Less is More - The Opus WebM Audio Codec

Compressing digital audio has always been a trade-off between the quality of the sound and the size of the file. Twenty-five years ago, the mp3 codec[1] took the audio world by storm, finding a way to reduce a .wav file to approximately 1/5 - 1/10 of its original size while maintaining similar audio quality.

But when audio is highly compressed using the mp3 codec, it loses quality. The listener begins to hear audio artifacts and may have problems understanding the audio being played. Several attempts have been made to create a new codec that outperforms mp3 by maintaining high quality audio while reducing the file size, but none have gained significant attention.

In the last decade a new codec, Opus WebM, has emerged that significantly outperforms mp3 in both size and quality when it comes to audio compression. It was developed by On2, Xiph and Matroska, sponsored by Google and released under a BSD license, which is a software license that imposes minimal restrictions on its use and distribution. It is incorporated in the open-source FFmpeg codec library that is widely used by developers around the world. More information about the Opus WebM codec is available here.

Unfortunately, .webm has not been widely publicized in the consumer world, nor has it been made available in freeware audio editors like Audacity. The only way to convert audio to .webm is by installing FFmpeg and using the command line to do the conversion, which keeps it out of the realm of the common man.

The good news is audio files can be easily converted within Scripture App Builder and Reading App Builder, without the need to learn how to use the command line. The process is being updated to make it easier, but currently anyone using either of these programs can shrink the size of apps that include audio. The amount of space saved is very significant. For those who are a bit adventurous and have FFmpeg installed, the program "FFmpeg Batch AV Converter" can be used to convert audio from files like .wav and .mp3 to .webm files.

I first learned of .webm when I read the release notes of Reading App Builder 8.5 which was released in February, 2021. It piqued my curiosity so I began to investigate.

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[1] codec = compressor/decompressor
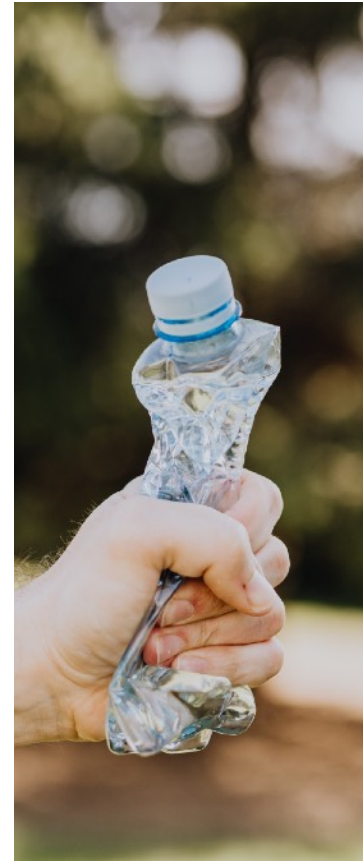
Testing

To begin, I recorded a series of Aesop's fables with background music. This resulted in a five-minute 30-second sound file that simulates the length of a recorded Bible story. I saved it as a stereo .wav file that was 55.5 MB.

I opened the .wav file with narration and music in FFmpeg Batch AV Converter and converted it to .webm files at several bitrates. Since Scripture App Builder and Reading App Builder cannot play back files encoded at variable bitrates, I used a constant bitrate (CBR). For comparison, I also exported the same file as an .mp3 file at several compression rates.

My goal was to create a range of sample files in order to observe what happened to the audio the more it was compressed. It is important to note that .webm and .mp3 bitrates (kbps) are not an "apples to apples" comparison. The .webm format offers many options (bit rate, compression, frame duration, VBR mode, application and cutoff) to tweak the compression. I stayed with the default options, and only experimented with the bit rates. See the chart below for a comparison of the exported file sizes.

5-Minute 30-Second Audio File	With Music	Compression	Format
Four Fables with music.wav	55.5 MB	none	wav
32k10c20msvbroff.webm	1.35 MB	32 kbps	webm
64cbrMono.mp3	2.51 MB	52 kbps	mp3
16k10c20msvbroff.webm	744 KB	16 kbps	webm
48cbrMono.mp3	1.9 MB	48 kbps	mp3
8k10c20msvbroff.webm	422 KB	8 kbps	webm
32cbrMono.mp3	1,290 KB	32 kbps	mp3
no notable compression artifacts some compression artifacts compression significantly impacts audio quality File size note: 1MB = 1,024 KB			
All compressed files referenced in this document are available in a single .zip file which can be downloaded here.			

