

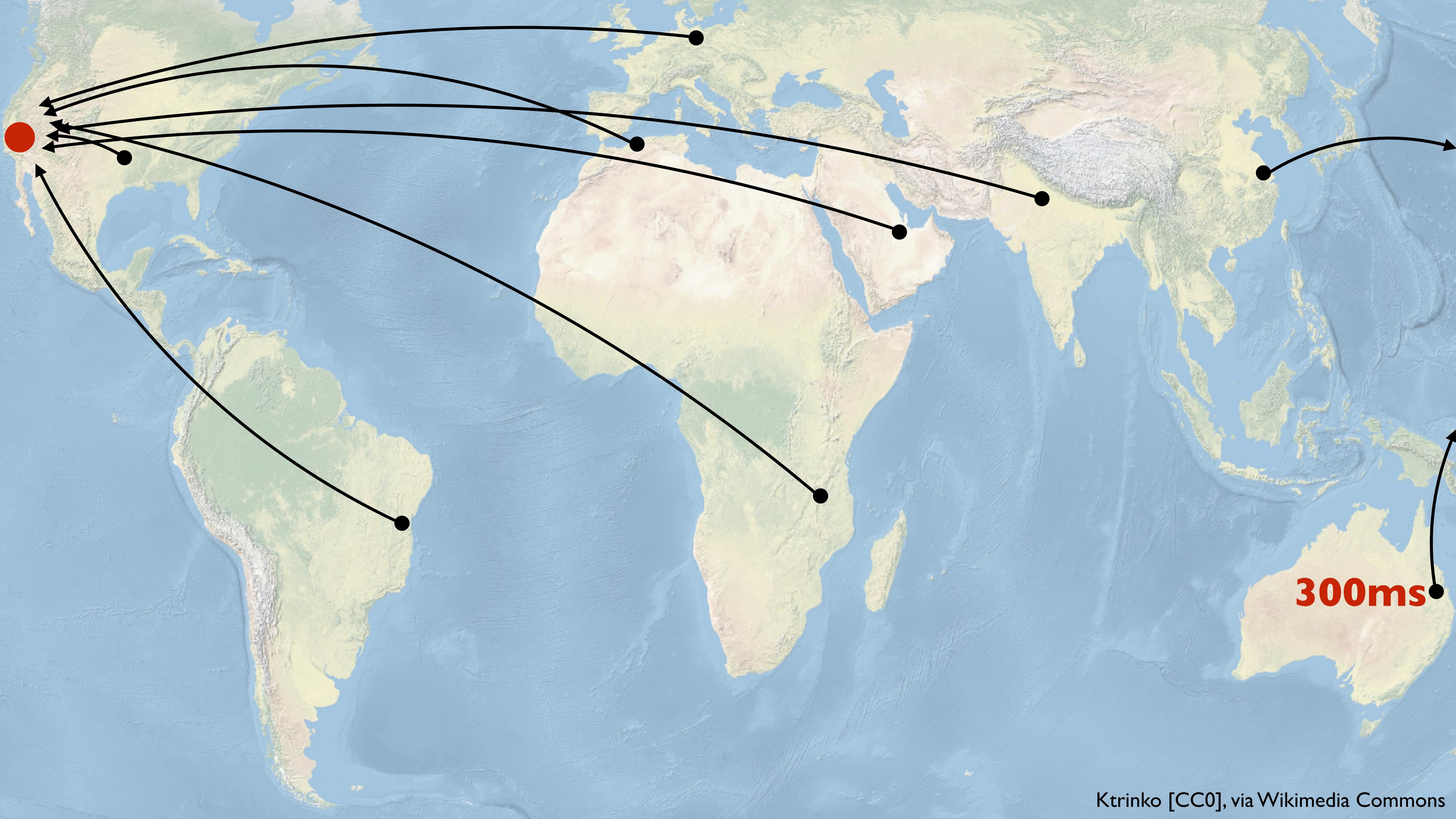
# Content distribution networks

Ankit Singla

ETH Zürich Spring 2017

# This lecture ...

- How do we deliver content globally?
- At low latency and high availability?
- Research!
- Next week??

