one.

The policy that the station develops can include a "wake-up" policy to determine when and what priorities and priority levels will trigger a new or updated active Wake-up Field state.

The Wake-up Field states include

- 00 – No active emergency message
- 01, 10, and 11 – Rotating through these values will inform the receiver that there is either a new emergency message or that there is new and substantial information being added to an existing message

According to A/331 [2], at least one AEAT is present with the `@wake-up attribute` = "true" when the Wake-up Field is any non-zero value. (See Section 7.10.) This enables a receiver that detects the presence of a new or updated active Wake-up Field to first decode enough of the broadcast to interrogate the associated AEAT and look for information on how to proceed.

(Conversely, it is acceptable to have an AEAT without the active Wake-up Field. In this case emergency info is provided to viewers when the device is in active use.)

There are 4 Priority states within the AEAT to allow for a hierarchy of how a receiver capable of AEA may respond once the Wake-up Field has been activated.

7.3 Long Term Emergency Events

A long term emergency event may continue to require additional information after the threat is over (e.g., shelter locations and power outage information after a hurricane has passed). In this use case the AEAT can still be present at this point and devices with AEA capabilities will still be able to supply information to the viewer.

Typically, as long as a notification that merits a wake-up is in effect, the Wake-up Field will remain in a non-00 state. However, if the station determines that wake-up is no longer required the Wake-up Field may be returned to a 00 state as per pre-determined policy. If new and substantial information becomes available, then the Wake-up Field can be activated anew if deemed appropriate.

When developing the wake-up policy, it must be thought through and considered with the utmost of care; any over use of the wake-up abilities of the system will only result in nuisance emergency messages and accusations of "crying wolf."

7.4 AEA NRT File Management

Rich media files related to the AEA message are sent via broadcast or broadband according to the Non-Real Time (NRT) data delivery method described in A/331 [4]. The AEAT signals the NRT files that are associated with each given AEA message.

7.4.1 NRT File Expiration

The NRT data delivery method described in A/331 [4] includes an EFDT parameter allowing a broadcaster to signal an expiry date for NRT files as determined by the alert originator/broadcaster for any given file. The expiry dates are intended to help receivers manage memory allocation. When broadcasters set realistic expiry dates that are relevant in the context of the AEA being provided in the EFDT the receiver can optimally manage its file storage space according to the broadcasters' wishes. For example, a broadcaster might wish for a given file to be available to a viewer after the original emergency message is expired, in which case the broadcaster assigns a longer expiry date to that file.

Providing appropriate expiry dates will help the receiver manage its cache as closely to the broadcaster's wishes as possible without overflow.

7.4.2 NRT File Updates and Deletion

As described in Section 7.6, emergency messages can be updated from time to time. In some cases one or more NRT files associated with an AEA message may need to be added, updated or removed.

All the resources that are valid for a given AEA message are signaled in all the instances of the AEAT carrying that message. In the case that an AEA message is updated, but a given NRT file has not changed, the file is still signaled in the update AEAT. This is to ensure that a receiver that did not receive the earlier versions of that AEA message can find and access the file.

An NRT resource can be updated with a newer version. The method for updating a resource is via the versioning mechanism in a MIME package as described in Section 6.2.1 of A/344 [10].

In order to indicate that a given file should be deleted and no longer presented in the context of a given AEA message, an updated version of the file is sent with an expiry date of "now".

7.4.3 NRT File Types

It is possible to signal a variety of types of NRT files in the AEAT, such as images, video clips, audio clips, images, and HTML pages. The file type can be any type that is permissible according to A/344 [10].

Some permitted file types are "app-like" files[2], such as HTML5, which can contain presentation logic, including page navigation buttons, placement of NRT resources in the context of a template, etc. This type of file could be fully self-contained, including all the presentation logic and all the resources that will be presented, or could be a "launch point" file such as "index.html", which uses pointers to other files in order to assemble the presentation. In addition, there can be .html or similar files that are intended as resources rather than a launch-able page.

Since AEA NRT files might be rendered by an RA, it is important to consider how app-like files might be presented, especially when files of other types are also signaled in the same AEA message.

When multiple files are signaled with a given AEA message, an RA might present a list of the files along with the `@mediaDescs` so that viewers can decide which files to view and in what order. If only one file is signaled, the receiver might simply present that file, without first presenting a list. If an app-like file is the only file signaled with a given AEA message, then an RA could present that file without first presenting a list. If an app-like file is signaled with other files, the RA might present a list of files and the broadcaster could give the app-like file a `@mediaDesc` of "start here" or similar clue to the viewer to select the app-like file first.

7.5 System Capabilities for Visually Impaired

ATSC 3.0 AEA system provides methods for associating aural representations of text fields which can aid the visually impaired.

Broadcasters can signal audio files intended for this purpose in the Media element of the AEAT, and use the `@mediaType` attribute to indicate the purpose of the audio file. The `@mediaType` attribute can be set to:

- `EventDescAudio` to indicate the aural version of the text carried in the `@eventDesc` attribute
- `AEAtextAudio` to indicate the aural version of the text carried in the `@aeaText` attribute

See also Section 9.7.1.

In addition, broadcasters might offer similar aural renderings of text within a BA.

7.6 Emergency Message Types: Alert (New Message), Update, and Cancel

There are three AEA message types which may be issued: alert (new message), update and cancel. This section describes how each message type is used in order to convey the alert originator's intent for the disposition of the message. See also Section 9.2.1 which pertains to receiver behavior for the different message types.

[2] • App-like files signaled in the AEAT conform to CTA WAVE 5000 per A/344. Such files would not have access to the A/344 websocket APIs.

7.6.1 Alert (New Message)

Urgent or important information may be communicated to viewing audiences by composing an AEA "alert" (`aeaType` value of "alert"; see Section 7.10 on AEAT). A new message ("alert") should be issued for a new or unique event or situation.

New messages may include rich, actionable content in the `<AEAText>` element, along with a short description of the event or incident in the `<EventDesc>` element (see Section 7.10 on AEAT). Information in the `AEAText` element describes the current incident or event, expected developments, anticipated impact, and any recommendations that may be applicable. `AEAText` should be clear and concise according to best practices as determined by social science research. The new message may include various media resources, such as audio files, video files, graphics or documents.

7.6.2 Updates

An "update" is used to amend or update a specific previously issued AEA message (`aeaType` value of "update"; see Section 7.10 on AEAT). After an AEA message has been issued, an event may evolve or the emergency message itself may need to be updated with new or additional information, additional media resources, changing the expiration time of the message, or other changes. If the original AEA message has not yet expired, an AEA update message may be issued.

An update, for example, would be amending a message with (minor) corrections, additional textual information (expanding on the contents of the `AEAText`, for example), or additional multimedia that may become available while the event is active. An "update" should be sent if there is a change in the expiration time in a previous active message describing the change. An "update" allows a message to be updated with new information, without starting an entirely new AEA message thread.

An AEA message may be cancelled by issuing an "update" with an explanation in `AEAText` and a change in the expiration time.

When an AEA message needs to be changed, a new message is issued that refers back to the previous AEA message. An AEA "update" is issued referencing the previous message that is being superseded. The reference value in the update is the `refAEAId` (see Section 7.10 on AEAT), which is simply the identifier of the original message.

