

# The Rise and Rise of Content Distribution Networks

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APNIC

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# Our Heritage

## The Telephone Network:

- Connected handset to handset
- Intentionally transparent network
- Peer-to-peer service construct
- Network-centric architecture with minimal functionality in the edge devices

# Computer Networks

The original concept for computer networks was like the telephone network:

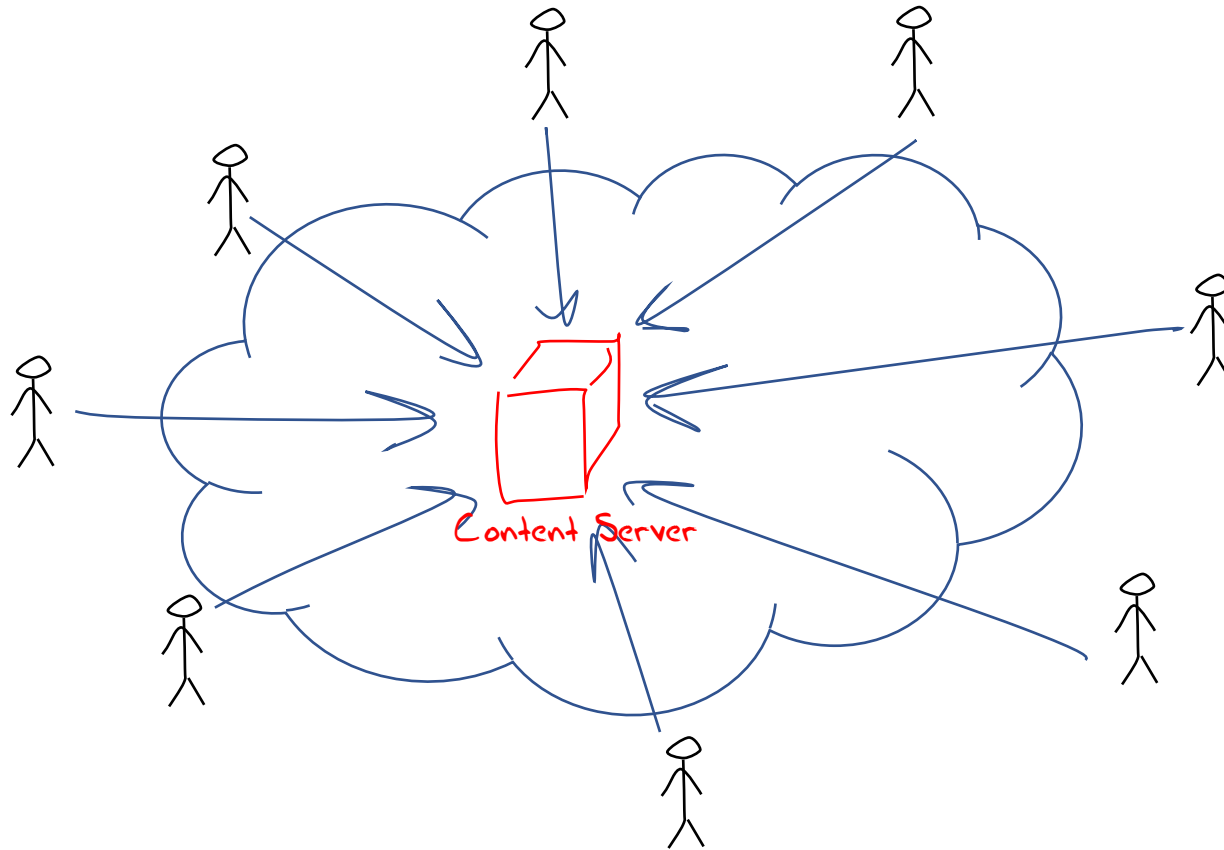
- The network was there to enable connected computers to exchange data
- All connected computers were able to initiate or receive “calls”
- A connected computer could not call “the network” – the network was an invisible common substrate
- It made no difference if the network had active or passive internal elements

# Clients and Servers

- The rise of the web-based content publishing model was accompanied by the creation of specialised server computers that published data, and specialised client-side devices who could only retrieve published data
- The rise of NATs enforced this role segmentation in the network
  - And, coincidentally removed any sense of urgency associated with the transition to IPv6

