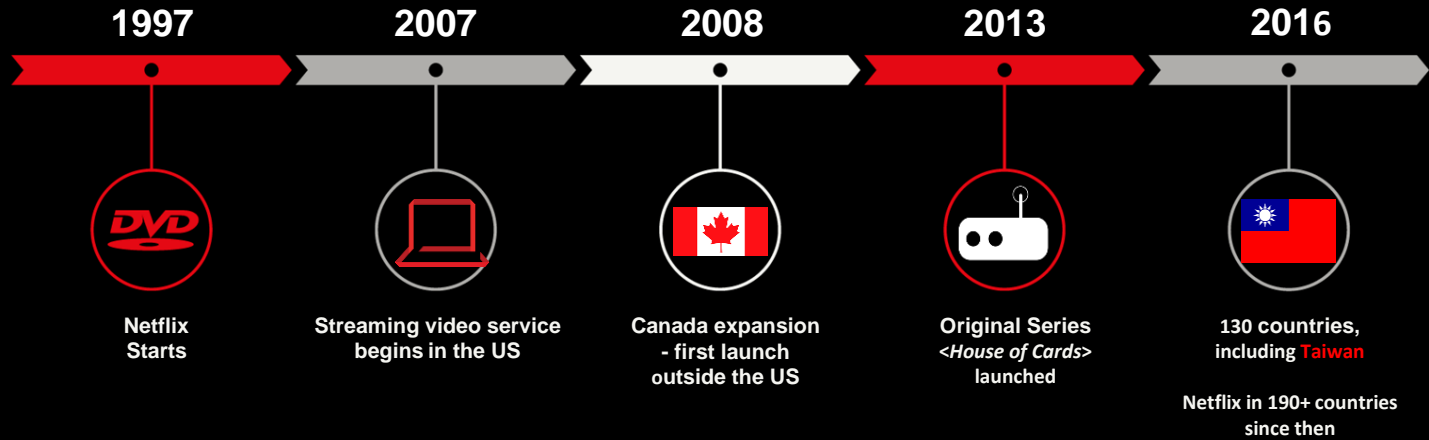


How Netflix Delivers Joy to the World

TWNOG 4.0
6th Dec 2019

Jocelyn Ooi

The Netflix journey





**More Than
190 Countries**

**Over 151 Million
Paid Memberships**

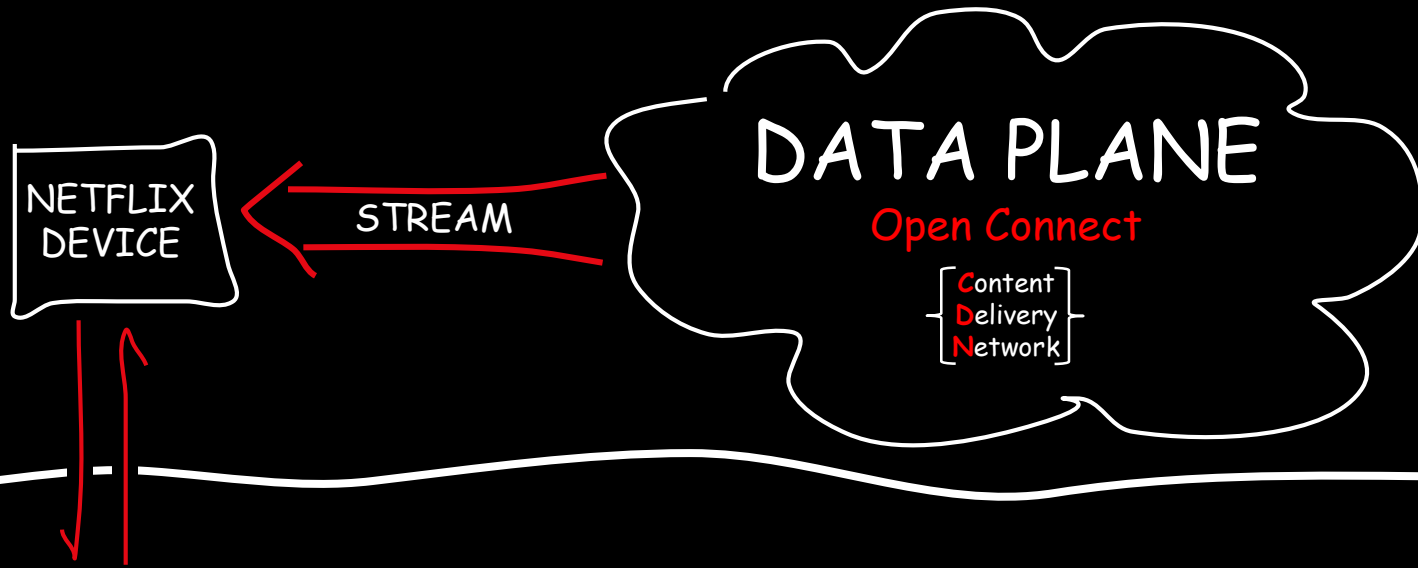
**60+% from
Outside of the U.S.**

How **Netflix** Works?