In the following examples, the broadcaster is careful to include information about the changes in the update in the `AEAText` field. Examples of `AEAText` in an update message include:

- Example 1 (expiration change): A wildfire warning has been extended until 10 p.m. PST. Authorities have advised that there will be substantial risk from a rapidly spreading wildfire.
- Example 2 (event time change): A wildfire warning has been cancelled for Smith County, effective 9 p.m. PST. Authorities still advise residents not to return to the area until local officials provide additional information. The wildfire warning has been cancelled for Smith County, effective 9 p.m. PST.
- Example 3 (additional info): Underwood County School District has announced the additional closings of the following schools: Underwood Elementary, Underwood Primary. The full list of school closings follows: Underwood High School, Underwood Catholic Schools, Underwood Elementary, and Underwood Primary. We will keep you updated as additional schools announce closures.

- Example 4 (message error): An evacuation warning for Corona County was issued in error. There is no evacuation. The evacuation warning you received for Corona County has been recalled. There is no emergency situation in Corona County.

  Note: Once the original AEA message has expired, an update message should not be sent referencing that expired message. Rather, a new AEA message (type "alert") should be composed. Also note that there is no benefit to continuing to issue the message referenced by `refAEAId` once the update message has been issued. Continuing to do so might cause unpredictable behavior in receivers.

7.6.3 Cancellations

To cancel a specific previous AEA message, an AEA "cancel" message is sent (`aeaType` value of "cancel"; see Section 7.10 on AEAT)). Per A/331 [4] an AEA cancel message references the AEA message to be terminated (`refAEAId` value). There is no benefit to continuing to issue the message referenced by `refAEAId` once the cancel message has been issued. Continuing to do so might cause unpredictable behavior in receivers.

An AEA cancel message may include a description of the event cancellation in the message's `AEAText` element. Below is an example of the message text which may be contained in a cancel message.

- Example 4 (message error): An evacuation warning for Corona County was issued in error. There is no evacuation. The evacuation warning you received for Corona County was sent in error. There is no emergency situation in Corona County.

However, because the AEA message is no longer disseminated, the AEA cancel message itself may no longer be available to the audience after receipt. Broadcasters can issue an AEA "update" with amended expiration time, rather than an AEA "cancel" message.

7.7 Station Workflow

Station on-air operations range from hub-based remote control with no local operators to stations staffed with operations and news personnel around the clock. For unstaffed Master Controls the AEA Content Server can be configured to pass through selected messages or trigger the display of pre-built messages, images, HTML pages, etc. At the other extreme, a fully staffed news operation can contribute a great deal of rich content.

Using a weather-related warning as an example, a fully staffed station's workflow could be as follows:

1) Master Control informs a meteorologist when a weather watch or warning is issued.
2) Meteorologist verifies accuracy and gives Master Control approval to air and forward banner information to AEA.
3) If no meteorologist is on duty, Master Control airs and forwards the weather watch or warning information as per local policy.
4) Master Control calls the news assignment desk about the watch/warning when the banner is running.
5) News Department will be responsible for enhanced AEA content.

Using a Tornado Warning as an example, if there is a clear and present danger from a tornado on the ground, EAS/NWS alerts can be forwarded to AEA Content Server as they come in and a banner runs continuously during the event.

The News Department can use the AEA Content Server user interface to create compelling coverage. Enhanced AEA weather coverage could include:

1) Recorded custom video of meteorologist
2) Current radar stills or storm tracking graphics
3) Cut down or repurposed newscast content
4) Shots captured from traffic cameras
5) Graphic pushing viewers to send photos to station website
6) Viewer or media photo slideshow

Another example of the full potential of AEA can be found in how a Child Abduction Emergency (CAE) or AMBER Alert could be processed:

- The plan designated alerting authority issues a CAE or AMBER Alert. The station may learn of the abduction via a WEA, EAS alert, email, RSS feed, or text. The News Department would use the AEA Content Server user interface to populate predefined fields and file locations. The Content Server would use basic data such as victim and abductor physical and vehicle descriptions, pictures of same and Law Enforcement contact information to create an informative, timely AEA message.

7.8 Broadcaster Apps (BAs) and Receiver Apps (RAs)

Stations may include Broadcaster Apps (BAs) as part of their service offerings. BAs can perform a wide variety of functions that can enhance a viewer's enjoyment of a service or enable new business models for broadcasters. Examples of functions BAs can enable are voting/polling/play-along, T-commerce, sports tickers, weather updates, dynamic ad insertions, personalization, and much more. BAs can run on receivers that have an ATSC 3.0 interactive environment implementation (A/344 [10]).

Use of BAs by broadcasters and implementation of the interactive environment on receivers are optional. As such, a broadcaster can include a BA in a service, and those receivers with an interactive environment can run the BA. Receivers without an interactive environment cannot run the BA and so the BA is ignored.

In addition to the example functions listed above, a BA can also render AEA material. Alternatively, broadcasters can rely on native receiver apps (RAs) to render AEA material. See important information about using BAs and/or RAs for rendering AEA material in Section 10.

7.9 Station Emission Configuration

The previous ATSC 1.0 system offered broadcasters only one operating point along the trade-off continuum of capacity to robustness; i.e., 19.39 Mbps at 15dB SNR. The ATSC 3.0 system offers broadcasters tremendous flexibility to configure their emission, allowing broadcasters to operate at different points along this trade-off continuum, opting for lower capacity and higher robustness, or higher capacity and lower robustness, or both. Each operating point, or configuration, is referred to as a Physical Layer Pipe (PLP). Broadcasters can deliver multiple services, each with its own PLP configuration, and can even use multiple PLPs for different components within a given service, for example to deliver the audio component of a service in a more robust PLP than the video component. Up to 64 PLPs can be used in a given RF band, and up to four PLPs can be used to carry the various components of a given service.

This section describes the factors that a broadcaster may wish to consider when configuring their emission in light of AEA use cases. See also A/321 [2] and A/331 [4] for additional details about the concepts described in this section.

Multiple PLPs may be used to deliver elements of a program (video, audio, captions, applications and their associated files), as long as a receiver is not required to access more than four PLPs in order to render the program. In order to detect any AEATs that might arrive, the receiver must monitor the Low Level Signaling (LLS) tables that describe the Service it is rendering, thus one of the four PLPs must be the one carrying the LLS tables.

More than one PLP may carry LLS. If more than one PLP carries LLS, the Service List Table (SLT) carried in a given PLP will describe a subset of the Services carried within the whole broadcast emission. The preamble signals which PLP(s) carry LLS.

There are several signaling elements related to advanced emergency messaging in the ATSC 3.0 system. Due to the flexibility allowed in placement and replication of various tables, a visual representation of a transmission frame may be helpful. Figure 4 helps identify the different parts of an ATSC 3.0 Frame. There is only one bootstrap and one preamble, but there may be multiple PLPs.

