The Death of Transit and Beyond

Dave Crosby, https://www.flickr.com/photos/wikidave/4044498586/

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This presentation is not about any specific network details

Or specific plans

Or particular services

Or any particular technology

Or anything like that

It's about architecture

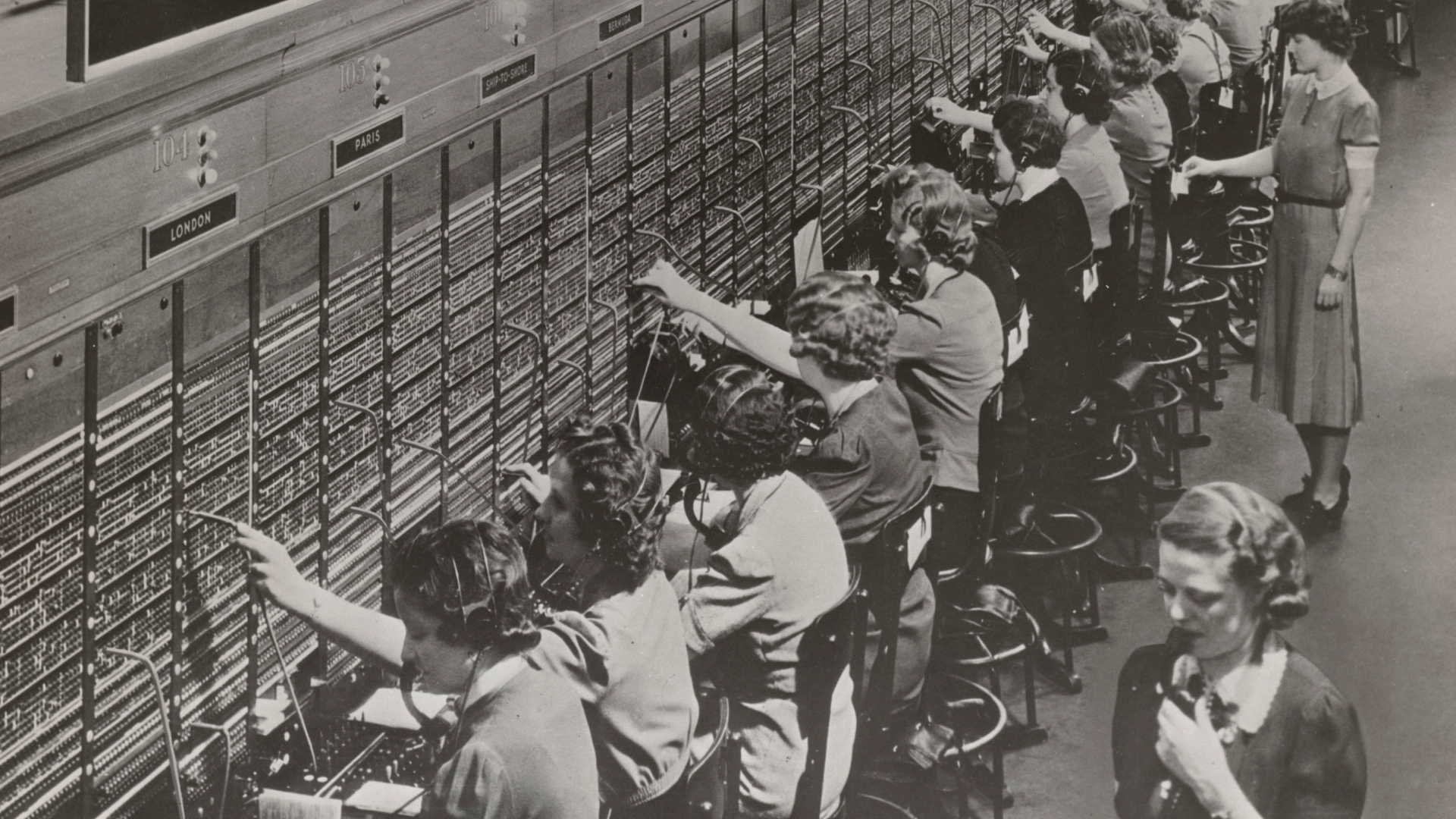
And, in particular, about the evolution of network architecture in the Internet

