Music & the Internet
MUMT301

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Plan

- Mid-term recap
- API and Webservices
- Music APIs
- JavaScript
- Assignment #6

MPEG-1 Layer-3 audio standard

- MPEG audio standard is **informative instead of normative**
  - minimum amount of **normative elements**:
    - the **data representation** (i.e., format of the compressed audio)
    - the **decoder** (however there is freedom in how to implement it)
- **Encoding** of MPEG audio is **left to the implementer**
  - the standard only gives description of example encoders
  - MPEG audio **encoders can vary in quality**

Intellectual property

Compiled from http://www.cipo.ic.gc.ca/

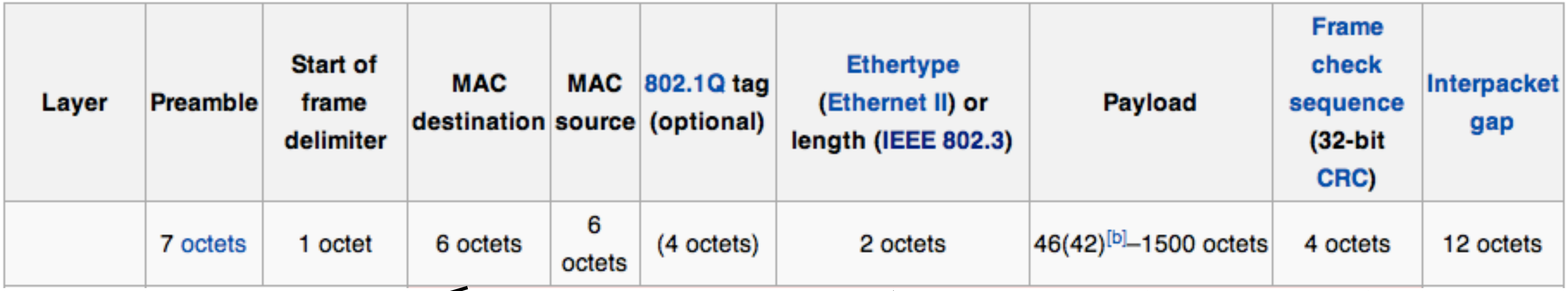
- Copyright Act: **any original** literary, dramatic, musical (musical compositions with or without words) or artistic work is **automatically protected by copyright the moment it is created**
- In the simplest terms, "**copyright**" means "**the right to copy**": the right to reproduce a work, or a substantial part of it, in any form
- In the case of music or sound:
  - **a recording consisting of sounds**
  - **a performance of a musical work**
  - **an improvisation of a musical work**
- Copyright in Canada

