

Music & the Internet

MUMT 301

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Plan

- Sound file formats
 - Audio compression
 - CSS (Cascading Style Sheet)
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- Final project ideas:
 - Bandwidths of public internet sites in Montreal (100+ site)
 - Website to allow people to submit and display the bandwidth information
 - Historical study of changes in web design of music-related websites (using the Wayback Machine)

Sound File Formats

- Lists
 - http://www.digitalpreservation.gov/formats/fdd/sound_fdd.shtml
 - http://en.wikipedia.org/wiki/Audio_file_format
- MIDI is not an audio file format
- Two types:
 - Uncompressed: e.g., .wav, aiff
 - Compressed: e.g., mp3, ogg/vorbis
 - lossy
 - lossless

Sound File Formats: Uncompressed

- LPCM (Linear Pulse-Coded Modulation)
- WAV
- AIFF (Audio Interchange File Format)

Sound File Formats: Uncompressed

- LPCM (Linear Pulse-Coded Modulation)
 - digital representation of analog signal
 - Sampling rate
 - Bit-depth

DVD-AUDIO

	16-, 20- or 24-bit depth					
	44.1 kHz	48 kHz	88.2 kHz	96 kHz	176.4 kHz	192 kHz
Mono (1.0)	Yes	Yes	Yes	Yes	Yes	Yes
Stereo (2.0)	Yes	Yes	Yes	Yes	Yes	Yes
Stereo (2.1)	Yes	Yes	Yes	Yes	No	No
Stereo + mono surround (3.0 or 3.1)	Yes	Yes	Yes	Yes	No	No
Quad (4.0 or 4.1)	Yes	Yes	Yes	Yes	No	No
3-stereo (3.0 or 3.1)	Yes	Yes	Yes	Yes	No	No
3-stereo + mono surround (4.0 or 4.1)	Yes	Yes	Yes	Yes	No	No
Full surround (5.0 or 5.1)	Yes	Yes	Yes	Yes	No	No

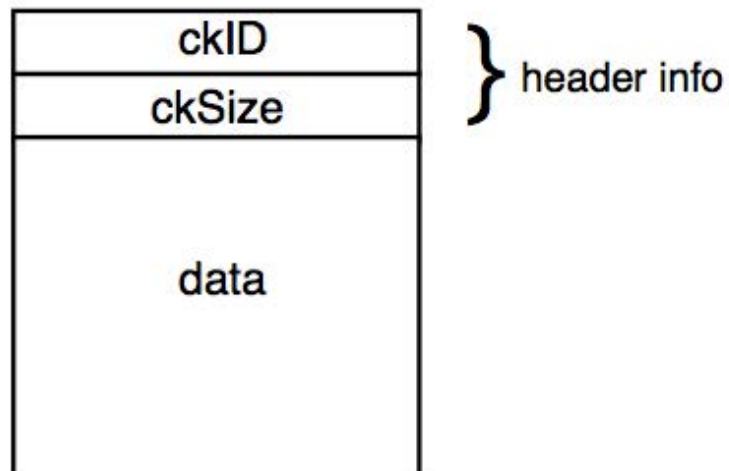
Sound File Formats: Uncompressed

- WAV (Microsoft & IBM; 1991)
- AIFF (Audio Interchange File Format; 1989)