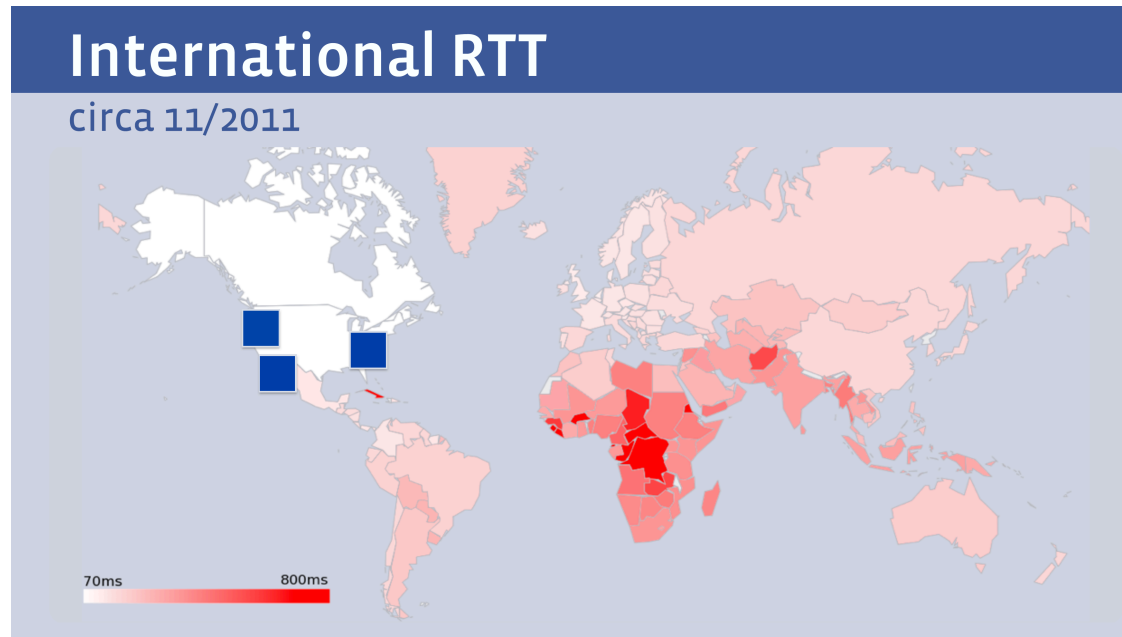


# Content Server



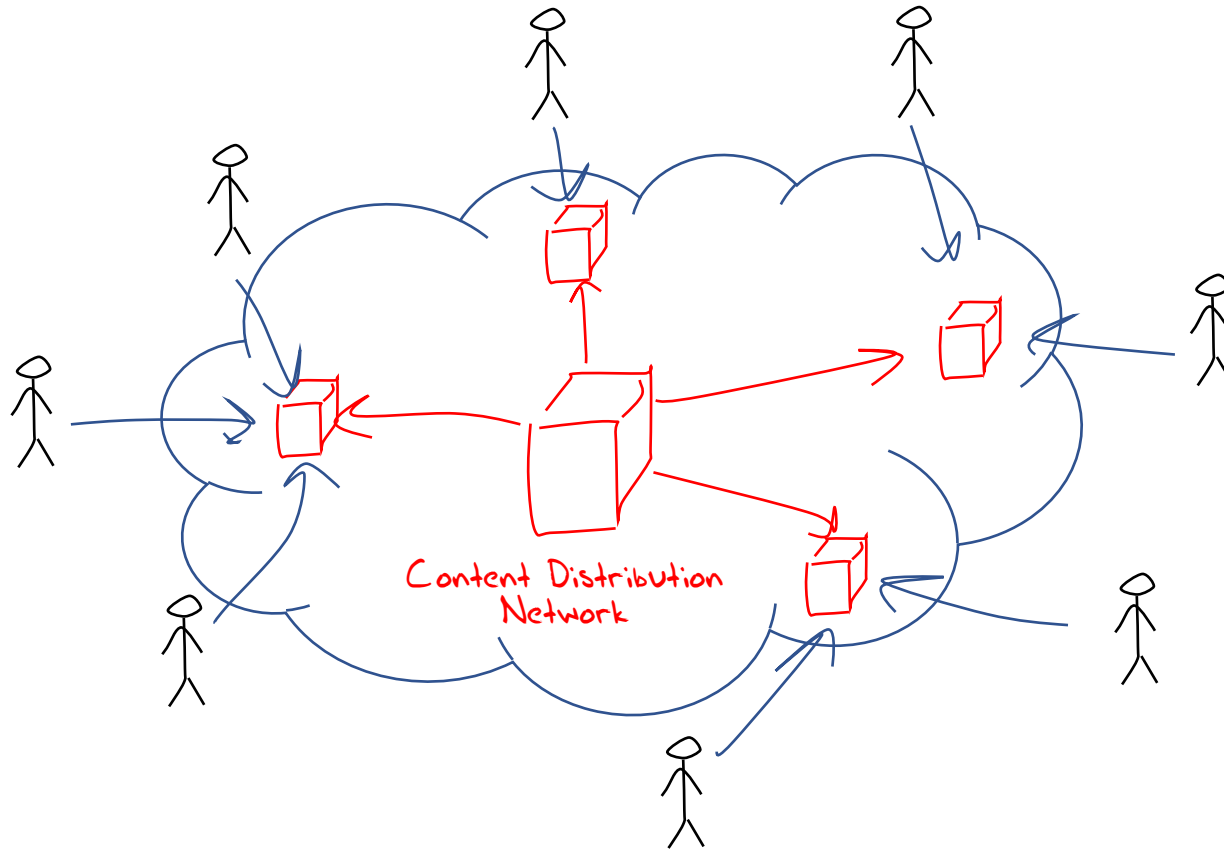
# The Tyranny of Distance

But not all clients enjoy the same experience from a single service portal



*Facebook presentation at  
NANOG 68*

# Content Distribution



# Let them eat data!

## The rise of the Content Distribution Network

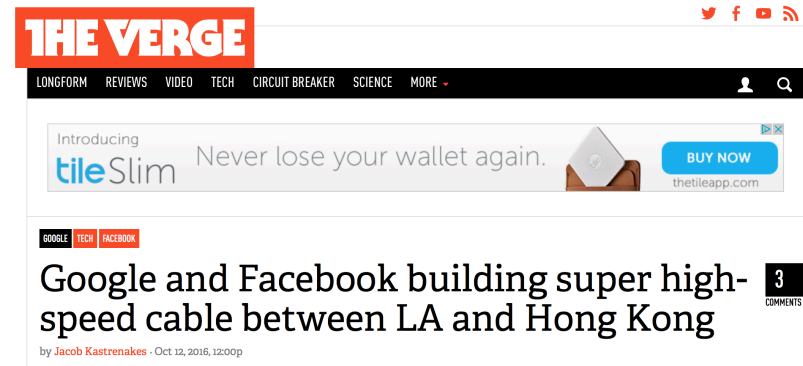
- Replicate content caches close to large user populations
- The challenge of delivering many replicant service requests over high delay network paths is replaced by the task of updating a set of local caches by the content distribution system and then serving user service requests over the access network
- Reduced service latency, increased service resilience, happy customers!