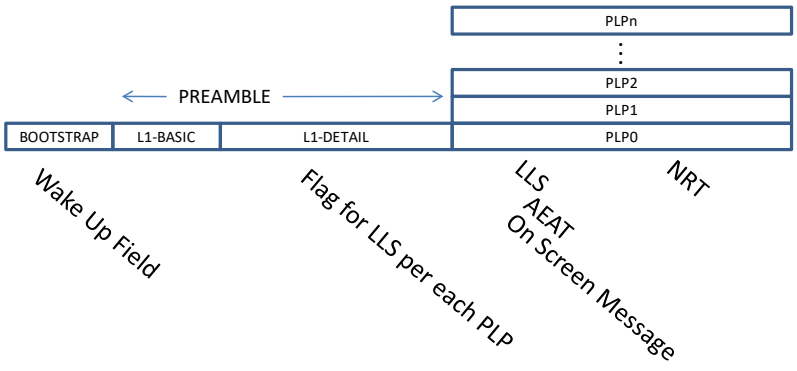

Figure 4 Illustration of PLPs and signaling elements.

The flexibility given by having multiple PLPs can lead to various non-obvious options for placement of data. Some considerations (see also A/331 [4], table 6.1.):

- The LLS/AEAT must be in one of the four (max) PLP's the receiver monitors to access the components of any given Service
- There may be multiple PLPs with LLS in a given broadcast emission
- Not all PLPs have LLS
- The LLS in a given PLP may include tables from multiple broadcasters (differentiated in the `LLS_table()` by `LLS_group_id`).

Below are two example use cases that suggest recommendations that can reduce confusion and ensure timely receiver processing of the emergency information.

Example Use Case A: One broadcaster or two or more cooperating broadcasters have more than one service in an RF (channel sharing). Cooperation means that there is one AEAT and one set of associated NRT files for this broadcast emission. There is a single LLS/AEAT and a single version of NRT files that are shared. This example PLP configuration has:

- One common PLP for LLS/AEAT[3]
- One common NRT PLP, which can be used for other program elements as well and could be same PLP as LLS/AEAT
- The NRT PLP is included in the set of at most four PLPs associated with any given service
- Each broadcaster uses one or two unique PLPs per service for their own exclusive use (or three unique PLPs per service if LLS/AEAT and NRT are together in a common PLP)

Example Use Case B: Two or more broadcasters are not cooperating and have one or more services each in a given RF. Not cooperating means that the broadcasters are treated as completely separate while occupying the same transmission.

- While there is more than one instance of unique LLS/AEAT, there is still only a single LLS/AEAT and a single version of AEA-related NRT files per broadcaster
- Each broadcaster operates the same as in Case A above, with no common PLPs between them

Note that there is only one bootstrap per RF band, and the Wake-up Field is carried in the bootstrap. Thus, broadcasters that are sharing an RF must coordinate with respect to the Wake-up Field. The AEAT includes a flag to indicate whether the AEA message is the reason for an active Wake-up Field. If two or more non-cooperating broadcasters are using the same RF band, and both issue an AEAT, it is possible that either or both AEATs could indicate that active Wake-up Field pertains to both broadcasters' AEA messages.

7.10 Advanced Emergency Information Table (AEAT) Element Descriptions

This section describes the elements of the Advanced Emergency Information Table (AEAT). See Table 4. More detailed information about the syntax and semantics of this table can be found in A/331 [4].

Table 4 Usage Descriptions of AEAT Elements

AEA element	Use Description	Notes:
<aeaId>	An aeaId is a string of up to 62 characters that serves to uniquely identify each specific AEA message. The aeaId is assigned at the creation of an AEA message. This text is limited to letters, numbers, dashes, dots and underscores. The aeaId can be used to identify unique messages, detect duplicate messages, identify messages for which an "update" has been issued, and identify messages which have been cancelled.	The scope of uniqueness is within a given RF channel or multiple bonded RF channels; if channel-sharing/bonding is present, then broadcasters coordinate to ensure aeaID's are unique in the shared channel or among the bonded channels.
<issuer>	The issuer is text that identifies or describes the broadcast station or entity originating - or forwarding - the AEA message. This text is limited to 32 characters.	Note: This free-form text can consist of any short identifier of a broadcaster, such as "WAEA, News Channel 4."
<audience>	The audience indicates generally for whom the AEA message is intended. The value would be "public" if	Note: The present document addresses "public" messages.

[3] If the NRT files are expected to be big, then it may not be efficient to send NRT in the most robust PLP, and so sending the NRT in a different PLP than the LLS/AEAT might be preferred. Whether a station usually sends big NRT files or usually doesn't would be a station policy decision and PLPs can be configured in advance accordingly.

	the message is intended for the general public. Other values can be “restricted” and “private”.	
<aeaType>	The aeaType identifies the general category of the message – whether it is an “alert” (new message), update or cancellation. ▪ An “Alert” means that the message is a new or unique informational message. ▪ An "Update" is used to amend or update a specific AEA message. Update indicates a change in the information in a previous emergency message, identified by a refAEAId. An update, for example, would be amending a message with (minor) corrections, additional textual information (expanding on the contents of the AEAtext, for example), or additional multimedia that may become available while the event is active. An “Update” allows a message to be updated with new info, without having to send an entirely new AEA thread. A substantial change in information may indicate a new AEA message is needed, rather than an update (such as major changes in event description, location, etc., [i.e., the changes would describe a new event]) ▪ “Cancel" is a message that cancels a specific previous emergency message, as identified by a refAEAId. An example of the use case would be issuing a cancel for an AEA message that is still active due to an event ending, so that fixed or mobile users do not get a message about an incident or event that is no longer relevant.	Note: An aeaType of “alert” is not meant to limit the contents or context of message to just “alerts” or EAS. “Alert” signifies an announcement or notification of information of compelling interest to the viewer and/or community.
<refAEAId>	The refAEAId is simply the aeaId used to identify which prior AEA message is affected when the aeaType is “Update” or “Cancel”.	
<priority>	The priority element provides simple scale to categorize the urgency of a message, from 0 to a maximum of 4. ▪ “4” represents a Maximum Priority message, with a highly urgent or extreme context. ▪ “3” represents a High Priority message, of important or severe impact to the audience. ▪ “2” is a Moderate Priority message for messages of moderate impact, but still actionable by audiences. ▪ “1” is a Low Priority message, for messages of an informative nature, or of minor and non-actionable information. ▪ “0” is a message of Minor Priority that is not expected to interrupt the audience. This type of priority may indicate a message of extremely minor context (such as a test or administrative signal).	See Figure 3 for an example decision flow for determining “priority.”
<wakeup>	The wakeup element is a true/false value for whether the Wake-up Field was activated for the emergency that this aeaId message describes.	Note: This field is “false” when the Wake-up Field is inactive. This field is “true” when the wake-up field is non-00 AND the wake-up pertains to the AEA message signaled in this instance of the AEAT.
<Header>		

