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 3rd-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
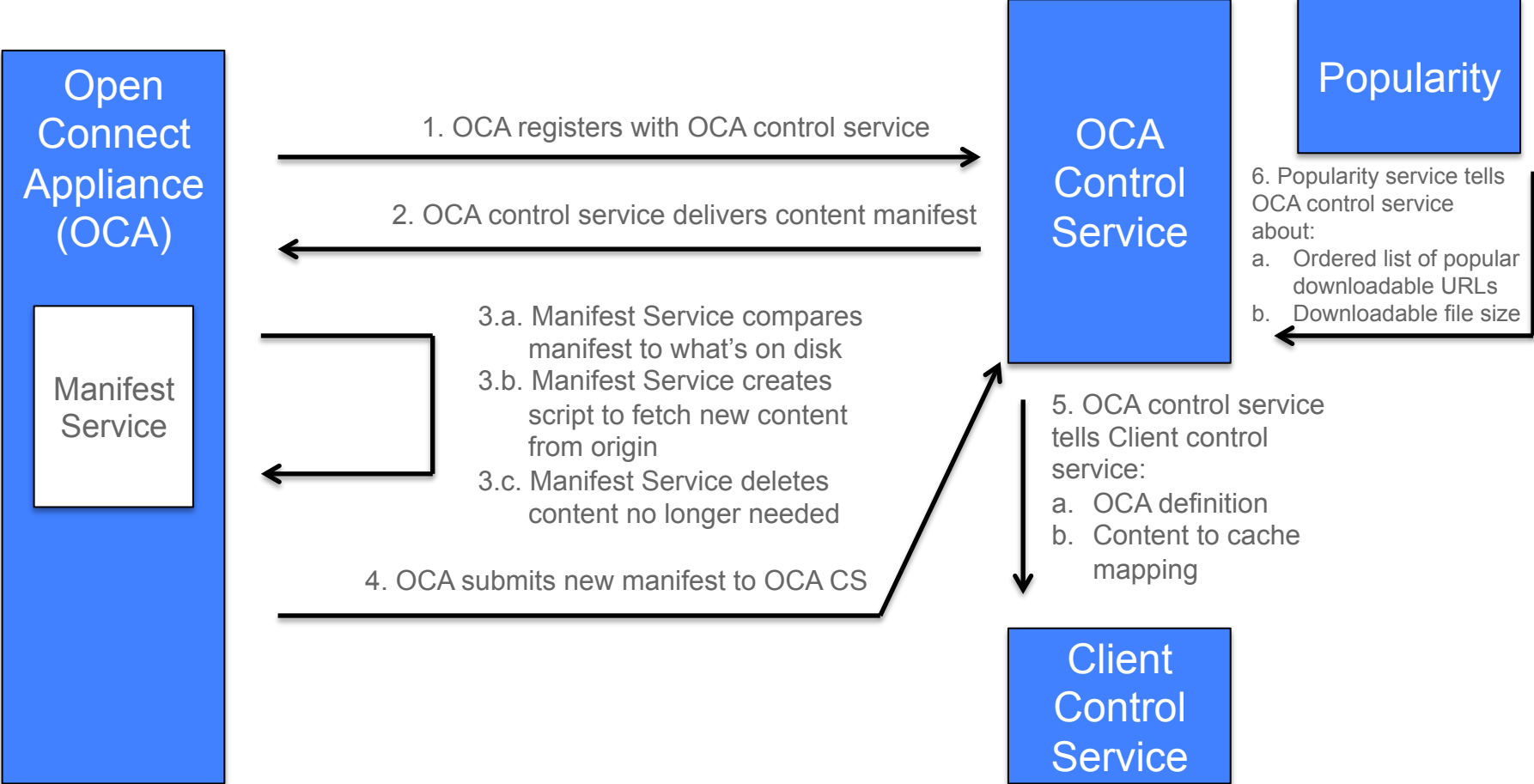
Open Connect