Inventing Internet TV:

- **The architecture of internet streaming**
- **Quality of Experience**
- **Cost**



CONTROL PLANE



N SERIES

NOWHERE MAN

84% Match 2019 TV-MA 1 Season

Watch Season 1 Now

Two nefarious schemes taking place 10 years apart entangle a dauntless triad member, who must break out of prison to rescue a loved one.

▶ PLAY

+ MY LIST



Starring: Alyssa Chia, Mavis Fan, Joseph Chang

Genres: Crime TV Dramas, Taiwanese TV Shows, Chinese TV Shows

This show is: Emotional, Dark

OVERVIEW

EPISODES

TRAILERS & MORE

MORE LIKE THIS

DETAILS

before streaming starts = control plane =



N SERIES
NOWHERE MAN
 84% Match 2019 TV-MA 1 Season
 Watch Season 1 Now
 Two nefarious schemes taking place 10 years apart entangle a dauntless triad member, who must break out of prison to rescue a loved one.
 ▶ PLAY + MY LIST
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OVERVIEW EPISODES TRAILERS & MORE MORE LIKE THIS DETAILS



N SERIES
NOWHERE MAN

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[▶ PLAY](#) [+ MY LIST](#) [👍](#) [👎](#)

Starring: Alyssa Chia, Mavis Fan, Joseph Chang
Genres: Crime TV Dramas, Taiwanese TV Shows, Chinese TV Shows
This show is: Emotional, Dark

- OVERVIEW
- EPISODES
- TRAILERS & MORE
- MORE LIKE THIS
- DETAILS

streaming = data plane = Open Connect

Data Plane

(streaming playback)

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A circular opening in a dark, textured surface, possibly a cave or a tunnel, looking out onto a sunset over a body of water. The scene is dimly lit, with the primary light source being the setting sun, which creates a warm, golden glow. The water in the distance is dark, and the sky is a mix of blue and orange. The overall mood is serene and contemplative.

NETFLIX

Open Connect

Open Connect Appliances

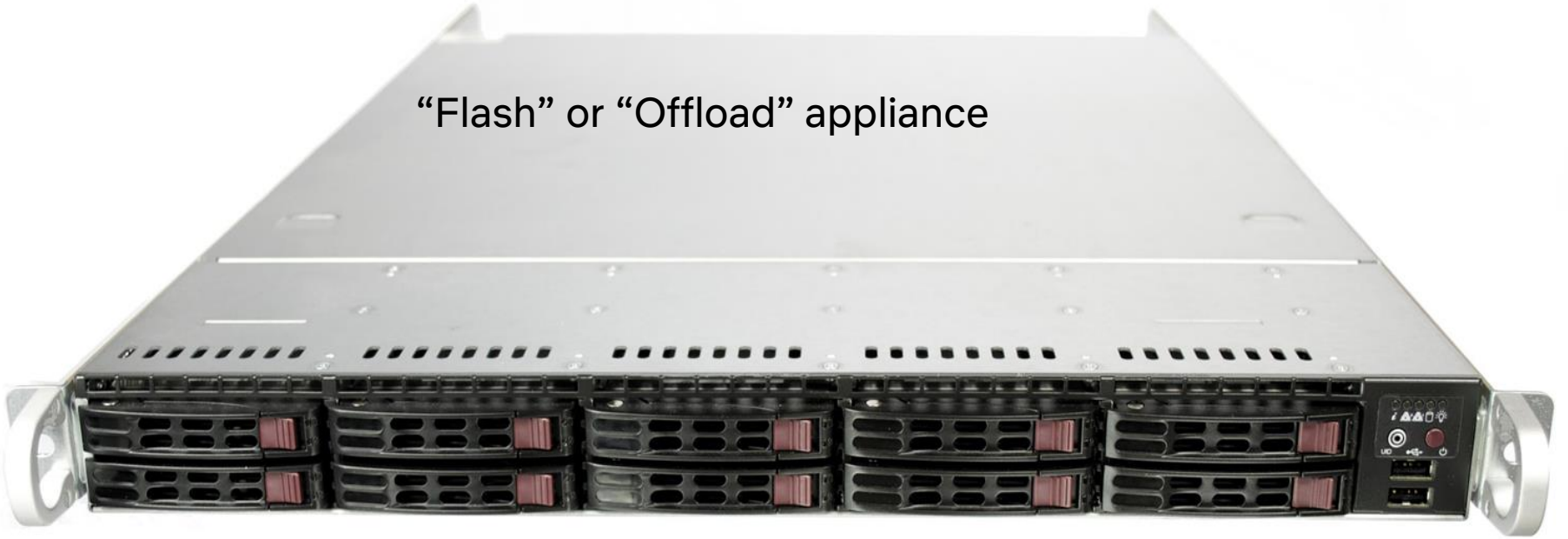
“Storage” appliance



Designed for bulk storage of the entire large regional content catalogs

Open Connect Appliances

“Flash” or “Offload” appliance



High-throughput servers, used to serve very popular content

Open Connect

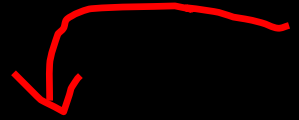
**connects directly to residential ISP
networks.**