<effective>	The effective time of the AEA message, which could be set in the present, or at some point in the future. If the effective value is omitted or absent, the effective time of the message is immediate.	
<expires>	The expires time of the AEA message indicates until what time/date an AEA message should be active.	
<EventCode>	A code identifying the event type of the AEA message. This would typically correlate to an EAS code in the US if the type was specified as "SAME". However, it is important to note that the **EventCode** is optional, and would not be relevant for many types of AEA messages that do not relate to EAS.	The EventType and EventCode fields might be useful for specialty applications and might not be useful for conventional receiver implementations.
<EventDesc>	The **EventDesc** is a short plain text description of the emergency event. Limited to 64 characters, the **EventDesc** type is intended to provide a very short human-readable summary of the message. Example could be "Evacuation Warning for Smallville", "School Lockdown at John Doe College", "Smith County School Closings", or "Urgent Traffic Information". An AEA message can contain multiple language versions of the same **EventDesc**. The meaning of the **EventDesc** can be represented in multiple languages.	
<Location>	The geographic code that identifies the affected area of the AEA message. The intended coverage area can be represented by one or more location types (FIPS, polygon, and/or circle) in an AEA message. Note that if multiple formats are used and do not indicate substantially similar geographic areas, receiver behavior might be unpredictable. If the Location is missing or omitted, then it is presumed that AEA message is relevant to the entire transmission area.	
<AEAText>	**AEAText** contains the specific informative text of the AEA message. There is no set limit to the length of text contained in the **AEAText** element. Broadcasters are encouraged to be clear and concise with descriptive and instructive contents covering the "who", "what", "where" and "when" of the message.	
<LiveMedia>	Contains the information of emergency-related real-time (live) A/V service which is delivered via broadcast stream.	
<bsid>	Identifier of the Broadcast Stream that contains the emergency-related live A/V service.	
<serviceId>	Integer number that identifies the emergency-related A/V Service.	
ServiceName	A user-friendly name for the service where the LiveMedia is available.	
<Media>	Contains the component parts of the non-real time multimedia resource.	
<mediaDesc>	A short text description of the type and content of the media file. For example, "Carteret County Evacuation Map" or "Jane Doe Photograph", etc.	Filenames are typically not used as mediaDesc values, especially in the case where the filename

		Note that when an RA is presenting AEA material mediaDesc may be the only context presented to the viewer for the given media asset, and so a good description of the asset is prudent (e.g., a value of “Picture” or “Document” would be of minimal use to the audience/user).	adheres to A/344 [10] for access by a broadcaster app.
	<mediaType>	Text identifying the intended use of the associated media. Three types of media have been specified: ▪ "EventDescAudio", which is the audio (voice) associated with the EventDesc element: ▪ "AEAtextAudio" which is the audio (voice) associated with the AEAtext element, and ▪ "EventSymbol", which pertains to a symbol/icon associated with the EventDesc. These three tags tell the receiver what to do with the particular media. Other forms of media are presumed to be “general multimedia” related to the AEA message.	
	<url>	The identifier of the media file	
	<contentType>	IANA media type of media content referenced by Media<url>	
	<contentLength>	Size in bytes of media content referenced by Media<url>	Optional
	<mediaAssoc>	URI of another Media element with which this attribute is associated as described in <mediaType>	

8. SYSTEM ARCHITECTURE AND TECHNICAL WORKFLOW

8.1 Overview

Figure 5 illustrates an example data flow of AEAT content sources and production.

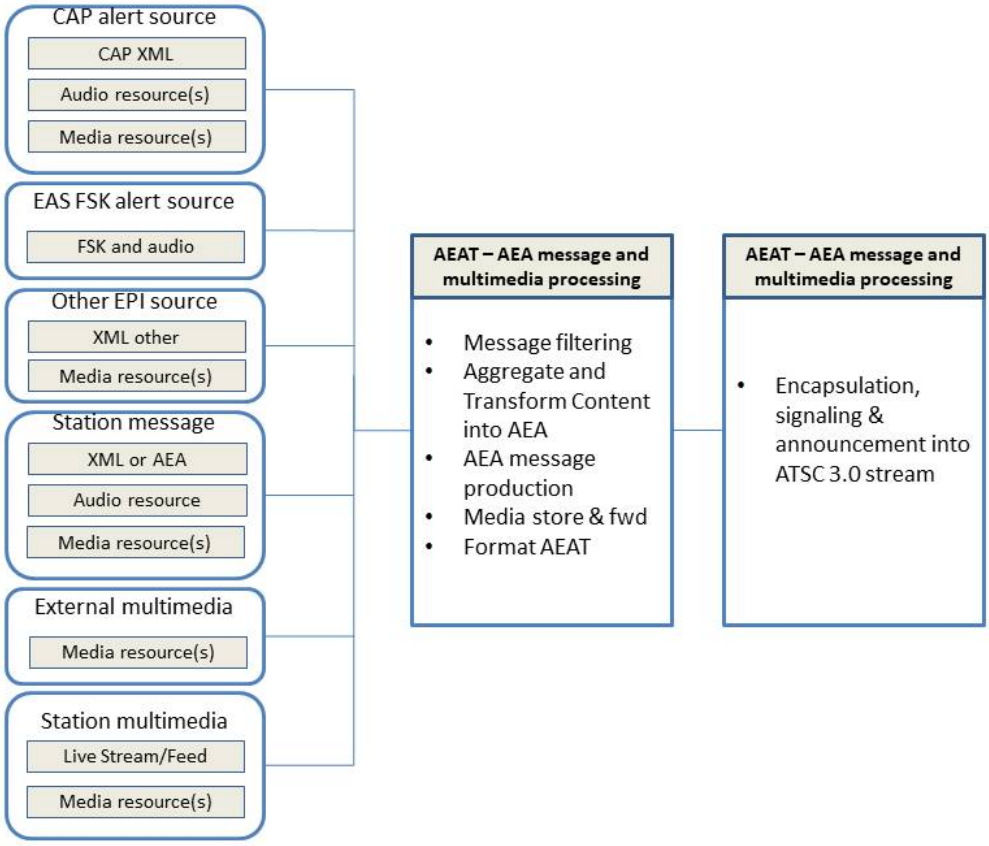

Figure 5 Example data flow diagram of AEAT content sources and production.

An example detailed signal flow is illustrated in Figure 6. A description of this example follows:

- The emergency messages are input into an EAS Receiver/Processor. This may be the station's existing EAS signal generator if the capability exists to output a processed message
- Rich media may be prepared externally and delivered to the system's rich media queue (e.g., prepared MP4 video clips)
    - Data for rich media may be provided to the system from an external source (e.g., NOAA weather data) or from the station's systems (e.g., data from the station's local weather measurement system)
    - Rich media files can be prepared in advance where appropriate (e.g., HTML pages of what to do before a hurricane)
    - Rich media files can be prepared on the fly just before or during an emergency (e.g., an MP4 file of a weather radar displaying a tornado on the ground)
- Files are delivered to the Rich Media Queue for immediate or later association with emergency messages and delivery to the signal flow
    - The emergency messages are delivered to the station's content manager
    - The Content Manager receives, prepares, and queues the messages for transmission

- The Content manager also provides an association between the messages and the associated rich media elements
- The emergency messages are output to the Signaling and Announcement generator
- In some cases, the Content Manager may reside within the Signaling and Announcement Generator unit

- The Signaling and Announcement data, the rich media elements, and the video/audio programming are multiplexed together in a simple router and the combined output is multiplexed into the station's DTV broadcast.

8.2 AEA Messaging Architecture

Figure 6 shows a functional block diagram of an example station architecture for AEA. In the following description of the diagram, italicized terms indicate various elements found in the figure.

