# Audio

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# What is an Audio File?

- An audio file is a digital recording or representation of sound.
- It contains information about the amplitude and frequency of sound waves over time.
- Audio files are used for various purposes, including music, speech, sound effects, and more.
- Different audio file formats exist to store and transmit audio data efficiently.

# Audio Codec

- **Lossy Codecs**
  - These codecs discard some audio data during compression, resulting in a smaller file size
  - **Ex:** MP3, AAC, WMA
- **Lossless Codecs**
  - Lossless codecs compress audio data without losing any information, allowing for perfect reconstruction of the original audio
  - **Ex:** FLAC, ALAC, WAV (in some cases)

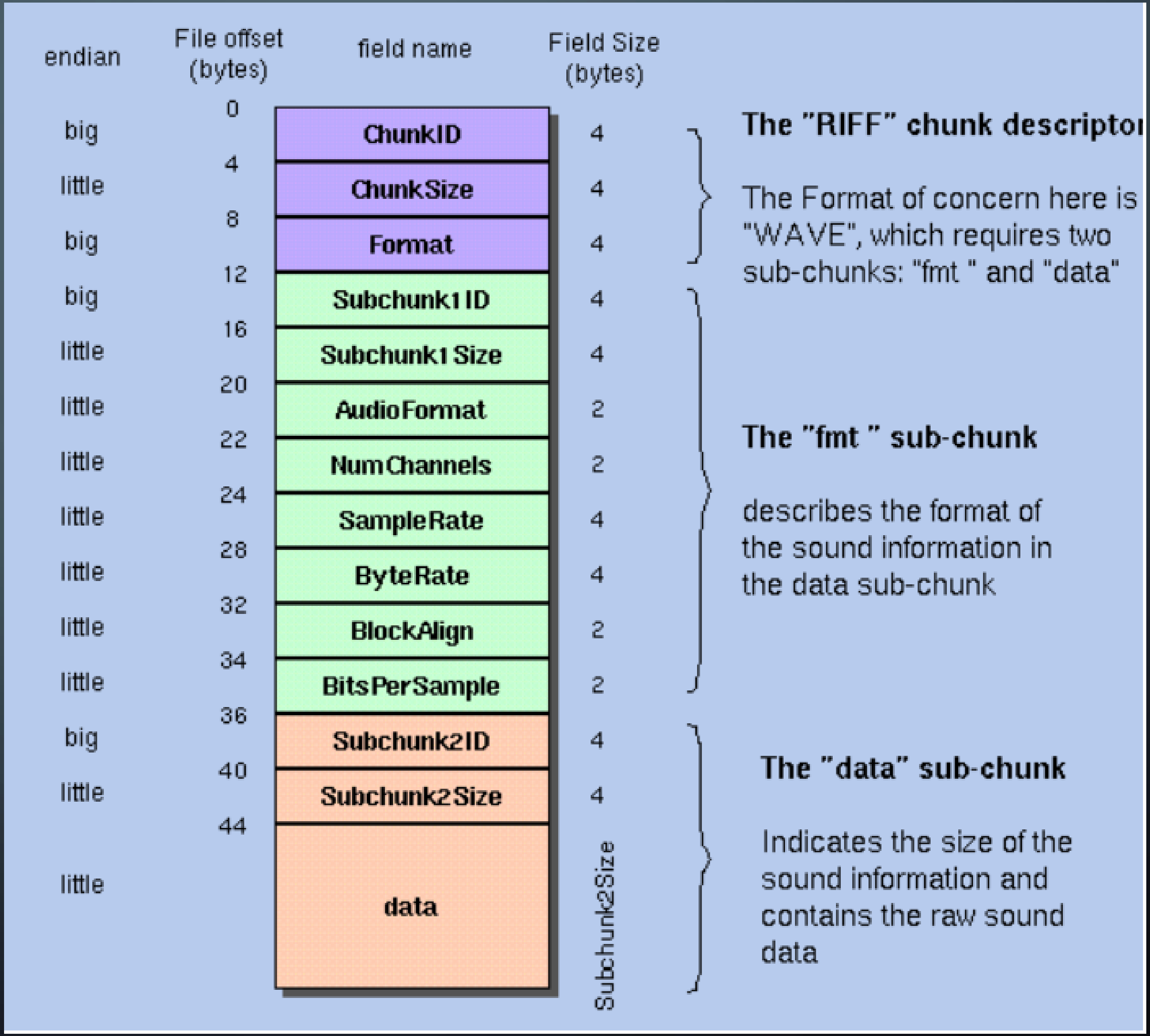
# Application

- **Streaming Services**
  - Codecs like AAC and MP3 are commonly used for streaming audio over the internet due to their efficient compression.
- **Music Storage**
  - Lossless codecs like FLAC and ALAC are favored for storing high-quality music files on devices with abundant storage.
- **Voice Communication**
  - Codecs like Opus are optimized for real-time communication applications, such as VoIP and online gaming.
- **Broadcasting**
  - Codecs like MPEG-2 Layer III (MP3) are used for radio broadcasting, allowing for the transmission of audio with reduced bandwidth requirements.

# WAV File

- Waveform Audio File Format (WAV) is a popular uncompressed audio file format developed by Microsoft and IBM.
- WAV files contain raw audio data without any compression, resulting in high audio quality but larger file sizes.
- WAV files are commonly used in professional audio production, where preserving the original quality is crucial.

# WAV Header


endian
File offset (bytes)
field name
Field Size (bytes)
big 0 ChunkID 4
little 4 ChunkSize 4
big 8 Format 4
big 12 Subchunk1 ID 4
little 16 Subchunk1 Size 4
little 20 AudioFormat 2
little 22 NumChannels 2
little 24 SampleRate 4
little 28 ByteRate 4
little 32 BlockAlign 2
little 34 BitsPerSample 2
big 36 Subchunk2ID 4
little 40 Subchunk2Size 4
little 44 data Subchunk2Size
The "RIFF" chunk descripto
The Format of concern here is "WAVE", which requires two sub-chunks: "fmt " and "data"
The "fmt " sub-chunk
describes the format of the sound information in the data sub-chunk
The "data" sub-chunk
Indicates the size of the sound information and contains the raw sound data

# PCM (Pulse Code Modulation)

- PCM is a method used to digitally represent analog signals, including audio.
- It involves sampling the amplitude of an analog signal at regular intervals and converting each sample into a digital code.
- PCM is the basis for many audio file formats, including WAV.
- PCM can be either linear or nonlinear, with linear PCM being the most common.

# How to Play Audio

- **Audio File Decoding**
  - The microcontroller needs to decode the audio file, especially if it's in a compressed format. This may require using a dedicated audio codec or a software decoder.
- **Digital-to-Analog Conversion (DAC)**
  - The microcontroller must convert the digital audio data into analog signals that can be played through speakers or headphones. This is achieved using a DAC.
- **Amplification**
  - In many cases, the analog signal may need amplification before being sent to speakers to ensure sufficient volume.
- **Output to Speakers**
  - Connect the output from the DAC or amplifier to speakers or headphones for audio playback.