Video Streaming and CDNs

Daniel Zappala

CS 460 Computer Networking
Brigham Young University

Video Streaming

Internet Video

37% of residential ISP traffic in 2015

16% of residential ISP traffic in 2015

Video characteristics

- Series of frames, 24 to 30 frames per second
  - each frame is an array of pixels
  - 640x480 (SD), 1280x720 (HD), 1920x1080 (full HD), 3840x2160 (4K)
- Lossless and lossy compression can reduce bit rate but may also reduce quality
- Typical compressed bitrates: 100kbps (low quality), 3 Mbps (HD), 10 Mbps (4K)
- 2 Mbps compressed video, 67 minutes $=$ 1 GB

HTTP Streaming and DASH

- DASH: Dynamic Adaptive Streaming over HTTP
- store video on server
    - divide into 2 second chunks
    - encode each chunk with multiple bit rates
- client downloads using HTTP GET requests
    - fetch a low quality version
    - if received in plenty of time, fetch higher quality next time
    - if not going to be received in time, abort and fetch lower quality
    - constantly adjust rate as congestion allows
- allows client to easily adapt to varying conditions – mobile to high-speed connectivity
- able to avoid freezing if adaptive algorithm is good
- able to use HTTP caches

Content Distribution Networks

Motivation

- streaming from a massive data center is infeasible
    - clients may be far away, with a transcontinental bottleneck
    - wasted bandwidth as popular videos sent many times to different clients
   - single point of failure

Content Distribution Network

- replicate content at many caches, in geographically diverse areas
- private (Google) or third-party (Akamai for Netflix and Hulu)
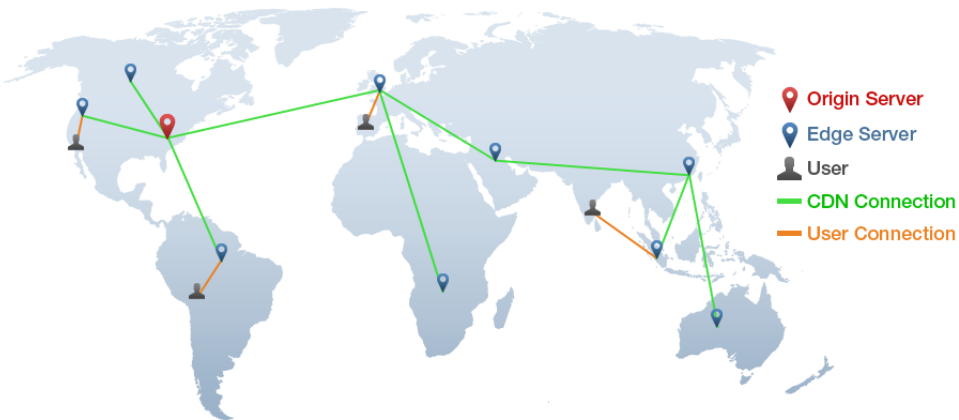
Content Distribution Network

- **enter deep**: locate servers in many ISPs close to users (Akamai)
- **bring home**: locate servers near IXPs and POPs near many ISPs, connect them with high-speed private links (Limelight)
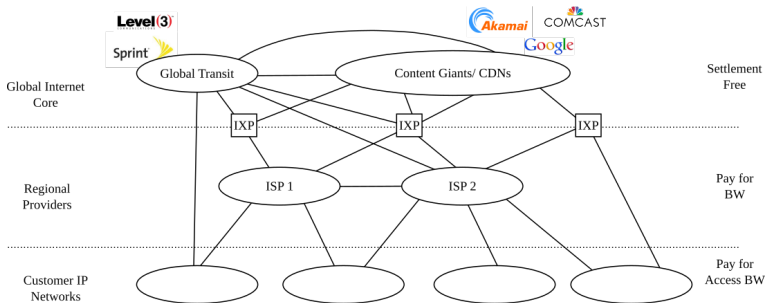
CDN Operation

- DNS
  - company places content on CDN servers
  - forwards DNS queries, e.g. video.company.com to server1.cdn.com
- cluster selection
  - CDN wants to forward client to nearest cluster
  - *geographical*: route to cluster geographically closest to the requesting DNS server – may not be lowest delay
  - *real-time measurements*: measure delay and loss between clusters and DNS servers, collect and use for selection
  - *IP anycast*: give all CDN servers the same IP address and use BGP to route to closest one

Case Studies

Netflix
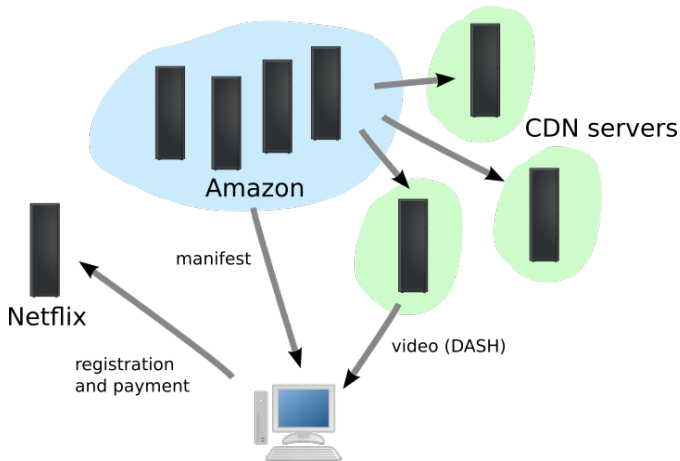
- originally rented CDN servers from a third party, now has private CDN in IXPs and ISPs

YouTube

- private CDN
- use DNS to redirect client to a cluster
  - usually smallest RTT between client and cluster
  - may be directed to more distant cluster for load balancing
  - may also be redirected if cluster doesn't have the file
- does not use adaptive streaming

Kankan

- P2P video distribution, in China
- similar to BitTorrent
  - contact tracker
  - download chunks of video from peers in parallel
  - focus on downloading chunks needed soon
- swarms of 10,000+ peers for popular videos
- recently added a CDN for initial loading of video and as a fallback if P2P download rate is too slow