It's about architecture

And some thoughts about the implications of these changes in terms of public policies for the Internet

Our Heritage

The Telephone Network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LONDON
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Our Heritage

The Telephone Network:

The major technology achievement of the twentieth century

- Connected handsets to handsets
- The network was intentionally transparent
- Real time virtual circuit support between connected edge devices
- Network-centric architecture with minimal functionality in the edge devices

Computer Networks

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

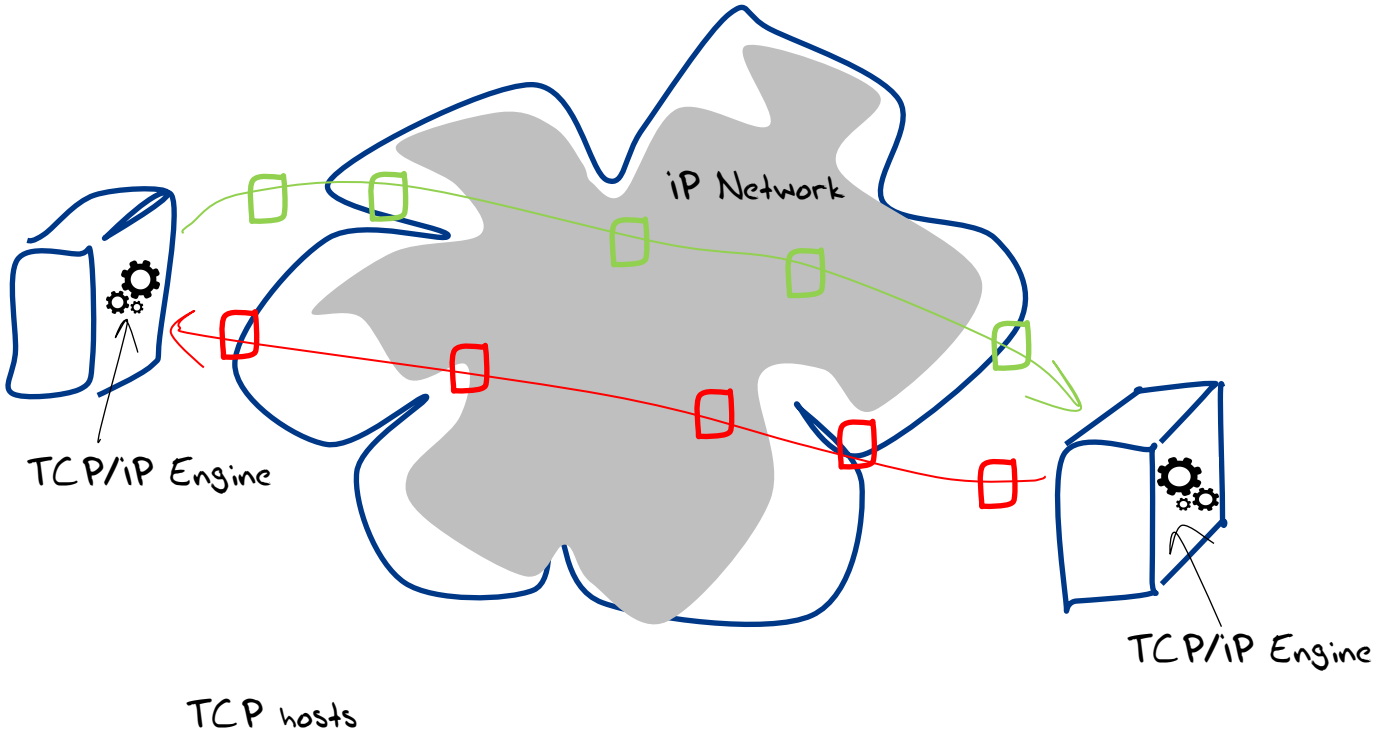
Internet Architecture (c1980's)

"End-to-End" design:

- Connected computer to computer
- The network switching function was stateless

  No virtual circuits, no dynamic state for packets to follow
- Single network-wide addressing model
- Single network-wide routing model
- Simple datagram unreliable datagram delivery in each packet switching element
- hop-by-hop destination-address-based packet forwarding paradigm

Internet Architecture (c1980's)



The Result was Revolutionary!