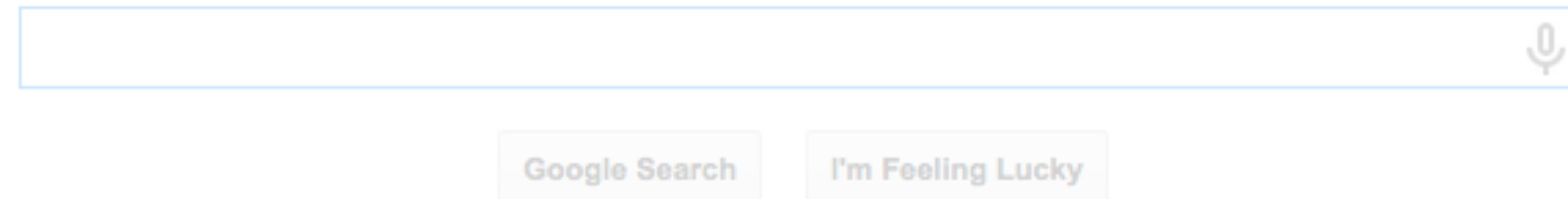


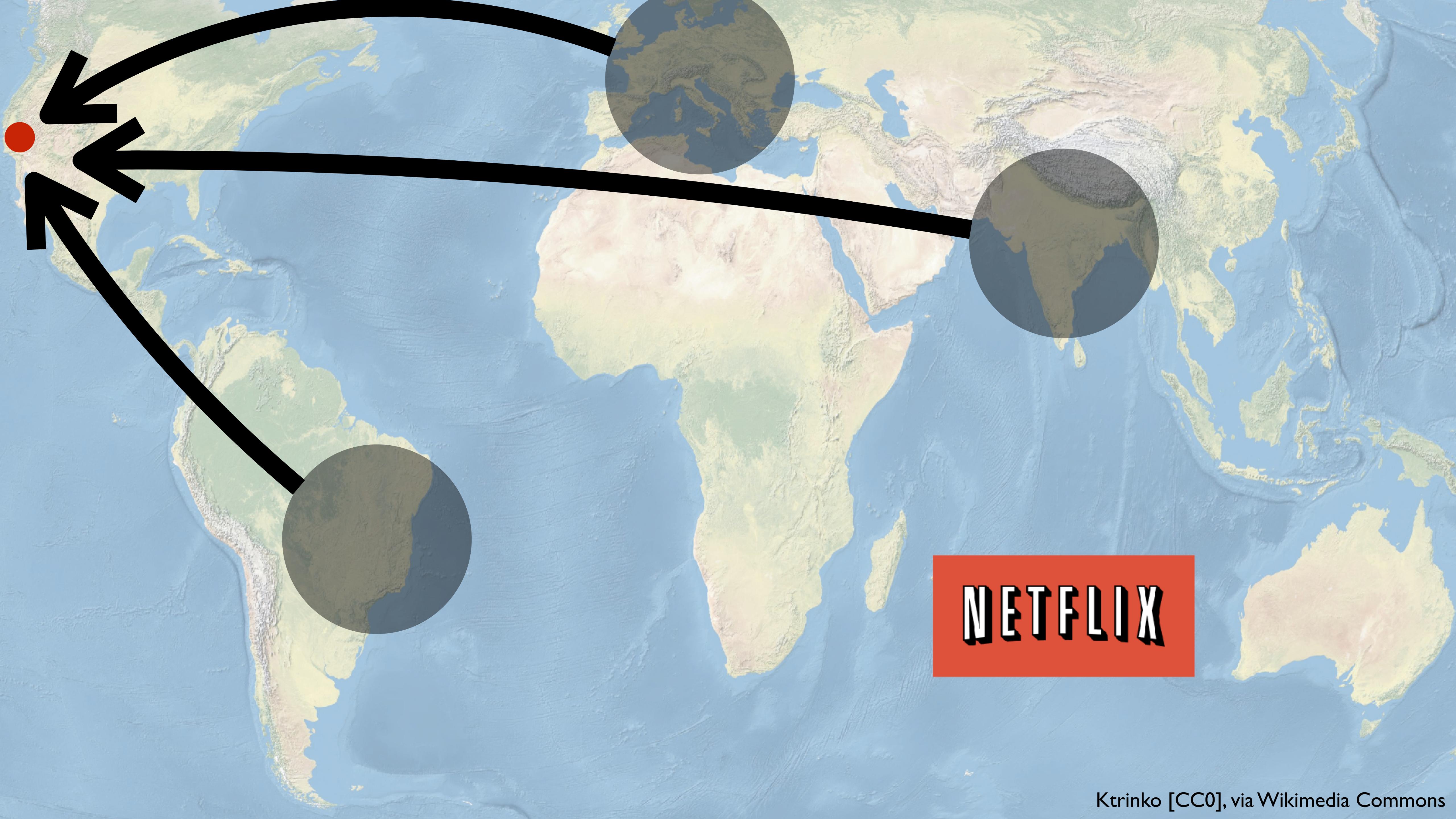
# 300ms

# Speed Matters for Google Web Search

Jake Brutlag  
Google, Inc.  
June 22, 2009

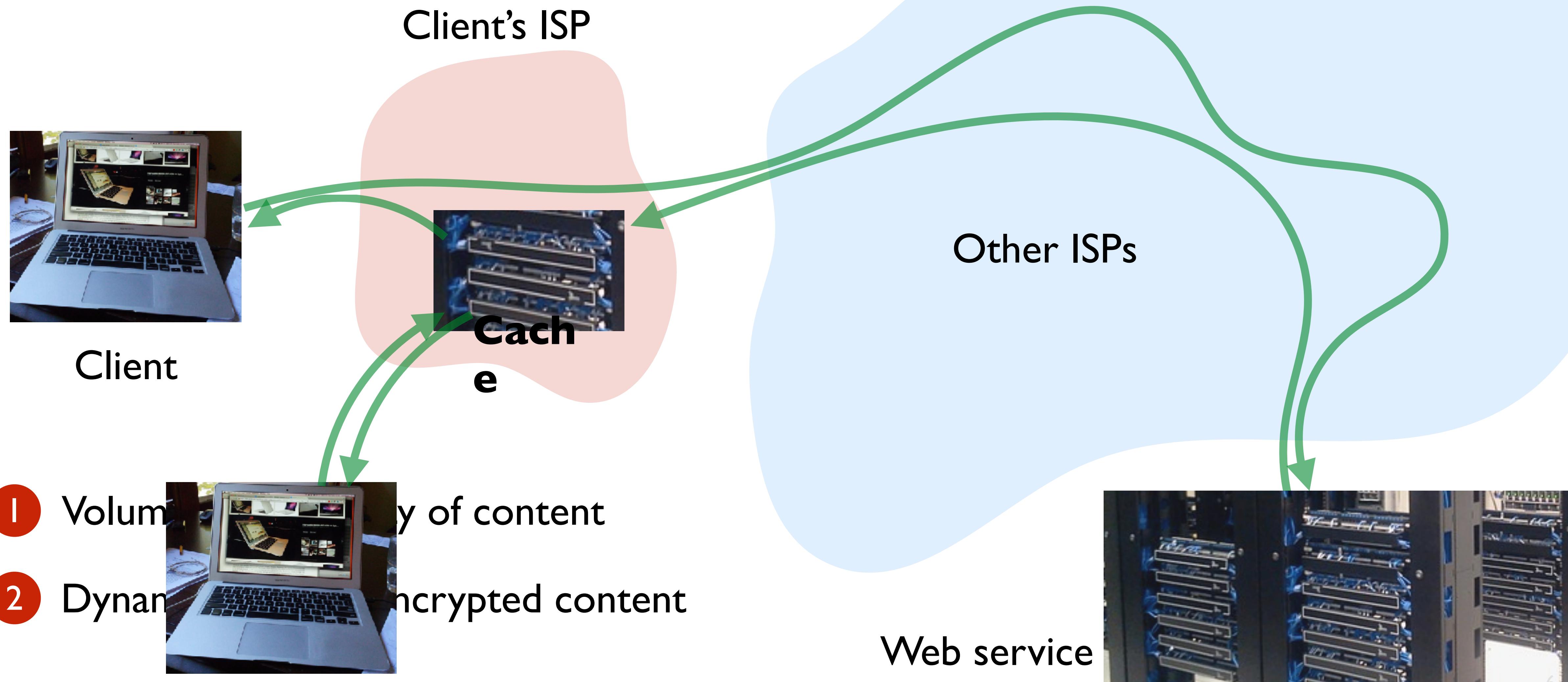
**0.4s ~ 0.74% fewer searches**





NETFLIX

# Why static caching is not enough



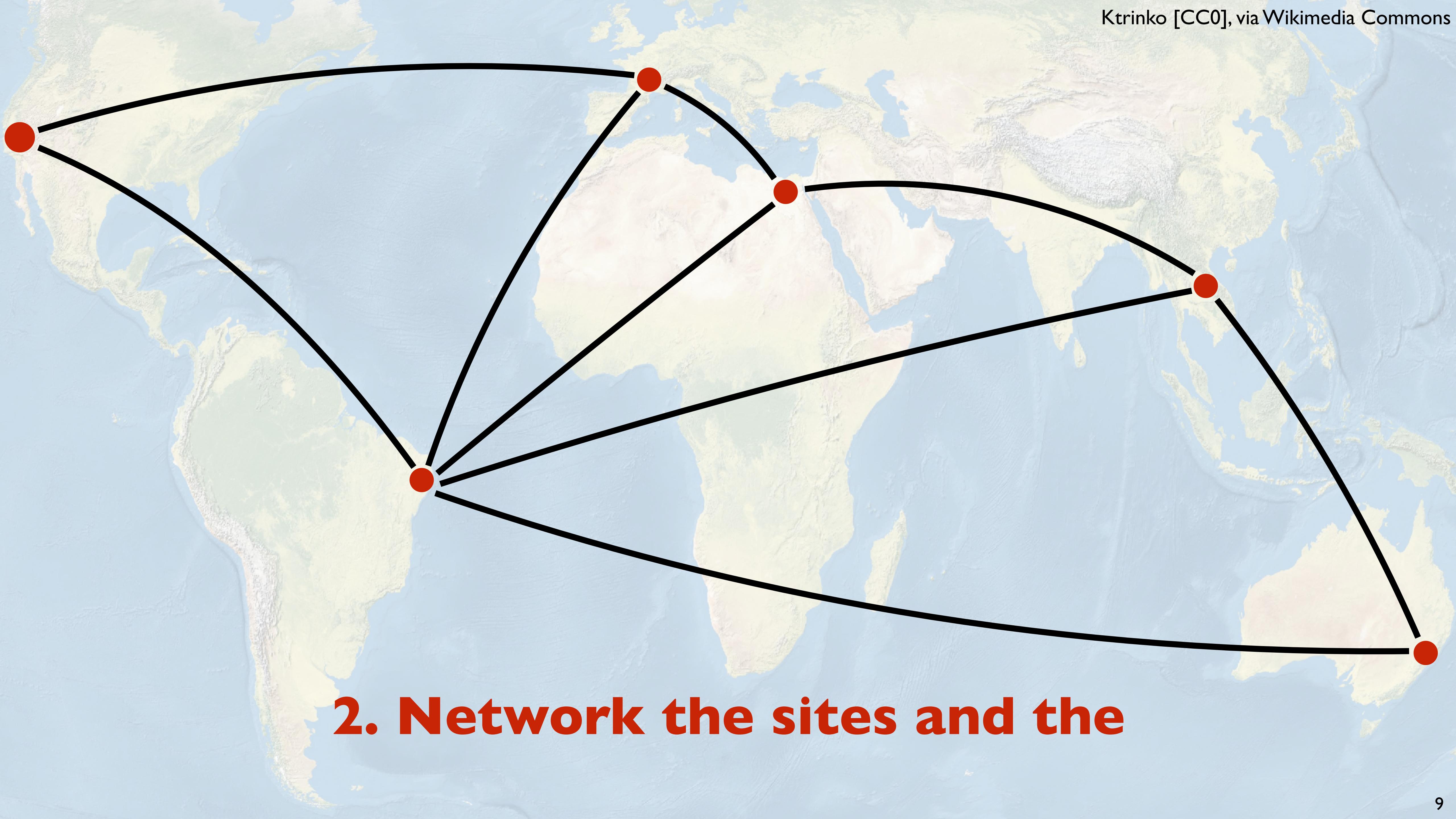
# CDNs solve these problems

*“Sixty-two percent of all Internet traffic will cross CDNs by 2019 globally, up from 39 percent in 2014.”*

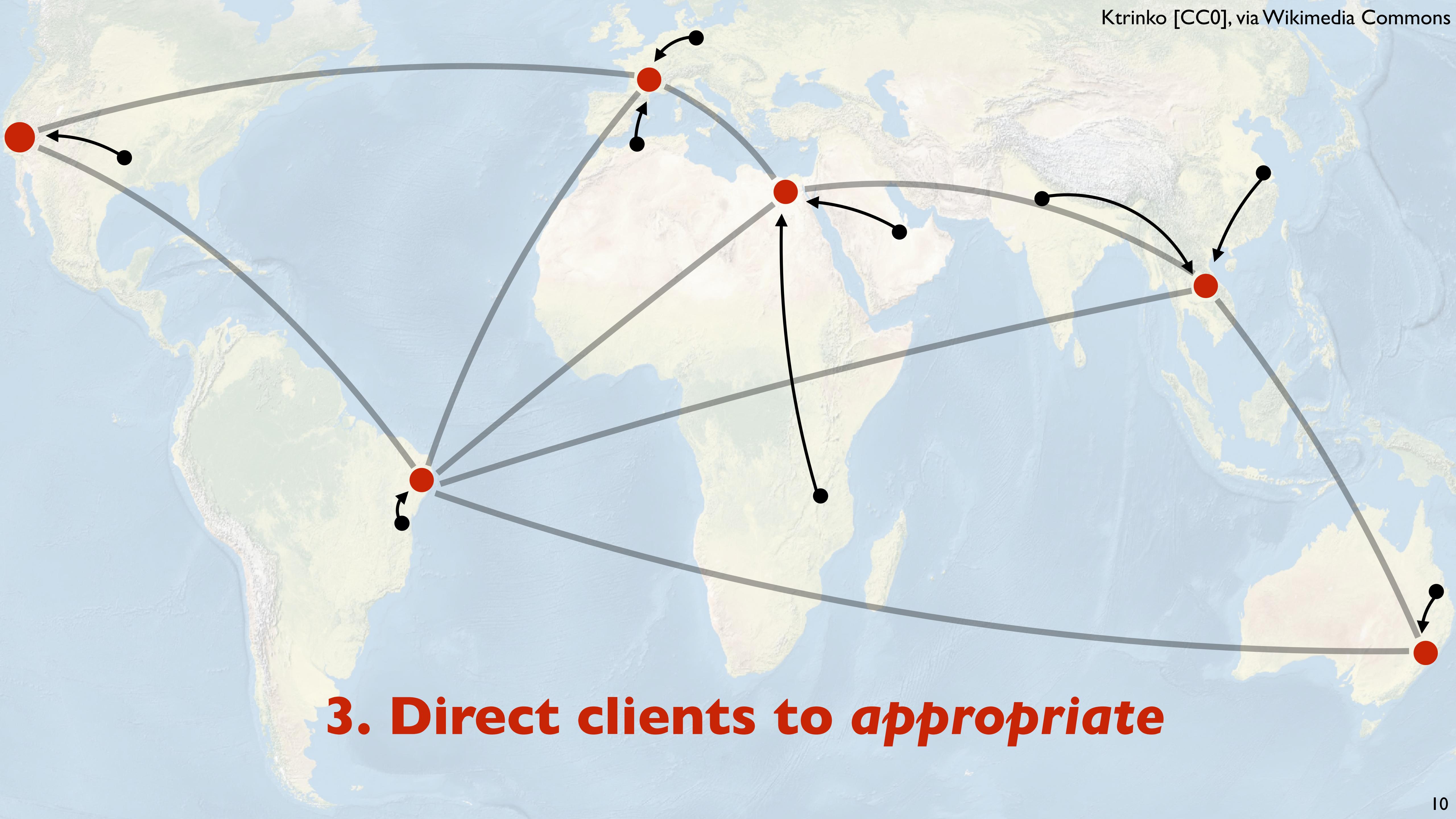
— Cisco



# I. Spread the content servers



**2. Network the sites and the**



### 3. Direct clients to appropriate



# I. Spread the content servers

Image adapted from: “Telehouse Docklands”, John Arundel. CC BY-SA 3.0 via Wiki



Adapted from image by Stefan Funke from Frankfurt, Germany (Switch Rack, Uploaded by MainFrame)  
[CC BY-SA 2.0], via Wikimedia Commons



