

Audio Signal Compression

Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie
AGH University of Science and Technology

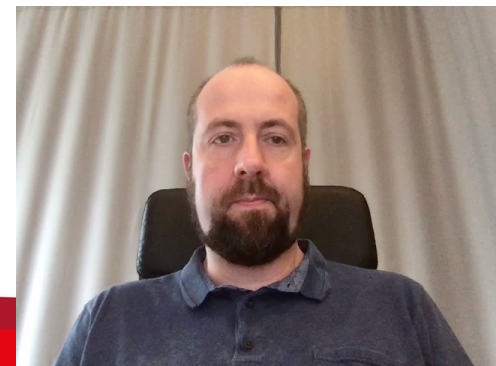
Mikołaj Leszczuk



What is a bit rate of a typical consumer stereo audio stream, compressed with MP3 codec?

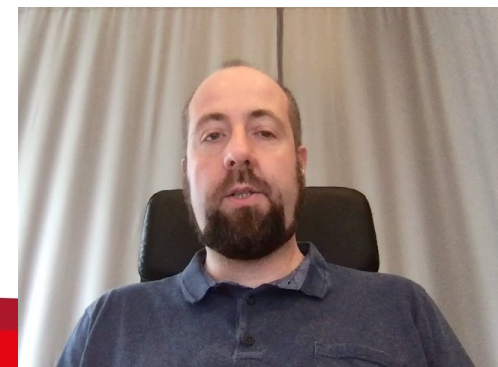
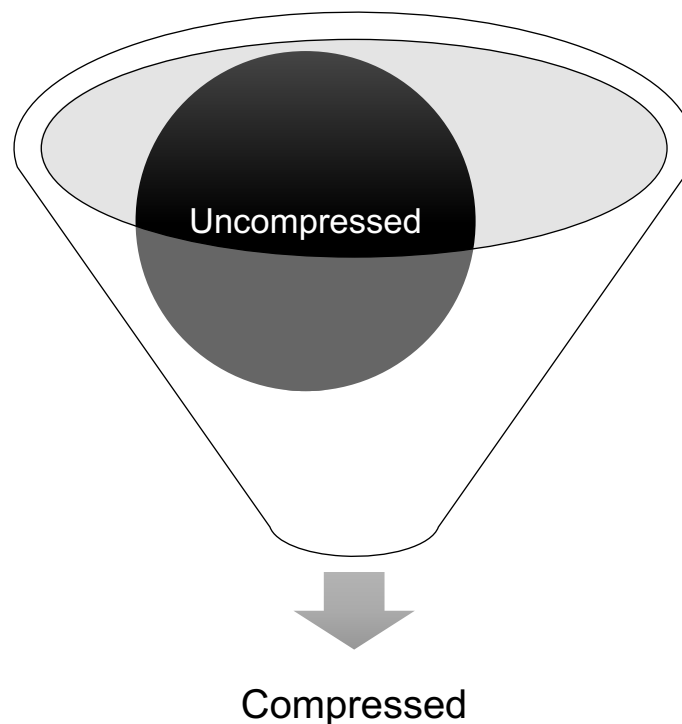