By stripping out network-centric virtual circuit states and removing time synchronicity the resultant carriage network was minimal in design and functionality

More complex functions, such as flow control, jitter stability, loss mitigation and reliability, were pushed out to the attached devices on the edge

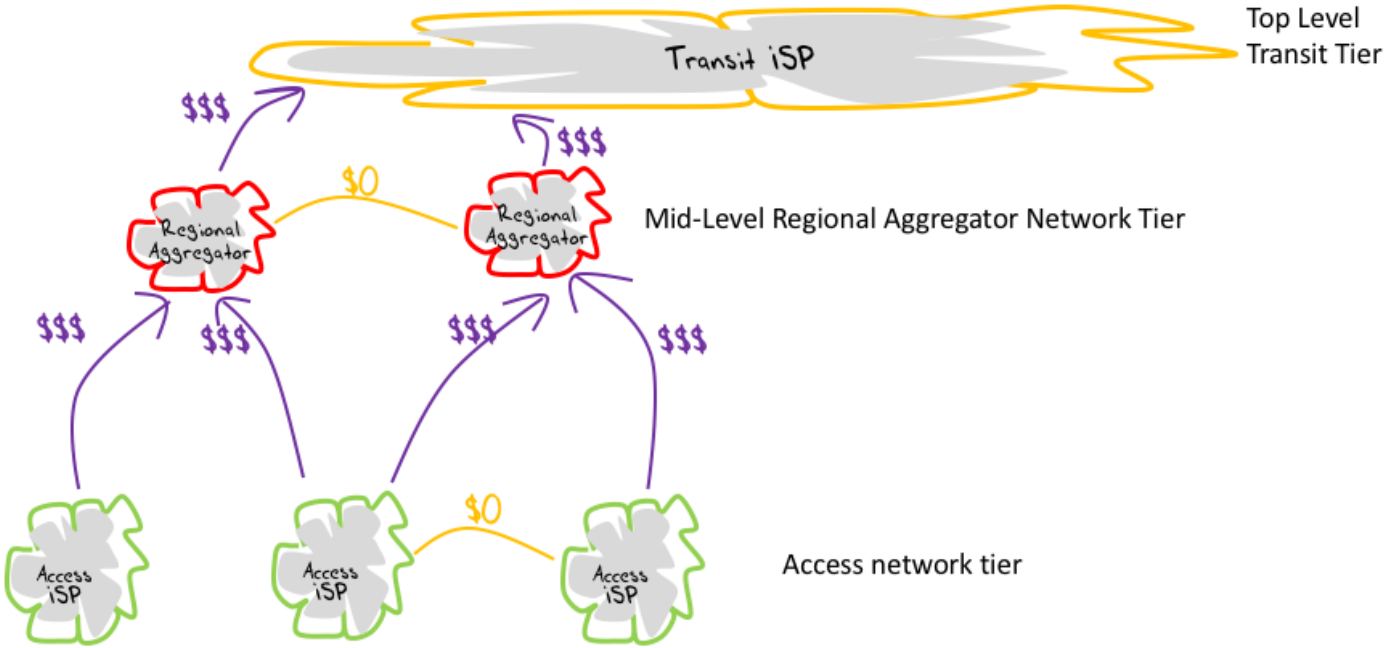
(in)Equality of Networks

In the regulated world of national telephone operators every telephone network was “equal”

But we rapidly started differentiating between Internet networks -- Internet networks were not all the same.

We started differentiating on roles and services and differentiating by the flow of revenues between networks

Network Role Segmentation



Enter Content

Breaking the edge into **clients** and **servers**

- Access networks service the needs “clients”
- Clients are not directly reachable by other clients
- Clients connect to services

The role of the network here is to carry clients to the service access point

- The assumption here is that there are many more clients than service points

Content vs Carriage

Who pays whom?