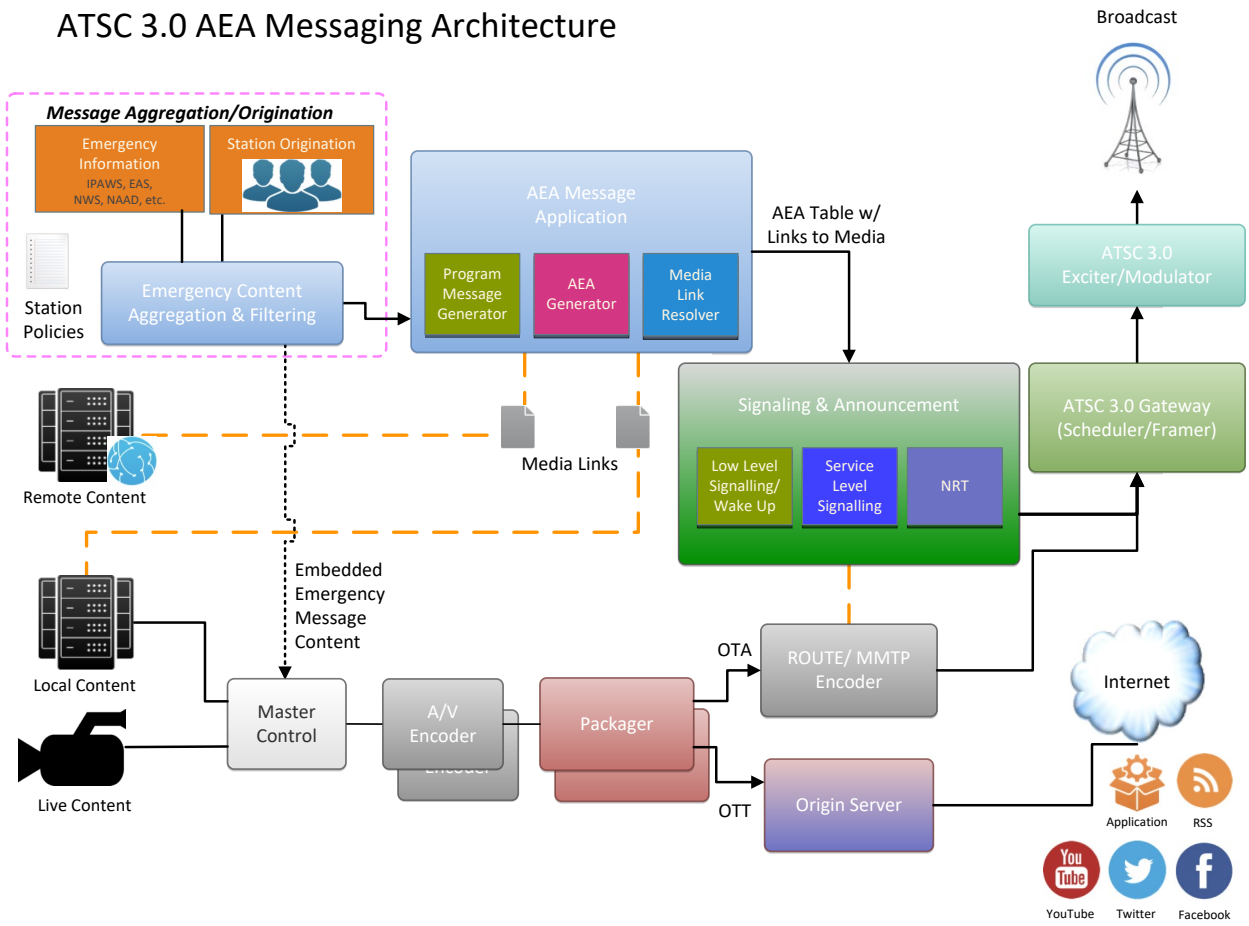

Figure 6 Example ATSC 3.0 AEA messaging architecture.

8.2.1 Message Aggregation and Origination

It is recognized that emergency messages may come from several sources both inside and outside of a facility. This area represents the ingest of *Emergency Information* from typically external sources such as EAS audio broadcasts, CAP messages from FEMA IPAWS, National Alert Aggregation and Dissemination (NAAD), NWS or many others. These messages are ingested in

to the *Emergency Content Aggregation & Filtering* module. In addition to the external inputs or in conjunction with an event, the station may wish to develop their own materials — graphic, text, videos, etc.—– that are also sent to the Emergency Content Aggregation & Filtering module. The various rules of what event codes and messages to accept or forward, what events and a priority level, including activating or modifying the Wake-up Field are defined under a set of rules referred to as the *Station Policies* (Section 7). The Station Policies are many and varied and uniquely suited to each station. It is beyond the scope of this document to determine or outline the elements of the Station Policies.

Any message passing the rules set by the Station Policies would then be presented to the *AEA Message Application* module.

The dotted line from the *Emergency Content Aggregation & Filtering* module to the *Master Control* module labeled *Embedded Emergency Message Content* is to indicate that some messages from the *Emergency Content Aggregation & Filtering* will be included as part of the primary program stream(s). This is equivalent to the EAS messages, which by regulation must be presented as part of the actual programming. In this manner, the *Emergency Content Aggregation & Filtering*, as outlined in the station policies, sends the appropriate content or information for inclusion in the actual program stream.

Note that a CAP message of type "cancel" may translate into an AEA message of type "update," because CAP "cancel" messages can contain update information intended for viewers. See Section 7.6 for information about AEA messages of type "update" and "cancel."

Inclusion in the programming does not preclude placing the information in an AEA message, however, the attributes of the "`OnScreenMessageNotification`" element of the *Low Level Signaling* can be set to assure any downstream graphics or applications keep the screen clear for the period the *Embedded Emergency Message Content* is actively presented in the affected services.

8.2.2 AEA Message Application

Information meeting the criteria set forth by the Station Policies and managed by the *Emergency Content Aggregation & Filtering* will be sent to the *AEA Message Application*. Several sub-functions are embodied within the *AEA Message Application*, with the over-arching mission to prepare the AEA message and any associated content for subsequent message propagation.

Within the *AEA Message Application* the *Program Message Generator* determines the requisite data necessary for the AEA table then passes that to the *AEA Generator* to create a properly formatted *AEA Table* while simultaneously handing any request media link to the *Media Link Resolver*.

It is important to understand message information passed from the *Emergency Content Aggregation & Filtering* may contain links to media files. These media files may consist of one or more images, videos, pdfs, and other content to support or augment a message. Examples may include a picture of a missing child, an evacuation route map, a plume map, a recovery or resource video, alternate language audio, and many others. These media elements may be elements provided by the alert originator or generated at the station and stored in *Local Content* severs, or element not station generated and stored outside the facility, in a *Remote Content* server, but accessible via a URI link.

The function of the *Media Link Resolver* is to gather any requested media content and make it presentable to the follow stages.

In essence, the function of the *AEA Message Application* will be to properly format the desired message and ensure all the elements are available to the Signaling & Announcement module.

8.2.3 Signaling and Announcement

At this point the message has been generated or passed to the *AEA Message Application* and is prepared for the *Signaling* generator for insertion into the ATSC broadcast stream. The *Signaling* generator monitors state transitions of the AEA Messages to appropriately manage and generate necessary AEA ATSC 3.0 components for inclusion into the stream. These include *Low Level Signaling* (AEA Table, `OnScreenNotification` Fragment), Wake-up Field, and NRT for broadcast delivered media.