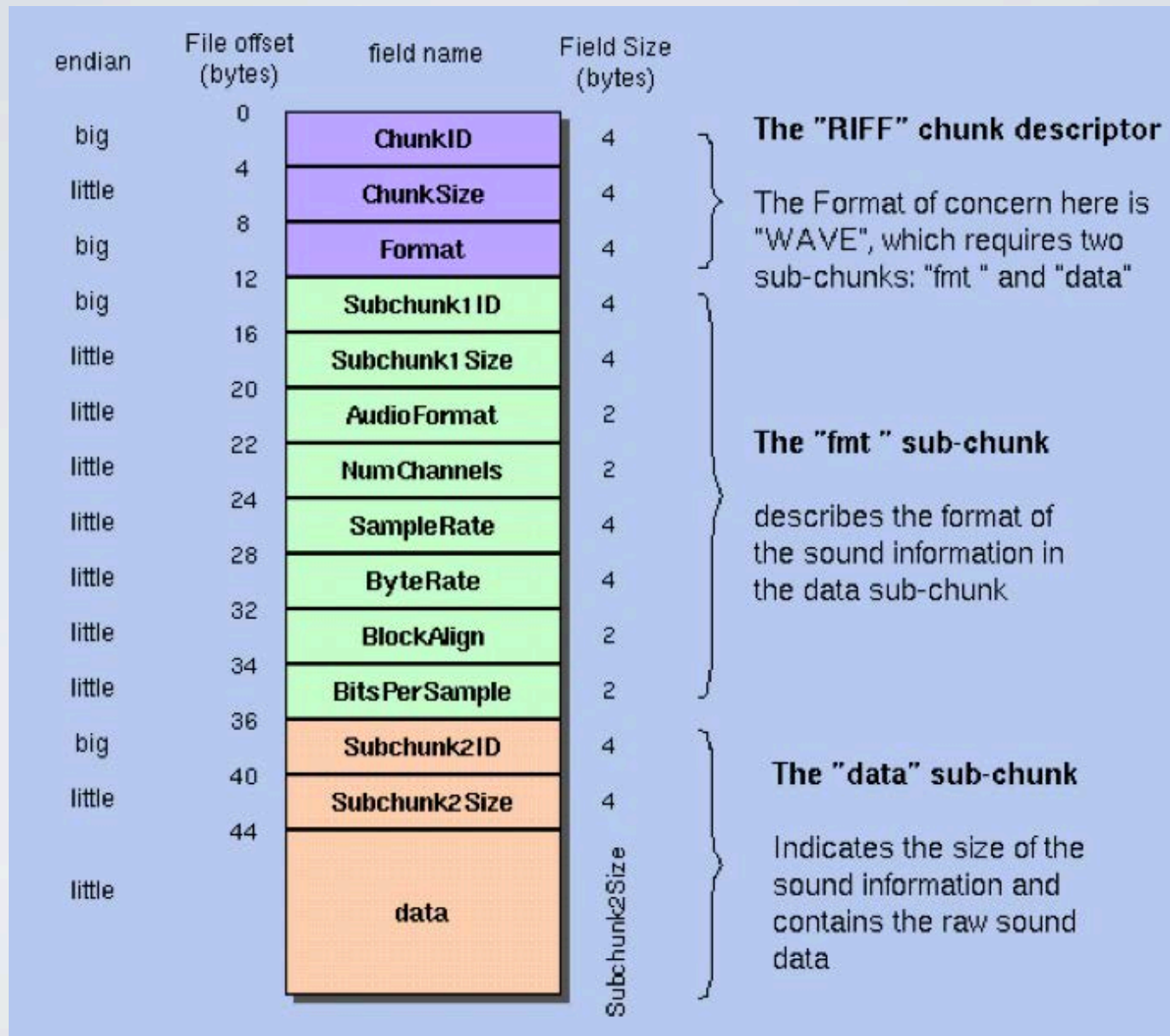
IFF File formats

- AIFF, WAV, RIFF, etc.
- Based on “EA IFF 85” Standard
- Based on ‘chunks’

A chunk.



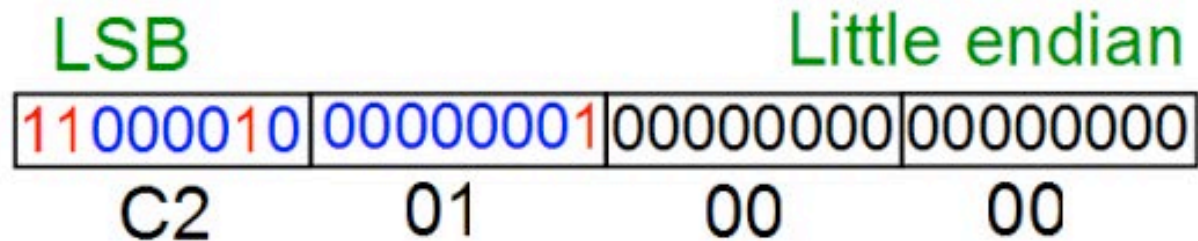
Sound File Formats: WAV



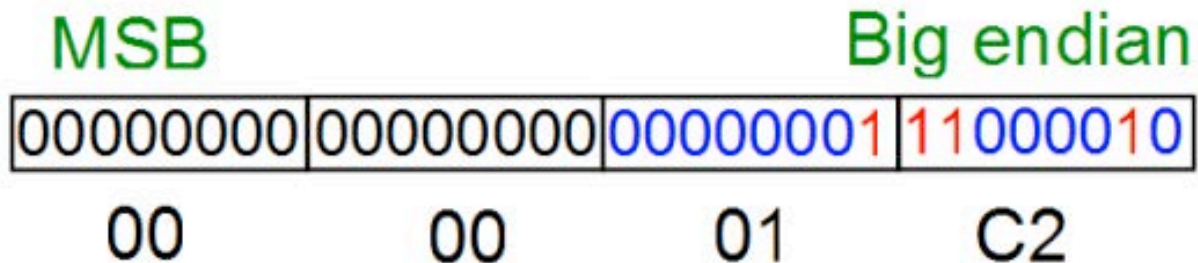
Little endian vs. Big endian

$$\text{Int } i = 450 = 2^8 + 2^7 + 2^6 + 2 = \text{x000001C2}$$

Intel, etc.