# Who's building now?

Almost all new submarine international cable projects are heavily underwritten by content providers, not carriers

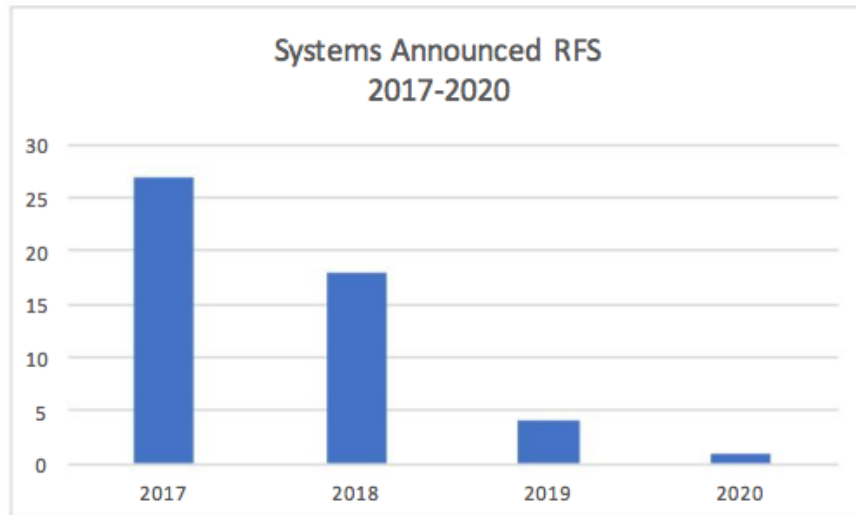
Large content providers have huge and often unpredictable traffic requirements, especially among their own data centers. Their capacity needs are at such a scale that it makes sense for them, on their biggest routes, to build rather than to buy. Owning subsea fibre pairs also gives them the flexibility to upgrade when they see fit, rather than being beholden to a third-party submarine cable operator."

Tim Stronge of Telegeography, January 2017

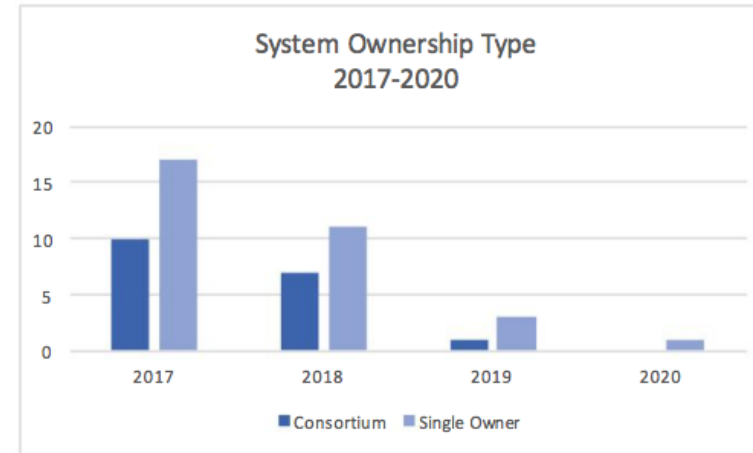


# Submarine Cables

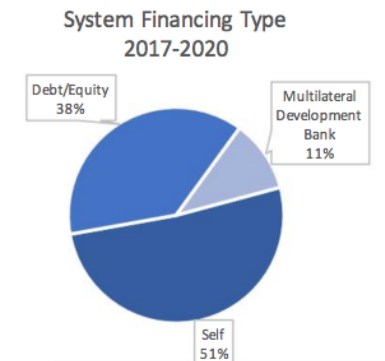
And those that are being built are now single owner cables