The *Signaling* generator can reconcile the state of the Wake-up Field by monitoring a series of AEA Messages to indicate when new, updated, and expired wake-up conditions exist. This information is conveyed to the *ATSC 3.0 Gateway (Scheduler/Framer)* when *Low Level Signaling* is sent via Scheduler/Studio to Transmitter Link (A/324 [3]) such that the Wake-up Field can be appropriately set in the PHY bootstrap.

Should messages contain references to media intended to be delivered via broadcast, this media is converted to and sent as NRT. The AEAT media references are adjusted to reference broadcast delivered URLs (relative references). Necessary bandwidth for the delivery of the NRT content needs to be provisioned.

Additionally, if a *Broadcaster Application* is intended to be delivered capable of processing AEA components, then the given *Broadcast Application* also must be provisioned and signaled appropriately. Broadcast delivered applications must also have necessary bandwidth provided within the broadcast stream. The delivery system must package and sign the AEA content (see A/331 [4] and A/360 [11]) and adjust relative URLs to point to where the data will land on the receiver. The files must land in locations known to the BA and the BA's `AppContextID` must be associated with the files to make them visible to the BA (see A/344 [10]).

8.2.4 Content Path

The content path is shown to recognize the alignment of both the real-time and non-real-time components of the final signal. The content path emerges from the *Master Control* and is encoded by one or more *A/V Encoders* which in turn send their outputs to *Packagers* for proper content alignment. Here the paths may split to serve different end points.

Both Over-the-Top (OTT or Internet) delivery and Over-the-Air (OTA) delivery are possible in the ATSC 3.0 system. Broadcasters might use OTA delivery as much as possible for AEA content, partly because the OTA infrastructure is historically the most robust, and partly because Internet networks can become congested during emergencies, or subject to cyber-attacks.

For OTT delivery the content is presented to an Origin Server and managed by the host of delivery tools for the intended target applications or services.

The OTA output is further encoded in a ROUTE (Real-time Object delivery over Unidirectional Transport) or MMTP (MPEG Media Transport Protocol) encoder of which the output is presented to the *ATSC 3.0 Gateway (Scheduler/Framer)* and combined with the AEA delivery path.

9. RECEIVER IMPLEMENTATION GUIDELINES

9.1 Introduction

The television receiver working with advanced emergency information represents a paradigm shift in the emergency messaging industry. The receiver can present unprecedented additional information about the event while targeting distribution to the interested audience by use of location and priority filters.

This new emergency messaging technology is completely separate from the traditional "burned-in" emergency information banner that has been a standard for decades. That banner could not be separated from the A/V program and was entirely out of the viewers' control.

While the "burned-in" scrolling banner will continue to be used, a major benefit of the advanced emergency information system is the ability of the broadcaster to push relevant information to the receiver in addition to the message text. This additional information can be in the form of pictures, video, and web pages. Each of these becomes available at the time of the event and can remain available in local storage for the duration of the event or longer based on expiry dates associated with the content. In addition, user customization options are possible with the advanced emergency messages, which allow the user to control many features such as

- Present the emergency message text again (i.e., present it on-demand)
- Play an audio version of the displayed emergency message banner
- Present pictures, video, web pages, etc. related to the emergency message on-demand
- Select a preferred language (if multiple languages are provided)
- Enable location filtering
- Enable priority filtering
- Select a preferred channel to monitor for emergency message notifications when the receiver is off (the user may allow the broadcaster to wake up the receiver for high priority emergency message)
- Dismiss an emergency message

Advanced emergency message content can be presented to a viewer by an application that is native to the receiver (Receiver Application, or RA) or by an application authored by a broadcaster (Broadcaster Application, or BA), as described in Section 10. The information presented in this section regarding the user experience apply to both types of implementations.

This section describes example receiver implementations which allow the viewer to take advantage of the advanced emergency information features of ATSC 3.0. The behavior described in this section generally applies to receivers that are designed with a full implementation of AEA capabilities. It should be noted that some receiver designs might not include full implementation. For example, some receivers might not sense the presence of an emergency event or have the capability to wake from standby, others might not have an RA, and still others might not be capable of running a BA. It should also be noted that some receivers may enable consumers to set preferences for which emergency messages they wish to see and/or how they wish to view them. As such, the receiver behavior described in this section does not represent all cases. Broadcasters utilizing the full capabilities of the AEA system can expect to reach the widest possible audience, enabling each receiver to present emergency material to the best of its ability.

9.2 Initial Emergency Message Reception

This section describes example receiver behavior upon initial reception of a new or newly updated emergency message. To detect AEAs, a receiver periodically monitors for the initiation of an emergency message. There are two ways for a receiver to recognize the initiation of an emergency message. One is the non-zero state of either bit in the Wake-up Field in the bootstrap, and the other is the presence of an AEAT in LLS. A new or newly updated emergency message could occur while the receiver is in stand-by mode, or could occur while the receiver is active.

9.2.1 Emergency Message Types

As described in Section 7.6, there are three emergency message types: "alert" (new), "update" and "cancel".

In the case of a new message (type "alert") the receiver can present the emergency information as described below.

In the case of an "update" message, the receiver parses the `refAEAId` to identify the previous message to which the "update" message pertains. It can then identify which information in the emergency message has changed and begin presenting the updated material. If an "update" message is received, which references a message that the receiver does not have (e.g., if the viewer tuned to the channel after the original message ceased broadcasting), the receiver can process the message as though it were a new message (type "alert"). In this case, the `refAEAId` can be ignored and no prior message need be deleted.

The "cancel" message type is used as a "kill switch" to indicate to receivers that the broadcaster wishes to stop communicating anything pertaining to the referenced advanced emergency message immediately. Note that if a broadcaster wishes to convey additional information about a canceled event, such as the reasons for cancellation, then an "update" message is used. Upon receiving a "cancel" message, the receiver ceases presenting all material pertaining to the messages referenced by `refAEAId`. If the receiver gets a "cancel" and the receiver does not have access to the prior message referenced by `refAEAId`, then the receiver can ignore the message. There is no message linked by `refAEAId` to delete and no screen message to clear.

9.2.2 Initial Emergency Message Reception from Stand-by Mode

The Wake-up Field (two bits in the bootstrap, see also Section 7.8) is used to signal the broadcaster's desire to wake a receiver. The receiver might periodically activate the tuner to catch the bootstrap information on the default monitor channel. The Implementation Team determined that a good balance between responsiveness and energy conservation would be that the period between sampling the bootstrap for the Wake-up Field be less than two minutes. This period is a tradeoff between energy consumption in the receiver and timeliness of detecting the emergency message.

A receiver might use various approaches to select the channel that it monitors for the presence of emergency messages during standby. In one example, the last channel tuned might be used as the default. In another example, the tuner might use an alternative criteria, such as the first or last entry in the receiver's internal channel map. In addition, a receiver might allow the user to override the default and select a preferred monitor channel. During standby, the receiver monitors the default or preferred channel for the presence of a wake-up event. If no wake-up occurs and the user turns the receiver on, the tuner might tune to a channel other than the monitoring channel, such as the previous tuned channel.