PowerPC, IP, etc.



Sound File Formats: Compressed

- Lossy perceptual audio coding
- MP3 (MPEG-1 Audio Layer 3)
 - Karlheinz Brandenburg (Fraunhofer)
 - Stereo or 5.1 channels (in MPEG-2 mode)
 - Sampling frequency: 16–48kHz
- AAC (Advanced Audio Coding; 1997)
 - m4a: created with iTunes by a user from a CD
 - m4p (DRM protected): when you buy a song from Apple on iTunes (as of 2009/01, iTunes offer DRM-free songs)
 - up to 48 channels
 - Sampling frequency: 8–96kHz

File Size Comparison

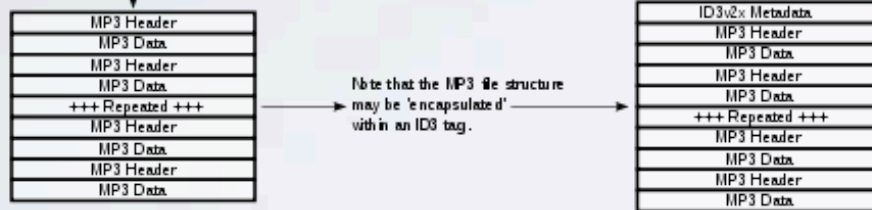
- CD: $44,100 \text{ samples/s} \times 16 \text{ bits per sample} \times 2 \text{ channels} = 1,411,200 \text{ bit/s}$
- MP3 compressed at 128 kbit/s: 128,000 bit/s
- Ratio: $1,411,200 / 128,000 = 11.025$.
- MP3 files @ 128 kbit/s are about 11 times smaller.