Fewer cables being built



And the majority are now self-funded

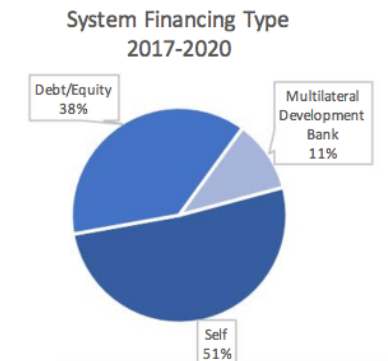
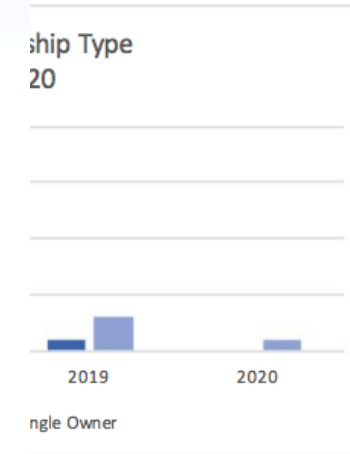
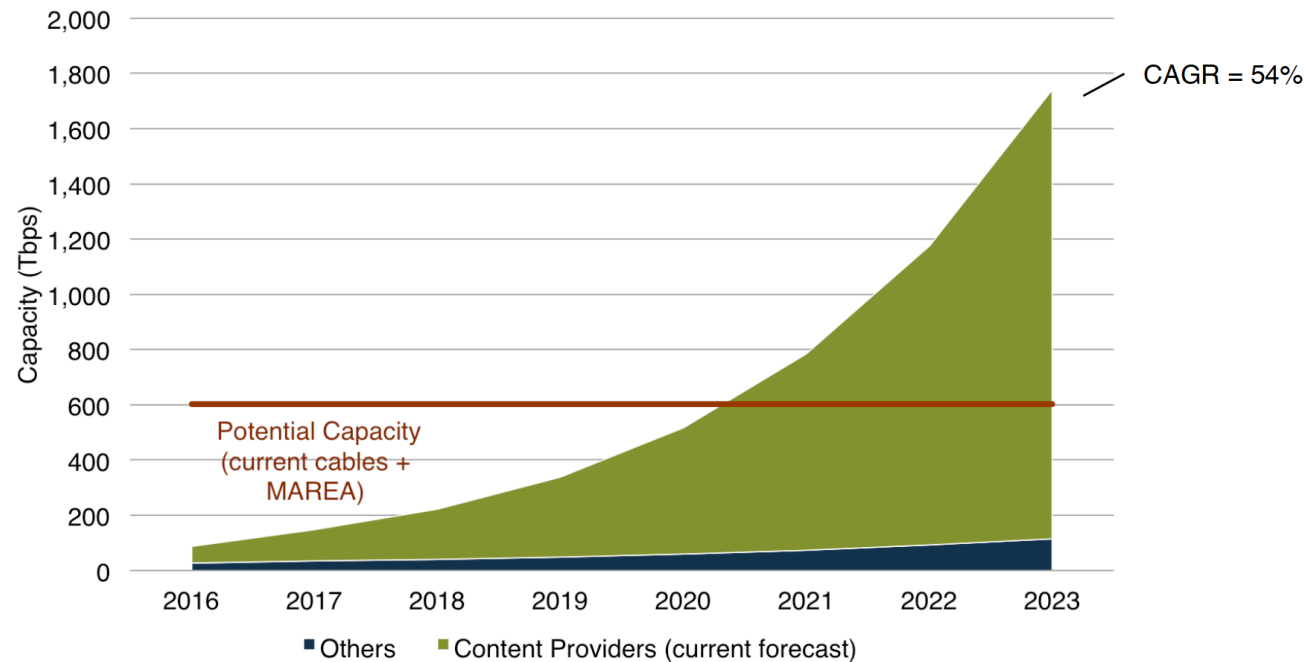