**95% of our traffic is directly
connected.**

We provide *free*
Open Connect Appliances
for Internet Service Provider (ISP) data
centers

**We also provide interconnection to ISPs
at Internet Exchange locations
throughout the world**

wait, what's an IXP?



An Internet exchange point
(IX or IXP) is
a *physical infrastructure* through
which
Internet Service Providers (ISPs)
and
Content Delivery Networks (CDNs)
exchange Internet traffic between
their networks





IX SITE

NETFLIX



SFI



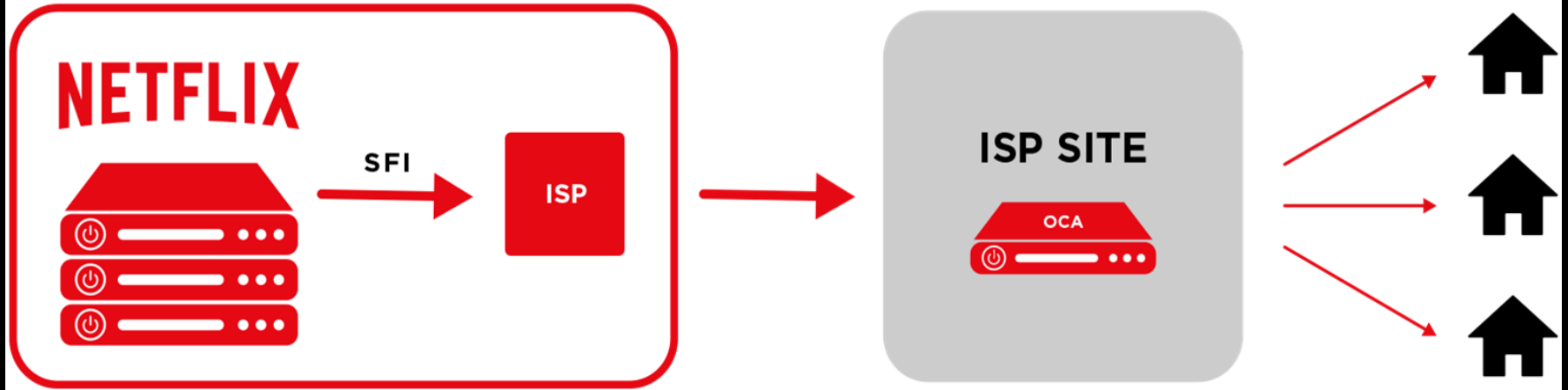
ISP

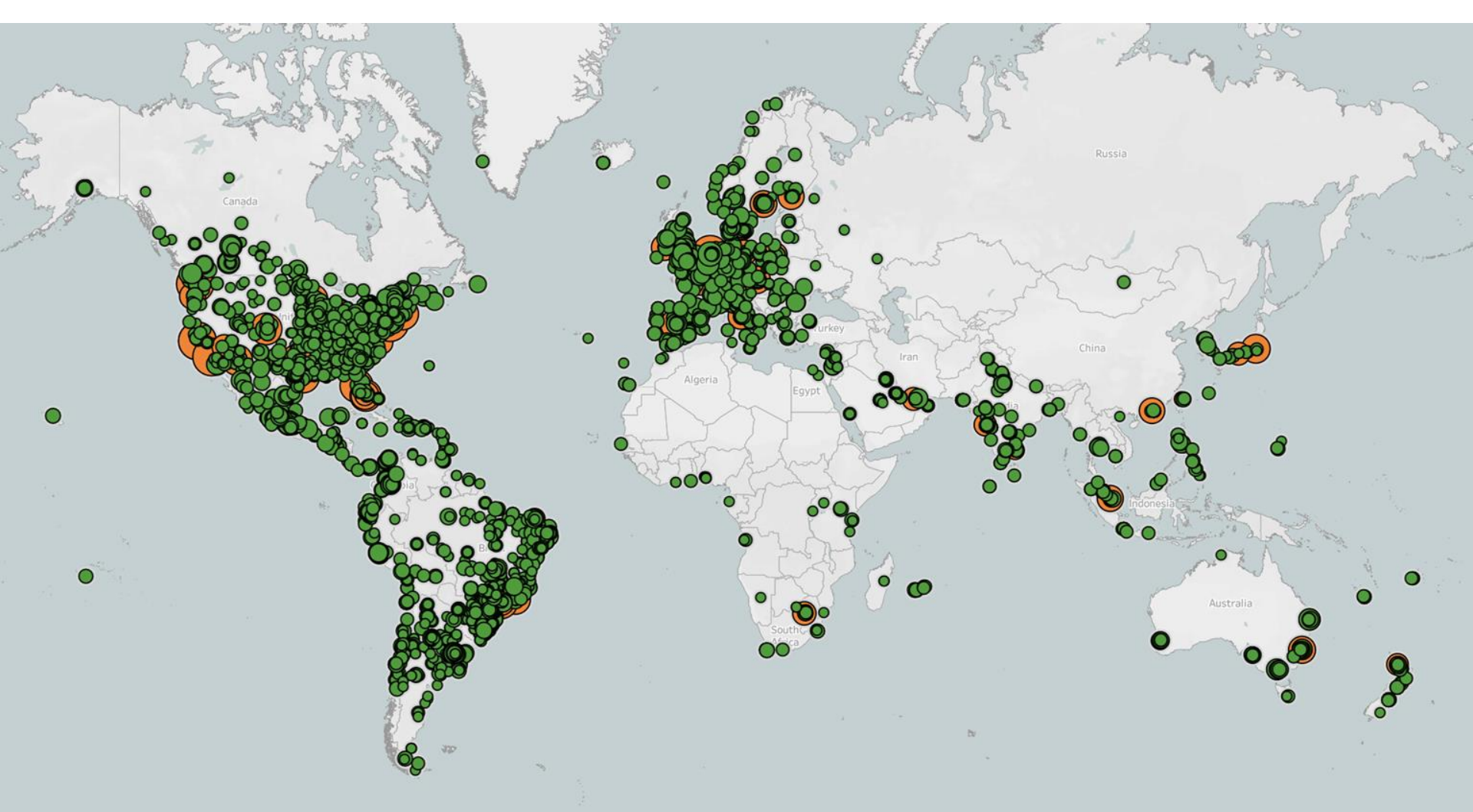


ISP SITE



IX SITE





Control Plane

(streaming setup)

NETFLIX

N SERIES

NOWHERE MAN

85% Match 2019 TV-MA 1 Season

S1:E2 "Chapter 2: The Child"

In the fallout of the kidnapping case, uncanny visions begin to haunt Ah Quan. Jiang Jing-fang and her child face a precarious future.

▶ NEXT EPISODE

+ MY LIST



OVERVIEW

EPISODES

TRAILERS & MORE

MORE LIKE THIS

DETAILS



Determine the preferred experience

TITLE



LOCATION



DEVICE



LANGUAGE



- Dansk
- Deutsch
- English
- Español
- Français
- Nederlands
- Norsk bokmål
- Português
- Suomi
- Svenska
- 日本語

NETWORK



Broadband - wired or
wifi
Cellular - Edge, 3G,
LTE, ...

CONNECTIONS



HDCP support,
etc.

That's exactly what I want

...now
where can I
get it?