# NETFLIX

## Open Connect:

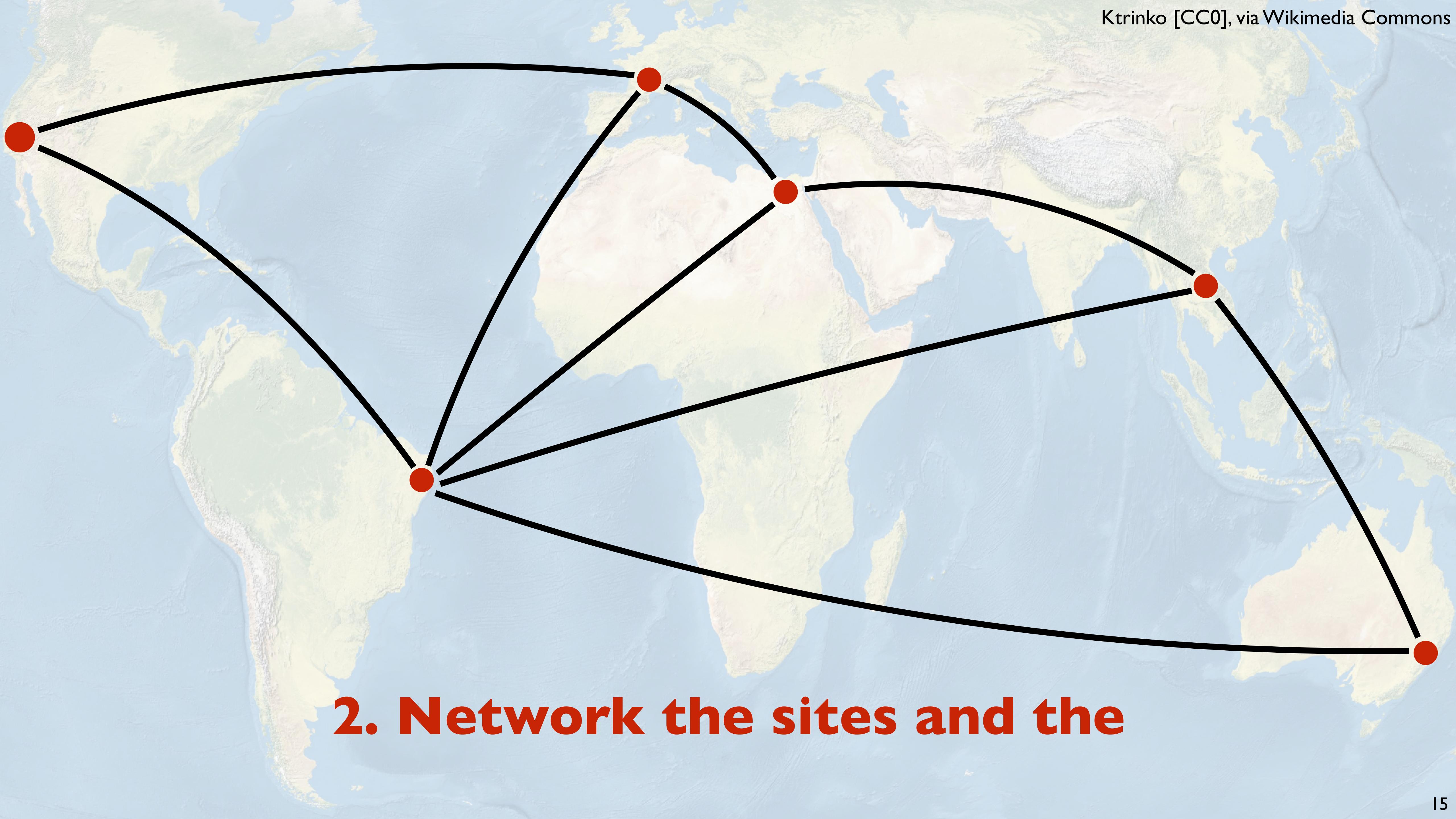
Storage Appliance  
Flash Appliance

- Storage Appliance
- Still 4U high
- ~550 watts
- 288 TB of storage
- 2x 10G ports
- 20Gbit/s delivery

- Flash Appliance
- 1U
- ~175 watts
- 24 TB of flash
- 2x 40G ports
- 40Gbit/s delivery



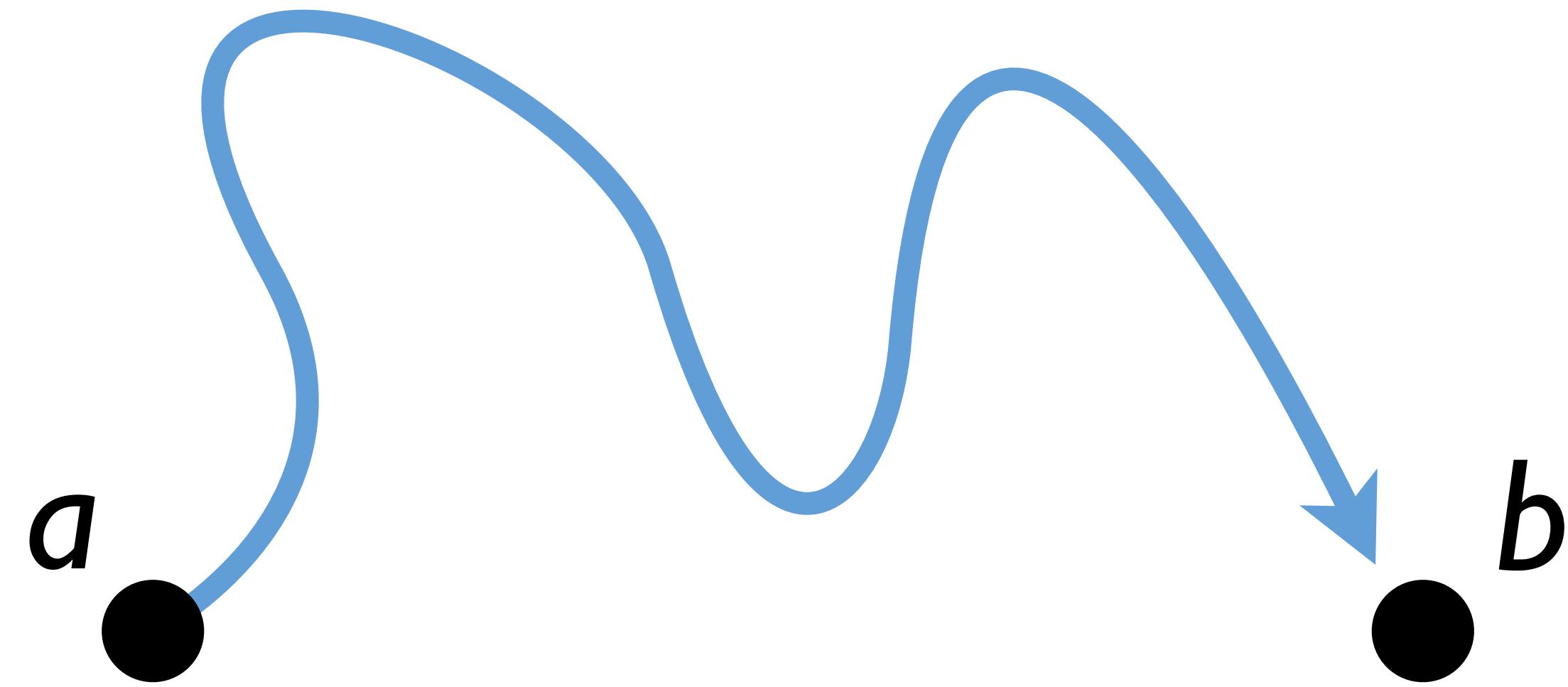
— Akamai



## 2. Network the sites and the

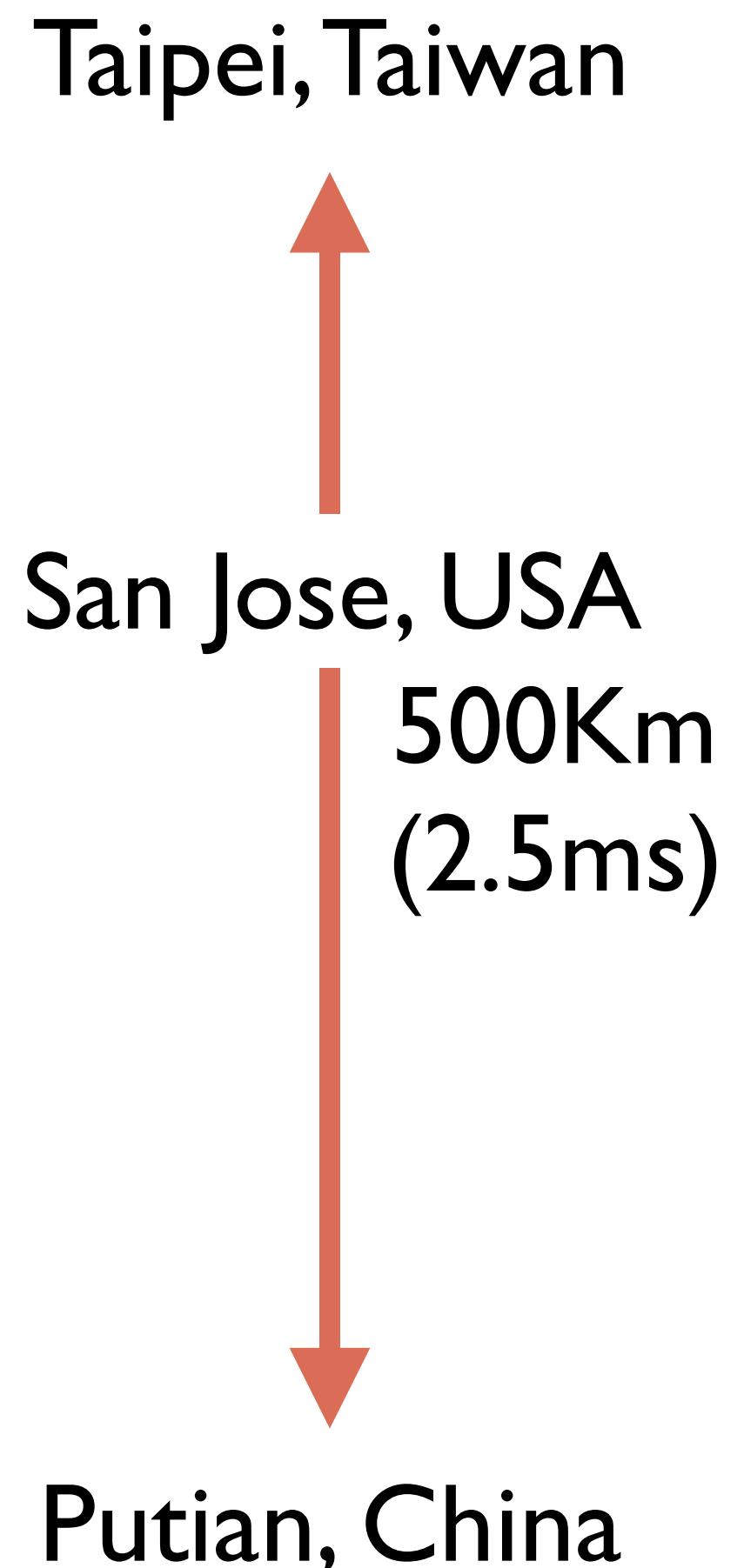
**How to get your own way  
on the Internet**