During standby, when the value of the Wake-up Field is zero, there is no need for the receiver to wake from its standby state. When either bit of the Wake-up Field is non-zero, there is an

emergency message that the receiver can check. The receiver treats any new non-zero state as an indication of a new high priority AEA message.

When a new wake-up state is recognized, the receiver keeps the tuner active long enough to acquire the LLS data until the related AEAT is found. In the case of shared channels, the receiver might start with the LLS associated with the last service tuned. For cases where the AEAT indicating a wake-up event is not found in the default or last tuned broadcaster's services, an optional implementation is that the receiver searches through all LLS PLPs until it finds an LLS carrying an AEAT indicating a wake-up event. Receivers might be capable of monitoring multiple LLS PLPs in parallel to reduce search time.

The `@wakeup` attribute in the AEAT indicates that a given emergency message within the AEAT is related to a wake-up event. The receiver can then determine if the related AEAT passes any relevance tests (e.g., geolocation, intended audience, or other tests). If the relevance of the emergency message is confirmed, the receiver can continue to wake the display circuitry to show the emergency message. Note that the AEA system allows more than one Service to share one AEAT. Upon wake-up from standby mode due the presence of the emergency message, the receiver chooses a service to acquire over which the emergency message can be displayed. The receiver may check for the presence of a Service identified by `AEAT.AEA.LiveMedia@serviceId`, and if present, may tune to the indicated Service. If there is no `@serviceId` attribute in `LiveMedia`, the Service that will be selected may be any one of the services associated with the AEAT signaling.

If the alert does not pass the preceding tests, the receiver can dismiss the current wake-up state and return to periodic monitoring of the Wake-up Field. The receiver can then ignore that Wake-up Field bit pattern and only search for a new AEAT after receiving a new, non-zero value.

9.2.3 Initial Emergency Message Reception from Active Reception

While the receiver is in active operation, it can monitor the LLS for the presence of an AEAT. If the LLS is in multiple locations, each location can be monitored. When an AEAT is found, it can be processed for relevance (priority, geolocation, audience, already viewed/dismissed state of a given AEA ID, etc.). If the relevance of the emergency message is confirmed, the receiver can proceed to render the message to the viewer.

Note that the receiver could also monitor the wake-up field for a change, but this would only lead to checking the LLS for an AEAT which is the first step above. Also note that the receiver monitors the LLS of the channel it is currently tuned to. (This may be a different channel than the default standby monitor channel that could be set by a viewer.)

If a broadcaster application (BA) is currently running and has subscribed to AEAT updates, then the BA has, in essence, claimed responsibility for presenting AEA material to the viewer. In this case, the receiver passes AEATs to the BA via the APIs defined in A/344 [9]. Also note that the receiver might pass AEATs that it has already presented to the viewer to the BA and AEATs that it has filtered out (see Section 9.3), and if so, indicates these circumstances to the BA using the relevant methods in the APIs. It is then up to the BA to perform any relevance vetting and present the content if the relevance of the emergency message is confirmed, with the caveat that in no case does a BA (or RA) present a non-public AEA message to the general public.

9.3 Receiver Filtering of Emergency Information Messages

There are several identification fields used in the AEAT. A receiver might allow the viewer to configure the receiver to use these to limit the emergency message to a desired set of relevant messages. Those fields include:

- Audience – public/restricted/private
- Priority – urgent, high/moderate/low, test
- Category – i.e., `EventCode` (e.g., SAME, CAP category)
- Location – FIPS or GPS area
- Language

9.3.1 Audience

A receiver that is intended for consumer use only responds to "Public" type messages. "Restricted" or "Private" type messages are intended for specific groups such as first responders.

9.3.2 Priority

A receiver might allow the viewer to set a priority level for filtering AEA messages. This feature might allow the viewer to reduce unwanted alerts. AEAs that fall below the user-selected priority level would be filtered out and not presented. It is unlikely that a receiver would allow the user to filter out all priority levels as this would effectively disable the presentation of all AEAs.

If the filter level is set at priority 4, only the most severe emergency messages would be displayed. If the filter level is set at priority 1, all but tests would be presented.

A receiver that is capable of filtering based on priority might set the default threshold such that it displays all AEA messages except tests.

9.3.3 Eventcode

In the U.S. the FCC created a list of approved three-letter event codes for use with the Emergency Alert System, EAS. The codes were divided into three categories: Weather Event Codes, Non-Weather Event Codes and Administrative & Required Event Codes. These codes were also referred to as SAME codes, Specific Area Message Encoding, since the codes and their messages were meant to cover specific areas of a state, such as counties, regions or townships.

The event codes were supplemented with a location code called FIPS, Federal Information Processing Code. Each county within a state is assigned a specific FIPS code. By tying the FIPS code with the Event Code, broadcasters could issue emergency messages of several types targeted for a specific area. The event and FIPS codes used are programmed into existing EAS encoders, which are located in the Master Control room of many TV stations. Weekly and monthly tests are required by the FCC.

SAME codes and similar category lists, such as CAP Category, were not intended for consumer use. As such, these and similar categorizations might not be suitable as consumer-facing filtering mechanisms.

9.3.4 Location

Devices that know their location, via GPS or zip code, can filter the emergency messages to dismiss messages outside of their location. Users who wish to be more informed could opt to include messages beyond their specific location.

Broadcasters can signal location information to be the entire coverage area for messages that must go to all receivers.

9.3.5 Language

The receiver can utilize user preferences set in the TV to present a default language for emergency messages rather than utilize a separate language preference for emergency messages. If the message is delivered in the chosen language, the language can be displayed. If no preferred language is selected or the preferred language is not included, information in either English or the first language available in the AEAT might be used.

9.4 AEAText

The primary purpose of the AEAT is to convey information about an important event. This is typically emergency information. The `EventDesc` is intended to carry a title of the event (e.g., "Tornado Warning"). The `AEAText` field is intended to contain a clear, concise, and complete description of what is happening, where it is happening, who is impacted, and how to react. This text might be displayed as a banner on the screen. While there is no limit to the length of this message; long descriptions might be displayed a few lines at a time in a scrolling or paged manner.

The text might be provided by the broadcaster in multiple languages. The text displayed can match the user selected device default language. If no user selection is made the default might be the primary language of the region or country. If only the primary language is available, and the user selected a different language, the primary language message can still be made available.

9.5 EventDesc

A title for the event described in the `AEAText` is carried in the `EventDesc` string, which is a short description in a few words expanding the information of the `EventCode` (ex. Tornado Warning). The `EventDesc` text can be available in multiple languages. The text displayed should match the user-selected device default language. If no user selection is made the default should be the primary language of the region or country. If only the primary language is available, and the user selected a different language, the primary language message should still be made available.

9.6 Audio for Accessibility

The emergency message text may also be provided by the broadcaster as an NRT audio file. If the user has selected accessible audio, this can play out as close to the time as possible as the text is displayed, understanding that typically the AEAT with the `AEAText` might be available for rendering before the audio NRT file has been completely received. Note that AEA in general does not replace today's EAS or emergency messaging systems, which might have regulatory requirements regarding audio version of text information.