It is notable that the same audio file exported as an .webm file using the 32 kbps setting was reduced to approximately 1/43 of the size of the original .wav file! When I listened to the original and the 32 kbps .webm file using my Sony WH-1000XM2 headphones, there was no perceptible difference.

I then compressed the same .wav file as an .mp3 file at 64 kbps in order to get a comparison between .webm and .mp3. The .mp3 file was 2.51 MB, almost twice the size of the .webm file. Needless to say, I was impressed.

A listening test using headphones (which I know is subjective) convinced me of the value of using the Opus WebM codec for apps which include audio. As stated earlier, when I compared the original .wav file with the 32 kbps .webm file and the 64 kbps .mp3 file I could not audibly tell the difference. At 16kbps, the compressed .webm file loses some of the sibilants ("s" sounds) but sonically is mostly unaffected by the compression. However, the 8 kbps compression rate significantly degrades the sound quality. It sounds similar to the 32 kbps .mp3 file. I also noted that even the highly compressed .webm files do not have the "swishing" sound that highly compressed .mp3 files are known for.

When I moved the highly compressed files to my Android phone and played them back using the built-in speaker, the 32cbrMono.mp3 file (1,290 KB) sounded slightly better than the 8 kbps .webm file (422 KB). Both sounded as if they were being played back on an AM radio.

This is where testing needs to be done with the intended audience. If, during testing, the test group responds negatively to a certain compression level, one can determine the maximum level of compression that should be used on projects intended for that group which include audio.

What about .opus?

It must be stated that Xiph has also developed .opus, which is very similar to .webm. As of v.2.4.2, Audacity enabled the export of .opus files, which made .opus available to the general public. Audio files encoded as .opus have a slightly better compression rate (2-3%) than .webm files, so the difference in space savings is not significant. However, .opus files only work on phones running Android version 10 (Android Q), released in September, 2019 and later versions. Phones running earlier versions of Android cannot play .opus audio files.

Conclusion

Since many will be engaging with the apps and audio on older Android phones, best practices dictate that .webm should be used for compatibility on as many devices as possible.

If one is comparing sound quality to file size, .webm is the clear leader. See the graph below for a visual reference. These files are of similar sound quality, but the .webm file is almost **two and a half times smaller**.

16k10c20msvbroff.webm 744KB				
48cbrMono.mp3 1,934KB				
0	500	1000	1500	2000
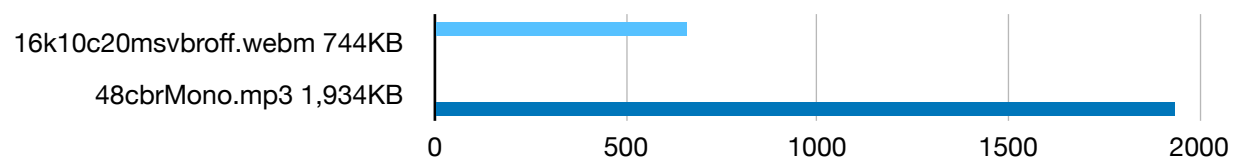
There are two obvious advantages of using WebM audio in apps. First is the reduction of the overall app size. Apps will be smaller and easier to transfer from one device to another. For instance, a New Testament app that is 500-800 MB can be reduced to 100 MB or less. Of course, end-user testing will be very important in

determining what compression rate should be used in order to maintain a listenable quality.

The second advantage is the Opus WebM codec is already being distributed in the open-source FFmpeg library, which is utilized by many computer audio players and editing software. Playback of the WebM files will be possible on the majority of phones, tablets or computers. Android devices running v.5.0 (Lollipop - 2014) or later have the built-in ability to play .webm audio files.

As of this writing (April 2021), it is not possible to export WebM audio files from Audacity.

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