# Internet routing can be circuitous

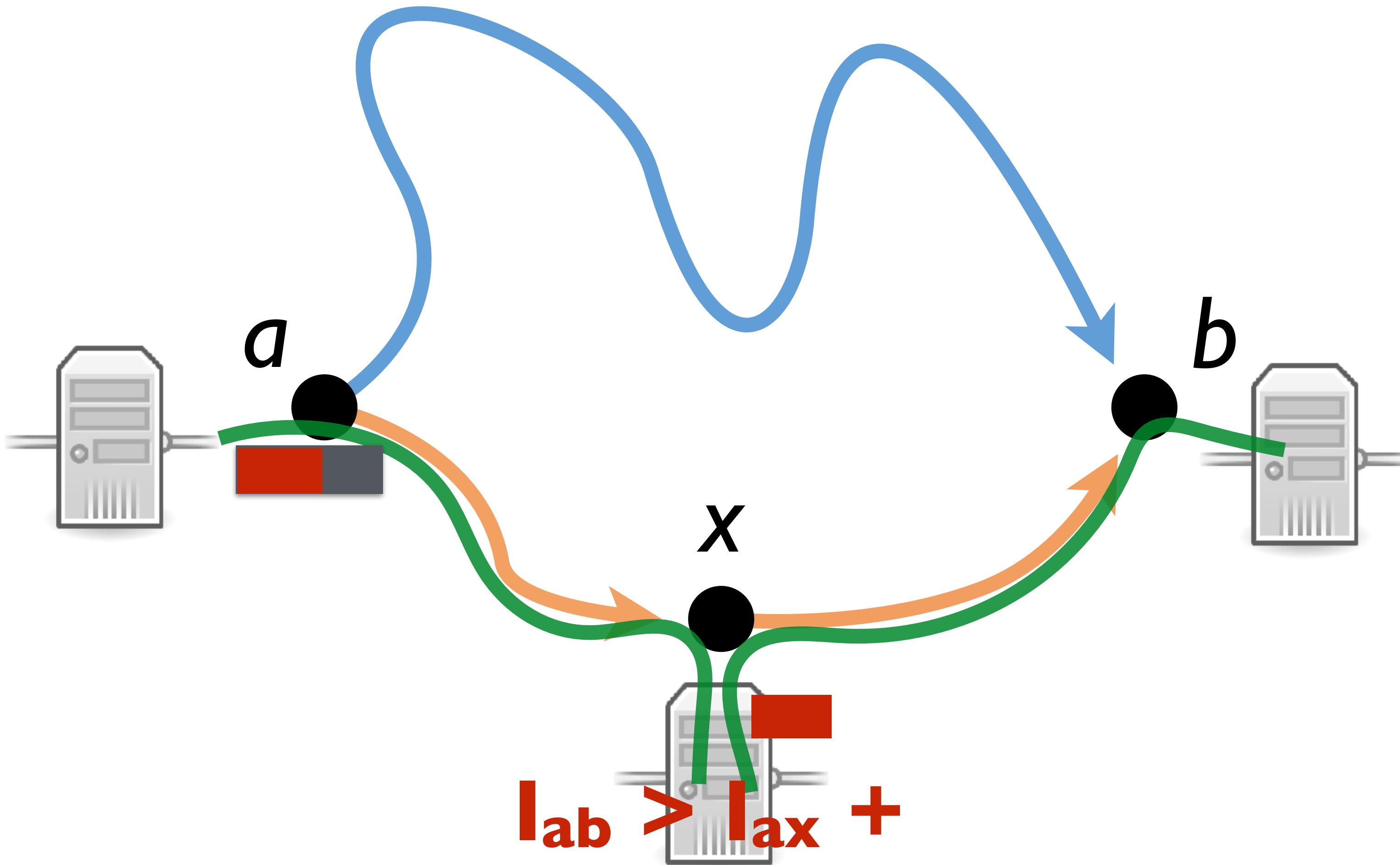


# Internet routing can be circuitous

```
1 140.109.17.1 1.857 ms 1.830 ms 1.819 ms
2 140.109.254.65 1.024 ms 0.964 ms 0.965 ms
3 140.109.254.29 1.702 ms 1.851 ms 2.036 ms
4 140.109.254.5 0.862 ms 0.895 ms 0.942 ms
5 202.169.174.1 1.320 ms 1.269 ms 1.433 ms
6 202.169.174.226 126.510 ms 126.498 ms 126.936 ms
7 4.59.4.1 276.592 ms 276.389 ms 276.527 ms
8 4.69.152.145 127.712 ms 127.741 ms 127.682 ms
9 4.53.210.110 128.843 ms 4.53.210.118 129.030 ms 4.53.210.114 128.602 ms
10 202.97.50.69 131.517 ms 131.466 ms 131.446 ms
11 202.97.50.117 305.707 ms 305.464 ms 305.652 ms
12 202.97.34.49 270.524 ms 270.410 ms 270.370 ms
13 202.97.50.225 306.119 ms 202.97.33.141 282.095 ms 202.97.50.241 277.718 ms
14 * * *
15 218.86.44.170 316.692 ms 316.784 ms 316.585 ms
16 218.6.10.242 291.273 ms 218.6.10.182 290.361 ms 218.6.10.166 297.248 ms
17 125.78.249.22 346.717 ms 218.6.10.138 296.387 ms 125.78.249.22 339.006 ms
18 125.78.249.22 335.653 ms 218.6.23.37 290.276 ms 290.287 ms
```



