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Matroska Stem Files
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Abstract

This document defines a multi-track profile of the Matroska container format for storing stems that is also backwards compatible with existing media players.

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1. Introduction

Stem are recordings of individual instruments, or clusters of instruments, used by DJs and music producers for live mixing of music. Historically stem files have been stored as individual audio files, or using patent-encumbered or vendor specific proprietary container formats. The Matroska container format formally specified in [RFC9559] is ideally situated as a container for stems. This specification documents a profile for the Matroska container format that allows it to store lossless or lossy stems as well as metadata about the stems for use in DJ applications or Digital Audio Workstations.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Requirements

STEM files have a few basic requirements:

- * Backwards compatibility with existing media players
- * The ability to store at 5 audio tracks
- * The ability to synchronize playback of multiple audio tracks
- * The ability to store file-level metadata and per-stem metadata

3. Track Layout

3.1. Audio Streams

Each stem file may contain an arbitrary number of tracks containing audio and MUST include at least 3 tracks (the mixed audio and at least two stems). Each track MUST be encoded using the same codec with the same parameters including bitrate, channel number, channel layout, and sample rate.

The first track containing audio data MUST be the final post-mix audio and MUST have the Matroska default flag set. This helps preserve backwards compatibility in media players which do not support this format (which typically play the first audio stream found).

The remaining tracks will be individual stems and MUST have the same audio length as the first track such that playing each stem track from the beginning would result in the same audio (excluding mastering) as the final mix present in the first track. For example, if the original track is 3 minutes long and the stem file includes a percussion track but the percussion does not start until minute 2 the percussion stem would still be 3 minutes long but would contain a minute of silence at the start of the track.

Each stem track MUST NOT have the Matroska default flag set.

The stem tracks SHOULD NOT have any gain normalization applied. Instead they should retain the same levels as they would have in the final mix present in the first track so that if all stems were played at unity gain the levels would be equivalent to the final mix.

Each stem track (ie. all tracks that are not the first track) MUST set the value of the `\Segment\Tracks\TrackEntry\Name` field to a human-readable track name for the stem, for example "Percussion" or "Vocals".

For each stem track a `\Segment\Tags\Tag` must also be set with its target set to the stem track. The tag must contain a `SimpleTag` element with the `TagName` field set to "StemColor" and the `TagString` field set to a color representing the track in RGB hex format (ie. "#145374").

4. Digital Signal Processor

Because mastering happens post-mix and the stems are pre-mix audio the stem tracks SHOULD NOT have any mastering steps applied. Instead, metadata for configuring a compressor and limiter SHOULD be included in the file's global metadata as simple tags. After mixing, playback applications MAY choose to feed the mix through a Digital Signal Processor configured with the limiter and compressor settings read from the metadata.

4.1. Compressor Metadata

Tag	Requirement Level	Values
STEM:COMPRESSOR:ENABLED	REQUIRED	"TRUE" or "FALSE"
STEM:COMPRESSOR:RATIO	OPTIONAL	TODO
STEM:COMPRESSOR:OUTPUT_GAIN	OPTIONAL	TODO
STEM:COMPRESSOR:THRESHOLD	OPTIONAL	TODO
STEM:COMPRESSOR:ATTACK	OPTIONAL	TODO
STEM:COMPRESSOR:INPUT_GAIN	OPTIONAL	TODO
STEM:COMPRESSOR:RELEASE	OPTIONAL	TODO
STEM:COMPRESSOR:HP_CUTOFF	OPTIONAL	TODO
STEM:COMPRESSOR:HP_DRY_WET	OPTIONAL	TODO

Table 1

4.2. Limiter Metadata

Tag	Requirement Level	Values
STEM:LIMITER:ENABLED	REQUIRED	"TRUE" or "FALSE"
STEM:LIMITER:RELEASE	OPTIONAL	TODO
STEM:LIMITER:THRESHOLD	OPTIONAL	TODO

STEM:LIMITER:CEILING	OPTIONAL	TODO
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Table 2

5. IANA Considerations

This memo includes no request to IANA.

6. Security Considerations

This document should not affect the security of the Internet.

7. Normative References

[RFC9559] Lhomme, S., Bunkus, M., and D. Rice, "Matroska Media Container Format Specification", RFC 9559, DOI 10.17487/RFC9559, October 2024, <<https://www.rfc-editor.org/info/rfc9559>>.

8. Informative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.

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