HTML

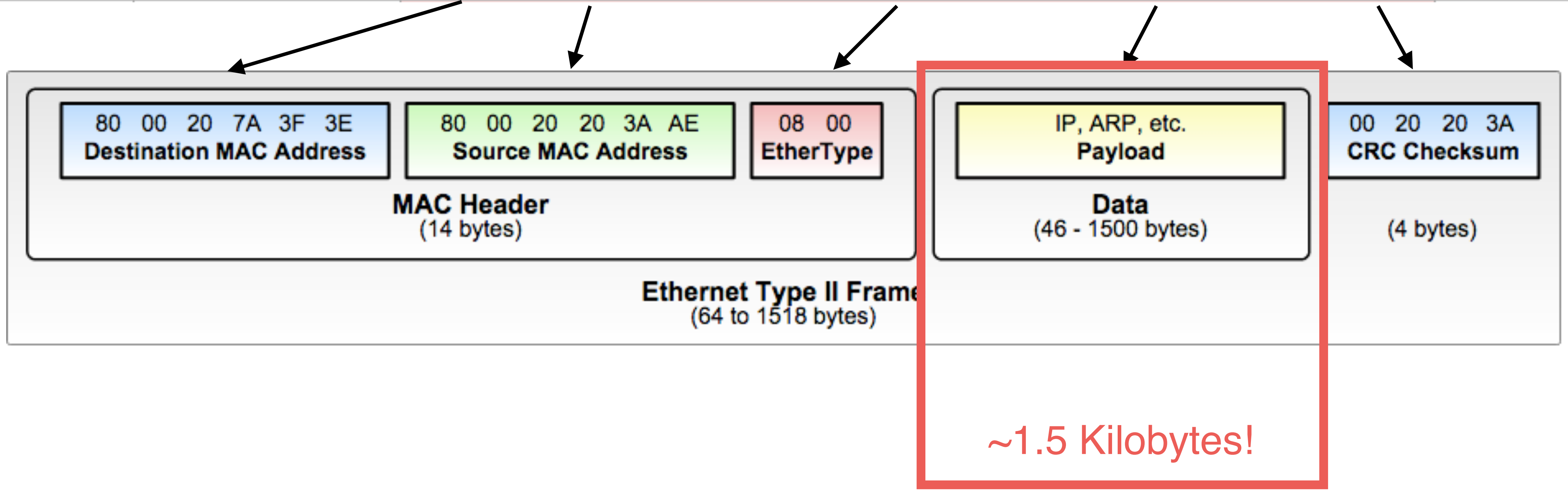
- The WWW system uses **marked-up text** to represent a **hypertext document** for transmission over the network
- WWW parsers **should ignore tags which they do not understand**, and **ignore attributes which they do not understand** of tags which they do understand
- **Backwards compatible** by design:
  - even the first webpage still work in a modern browser
  - modern webpages should be readable in old browsers

Ethernet packet and frame

802.3 Ethernet packet and frame structure



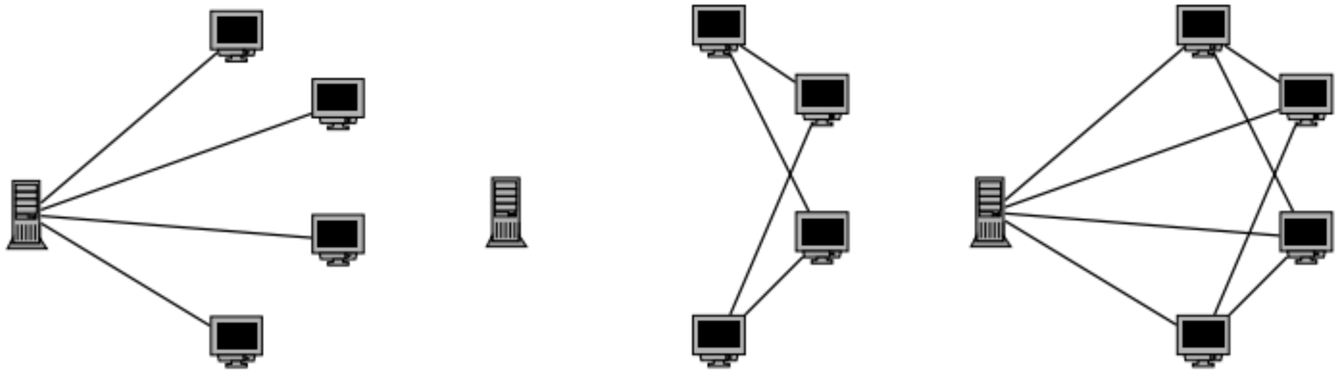
Layer	Preamble	Start of frame delimiter	MAC destination	MAC source	802.1Q tag (optional)	Ethertype (Ethernet II) or length (IEEE 802.3)	Payload	Frame check sequence (32-bit CRC)	Interpacket gap
	7 octets	1 octet	6 octets	6 octets	(4 octets)	2 octets	46(42)[b]–1500 octets	4 octets	12 octets



~1.5 Kilobytes!

Taken from http://en.wikipedia.org/wiki/Ethernet_frame

Peer to peer (P2P)



(a) Client-server (b) Peer-to-peer (c) Peer-assisted

Figure 1.1: Three types of protocols.