MP3 File Format

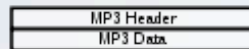
An MP3 File



Internal Structure of an MP3 File



An MP3 Frame



Example MP3 Header

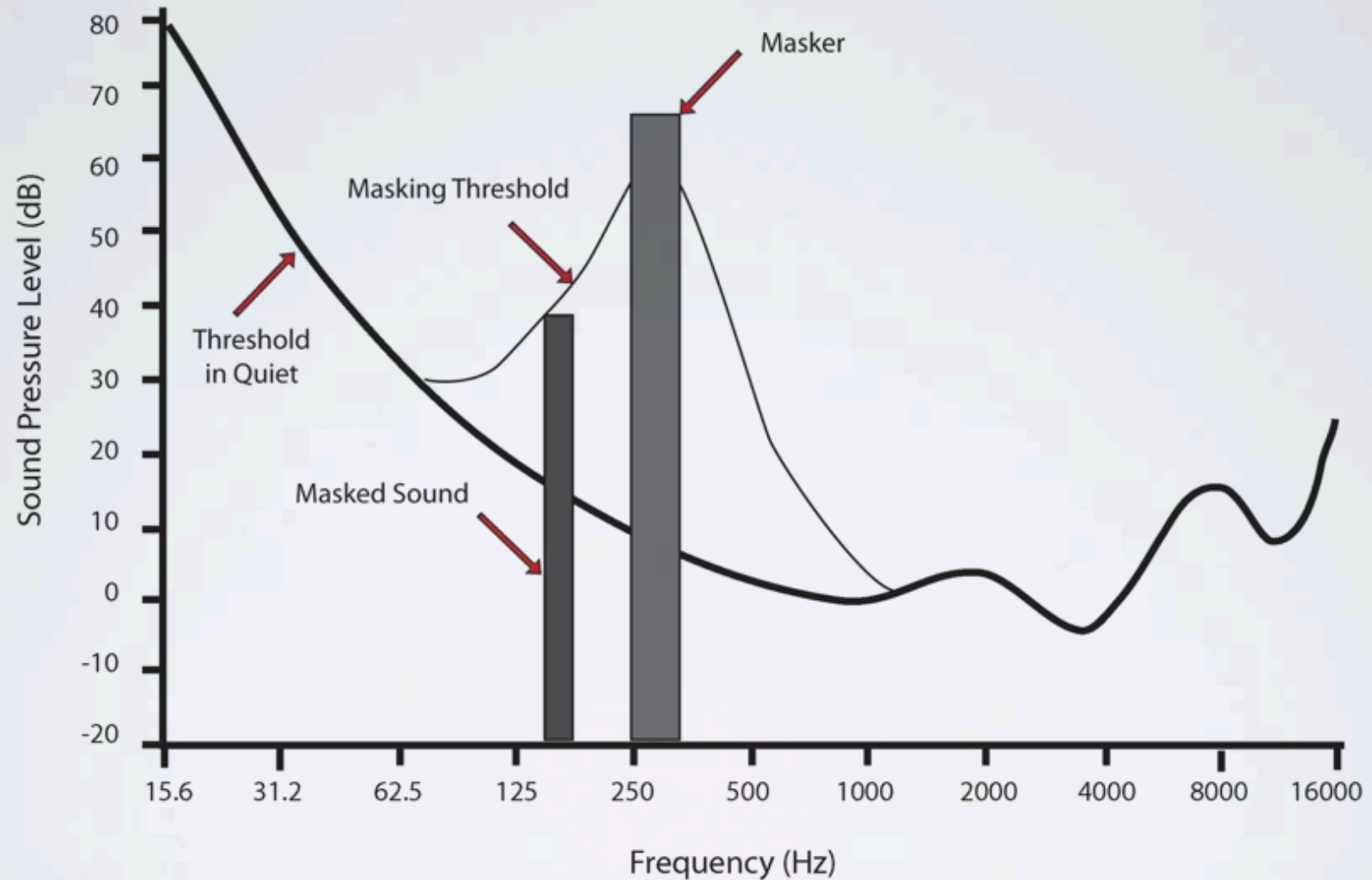
FFFBA040

Colour-coding shows binary bit mapping to hex values below

Detail of an MP3 Header

Bits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
Binary	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Hex	F	F	F	F	F	F	F	F	F	F	F	F	B				A					0					4					0	
Meaning	MP3 Sync Word												Version	Layer	Error Protection	Bit Rate				Frequency	Pad. Bit	Priv. Bit	Mode	Mode Extension (Used With Joint Stereo)		Copy	Original	Emphasis					
Value	Sync Word												1 = MPEG	01 = Layer 3	1 = No	1010 = 160				00 = 44100 Hz	0 = Frame is not padded	Unknown	01 = Joint Stereo	0 = Intensity Stereo Off	0 = MS Stereo Off	0 = Not Copy-righted	0 = Copy Of Original Media	00 = None					

Auditory Masking



Open-source Audio File Formats

- FLAC (Free Lossless Audio Codec; 2001)
 - Typically reduced to 50-60%
- Ogg/Vorbis (2000)
 - Used by Spotify (streaming music service)
- LAME (1998) “**L**ame **A**in’t an **M**P3 **E**ncoder”
- <http://www.cdburner.ca/digital-audio-formats-article/digital-audio-comparison.htm>

Compressed vs Uncompressed

- Q.: Can people hear the difference?
- A.: It depends
- Listeners can tell the difference between CD quality and MP3 compression (92–192 kb/s) [Amandine et al. 2009]
- Listeners can not tell the difference between CD quality and MP3 compression (256–320 kb/s) [Amandine et al. 2009]

MIDI

- Musical Instrument Digital Interface (1982)
- Communication protocol (not really even a file format)
- Designed to be able to communicate between electronic musical instruments with each other (especially between different manufactures)
- Standard MIDI File 1.0 (1988)
- <http://www.sonicspot.com/guide/midifiles.html>



Working with audio

- Editor: Audacity
- Rippers
 - CD: iTunes, VLC
 - DVD: HandBrake
 - Internet Streams (incl. Skype): Soundflower (Mac), Audacity (Win), ALSA (Linux)
 - FLV (YouTube)
 - Firefox: Video downloadhelper
 - To extract audio from FLV:
 - iExtractMP3 (Mac)
 - VLC (<http://www.michael-noll.com/blog/2010/01/20/how-to-extract-audio-from-flv-files-using-vlc/>)

Break

CSS (Cascading Style Sheet)

- CSS define how to display HTML elements
 - http://www.w3schools.com/css/demo_default.htm
- CSS saves lot of work
- Three ways to insert style
 - External (stored in CSS files)
 - Internal
 - Inline
- http://www.w3schools.com/css/css_syntax.asp