

CS3200: Computer Networks

Lecture 32

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Streaming Audio and Video

- While the idea of sending audio and video over the Internet has been around since the 1970s at least, it is only since roughly 2000 that real-time audio and real-time video traffic has grown with a vengeance.
- Real-time traffic is different from Web traffic in that it must be played out at some predetermined rate to be useful.
- The key issue for designing streaming and conferencing applications is network delay.
- For playing music and movies over the network, the absolute delay does not matter, because it only affects when the media starts to play. But the variation in delay, called **jitter**, still matters.

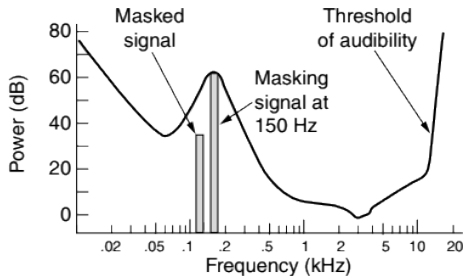
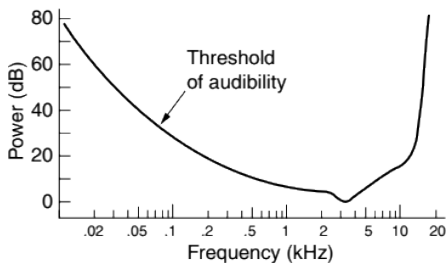
Audio Compression

- Audio is often compressed to reduce bandwidth needs and transfer times, even though audio data rates are much lower than video data rates.
- When the decoded output is not exactly equal to the original input, the system is said to be **lossy**. If the input and output are identical, the system is **lossless**.
- Many audio compression algorithms have been developed. Probably the most popular formats are **MP3** (MPEG audio layer 3) and **AAC** (Advanced Audio Coding) as carried in **MP4** (MPEG-4) files.
- One coding technique is **perceptual coding**. It exploits certain flaws in the human auditory system to encode a signal in such a way that it sounds the same to a human listener, even if it looks quite different on an oscilloscope.

Perceptual Encoding

- Key property of perceptual coding is that some sounds can mask other sounds.
- Live flute concert and jackhammers.
- **Frequency masking** — a loud sound in one frequency band to hide a softer sound in another frequency band that would have been audible.
- Short period of time because the ear turns down its gain when they start and it takes a finite time to turn it up again. This effect is called **temporal masking**.

Frequency Masking

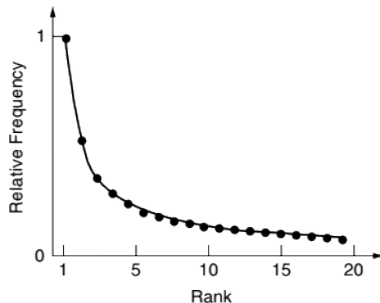


Content Delivery

- Early in the growth of the Web, more demands for content led to servers and networks that were frequently overloaded.
- In response to consumer demand, very large amounts of bandwidth were provisioned in the core of the Internet, and faster broadband connectivity was rolled out at the edge of the network.
- To reduce the endless delays, researchers also developed different architectures to use the bandwidth for distributing content.
- One architecture is a **CDN (Content Distribution Network)**. In it, a provider sets up a distributed collection of machines at locations inside the Internet and uses them to serve content to clients.
- An alternative architecture is a **P2P (Peer-to-Peer) network**. In it, a collection of computers pool their resources to serve content to each other, without any central point of control.

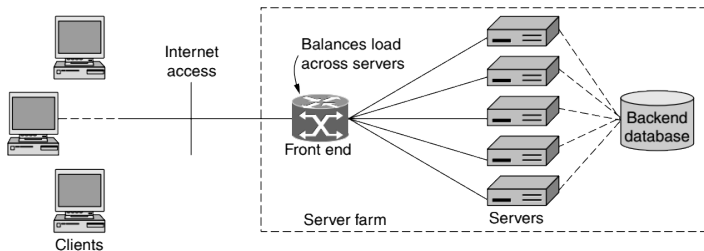
Zipf's Law

- Experimentally, when N movies are available, the fraction of all requests for the k^{th} most popular one is approximately C/k .

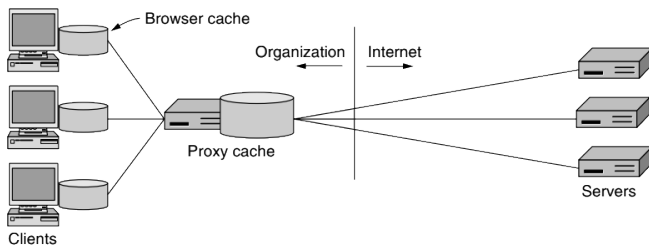


- Thus, the most popular movie is seven times as popular as the number seven movie. This result is known as **Zipf's law** (Zipf, 1949).
- Zipf distribution captures the notion that there are a small number of popular items and a great many unpopular items.

Server Farms

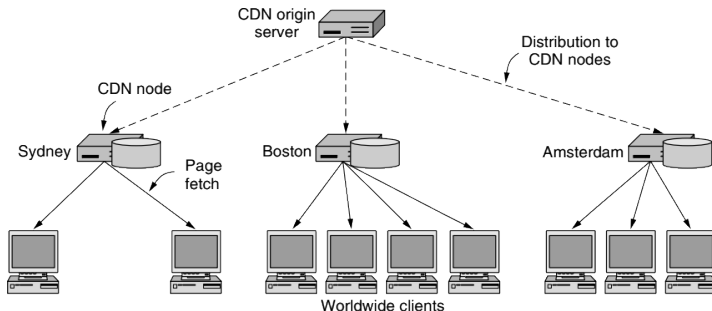


Web Proxy

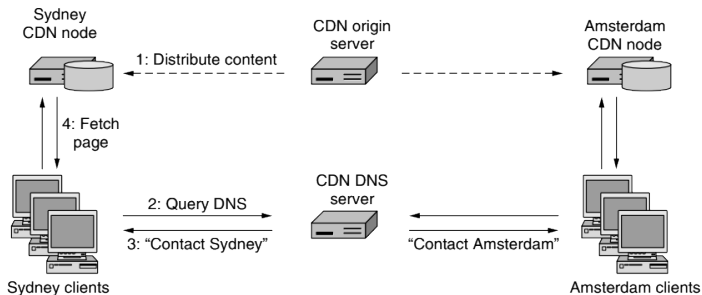


CDNs (Content Delivery Networks)

Clients look for a copy of the requested page in a nearby cache, it is the provider who places a copy of the page in a set of nodes at different locations and directs the client to use a nearby node as the server.



DNS Redirection



BitTorrent — A Peer-to-Peer Application

- BitTorrent protocol was developed by Brahm Cohen in 2001 to let a set of peers share files quickly and easily.
- How does a peer find other peers that have the content it wants to download?
- How is content replicated by peers to provide high-speed downloads for everyone?
- How do peers encourage each other to upload content to others as well as download content for themselves?

Working of BitTorrent

Torrent file has information about **tracker**, and a list of equal-sized pieces, or chunks, that make up the content.