PLAYBACK

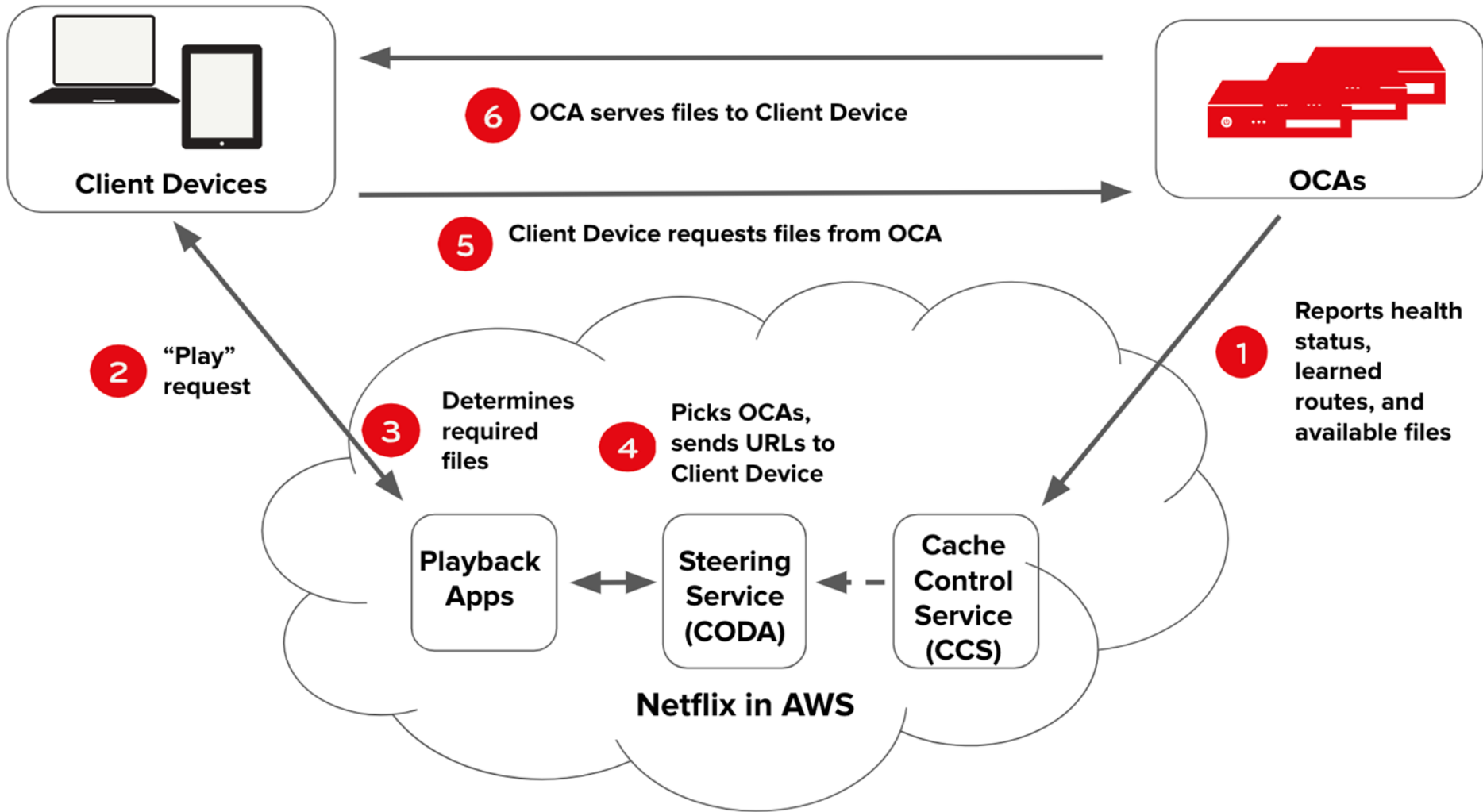
GENERATE
PLAYBACK
MANIFEST

PLAYBACK
MANIFEST

▶ PLAY

[This is how we steer the request to the correct
server/network/location]







6:19



Nowhere Man S1:E2 Chapter 2: The Child



Content Filling

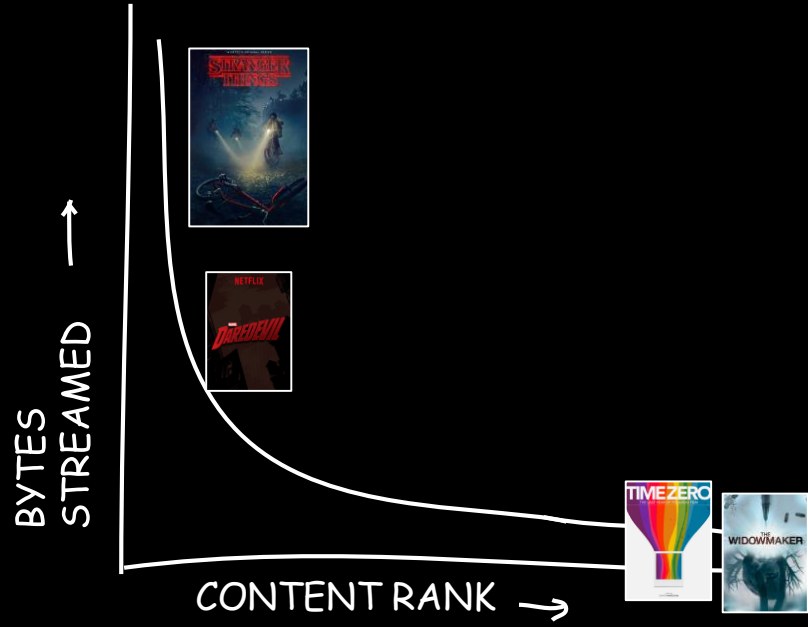
pre-positioning



A high-angle, top-down photograph of three men lying on their backs on a grey, textured concrete floor. The man on the left is wearing a white tank top and a dark jacket, laughing with his head tilted back. The man in the center is wearing a black t-shirt and a dark jacket, looking upwards with a neutral expression. The man on the right is wearing a light-colored t-shirt and a light-colored jacket, appearing to be asleep with his eyes closed. The lighting is dramatic, casting soft shadows. In the upper right corner, there is a small, dark, rectangular object on the floor.