- 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
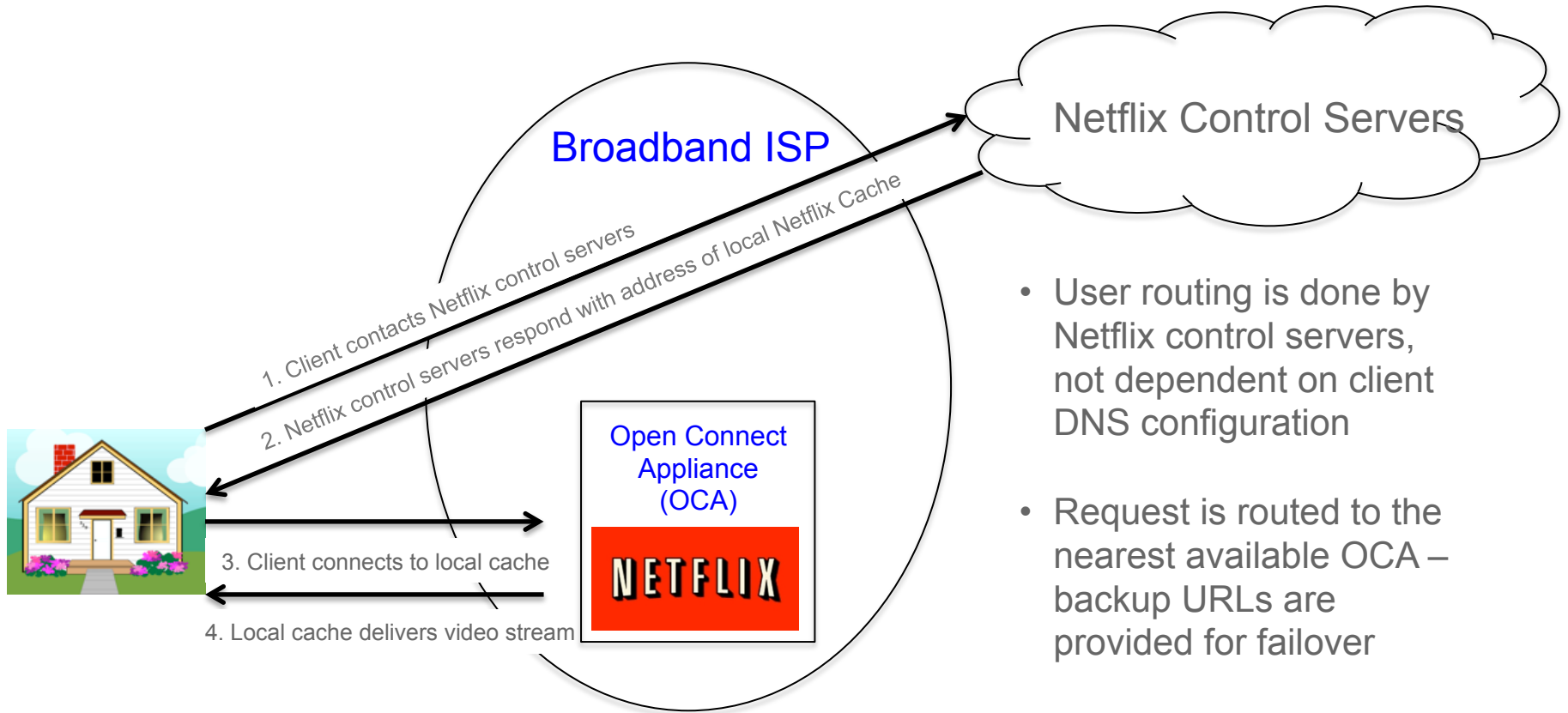
- Proactive caching