# Internet routing can be circuitous

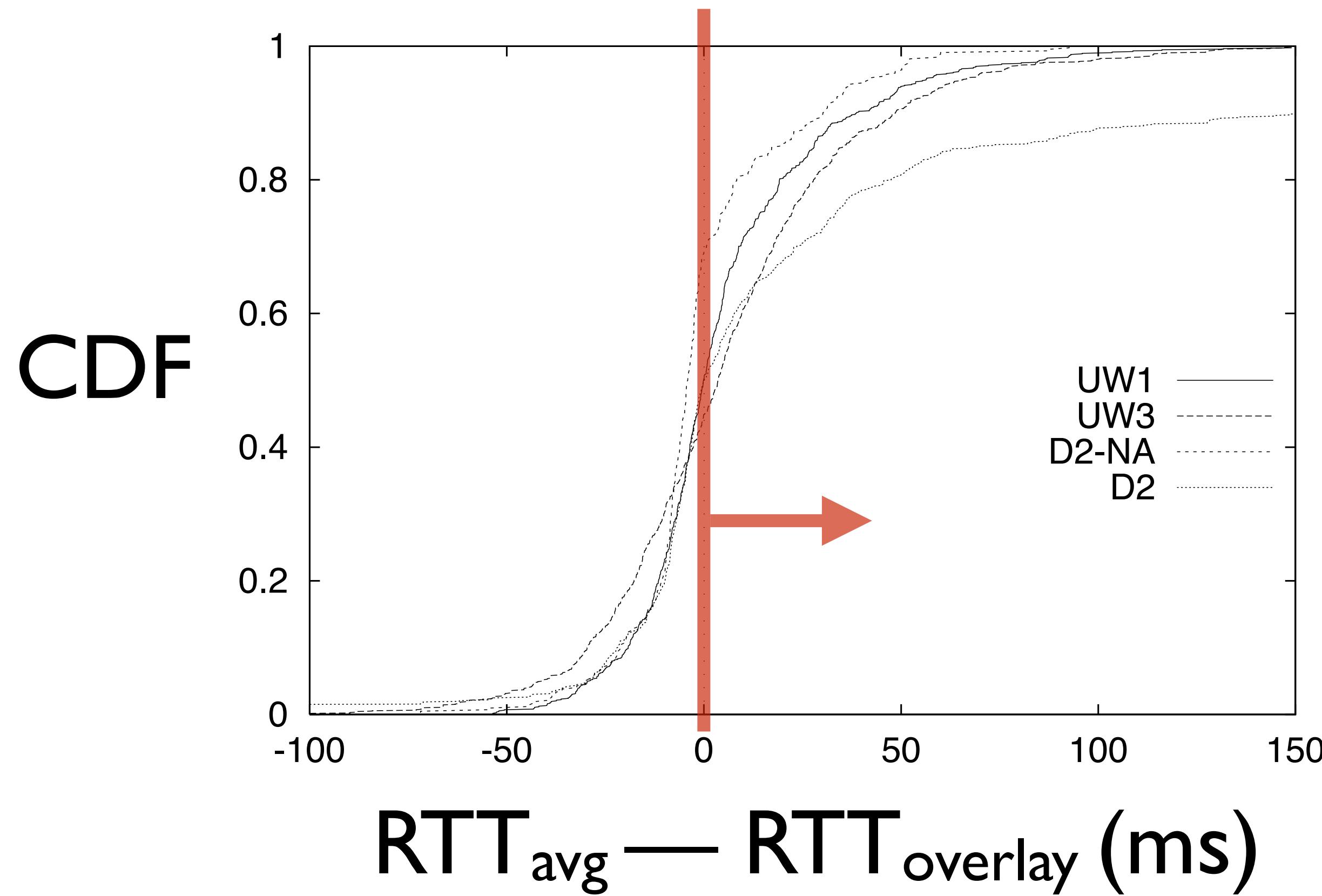


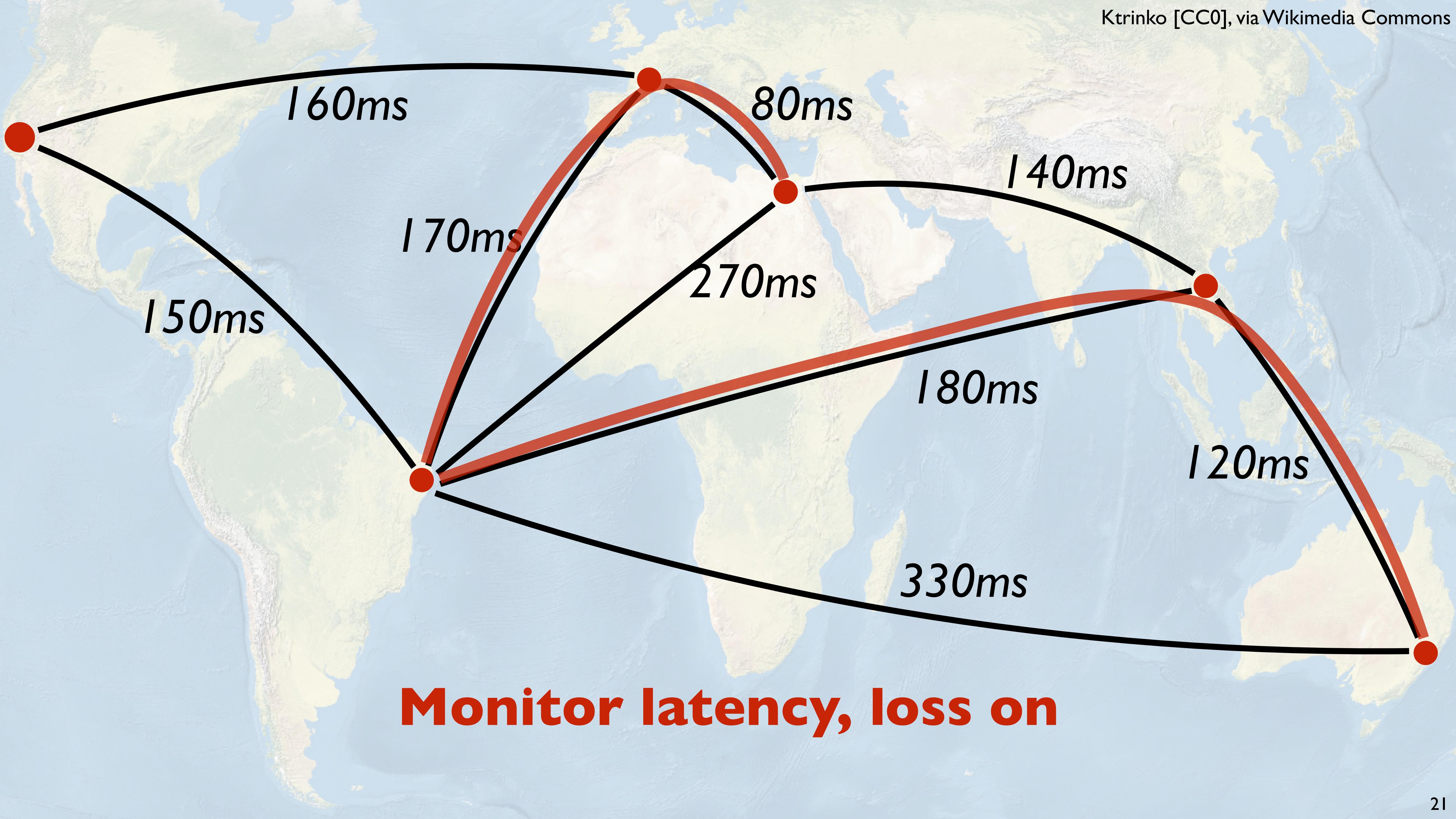
# Overlay routing: lower latency, loss

ACM SIGCOMM, 1999

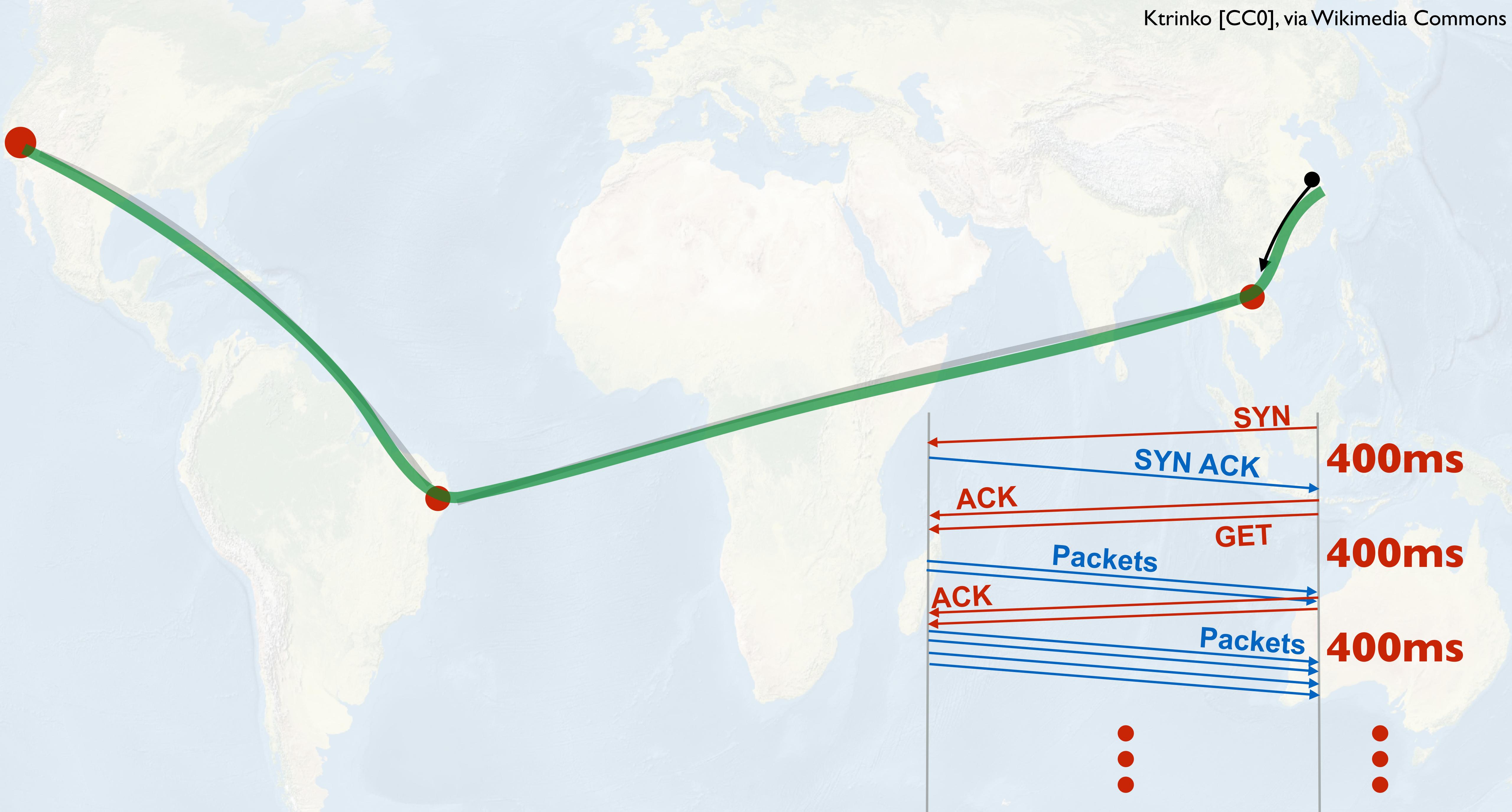
## The End-to-End Effects of Internet Path Selection

