ATSC Recommended Practice: Audio Watermark Modification and Erasure

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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 for digital television. The ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

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

ATSC was formed in 1982 by the member organizations of the Joint Committee on InterSociety Coordination (JCIC): the Electronic Industries Association (EIA), the Institute of Electrical and Electronic Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable Telecommunications Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE). Currently, there are approximately 120 members representing the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

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

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

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

Revision History

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Proposed Recommended Practice approved	3 November 2017
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1. SCOPE

This document provides recommended practices for methods to be employed in the erasure and modification of VP1 audio watermarks.

1.1 Introduction and Background

"ATSC Standard: Audio Watermark Emission" [2] specifies the emission format for the VP1 audio watermark that may be included in ATSC 3.0 broadcast services. The VP1 audio watermark conveys information via data symbols embedded in a perceptually important region of the audio frequency spectrum of an audio presentation and is resilient to most types of audio processing, including modern techniques for lossy audio encoding.

The resilience of the VP1 audio watermark to audio processing enables its use as a reliable channel for delivery of a data payload to accompany audio and audiovisual content through environments employing heterogeneous audiovisual formats, protocols, and interfaces. "ATSC Standard: Content Recovery in Redistribution Scenarios" [4] specifies means for use of the VP1 audio watermark to allow ATSC 3.0 receivers to recover service signaling information via broadband for ATSC 3.0 broadcast services received through an intermediary, such as a cable, satellite or IPTV operator, or from an ATSC 1.0 emission. An example of the use of the VP1 audio watermark to recover service signaling is to enable receivers to discover and acquire via broadband supplementary content such as interactive applications or alternate audio tracks that may not be transmitted by the intermediary.

The resilience of the VP1 audio watermark to audio processing may also lead to scenarios where it becomes desirable to modify or erase previously embedded data.

For example, a broadcaster may wish to include in a broadcast service a segment of content that was recorded from a prior broadcast (e.g. under the "fair use" principles of limited, transformative use for commentary, criticism, or parody). If the prior broadcast carried the VP1 audio watermark, it's re-use without modification could cause an ATSC 3.0 receiver that detects the watermark to acquire service signaling associated with the prior broadcast. To avoid this, the broadcaster would need to erase the watermark embedded by the prior broadcaster or modify it to convey their own watermark data before re-using the previously watermarked content in their broadcast service.

2. REFERENCES

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

2.1 Informative References

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

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

[2] ATSC: "ATSC Standard: Audio Watermark Emission," Doc. A/334:2016, Advanced Television System Committee, Washington, D.C., 19 September 2016.

[3] ATSC: "ATSC Standard: Audio Common Elements," Doc. A/342 Part 1:2017, Advanced Television Systems Committee, Washington, D.C., 24 January 2017.

[4] ATSC: "ATSC Standard: Content Recovery in Redistribution Scenarios," Doc. A/336:2017, Advanced Television System Committee, Washington, D.C., 5 June 2017.

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] shall be used. Where an abbreviation is not covered by IEEE practice or industry practice differs from IEEE practice, the abbreviation in question will be described in Section 3.3 of this document.

3.1 Compliance Notation

This section defines compliance terms for use by this document:

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 Acronyms and Abbreviation

The following acronyms and abbreviations are used within this document.

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PCM– Linear Pulse Code Modulation. In this document this is understood to be the uncompressed format for audio signals.

VP1 – The audio watermarking technology specified in "ATSC Standard: Audio Watermark Emission" [2].

3.3 Terms

The following terms are used within this document.

audio presentation – Has the meaning given in the ATSC A/342 Audio, Part 1: Common Elements [2]. Also referred to as a Preselection (DASH-IF), a Presentation (AC-4), or a Preset (MPEG-H).

audio signal – Has the meaning given in the "ATSC Standard: Audio Common Elements" [3].

audio watermark – Data which is embedded in audio essence in such a way that it can be extracted (i.e., read) by an appropriately designed extractor.

cell – A complete transmission of an independently recoverable packet of data in an audio watermark.

contribution encoding – An audio encoding format that is configured for the purpose of distributing broadcast audio within and among professional broadcast environments, where multiple stages of encoding and decoding are expected to be performed.

embed – The process whereby an audio signal is modified to include an audio watermark.

extractor – A tool or process that is able to extract audio watermark packets from an audio signal.

emission coding – An audio encoding format that is configured for the purpose of broadcast emission to receivers (viewers).

marked audio – Audio that has an audio watermark embedded in it.

symbol – The representation of a bit of binary information in the audio watermark.

transcoding – The process by which audio that is represented in one encoding format is converted into another encoding format. This is typically achieved by decoding the audio from the first encoding format to PCM audio, followed by encoding of the PCM audio into the destination format.

4. AUDIO FORMAT FOR WATERMARK PROCESSING

VP1 audio watermark processing is expected to be performed on PCM audio prior to emission encoding or at a location in the distribution chain at which transcoding is performed.

5. AUDIO QUALITY PRESERVATION

The introduction of additional audio processing (including transcoding, audio watermark modification, and watermark erasure) can produce accumulated degradation of audio quality.

To preserve the highest possible audio quality, it is recommended to seek to obtain a version of an audio presentation that does not carry the VP1 audio watermark. This avoids the need for any modification or removal of the watermark.

When VP1 audio watermark modification or removal is performed, it is recommended to obtain a version of the audio presentation in PCM or contribution encoding format. This will reduce (or eliminate) the audio quality impact of any transcoding employed to enable watermark processing of the audio presentation in PCM format.

6. WATERMARK MODIFICATION

The VP1 audio watermark is specified in "ATSC Standard: Audio Watermark Emission" [2] to be a sequence of contiguous symbols embedded across a continuous time interval of an audio presentation. All audio signals in a marked audio presentation are synchronously embedded with the same symbol.

Watermark modification comprises processing an original audio presentation that contains a VP1 audio watermark conveying an original symbol sequence to produce a modified audio presentation that contains a VP1 audio watermark conveying a different symbol sequence.

A recommended practice for modification of a previously embedded VP1 audio watermark in a marked audio presentation is to modify symbols in each audio signal in the marked audio presentation to convey the value associated with the desired VP1 audio watermark symbol sequence.

Some symbols in the original symbol sequence may have the same value of the corresponding symbol in the desired symbol sequence. It is not necessary for such symbols to be modified. In any case, the boundaries of all symbol intervals should be preserved during watermark modification to avoid data remanence.

The VP1 audio watermark produced as a result of watermark modification should conform to "ATSC Standard: Audio Watermark Emission" [2].

7. WATERMARK ERASURE

VP1 audio watermarks are statistically balanced in the sense that each symbol has an equal likelihood of conveying the bit value 0 or 1. This property results from the use of a balanced header sequence [2] and balanced whitening sequences [4].

A recommended practice for the erasure of the VP1 audio watermark is to modify symbols in each cell in each audio signal in the audio presentation, to convey the bit value 1 using standard

signaling. This sequence is maximally unbalanced, minimizing the likelihood of confusion with a valid VP1 audio watermark by an extractor.

Watermark modification performed to achieve watermark erasure should follow the recommended practice for watermark modification described in section 6.

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