- The only reason why access networks have clients is because there are content services that clients want to access
  - Therefore carriage should pay for content

- There is no “end-to-end” financial settlement model in the Internet – both “ends” pay for access and network providers settle between themselves. To a carriage network, content is just another client
  - Content should pay for carriage, just like any other client

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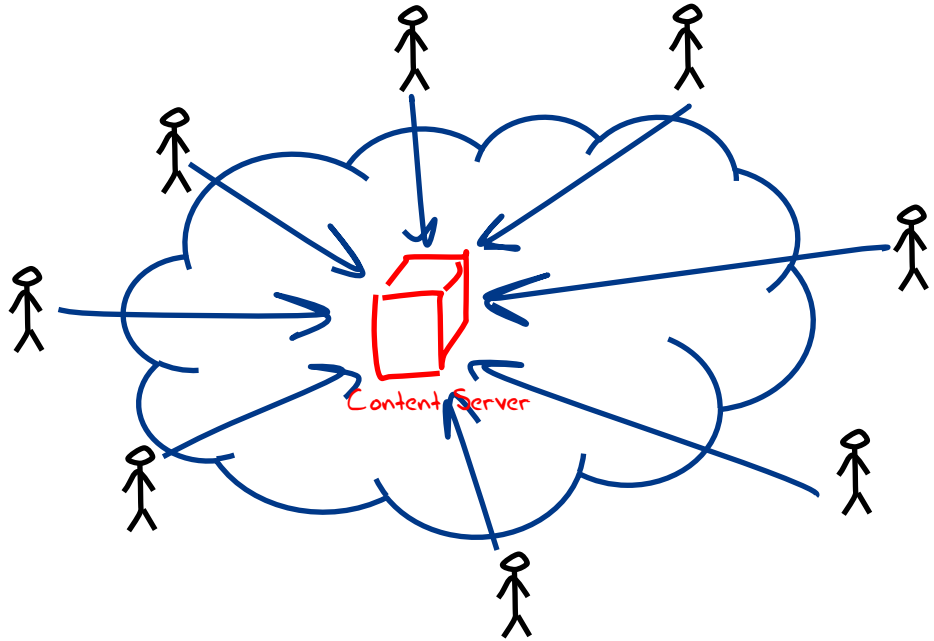
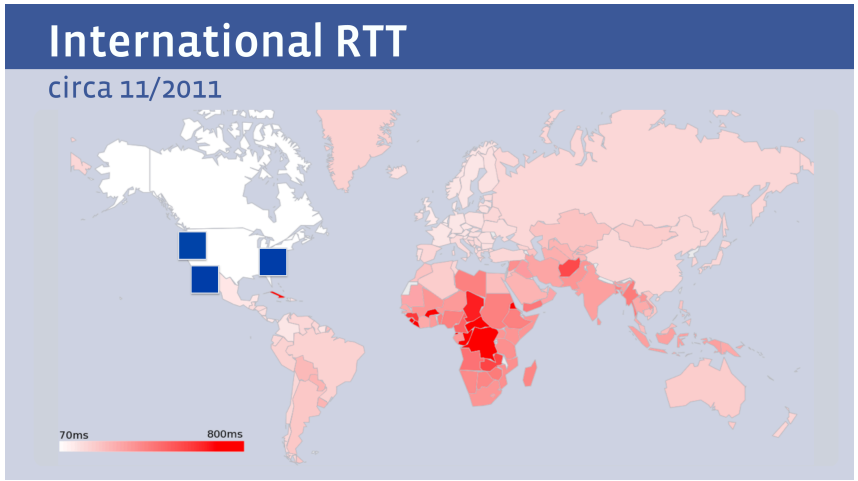
The content folk resolved this fight by going "over the top" and created relationships directly with end users

