Content Delivery Summit
May 2013
Netflix Content Delivery

- Brief History
- Open Connect
- Common misconceptions
Netflix

- Launched streaming service in January of 2007
- More than 36 million members
- 40 countries
- More than 1 billion hours per month
- 33% of downstream internet traffic in the US during peak hours
- Multiple terabits per second
The First Evolution of Netflix Content Delivery

- Built our own 5 POP domestic CDN for launch in 2007
- Original CDN used anycast for geolocation and had all content in each pop
- Successfully scaled to hundreds of gigabits
- Decided to move to 3\textsuperscript{rd}-party CDNs in 2008/2009 for two reasons
  - CDN pricing came into line with transit
  - We realized the value of autonomous, intelligent clients coupled with simple HTTP delivery
The Evolution of Netflix Clients

- We created our own adaptive bitrate algorithms to adapt to changes in throughput
- We created our own CDN selection algorithms to adapt to changing network conditions
  - Overloaded links
  - Overloaded servers
  - Errors
- The “control plane” (Netflix services running in AWS) increased in sophistication over time
  - Authentication/Device Registration
  - Content selection/Dynamic user interfaces
  - Content routing
The Second Evolution of Netflix Content Delivery

- Mid-2011 – we realized our scale warranted a dedicated solution to maximize network efficiency
- We created Open Connect, a Netflix-specific, specialized content delivery system – launched June 2012
- Open Connect is provided at no cost to ISPs
- Open Connect is the most efficient way to deliver Netflix content to ISP subscribers
Open Connect

- Known set of users + known set of content = simplified content delivery
- Combines ISP routing information with Netflix content routing to create a robust, extensible layer 3-7 routing engine
- Owning server + client logic allows us to optimize streaming performance
- Proactive caching
Advantages of Proactive Caching

- Off-peak pre-population of content within ISP networks
  - Dramatically reduces upstream network utilization at peak times (75-100%)
  - Removes the need for ISPs to scale transport / IX links for Netflix traffic
- Central popularity calculation is more accurate than a cache or proxy trying to guess popularity based on requests it sees
- Appliances are simple web servers that know how to store files and report on health, 100% utilized and optimized for throughput
Content Flow – Open Connect Appliance (OCA)

1. OCA registers with OCA control service
2. OCA control service delivers content manifest
3.a. Manifest Service compares manifest to what's on disk
3.b. Manifest Service creates script to fetch new content from origin
3.c. Manifest Service deletes content no longer needed
4. OCA submits new manifest to OCA CS
5. OCA control service tells Client control service:
   a. OCA definition
   b. Content to cache mapping
6. Popularity service tells OCA control service about:
   a. Ordered list of popular downloadable URLs
   b. Downloadable file size
Directing Clients to Caches

1. Client contacts Netflix control servers
2. Netflix control servers respond with address of local Netflix Cache
3. Client connects to local cache
4. Local cache delivers video stream

- User routing is done by Netflix control servers, not dependent on client DNS configuration
- Request is routed to the nearest available OCA – backup URLs are provided for failover
- ISP controls client to OCA mapping/clustering/failover via BGP
Three Tier Architecture

Cache hardware is identical in each tier – different manifests create different roles

ISP Network

Sharded content ≈ 95+% offload

Peering/Origin Location

Sharded content 100% of active catalog

AWS S3

All downloadables archived on S3
Open Connect Servers

- Purpose-Built hardware and software
- Low power, high density
  - >12Gb/s, 4U, 500W for basic Open Connect Appliance
  - 1 tpbs/rack at densest locations
- Open Source Software
  - BSD
  - nginx
  - BIRD (BGP)
- Open Hardware Spec
Open Connect Appliances – Spinning Drives
Open Connect Appliances – Flash Drives
21 Global Pops
Advantages to ISP Partners

- Open Connect is free and easy to implement
  - We work with ISPs to plan deployment
  - We provide servers free of charge
  - Open Connect offload gives back 33% of upstream capacity
- Partners are able to deliver a valued service their subscribers at higher quality with reduced cost
- Working with Open Connect allows ISPs to market a differentially better service than their competitors who do not
  - SuperHD, 3D
  - Fewer interruptions
Common Misconceptions about OTT Delivery

- Internet-based delivery can never scale to current cable viewership levels
- Internet-based delivery is less efficient
- Internet-based delivery offers inferior picture quality
Scaling OTT Delivery

- Middle-mile and long haul bandwidth don’t need to scale to make Netflix work (we don’t use the “internet backbone”)

- Current last-mile bandwidth is more than sufficient for SuperHD streams
  - When we started, our max stream was equal to or greater than most people’s max bandwidth
  - Now, our max stream is less than 1/3 of most people’s max bandwidth
OTT Advantages

- IP delivery supports what users want – rich content recommendation, selection and playback on their schedule
- IP delivery allows for rapid iteration/ improved quality – we can re-encode our entire catalog in a couple of weeks – vs years for fixed standards
- Since inception, we’ve been on a great trend of delivering higher quality streams at lower bitrates, and we expect that trend to continue
OTT Audio/Visual Quality

- We currently serve SuperHD, 3D, HD – 1080p, 5.1
- We’ll be first with UltraHD delivery
- Current global library of transcoded files >3 petabytes
Other Alternatives

- Proxies – we’ve seen many instances of poor Netflix performance caused by proxies
  - Play delay
  - Rebuffers
  - Low bitrates
  - Proxies require constant reverse engineering to keep up with changes to the Netflix service
  - Multiple cases of “bad” proxies breaking the service

- Internal ISP CDN / Virtual Machine
  - Not optimized for Netflix (we use 100% of hardware resources on Open Connect boxes)
  - Insufficient storage (we shard content across hundreds of terabytes of storage)
  - Impractical for Netflix to integrate with hundreds of different internal CDNs
Questions?

http://openconnect.netflix.com