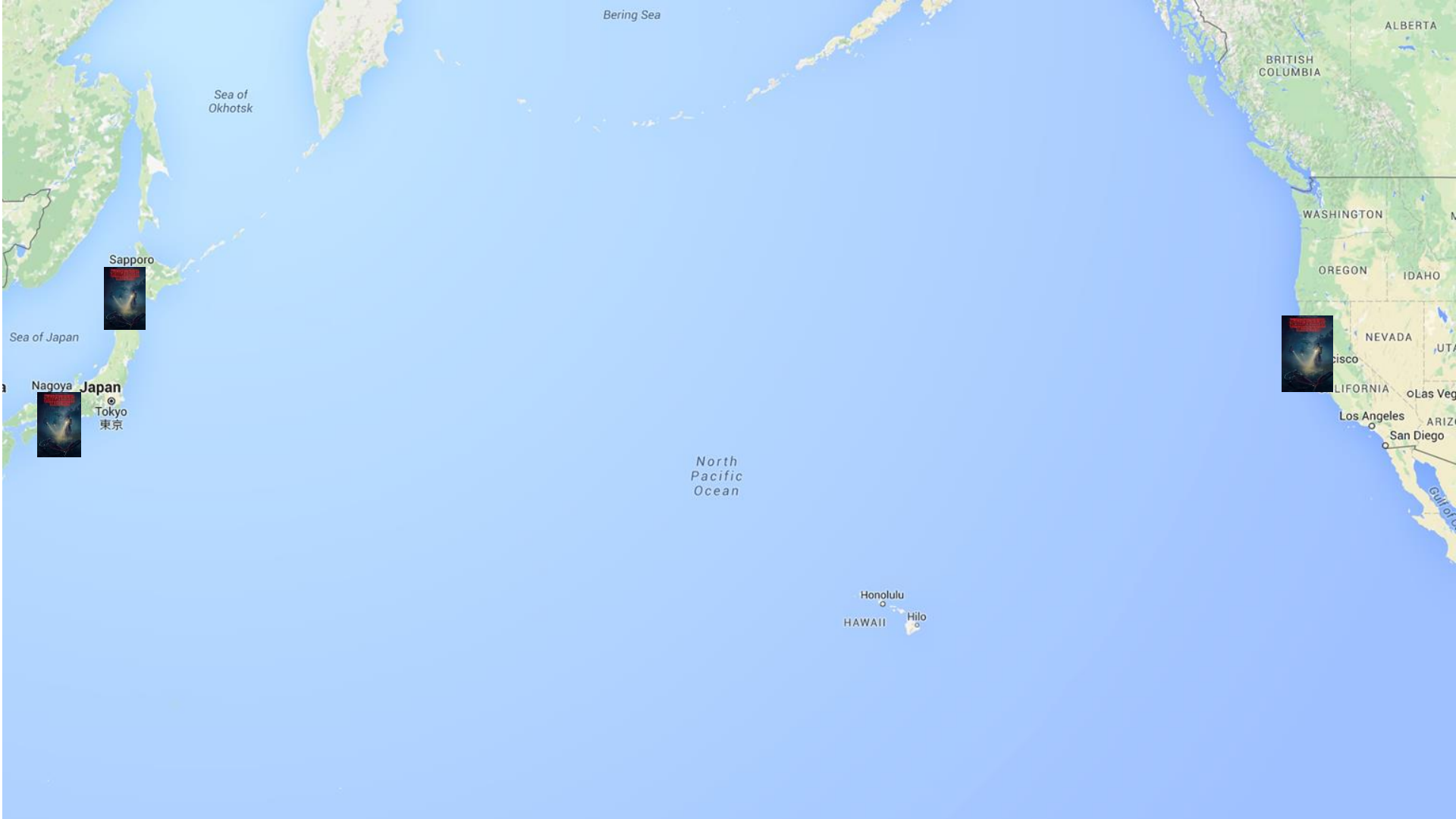
**Caches fill while
you sleep**

Files are copied *off-peak*
(in the middle of the night)
when networks are not
loaded, using pre-
positioning algorithms



PREDICTABLE VIEWING PATTERNS

Using the purpose-built
Open Connect network,
we can copy each new **Netflix**
show into a region *once*, then
show it *thousands or millions* of
times.