Content Server



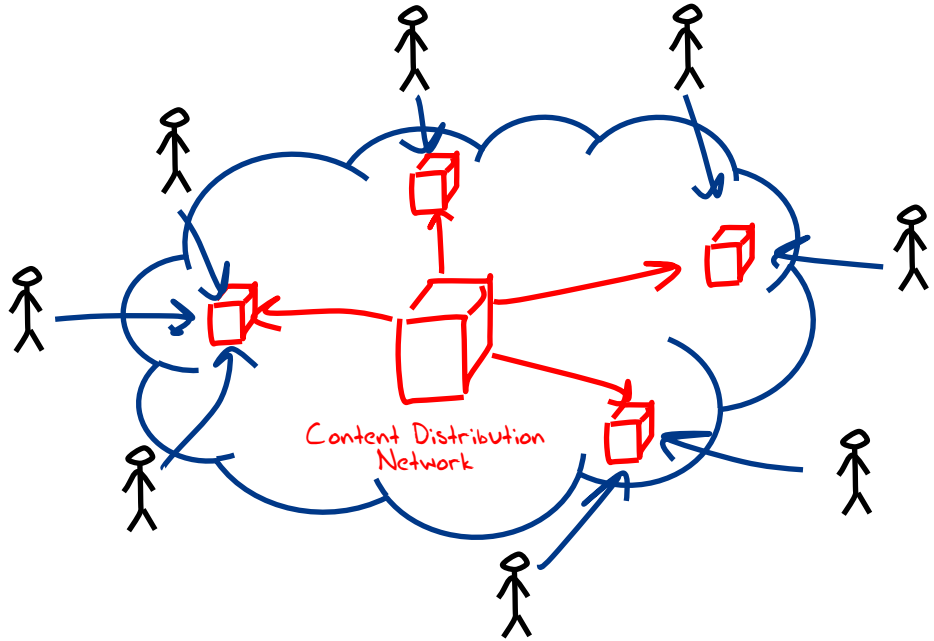
The Tyranny of Distance

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



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!

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

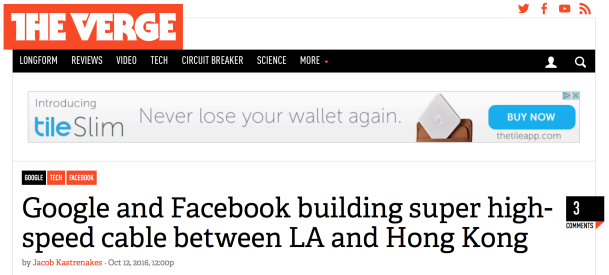
This shift has some profound implications for the Internet

Who's building now?

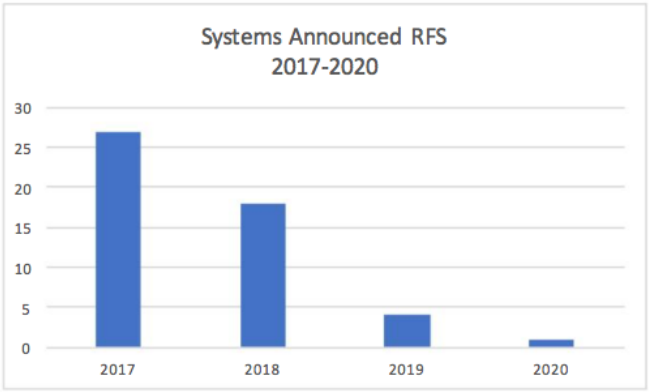
Almost all new submarine international cable projects are heavily underwritten by content providers, not carriers