<https://www.menti.com/ahd8rr5vie>

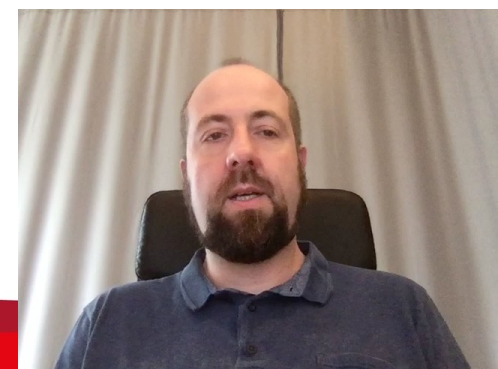
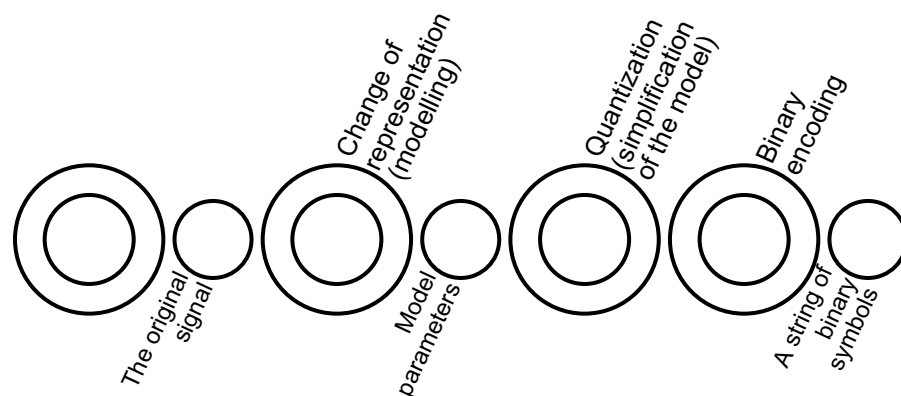


Why Compression?

- Uncompressed audio:
 - PCM telephony – **64 kbit/s**
 - First media – **131-384 kbit/s**
 - Radio and TV broadcasting – **512, 768 kbit/s**
 - Consumer Hi-Fi: CD, DAT – **705.6, 768 kbit/s**
 - High End and studio – **1920-4608 kbit/s**
- **Compression is required!**
- Compressed audio (**lossy**) – **64 kbit/s**
- Achieved ratio – **1:200**



Lossy Audio Compression (Coding) Steps



Most Popular Lossy Audio Codecs

MPEG Audio
Layer III
(MP3)



Advanced
Audio Coding
(AAC)



Vorbis



MP3 – General Info

- » **Initial release: 1993**
- » Developed by **Fraunhofer (IIS) & Thompson**
- » Standardized by MPEG Audio Committee of **ISO & IEC**
- » **Closed format** – active patents in **United States**

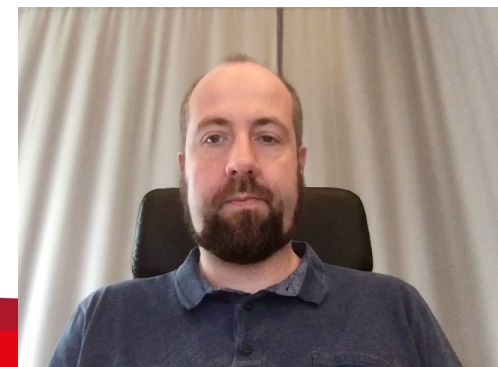


[This photo](#), author: Author
unknown, license: [CC BY-SA](#)

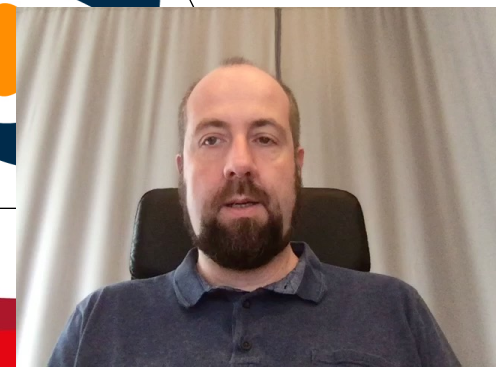


MP3 Compression

- » Faithful **CD** audio reproduction at **128 kbit/s (1:11)**:
 - Higher bit rate => higher quality
 - Lower bit rate => lower quality
- » **Perceptual coding** – reducing certain parts of audio accuracy beyond **auditory** ability
- » Using **psycho-acoustic models** to:
 - Discard/reduce less audible components by **Modified Discrete Cosine Transform (MDCT)**
 - Record remaining information
- » **Stereo** or **5.1** audio
- » Supported sampling rates up to **48 kHz**