Stefan Savage, Andy Collins, Eric Hoffman  
John Snell, and Thomas Anderson

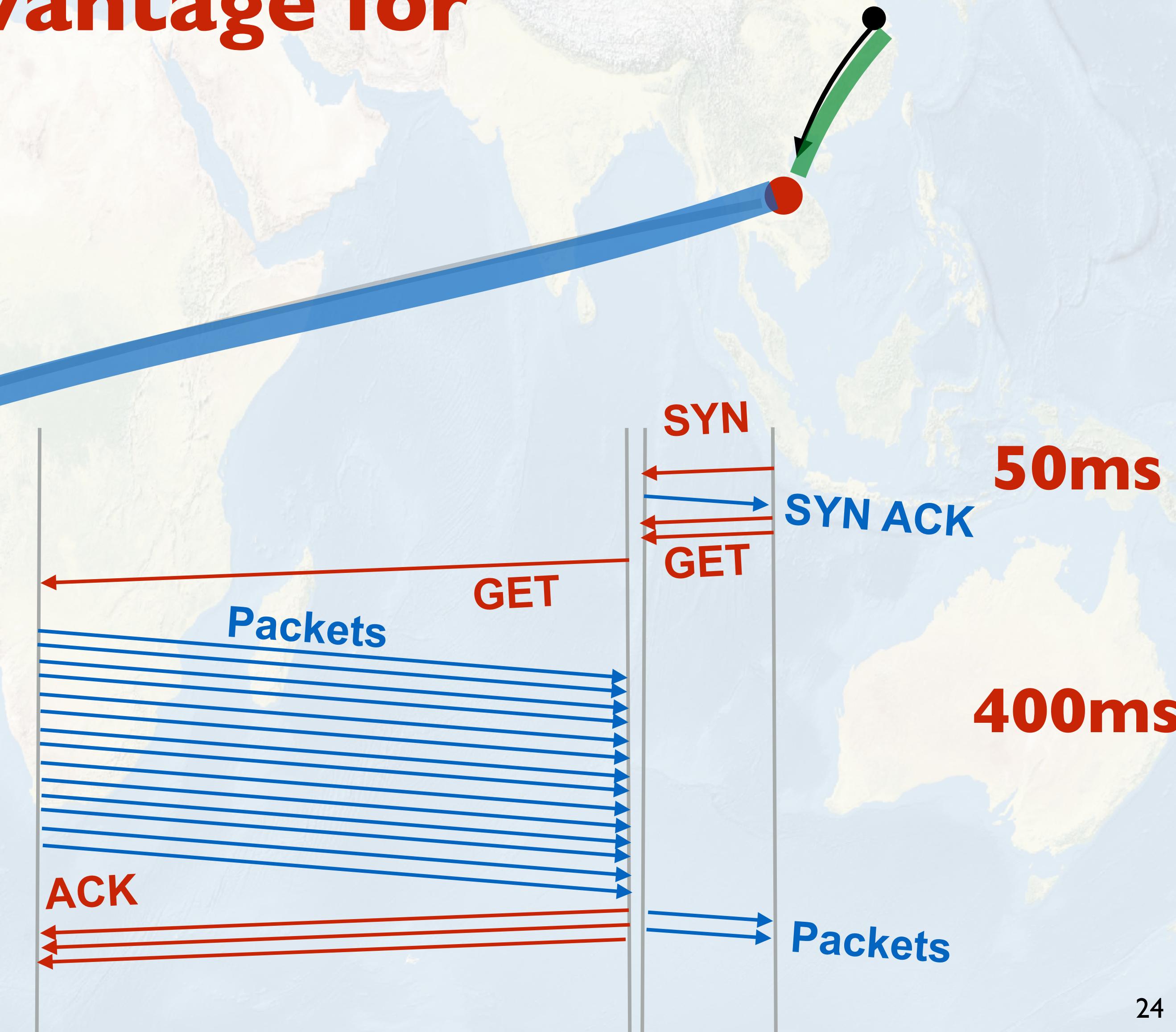


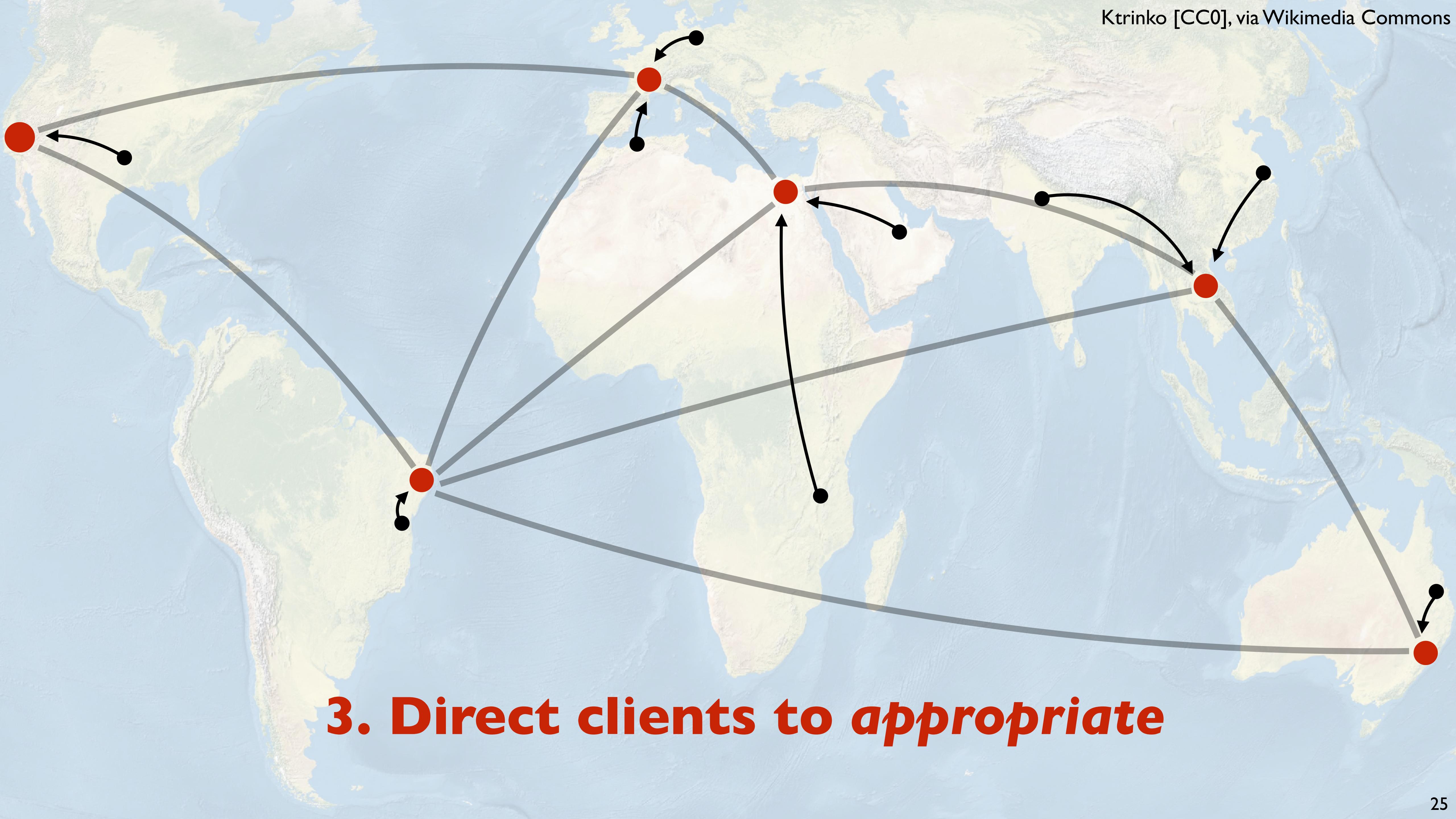


Tweaking transport  
for speed



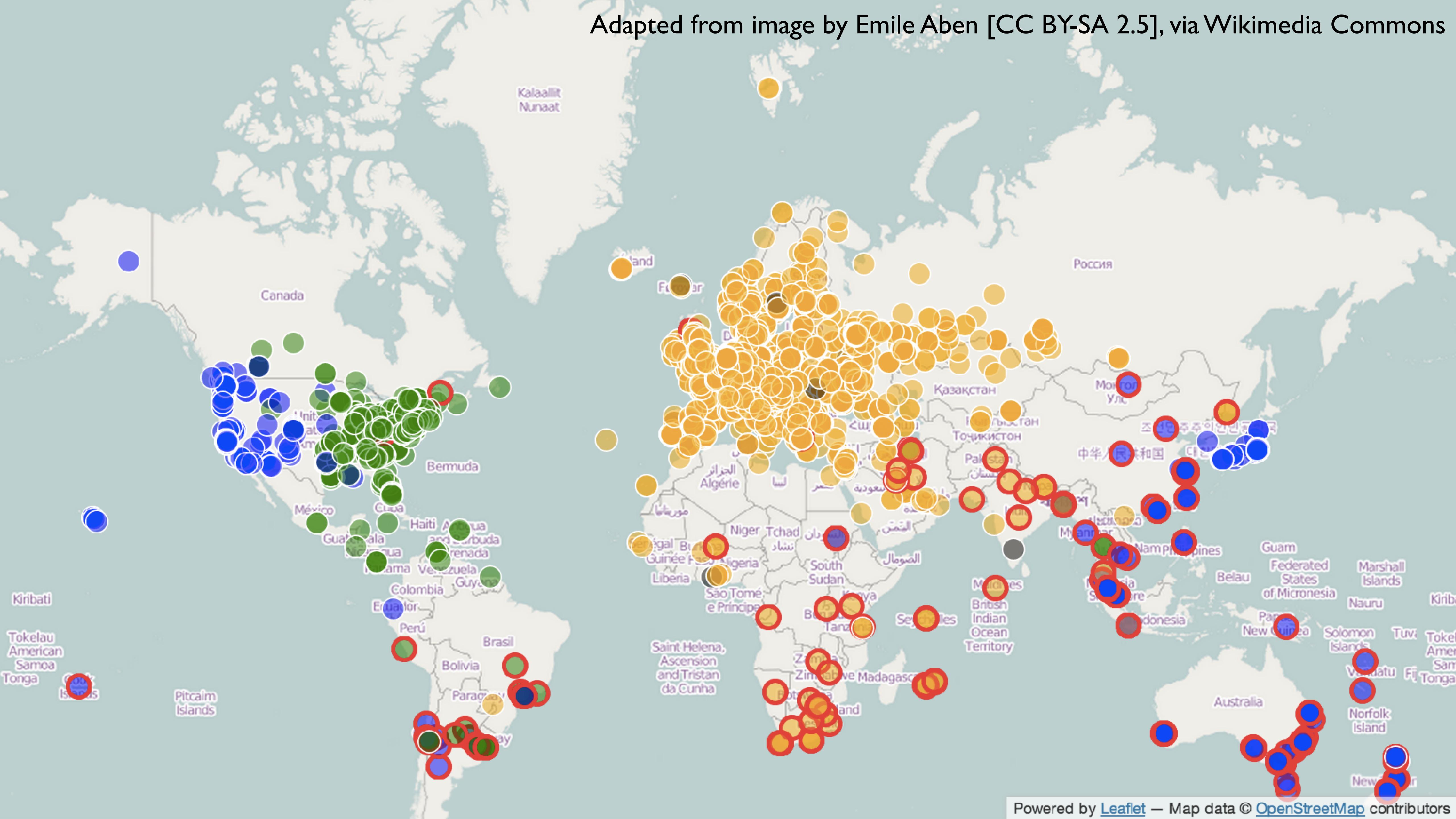
# Even bigger advantage for





### 3. Direct clients to appropriate

Adapted from image by Emile Aben [CC BY-SA 2.5], via Wikimedia Commons



# URL rewriting

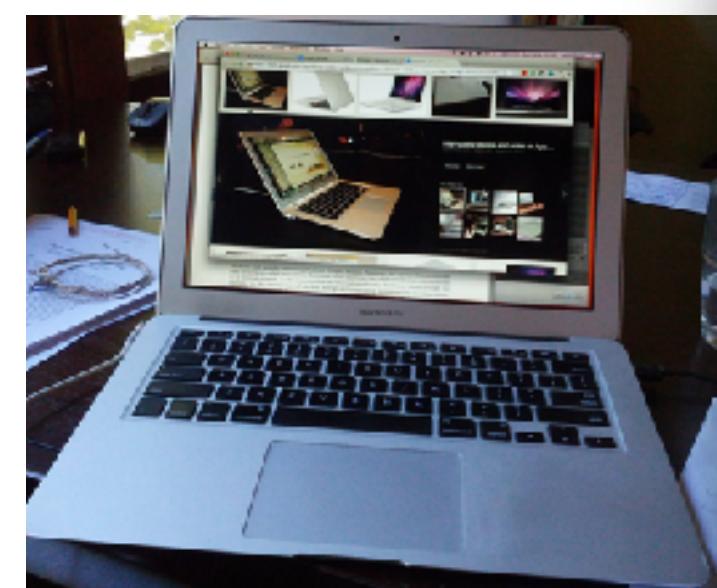
```
<html>
  ...

  ...
</html>
```

**cdnurl.abc.com**

# Manipulate DNS for the rest

# DNS customized by location



Client's ISP

What if the client isn't  
using the local DNS  
resolver?

DNS response depends on Local DNS resolver's guessed

GET ...

resolver

TL resolver

cdn.abc.com ?