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

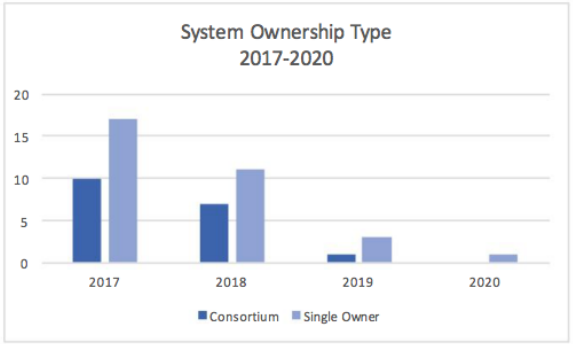


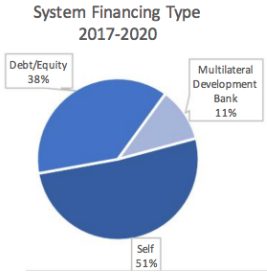
Submarine Cables



Fewer cables being built

And those that are being built are now single owner cables





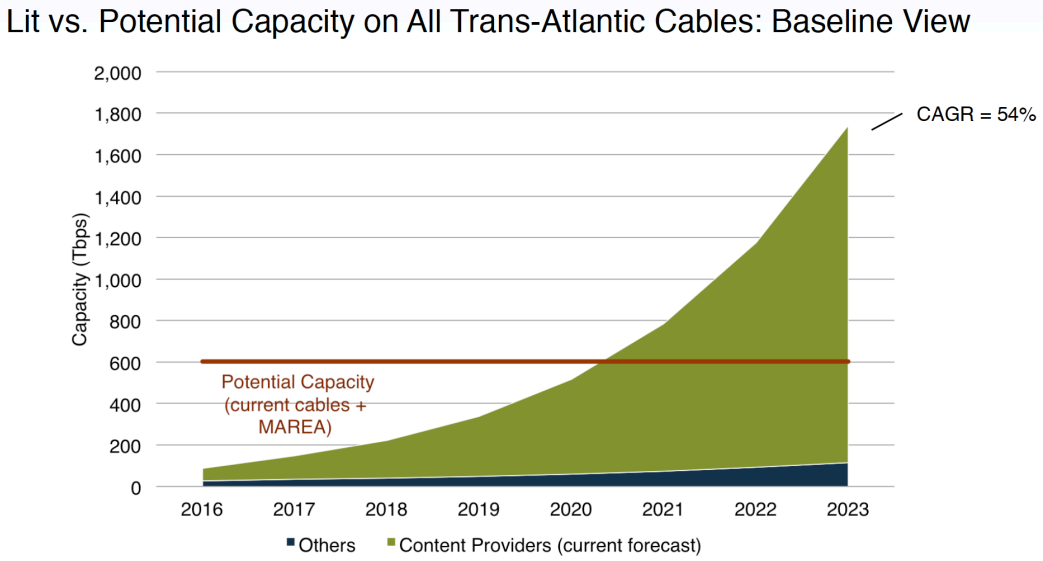
And the majority are now self-funded

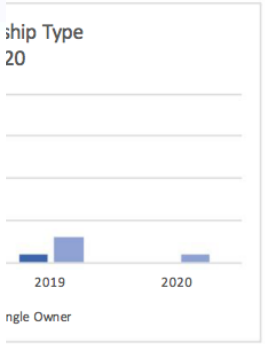
Tim Stronge, Telegeography, Jan 2017

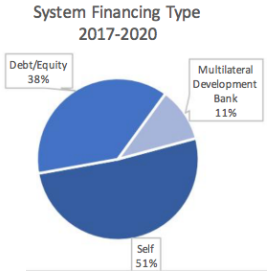
Submarine Cables

being built are now

Growth depends on content







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Tim Stronge, Telegeography, Sept 2017

Today's Internet Architecture

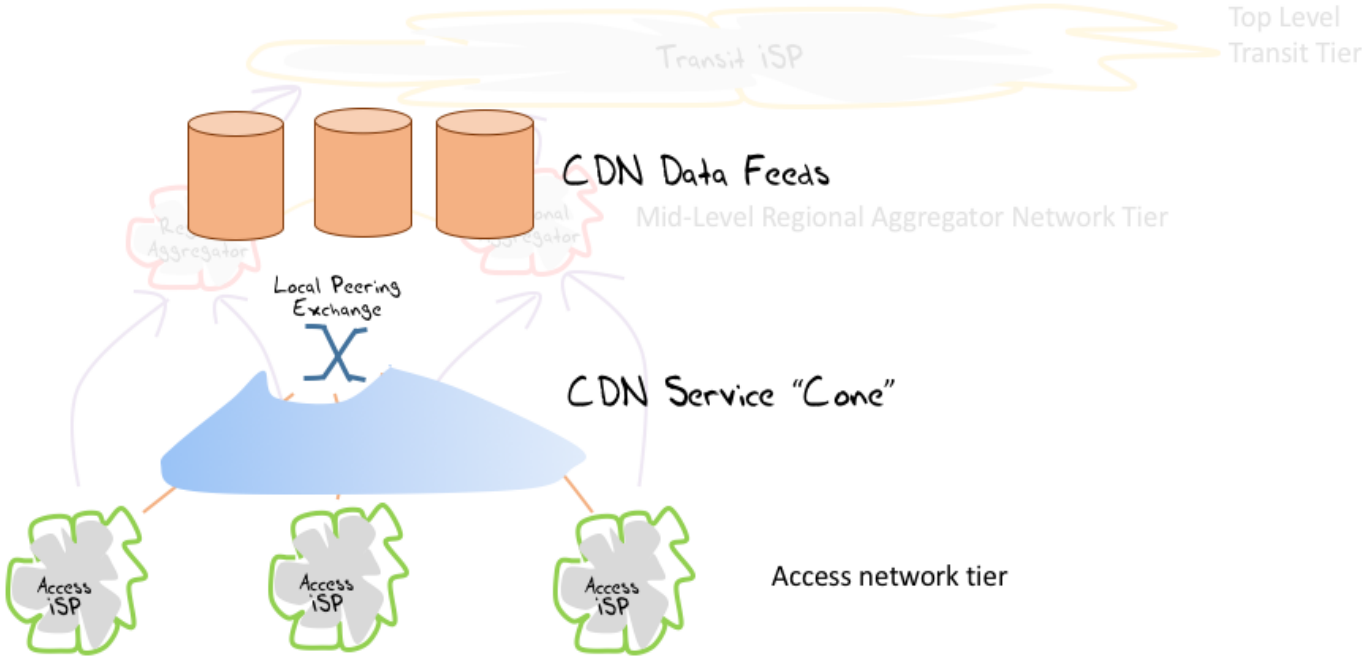
We've split the network into clients and servers