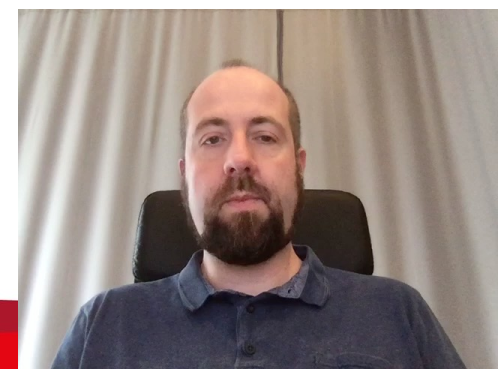


MP3 Market Adoption



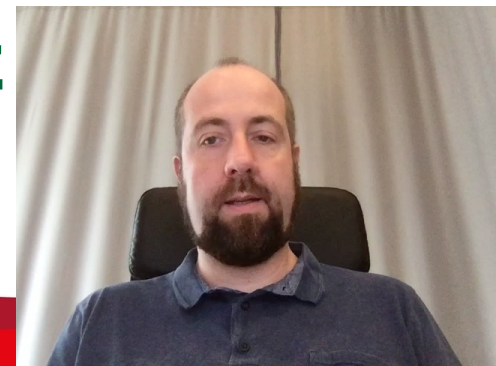
AAC – General Info

- » **Initial release: 1997**
- » Developed by **Bell Labs, Fraunhofer (IIS), Dolby Labs, Sony & Nokia**
- » Standardized by **ISO & IEC**
- » Part of specifications of **MPEG-2 & MPEG-4**
- » **Closed format** –
codec license required



AAC Compression

- » Designed to be successor of **MP3**
- » Better quality at similar **bit-rates**
- » Featuring
 - Up to **48** audio channels with frequency range up to **96 kHz**
 - Up to **16** LF effect channels with frequency range up to **120 Hz**



AAC Market Adoption

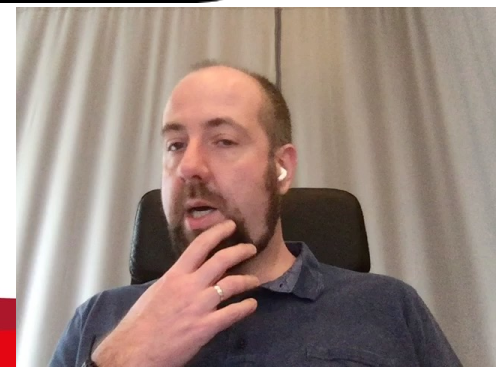


Vorbis – General Info

- » **Initial release: 2000**
- » Developed by
**Xiph.Org
Foundation**
- » **Standardised** by
specification
- » **Open format** – lack
of patent restrictions



[This photo](#), author: Author
unknown, license: [CC BY-SA](#)



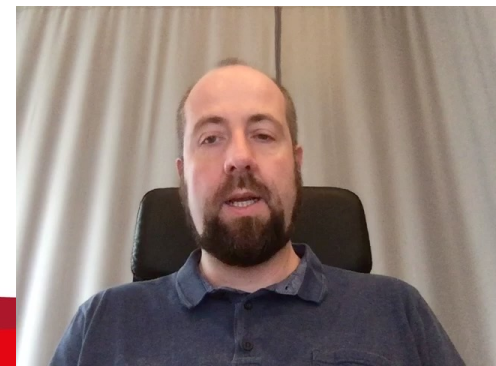
Vorbis Compression (1/2)

» Algorithm also based on **MDCT** but minimally:

- Smaller files, or
- Higher quality

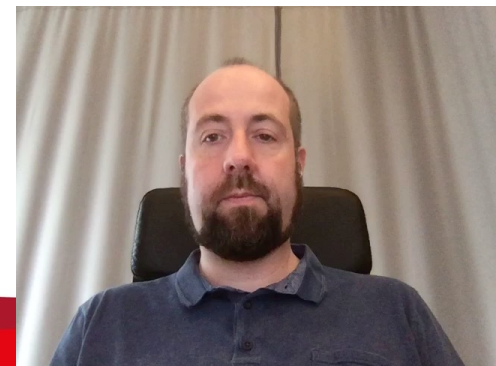
» Features:

- Up to **255** channels
- **16-bit** sound
- Frequency range up to **48 kHz**

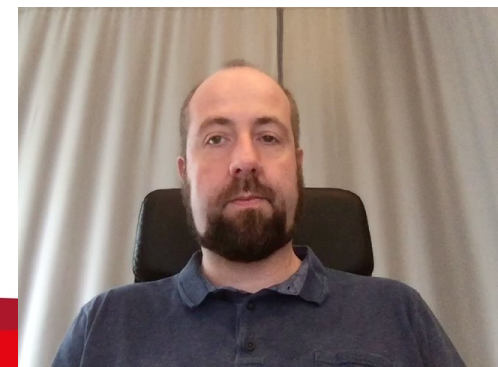
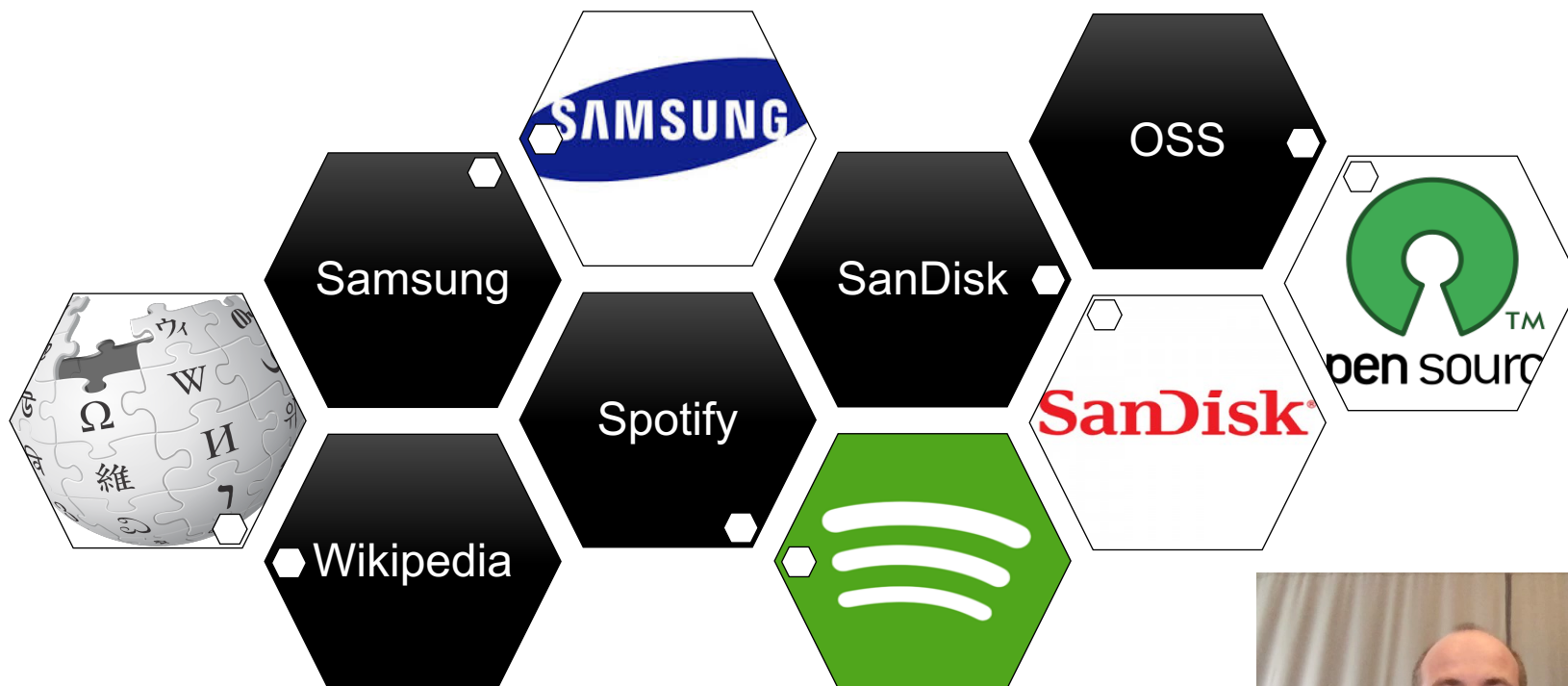