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
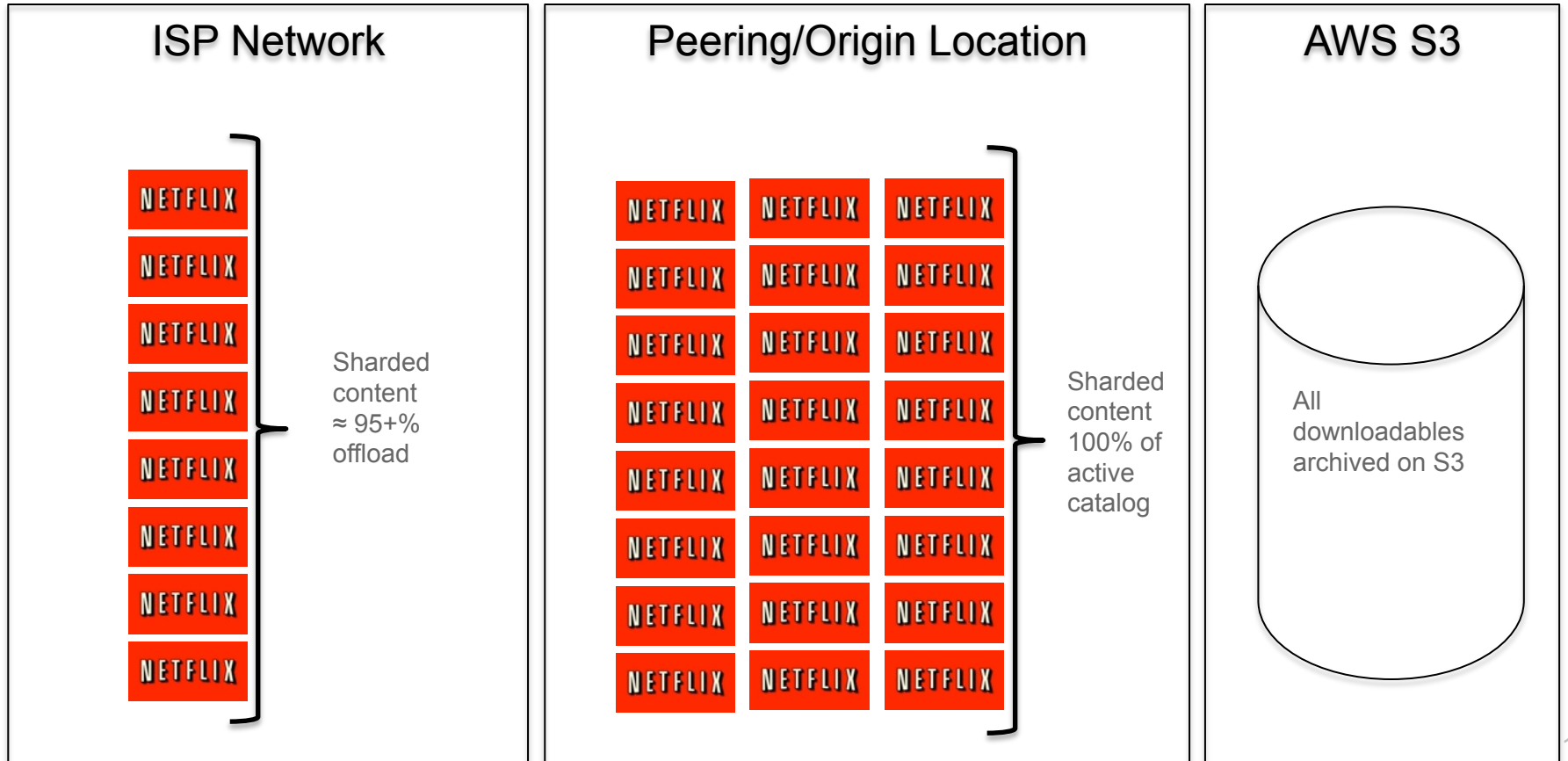
Content Flow – Open Connect Appliance (OCA)

Open Connect Appliance (OCA)

Manifest Service

OCA Control Service

Popularity

Client Control Service

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

Broadband ISP

Netflix Control Servers

1. Client contacts Netflix control servers

2. Netflix control servers respond with address of local Netflix Cache

Open Connect
Appliance
(OCA)

NETFLIX

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	Peering/Origin Location	AWS S3

Sharded content ≈ 95+% offload

Sharded content 100% of active catalog

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?