# Submarine Cables

## Growth depends on content

being built are now

Lit vs. Potential Capacity on All Trans-Atlantic Cables: Baseline View



And the majority are now self-funded

# Today's Internet Architecture

We've split the network into clients and servers

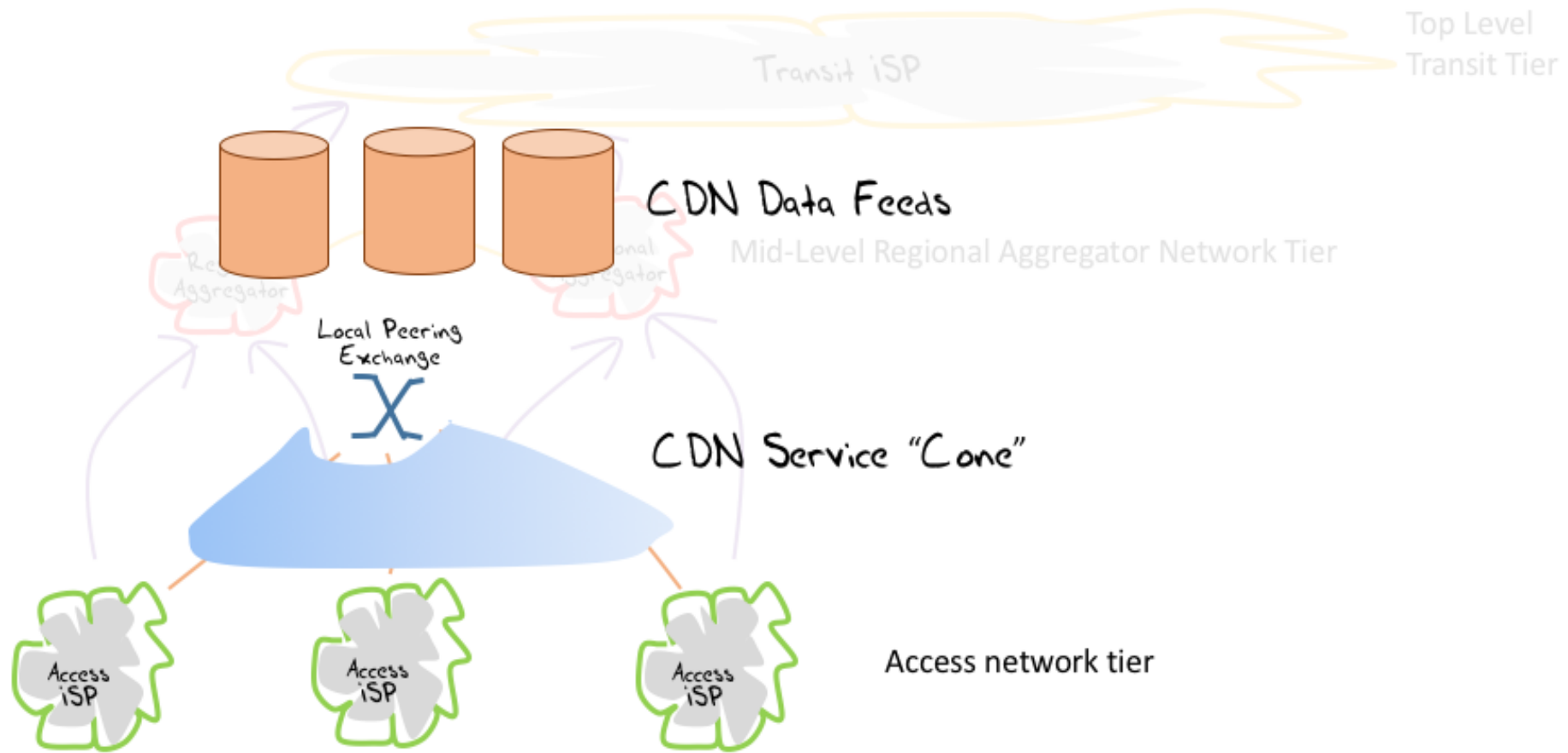
- Web servers
- Streaming servers
- Mail servers
- DNS servers

Servers and services now sit in CDN bunkers with global replication and DDOS hardening

Users don't reach out to content any more - the CDNs bring content to users



# Today's Internet Architecture



# Role Reversal

Service portals are increasingly located adjacent to users

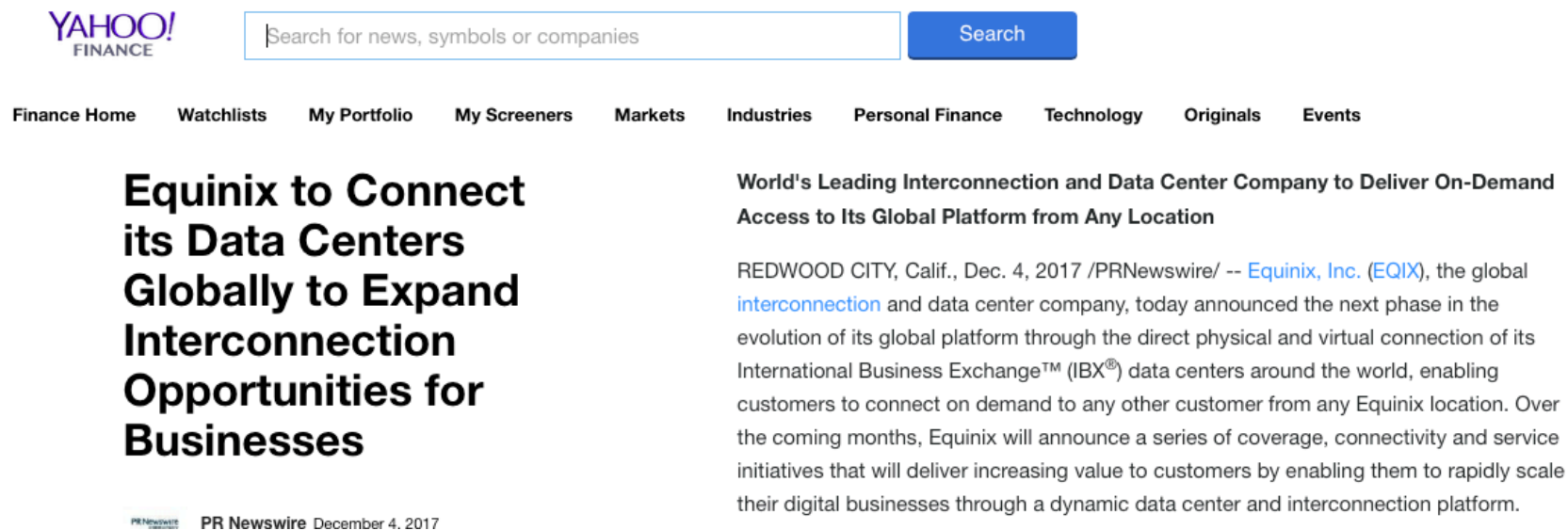
And that means changes to the network:

- Public Networks no longer carry users' traffic to/from service portals via ISP carriage services
- Instead, Private Networks carry content to service portals via CDN services

This shift has some profound implications for the Internet

# Does Transit have a Future?

We see the CDN systems reserve a carriage resource through dedicated bandwidth / wavelength / cable purchase and effectively bypass the open IP carriage infrastructure



The screenshot shows the Yahoo Finance website interface. At the top, there is a search bar with the text "Search for news, symbols or companies" and a blue "Search" button. Below the search bar is a navigation menu with links: "Finance Home", "Watchlists", "My Portfolio", "My Screeners", "Markets", "Industries", "Personal Finance", "Technology", "Originals", and "Events". The main content area features a large, bold headline: "Equinix to Connect its Data Centers Globally to Expand Interconnection Opportunities for Businesses". To the right of the headline is a sub-headline: "World's Leading Interconnection and Data Center Company to Deliver On-Demand Access to Its Global Platform from Any Location". Below the headline is a paragraph of text: "REDWOOD CITY, Calif., Dec. 4, 2017 /PRNewswire/ -- [Equinix, Inc. \(EQIX\)](#), the global [interconnection](#) and data center company, today announced the next phase in the evolution of its global platform through the direct physical and virtual connection of its International Business Exchange™ (IBX®) data centers around the world, enabling customers to connect on demand to any other customer from any Equinix location. Over the coming months, Equinix will announce a series of coverage, connectivity and service initiatives that will deliver increasing value to customers by enabling them to rapidly scale their digital businesses through a dynamic data center and interconnection platform."








PR Newswire December 4, 2017

# Does Transit have a Future?

- If users don't send packets to users any more...
- If content is now delivered via CDNs to users via discrete service cones...
- If there is no universal service obligation for content...
- If there is no visible definition of the "Internet Route Set" ('default') any more...
- If there is no economically viable demand for transit any more...

Then why do we still need Transit Service providers?

# The Large and the Largest

	Company	\$B USD
	Apple	791
	Alphabet	664,
	Microsoft	589
	Amazon	459
	Berkshire Hathaway	451
	Alibaba Group	436
	Tencent	405
	Facebook	399
	Exxon Mobil	348
	Johnson & Johnson	347

The world's 10 largest publicly traded companies, as ranked by their market capitalization, September 2017

# Content Really is King

- None of these seven technology companies are a telephone company, or even a transit ISP, or even an ISP at all!
- All of them have pushed aside carriage networks in order to maintain direct relationships with billions of consumers
- These valuable consumer relationships are based on content services, not carriage

# Content Consolidation

- There are not thousands of content service platforms
  - There are just a few left
- And the space is dominated by a small number of dominant actors who set the rules of engagement for all others

# Content Consolidation

"The size and scale of the attacks that can now easily be launched online make it such that if you don't have a network like Cloudflare in front of your content, and you upset anyone, you will be knocked offline.

...

In a not-so-distant future, if we're not there already, it may be that if you're going to put content on the Internet you'll need to use a company with a giant network like Cloudflare, Google, Microsoft, Facebook, Amazon, or Alibaba.

...

Without a clear framework as a guide for content regulation, a small number of companies will largely determine what can and cannot be online.

Matthew Prince

August 2017

<https://blog.cloudflare.com/why-we-terminated-daily-stormer/>



# We've been here before...



## American Art: The Gilded Age

Mark Twain coined the phrase "the Gilded Age" in 1873. This term, with its connotations of superficiality and ostentatious wealth, has come to refer to the decades following the Civil War. During that period of rapid industrialization, the contrast between the lifestyles of so-called robber barons and average workers was enormous. The metaphor of gilded surfaces resonates in the richly decorated possessions of the ruling class, from domestic furniture to picture frames.

This gallery examines the leading cultural phenomenon of the 1870s and 1880s, the American Aesthetic movement, through a range of objects produced for affluent consumers. Aestheticism, rooted in the English philosophies of John Ruskin and William Morris, advanced the notion that a beautiful environment could promote moral and social reform. In the process, the Aesthetic movement helped to liberate American art and design from the confines of historicism by admitting fresh influences from foreign lands.