Vorbis Compression (2/2)

- » Breakdown of stream on windows in **2** sizes:
 - Large (usually **2048** samples)
 - Small (typically **256** samples)
- » Performing **MDCT** in each window
- » Simplifying data from **MDCT** (**psycho-acoustic model**)
- » Scaling of data depending on energy
- » Quantification and lossless data compression



Vorbis Market Adoption

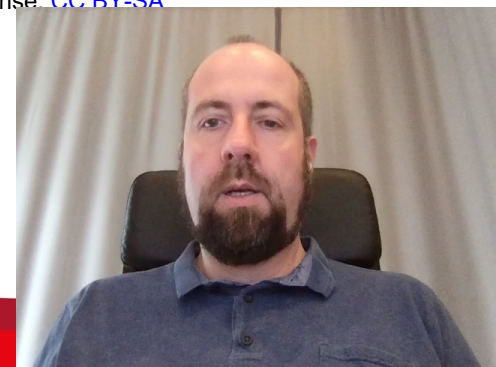


FLAC

- » **Free Lossless Audio Codec; /flæk/**
- » **Audio coding format**
- » **Lossless compression**
- » Developed by the **Xiph.Org**
- » Audio reduced to 50-70% of its original size

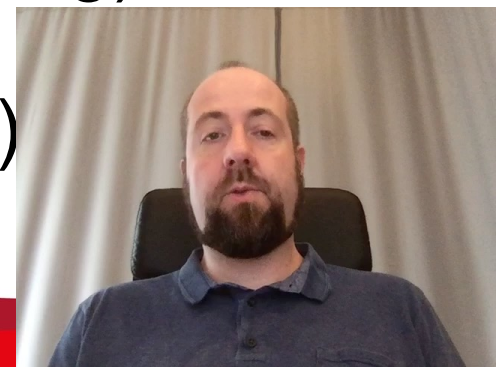


[This photo](#), author: Author unknown, license: [CC BY-SA](#)



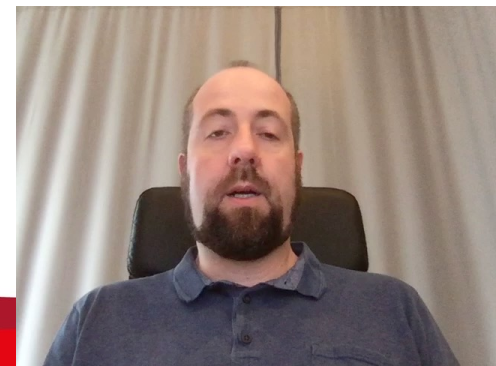
Other Audio Codecs

- » **ATRAC** (created and patented by **Sony Corp.**, used for PlayStation)
- » **AC-3** (created and patented by **Dolby Laboratories**, used for **DVD players** and **digital television**)
- » **MP2 – MPEG-1, 2 Audio Layer II** (MP3 predecessor)
- » **RealAudio** (used for live broadcasting)
- » **WMA – Windows Media Audio** (created and patented by Microsoft)



Speech Codecs

- » **SILK** (created and patented by **Skype Limited**, free, used in **Skype** for voice recording)
- » **G.711** (standardised by **ITU-T**, free, used in many **VoIP** software)
- » **G.726** (standardised by **ITU-T**, free, used in some **VoIP** software)
- » **AMR** (created and patented by **3GPP**, used by mobile network operators)
- » **Speex** (popular for open-source applications because of lack of patent restrictions)
- » **Siren 7** (created and patented by **Polycom** Inc., used by **Microsoft Lync**)



A typical consumer stereo
audio stream, compressed
with MP3 codec, has bit rate of
around...

<https://www.mentimeter.com/s/ffecf2fbe62b6f9d8b494f4bdbd97c7e/132c6912b228>