- 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



Transit?

- 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…

Then why do we still need Transit Service providers?

Transit?

- Once the CDN caches sit “inside” the Edge NAT of the Access ISP then the entire wide area network becomes a marginal activity compared to the value of the content feeds!

Internet Names and Addresses?

If the Internet is (or maybe soon will be) a collection of discrete CDN service ‘cones’ then why do we expect end users to pay for the maintenance of:

- A global address plan?
- A global name system?
- A single global network?

It's not just the Death of Transit

It’s the re-purposing of the entire network

- Service provisioning sits within cloud providers and distributed data centres
- Edge computers are now acting as televisions into the clouded world of data
- The distinction between personal and public data realms is disappearing into the realm of corporately owned private data empires

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

Policy?

If CDN feeder networks are private networks, and there is little residual public carriage other than last mile access networks, then what do we really mean by “public communications policy”?

In the regulatory world ‘content’ is ***commerce***, not ***carriage***!

Policy?

In today's Internet what do we mean in a policy sense by concepts such as:

"***universal service obligation***"

"***network neutrality***"

"***rights of access***" or even

"***market dominance***"

when we are talking about diverse CDNs as the dominant actors in the Internet?

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 five 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.

https://blog.cloudflare.com/why-we-terminated-daily-stormer/ August 2017

Competition or Cartel?

With a small number of truly massive enterprises at the heart of the area of digital content and service is this still a space that is shaped by competitive pressures?

Or do these dominant incumbents get to set their own terms of engagement with each other, with users, and even with the public sector?

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As concerning as this might sound, it's not a novel situation!

We've been here before…

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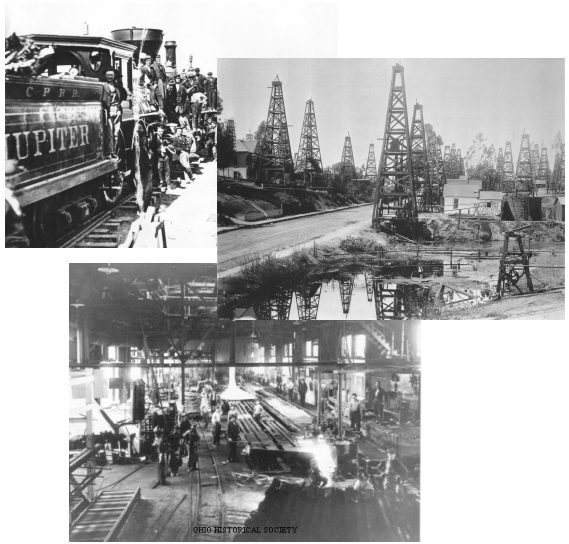
We've been here before…