High Museum of Art, Atlanta

# The Gilded Age

A term applied to America in the 1870 – 1890's about the building of industrial and commercial corporate giants on platforms that were a mix of industrial innovation and enterprise with elements of greed, corruption and labor exploitation

Andrew Carnegie - US Steel

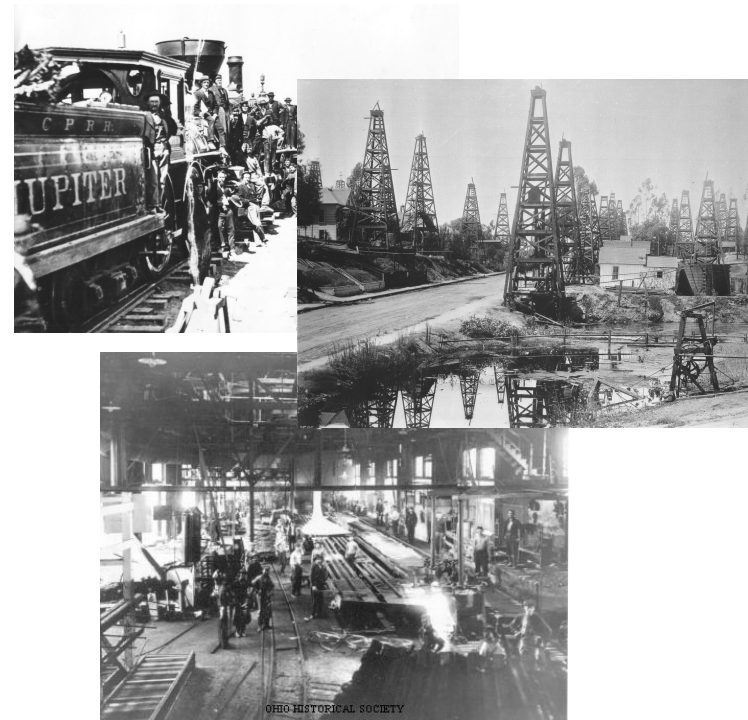
John Rockefeller - Standard Oil

Theodore Vail - AT&T

George Westinghouse – Rail Brakes

Thomas Edison – General Electric

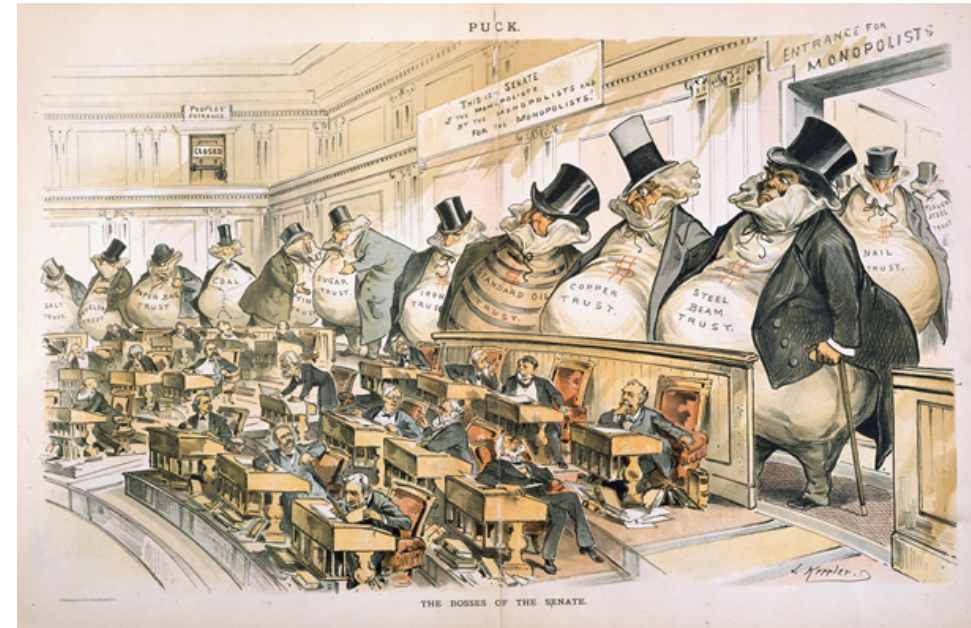
J P Morgan - Banking



# The Gilded Age

During this period in the United States the dominant position within industry and commerce was occupied by a very small number of players who were moving far faster than the regulatory measures of the day.