9.7 Non-Real Time (NRT) Media

The AEAT includes signaling for various types of rich media that enhance the AEA text. Those media files can be downloaded from the broadcast as Non-Real-Time (NRT) files of video, pictures, web pages and audio or they might be available from broadband. Signaling might also include a link to live programming. The intended receiver handling of these media files are explained below.

The AEAT contains information that associates rich media with particular messages and with one another, in some cases. Downloaded AEA media stored with the information necessary to maintain the associations indicated in the AEAT can be re-presented in the context of the original AEA message. This enables the user to recall media for a specific message thread.

9.7.1 NRT Audio for Accessibility

An audio file with an `@mediaType` of "`AEAtextAudio`" can be used to speak aloud the `AEAText` when it is displayed. The receiver can render the audio for accessibility if the voice/audio assistance option is enabled in the TV.

Similarly, an audio file with an `@mediaType` of "`EventDescAudio`" might be used to speak aloud the `EventDesc` text.

The AEAT contains information that associates verbal versions of written texts for the above items. When present, these associations can be stored with the files so that the associations are preserved in the event that the viewer wishes to recall the information.

9.7.2 Media Files

All media files downloaded and associated with the emergency message thread can be stored and made available to the user through a selectable list or other interface, for the user to choose and view for the duration of the event or longer based on the expiration time of the NRT content.

Media files might be available via broadband and are intended to be consumed "on demand." In this case the receiver can cache the URL link and not the file itself. The link (or file) can be included in the user list for the duration of the emergency message thread.

9.8 Live Media

The AEAT can include a link to a live broadcast service. This can be presented to the user as a choice for viewing continued coverage. However, if the television finds this link included in the AEAT as a result of a wake-up event, the TV might assume this is the desired channel for display directly from the wake-up state.

9.9 Persistence of AEA Material

AEA NRT files can be retained by the receiver until the files reach their expiry date (as signaled in the EFDT per A/331 [4]) or until the receiver must delete files; e.g., to make room for newer files. Additionally, the AEAT includes information about how AEA NRT files are associated with one another, such as an audio file which is an aural representation of a text file. These associations can also be retained by the receiver so that the associations persist as long as the files they pertain to persist.

In the case that the message expires or is canceled via signaling in the AEAT, AEA NRT files can still be retained by the receiver until the files themselves expire, because in some cases a given file can be useful across a longer span of time than any single emergency message. For example, an evacuation map might be valid for a given area across multiple evacuation events. Note that it is possible for a broadcaster to replace a file with a new version before the original file expires, and the new version could have a very short expiry window if the goal is to delete the file for some reason.

In the case that the viewer dismisses the emergency message, the receiver can retain the AEA NRT files so that the material can be recalled by the viewer. User interfaces can be provided as a means for viewers to retrieve dismissed AEA NRT files at any time before expiry.

In the case of when the viewer changes the channel/service, the receiver can retain the files associated with the previous service so that the viewer could recall the material from the channel they tuned away from, and also to avoid re-downloading the files if the viewer tunes back to the original channel.

It should be noted that if the Receiver App (RA, see Section 10) is presenting the AEA material, the RA can present material from multiple broadcasters in some circumstances; e.g., when the viewer wishes to recall AEA NRT files and the RA is not presently parsing an AEAT. However, a Broadcaster App (BA, see Section 10) is limited to presenting only AEA NRT files that are associated with its `AppContextID` (see A/344 [10])

Receiver implementation designs that have a runtime environment include the `AppContextID` caching methods described in A/344 [10]; however, implementation designs that do not have a runtime environment might nonetheless benefit from implementing the `AppContextID` caching methods in order to efficiently use memory when `AppContextID` is present in AEA content signaling.

10. ATSC 3.0 INTERACTIVITY AND RENDERING AEA MATERIAL

10.1 Introduction

As stated above, ATSC 3.0 enables Advanced Emergency Information (AEA) features, which primarily include the following:

- Ability to signal a "wake-up" to receivers in stand-by mode
- Ability to send an Advanced Emergency Information Table (AEAT) which can include
    - A digital EA banner
        - This is similar to the EAS "crawl" but in this case the text can be digitally rendered by the receiver's graphics engine, rather than "burned-in" to the video
    - Pointers to rich media elements such as web links, images (e.g., evacuation maps), videos, audio tracks, etc. that are in the NRT broadcast stream or on a network server
    - Various other AEA information such as location, priority, start/end times, etc.
- Ability to send an `OnScreenNotification` flag, which is a Boolean flag that informs a receiver when there is something in the main A/V that the broadcasters wished to be unobscured by receiver-generated graphics or sound (e.g., a burned-in EAS crawl)

The AEAT enables receivers to render AEA material via native code. For the purposes of this document, we can call this native code capability a Receiver App (RA).

In addition to the above AEA features, ATSC 3.0 includes an interactive application standard which enables a Broadcaster App (BA) to perform a wide variety of functions using media files, JavaScript logic, etc. The operations of a BA are opaque to a receiver. The receiver cannot know what is being presented by the BA. Thus, it is possible for a BA to render emergency-related material without the receiver knowing it.

In ATSC 3.0 it is possible for a BA and an RA to render AEA material. This creates a need for some method of avoiding conflicts between the RA and the BA in receivers that have both an RA and an interactive runtime environment capable of running BAs.

Broadcasters may find it most efficient to employ a single workflow for sending AEA material so that either a BA or an RA can access the material. To facilitate this, ATSC 3.0 provides methods for the following functions (see A/344 [10]:

- BA can access the AEAT. Both the BA and RA can use the information in the AEAT to know what AEA material is available and where to find it as well as details about the emergency, including priority level, type of emergency, location of emergency, etc.

- Each AEA message includes a flag to indicate if the emergency message is associated with an active Wake-up request. This flag is available to the BA for every AEA message.
- BA can access the OSN table.
- BA can claim responsibility for rendering AEA material by initiating the Subscribe AEAT API (A/344 [10]).

Ideally, both RA and BA utilize language and accessibility settings in the TV rather than requesting the information from the viewer anew, as s/he might have already provided it via the TV's set-up menu. The BA can access this information via APIs defined in A/344 [10].

Given the above, guidelines for coordinating message presentation between RAs and BAs can be very helpful in order to avoid presentation of duplicate messages or other unwanted behavior that might cause consumer confusion or frustration.

10.2 BA AEA Message Filtering

The receiver might have a set of filter settings for accepting an AEAT. These settings can be checked by the receiver before sending an AEAT to a BA. An AEAT that is filtered out by the receiver can still be sent to the BA with a flag indicating that the message has been filtered out (see A/344 [10]). If the BA has a separate set of filtering criteria, it might first query the user for whether they would like to use the preferences set up in the receiver or use a new set of filters in the BA in order to avoid consumer annoyance.

If the BA creates a new set of filters, messages might be presented according to the BA filter criteria even if those criteria contradict the receiver filter criteria. Regardless of any filter criteria or status, the BA does not present non-public emergency messages to the general public. Restricted or Private messages can be processed by the BA for statistical reporting purposes, but are not presented to a consumer.

As stated in Section 9.2.2, the receiver might parse and filter a given AEAT prior to waking up. In the case of an AEAT filtered out prior to wake up, the BA does not receive the AEAT.

End of Document