Bering Sea

Sea of Okhotsk

Sapporo

Sea of Japan

Nagoya Japan

Tokyo
東京

North
Pacific
Ocean

Honolulu
HAWAII
Hilo

BRITISH
COLUMBIA

ALBERTA

WASHINGTON

OREGON

IDAHO

NEVADA

UTAH

CALIFORNIA

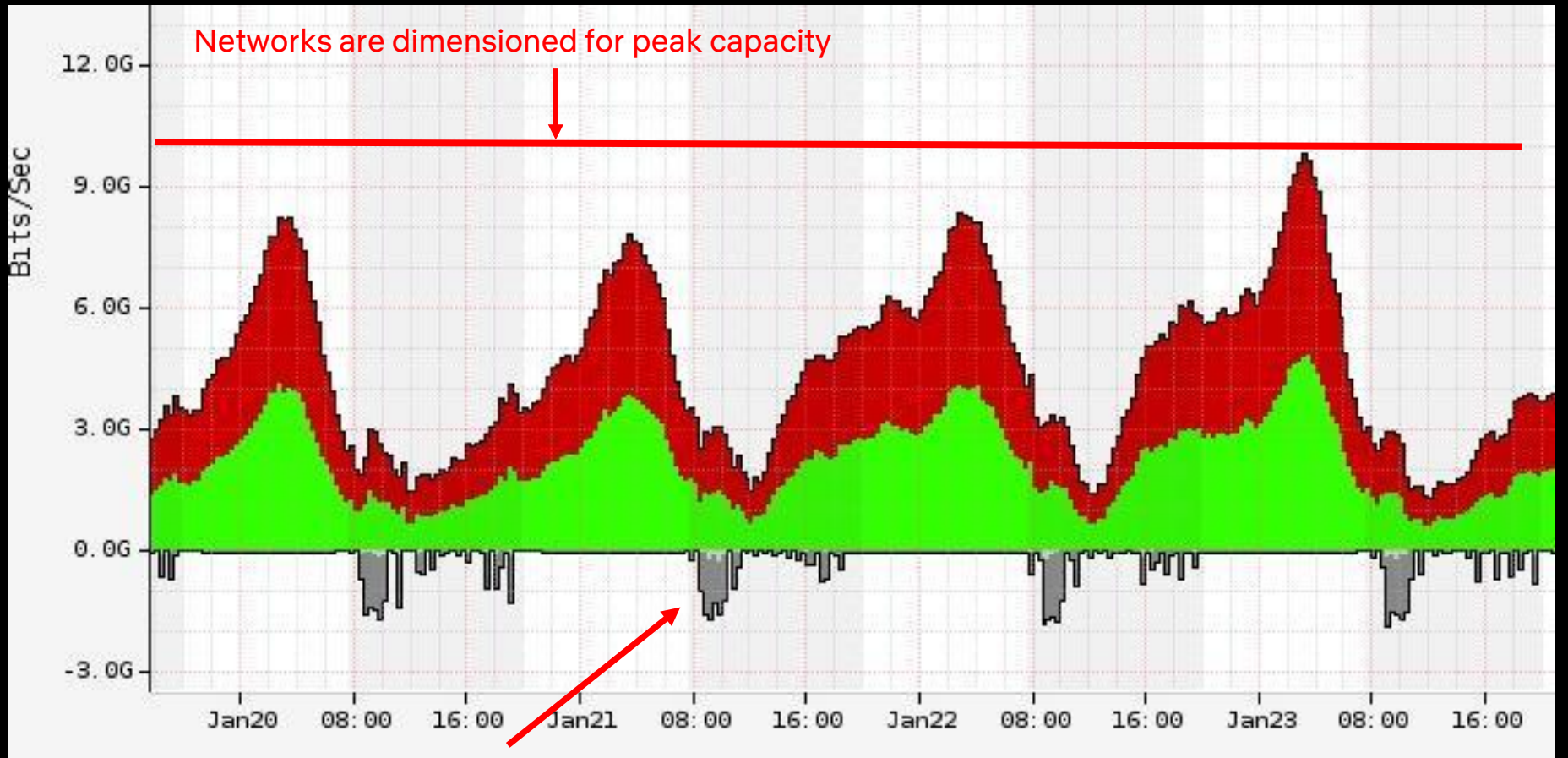
ARIZONA

Los Angeles

San Diego

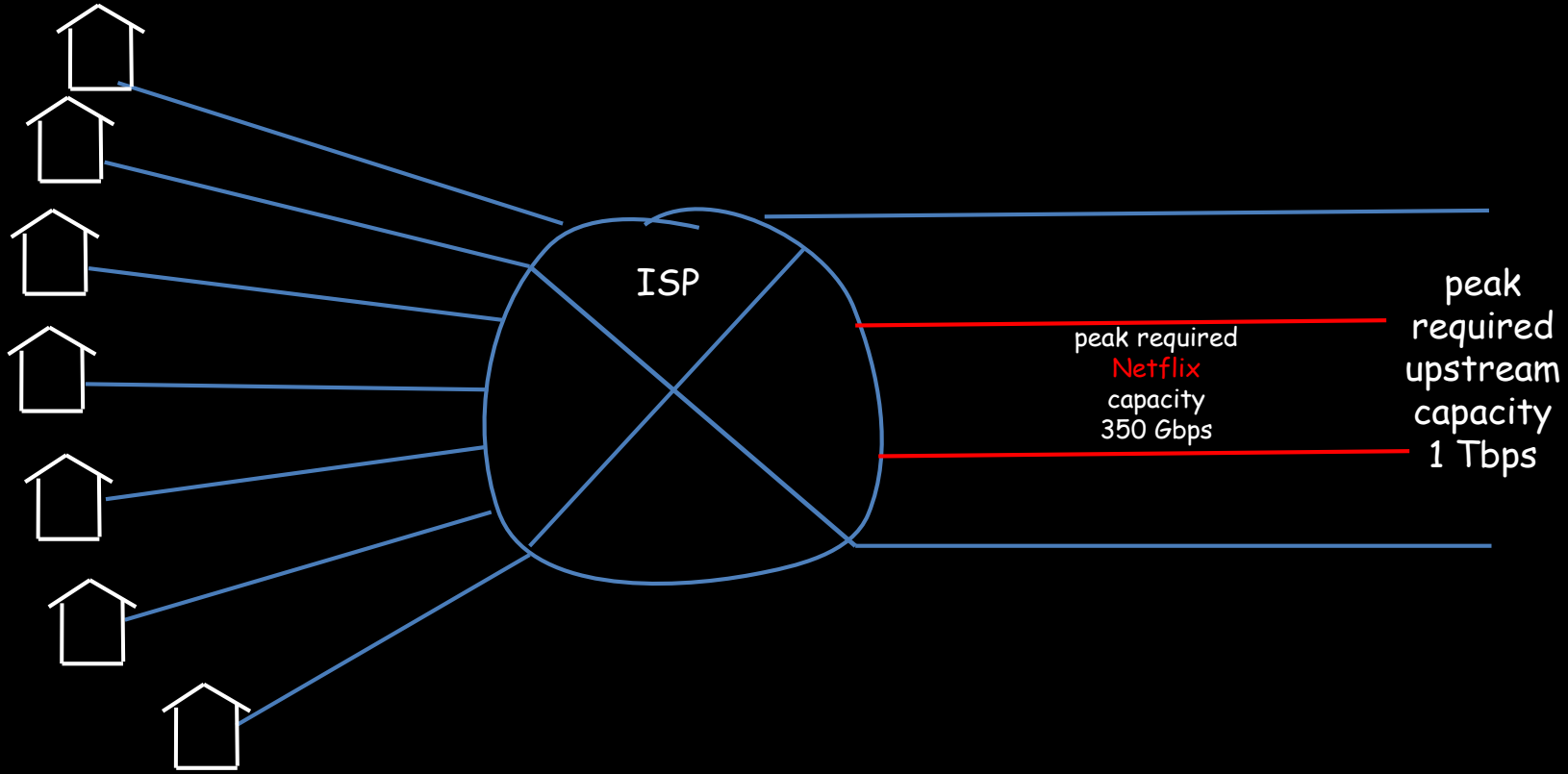
Las Vegas