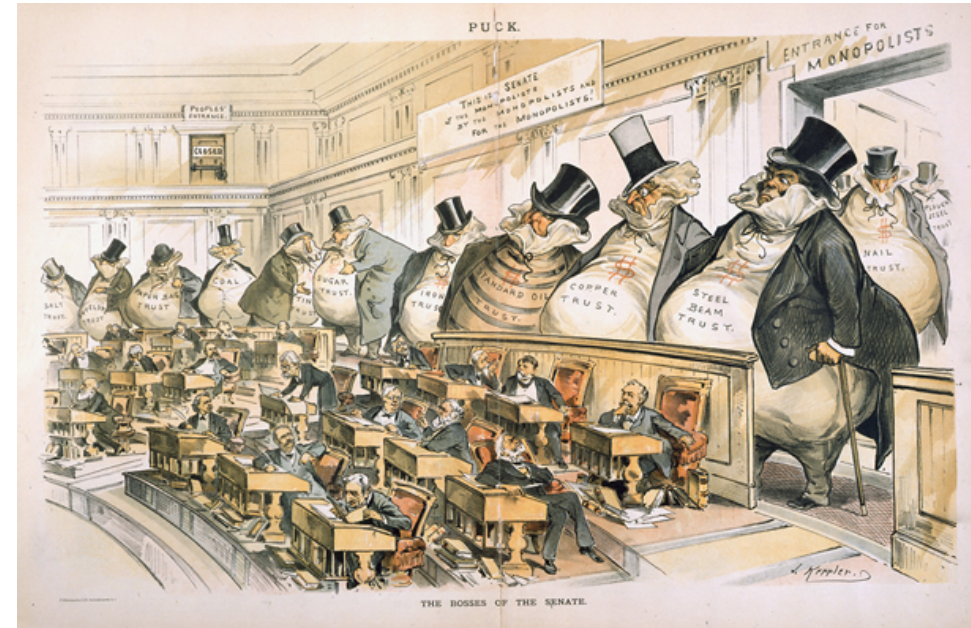
The resulting monopolies took the US decades to dismember, and even today many of these gilded age companies remain dominant in their field












# The Internet's Gilded Age

At some point in the past decade or so the dominant position across the entire Internet has been occupied by a very small number of players who are moving far faster than the regulatory measures that were intended to curb the worst excesses of market dominance by a small clique of actors.



# Who's Gilding?

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# The Internet's Gilded Age

These actors have enough market influence to set their own rules of engagement with:

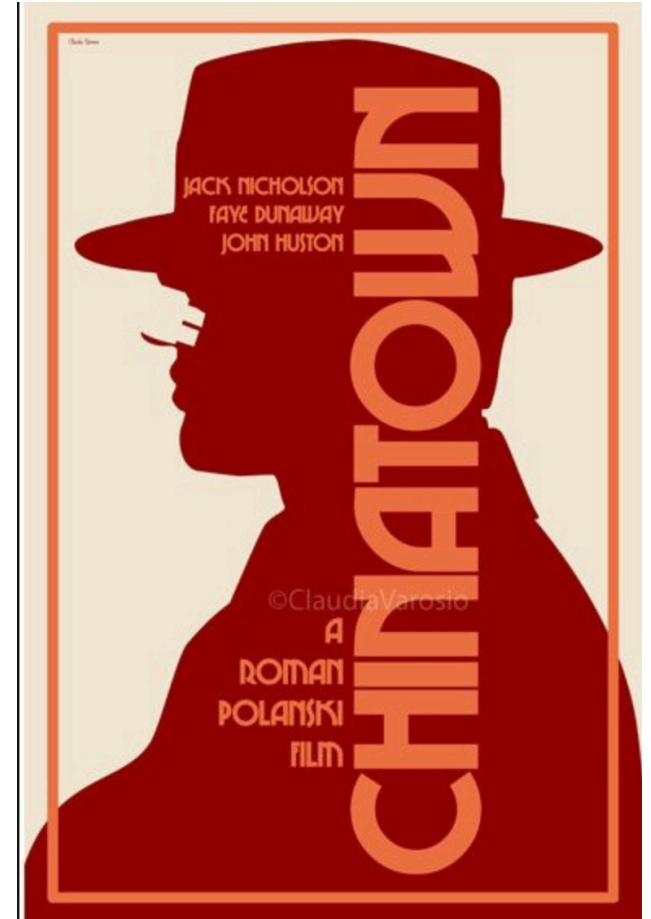
- Users,
- Each other,
- Third party suppliers,
- Regulators and Governments

By taking a leading position with these emergent technologies, these players are able to amass vast fortunes, with little in the way of accountability to a broader common public good

# The Internet's Future

Gittes: How much are you worth?  
Cross: I've no idea. How much do you want?  
Gittes: I just want to know what you're worth. Over ten million?  
Cross: Oh my, yes!  
Gittes: Why are you doing it? How much better can you eat? What can you buy that you can't already afford?  
Cross: The future, Mr. Gittes - the future!

Chinatown (1974)



# Exactly where are we?

- We started this journey building a telephone network for computers to communicate between each other
- But now one-way content distribution lies at the core of today's Internet
- This content distribution role is an enterprise service framework rather than a public carriage service
- The internal parts of the carriage network are now being privatized and removed from public regulatory scrutiny
- What's left is just the last mile



# Last Mile Futures

- Can independent last mile access networks survive as independent entities in this environment?
  - Like the experience with transit markets will they fall victim to the pressure from the cashed up service provider sector and their CDNs?
  - If access networks come to rely on imposing tolls on content providers, then at what point will the folk paying the these tolls assert proprietorial control over this last mile asset?
- Is this something that markets will resolve, or will we see this as a more insidious form of market failure?

Fin!