CDN  
resolver

CDN  
cluster



# What black magic is this?

Adapted from <http://stackoverflow.com/>

## Why Google public DNS(8.8.8.8)'s ping latency so low?

I found that DNS's latency is low around the world. Many cities are far from each other, but they got the same low latency in ping (about 5ms).

edited Apr 24 '12 at 8:18



user166390

asked Apr 24 '12 at 8:15



Celebi

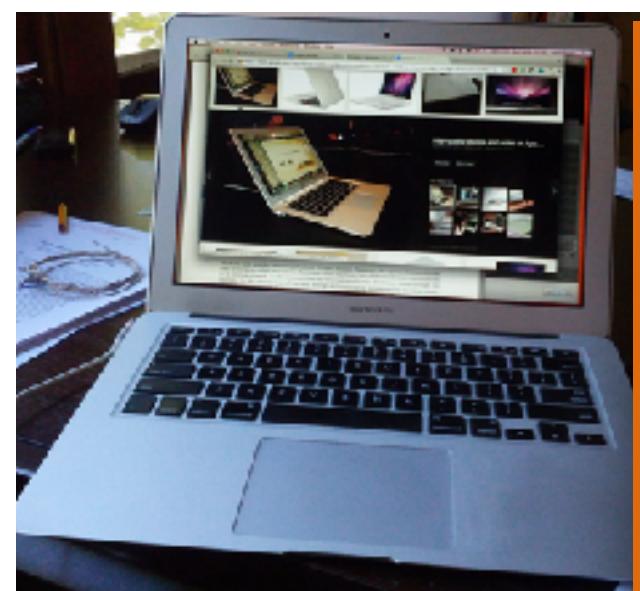
518 ● 3 ● 8 ● 19

# Anycast routing based CDNs

**Announce the same BGP prefix from multiple**

Client's ISP

I.m.n.o



**Performance-based  
selection?**

**BGP route flaps?**

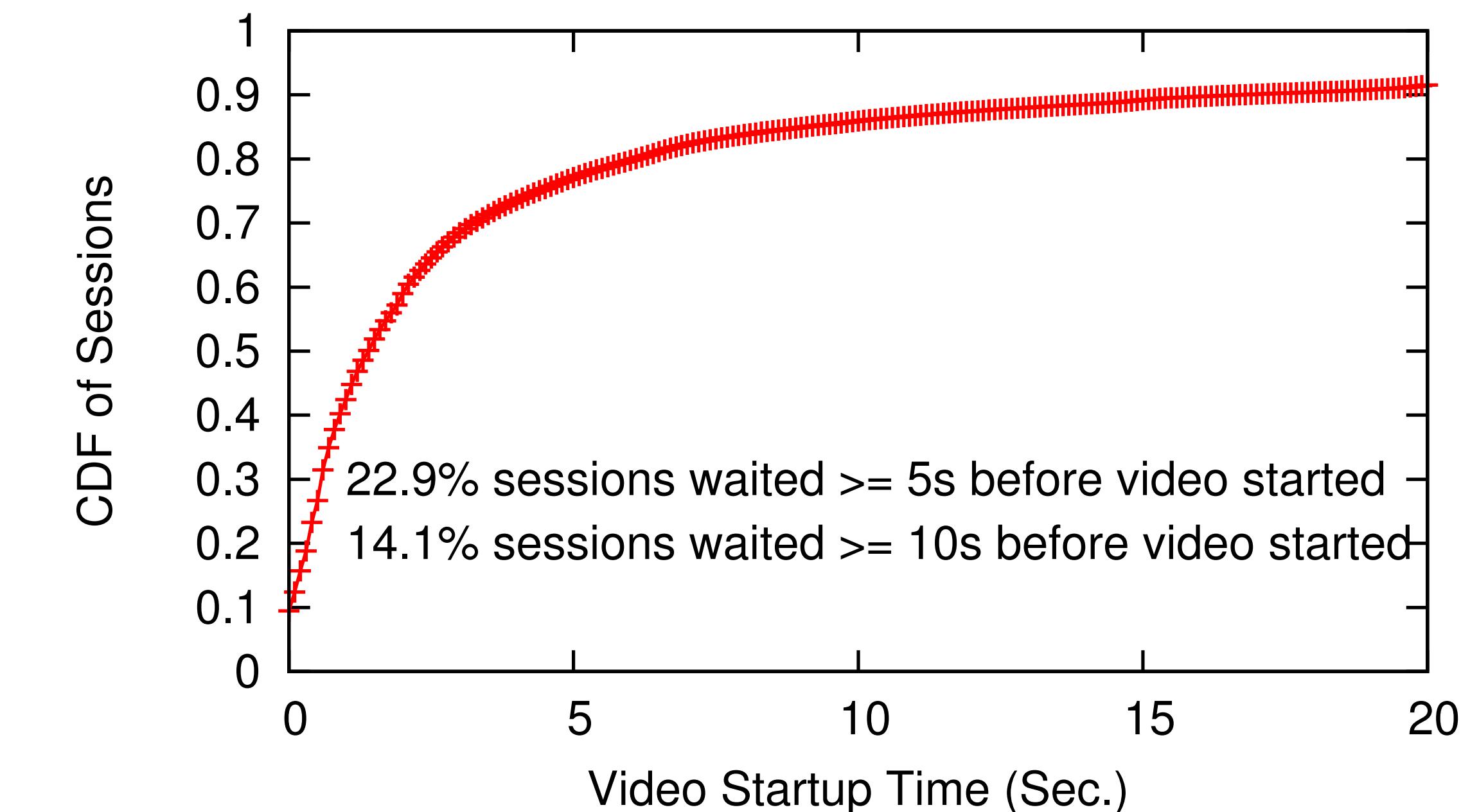
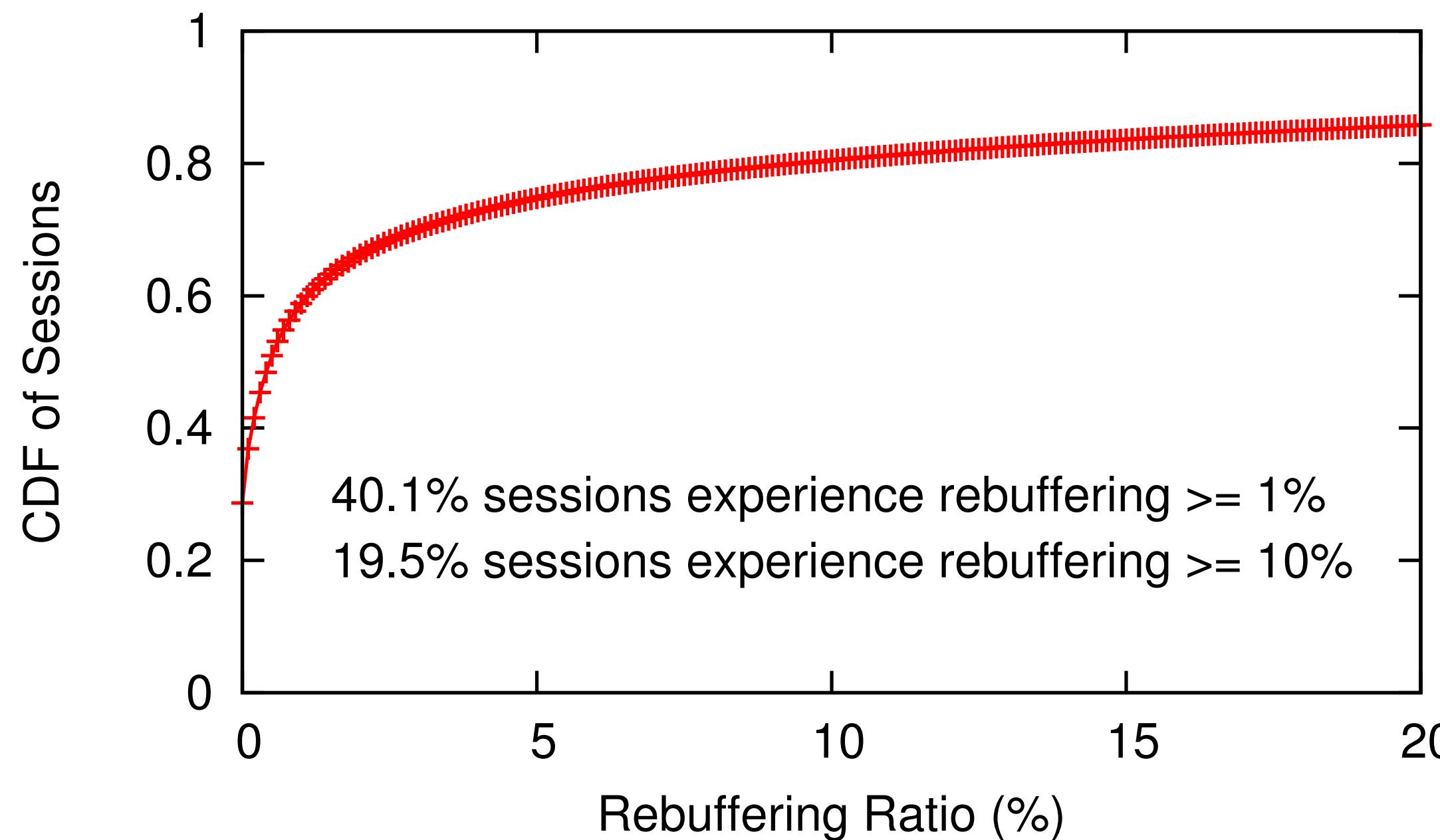
or ISPs