Gulf of California

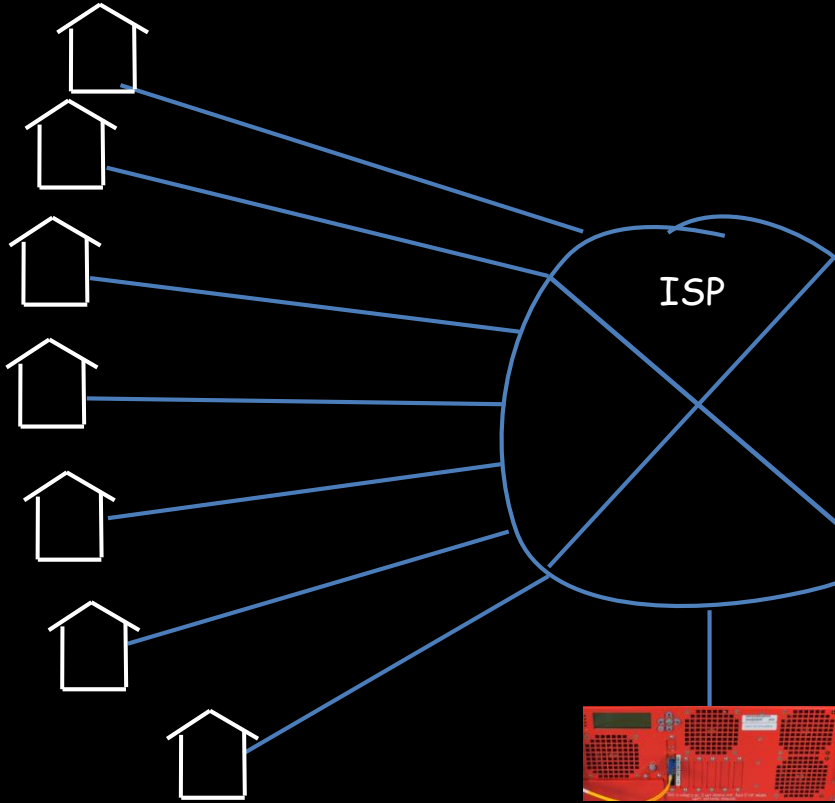


Off-peak cache fill means no need for additional capacity

ISP customer homes



ISP customer homes



peak required Netflix capacity 0

peak required upstream capacity 650 Gbps

<https://openconnect.netflix.com>



Questions?

NETFLIX

Thank you

NETFLIX