Taken from Kreitz, G. 2011. Aspects of Secure and Efficient Streaming and Collaboration. PhD Thesis. KTH Computer Science and Communication.

- By the end of the 90s, the P2P protocol irrupted, **allowing users to share files between their own computers** through a network
- In P2P, the **clients talk directly to each other** to accomplish a task
- It is also common a server remains in the picture providing some functionality such as helping to peers to find each other
- Easily **scalable to large number of users**: each client helps in serving other clients
- The **content is sent from peers**, and so data is not always available

Transformations in the music industry

- Several **transformations** in the media environment have had tremendous **impact** on the structure and logic of the **music industry**
  - Phonograph recordings by end of 19th century
  - Broadcast radio programming in the 1920s
  - Magnetic tape in the 1930s
  - Compact cassette in the 1970s
  - Deregulation of media ownership in the 1990s
  - Shift from physical to virtual in the 2000s
  - Streaming in the 2010s

Widespread infrastructure

- **US Federal agencies** made and implemented **policy decisions** that shaped Internet by the late 80s
  - Federal agencies **shared the cost of common infrastructure**
  - NSF encouraged regional networks to **look for non-academic customers** to lower costs
  - NSF **prohibited the use of its national network for non-academic or research purposes** with the intention of **stimulate the growth of private networks**
  - The **NSF national network was defunded** in 1995, but its policies led the Internet to grow to around 30,000 networks just in the US
- 1995: FNC passed a resolution **defining the term Internet:**
  - **"Internet" refers to the global information system that:**
    - is linked together by a globally **unique address space** based on the IP
    - is able to **support communications using TCP/IP**
    - provides **high level services** layered on the communications and infrastructure previously described

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Compressed sound file formats

- Lossy and Lossless
- **Lossy compression**:
  - only **an approximation of the original data can be reconstructed after decompression**,
  - How well it approximates the original data **depends on the compression rate**
  - Common lossy formats
    - MP3 (patented!)
    - Vorbis (aka Ogg Vorbis), xiph.org webpage (free and open source) (V1.0 2002)
    - WMA
- **Lossless compression**:
  - **data can be perfectly reconstructed after decompression**
  - Lossless formats
    - Monkey's Audio, WavPack, Apple Lossless, ...
    - FLAC, xiph.org webpage
      - non-proprietary
      - no patent restricted
      - open-source

MPEG-1 Layer-3 characteristics

- **Flexibility**
  - **Different operating modes**:
    - **Single channel**
    - **Dual channel** (two independent channels, e.g., two different language versions of an audio piece)
    - **Stereo** (no joint stereo coding, the two channels are encoded independently)
    - **Joint stereo** (information about differences from each channel is stored in one channel, whilst identical information is stored in the other. Help to reduce bit-rate)
- **Sampling frequency**
  - **MPEG-1**: **32kHz, 44.1kHz, 48kHz**
  - MPEG-2: extends MPEG-1 to half rates: 16kHz, 22.05kHz, 24kHz
  - MPEG-2.5: Fraunhofer-proprietary: 8kHz, 11.05kHz, 12kHz
- **Bit-rate**
  - the MPEG-1 standard defined a range of **bit-rates from 32 kbits/s up to 320k bits/s**
  - MPEG-2 standard extends the bit-rate to 8 kbits/s
  - **selection of bit-rate left to the operator of the audio coder**

Digital music distribution models

- **Music locker (cloud based)**
  - Amazon Drive (Cloud Drive)
    - free for 5GB or up to 250 songs
    - free for Amazon-bought music
    - up to 10 devices
    - max: 250k songs (US only)
    - Also Cloud player
  - Google Music (up to 20k songs per personal music collection)
  - Apple's iTunes Match