I.m.n.o

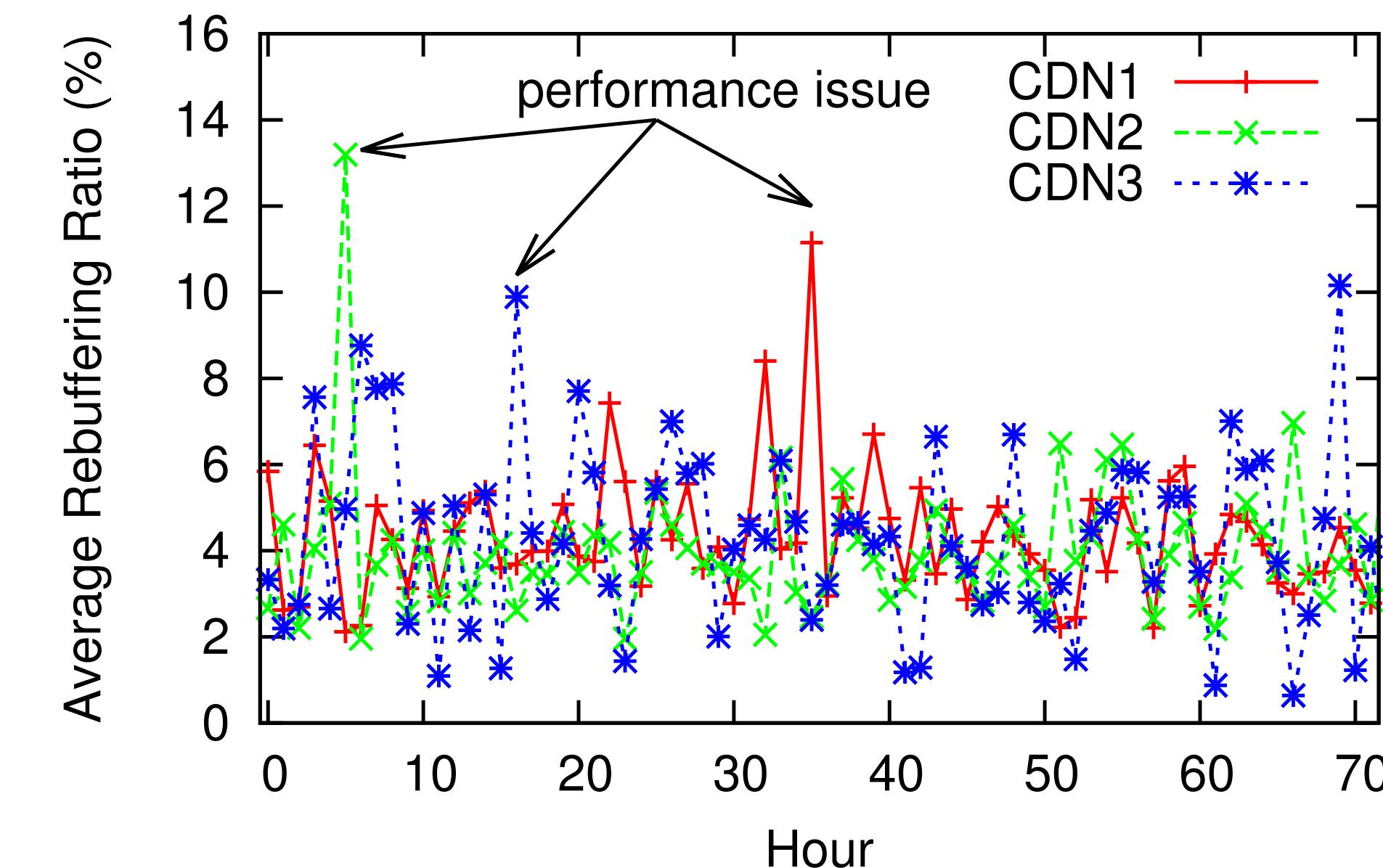
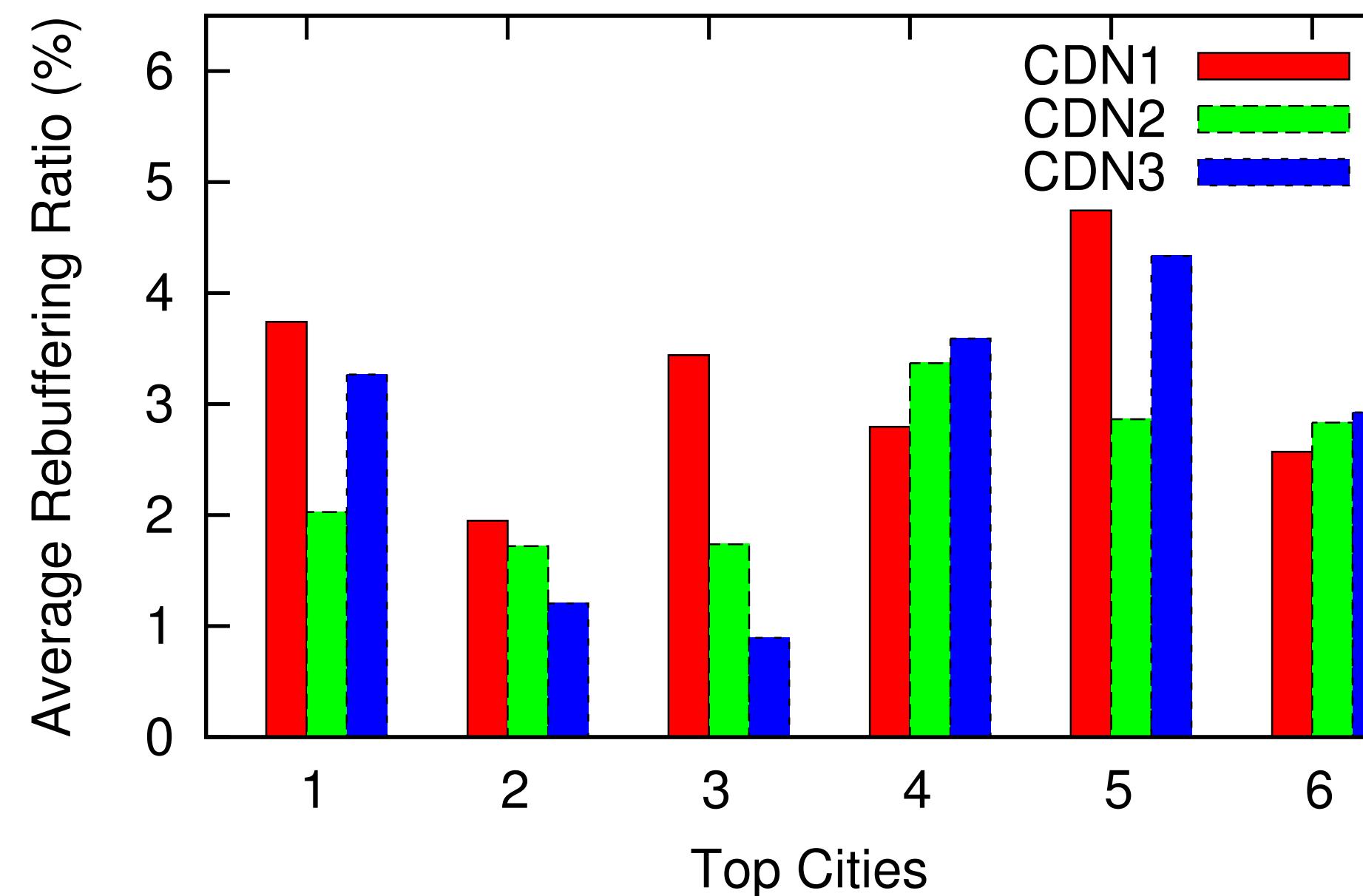
# Sometimes, a CDN is not enough ...

Poor performance for many users, despite the use of CDNs

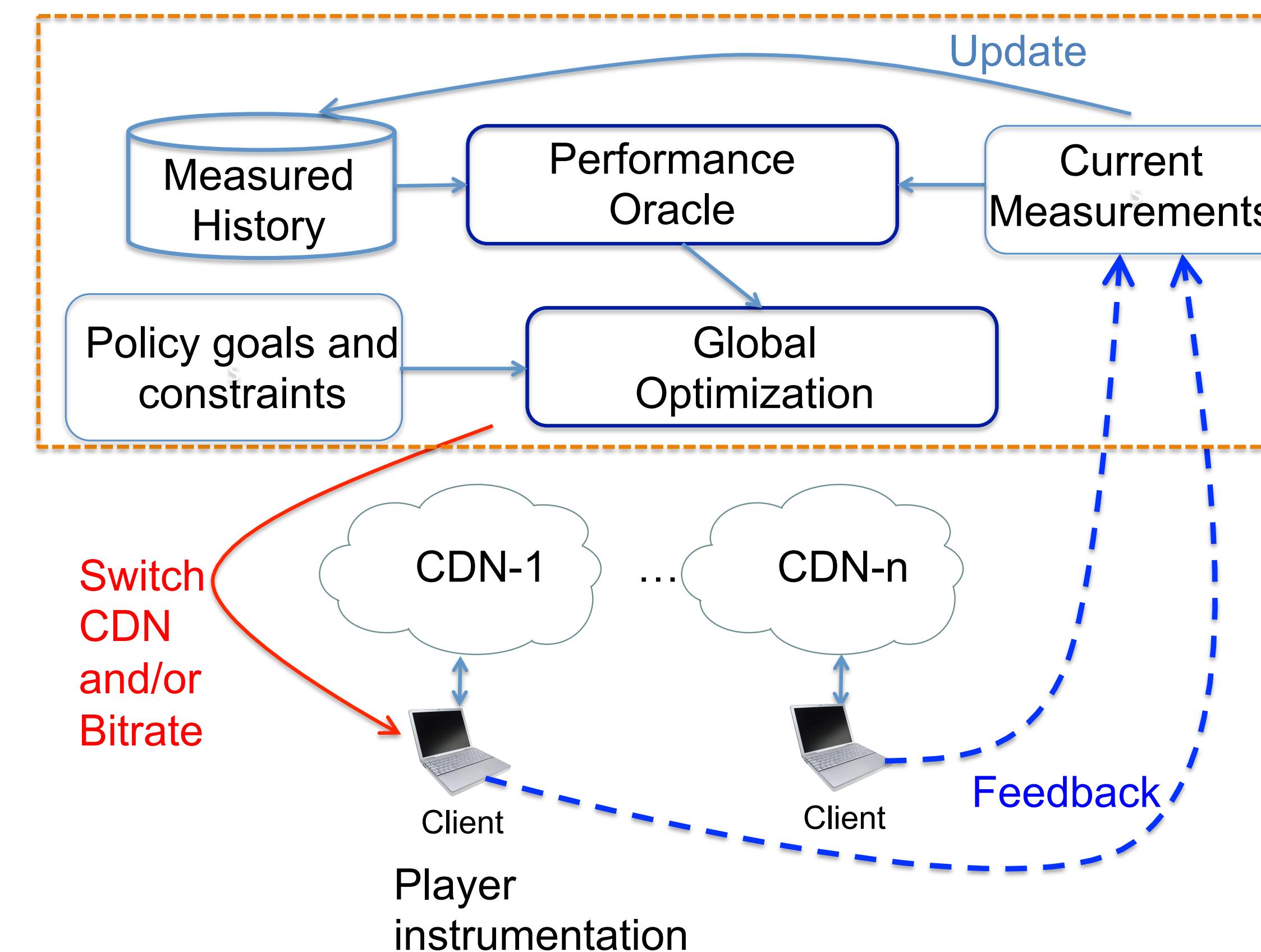


# Sometimes, a CDN is not enough ...

There's significant variability in CDN performance across time and space



# So ... perhaps one can use many CDNs?



A new beast on the scene: “CDN broker”

# Weekly reading guide

# Your favorite networking paper!



???

- Not from the class' readings so far!