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

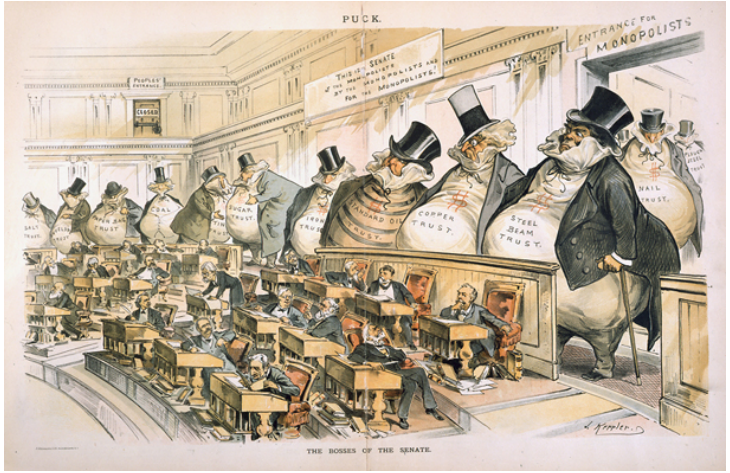
Andrew Carnegie - US Steel
John Rockfeller - Standard Oil
Theodore Vail - AT&T
George Westinghouse – Rail Brakes
Thomas Edison – General Electric
J P Morgan - Banking



The Gilded Age

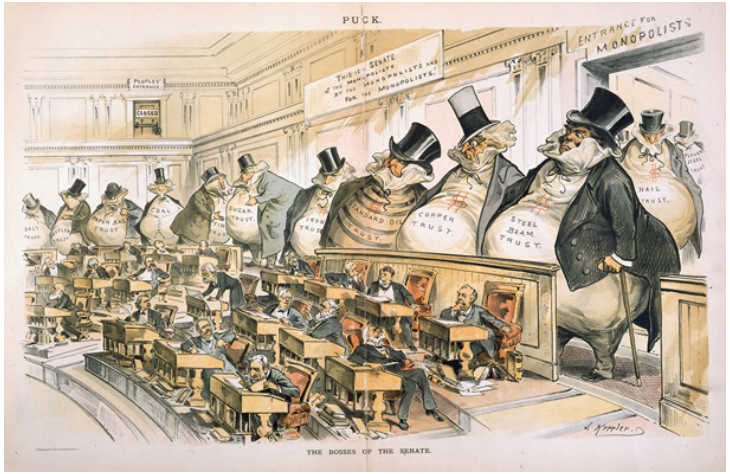
During this period in the United States the dominant position within industry and commerce was occupied by a very small number of players who were moving far faster than the regulatory measures of the day.

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.



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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

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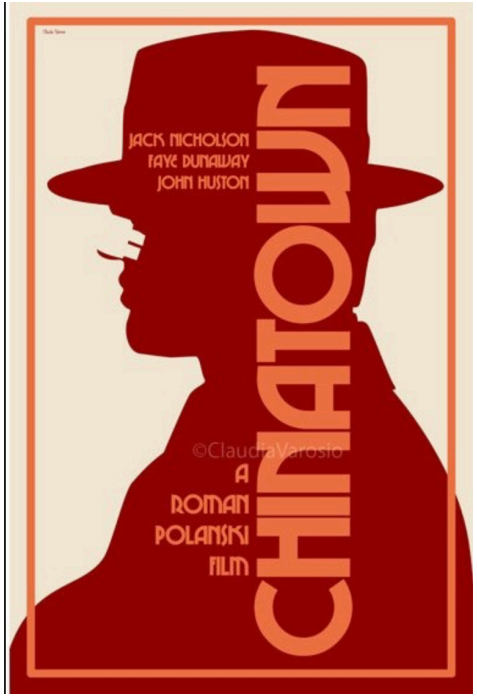
The Internet's Future

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)



What is this all about?

This is no longer just a conversation about incremental changes in carriage and communications within the Internet.

For me, the essential topic of this conversation is how we can strike a sustainable balance between an energetic private sector that has rapidly amassed overarching control of the digital service and content space, and the needs of the larger society in which we all would like some equity of opportunity to thrive and benefit from the outcomes of this new digital age.

Thanks!