- **Music streaming via subscription**
  - Pandora
  - Spotify
  - Rdio
  - Songza
  - Deezer
  - Google Music
  - Apple Music
  - Last.fm
  - Soundcloud
  - slacker.com
  - Microsoft Groove
  - Playstation Music
  - Tidal
  - Amazon Music Unlimited
  - and many others …

Ports

- **Virtual pathways** on which Internet data travels
- **Metaphor**: If we think of **IP addresses as telephone numbers**, ports are **telephone number extensions**
- The port number added to the IP address completes the address for a communication session
- **Ports identify unique applications or processes** running on a computer and enable them to share a single physical connection in the Internet
- **All data sent to an IP address is sent on specific ports**
- Syntax: `(IP Address):(Port Number)`
- **16 bits** are dedicated for port numbers in TCP and UDP (65536 different ports)
  - Typical **system ports**: 21 (FTP), 22 (SSH), 25 (SMTP), 53 (DNS), 80 (HTTP), 194 (IRC), 443 (HTTPS)
  - **Registered ports**: 5050 (Yahoo! Messenger), 9293 (Sony Playstation remote play), 19294 Google Talk, ... partial list here

API and Webservices

- **API** (Application Programming Interface)
  - Specifies a software component in terms of:
    - their **inputs** and **outputs**
    - the underlying **types**
    - its **operations**
  - APIs can come as a **specification** of **remote calls** exposed to the API consumers

API and Webservices

- Web service:
  - "...a software system designed to support interoperable **machine-to-machine interaction** over a network." (W3C)
  - **method of data exchange** that **doesn't depend upon a particular programming language**
  - Web services can be **used by other applications**

REST

- REpresentational State Transfer
- Set of principles for creating web services
- Language and platform independent
- Uses HTTP or HTTPS
- HTTP-based RESTful APIs are defined with these aspects:
  - base URI, such as `https://example.com/resources/`
  - standard HTTP methods (e.g., GET, PUT, POST, or DELETE)
  - an Internet media type for the data. This is often XML or JSON but can be any other valid Internet media type
- Message format can be: XML, JSON, HTML, plain text, etc.

Message formats JSON/XML

- JSON (JavaScript Object Notation)
  - open-standard format that uses human-readable text to transmit data objects consisting of attribute–value pairs
  - https://json.org/example.html
- Download a JSON viewer for your browser
  - https://jsonview.com/example.json
- XML and JSON example
  - https://musicbrainz.org/ws/2/artist?query=ratatat&fmt=xml
  - https://musicbrainz.org/ws/2/artist?query=ratatat&fmt=json

API and Webservices

- Weather
- Exchange rate   Stock prices
- Social data: Instagram, Twitter, Facebook
- Music APIs!

Music APIs

- MusicBrainz API
- LastFM API
- Echonest API (RIP)
- and many others ...
  - http://musicmachinery.com/music-apis/

MusicBrainz API

- An **interface** to the MusicBrainz Database
    - https://musicbrainz.org/doc/MusicBrainz_Database/Schema
- Aimed at any applications requiring **music metadata**
- The service's architecture follows the **REST design** principles
- Interaction with the web service is done **using HTTP** and all **content is served in XML and JSON**
- https://musicbrainz.org/doc/Development
    - The **web service root URL** is http://musicbrainz.org/ws/2/
- **Lookup:**
    - http://musicbrainz.org/ws/2/artist/f467181e-d5e0-4285-b47e-e853dcc89ee7
- **Search:**
    - http://musicbrainz.org/ws/2/artist?query=ratatat
- **Query:**
    - http://musicbrainz.org/ws/2/release?artist=f467181e-d5e0-4285-b47e-e853dcc89ee7&type=album
    - http://musicbrainz.org/ws/2/release-group?artist=f467181e-d5e0-4285-b47e-e853dcc89ee7&type=album

BREAK

JavaScript

- https://mumt301.github.io
- In-class assignment: create a small website that asks a user for an artist and returns the Musicbrainz ID for that artist