

# The Rise of the Internet

Geoff Huston

# The Rise and Fall of the Internet

Geoff Huston

# It was thirty years ago today...

On Sunday 23<sup>rd</sup> June 1989 we commissioned a permanent IP link between the the University of Melbourne and the University of Hawaii, using a 56Kbps satellite link

The Internet had arrived in Australia

And almost nobody noticed

# Over these thirty years...

We seen the inexorable and rise of the Internet weaving its way into the very fabric of our lives:

- From FTP to WAIS to the Web to apps
- From data to search to streaming
- From mainframes, to workstations to desktops to mobile devices
- From bits to megabits to gigabits

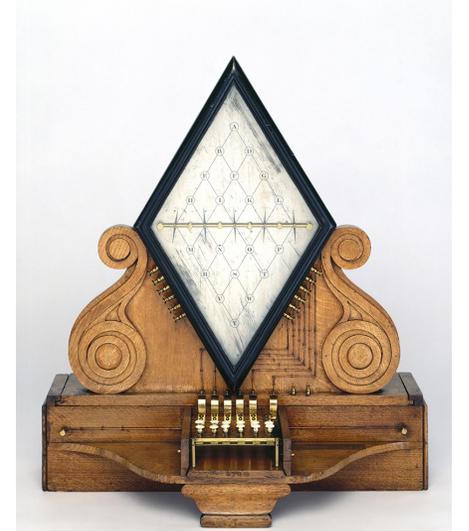
And we've seen optimism and hope turn to disillusion and distrust

All in just thirty years

How did we get here?

# The Victorian Internet - the Telegraph

- In 1800 **Alessandro Volta** invented the battery that allowed electricity to be used in a controlled manner
- In 1820 **Hans Christian Oersted** demonstrated the connection between electric current and magnetism
- In the 1830's in the UK **William Cooke** and **Charles Wheatstone** used a system of five pointers to send text - the first use was railway signalling in the UK
- In the 1840's **Samuel Morse** developed a simpler system using a keypad to complete a circuit.
- By 1861 telegraph lines spanned the US
- By 1870 an undersea cables spanned the Atlantic



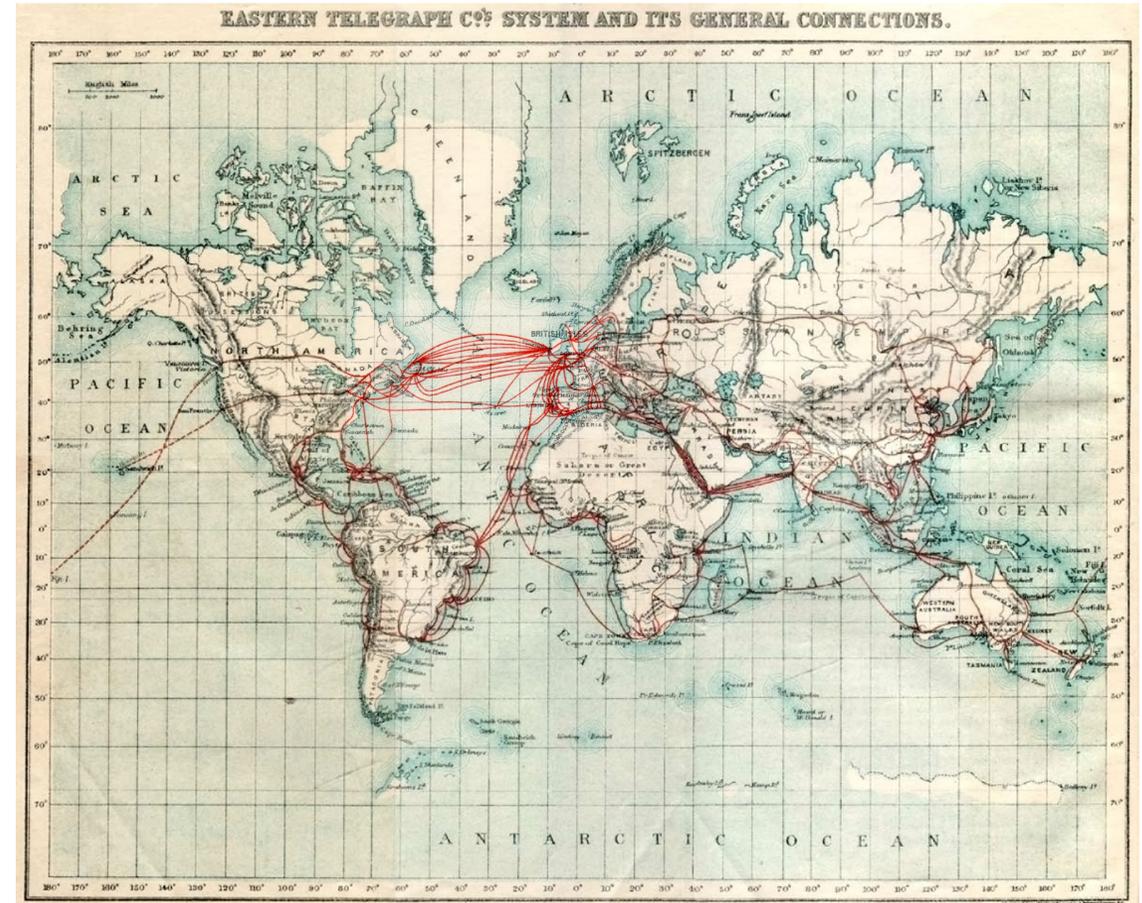
# The Great Telegraph Boom

The period from the 1850's to the 1900 saw major investments in national and international telegraph cable systems

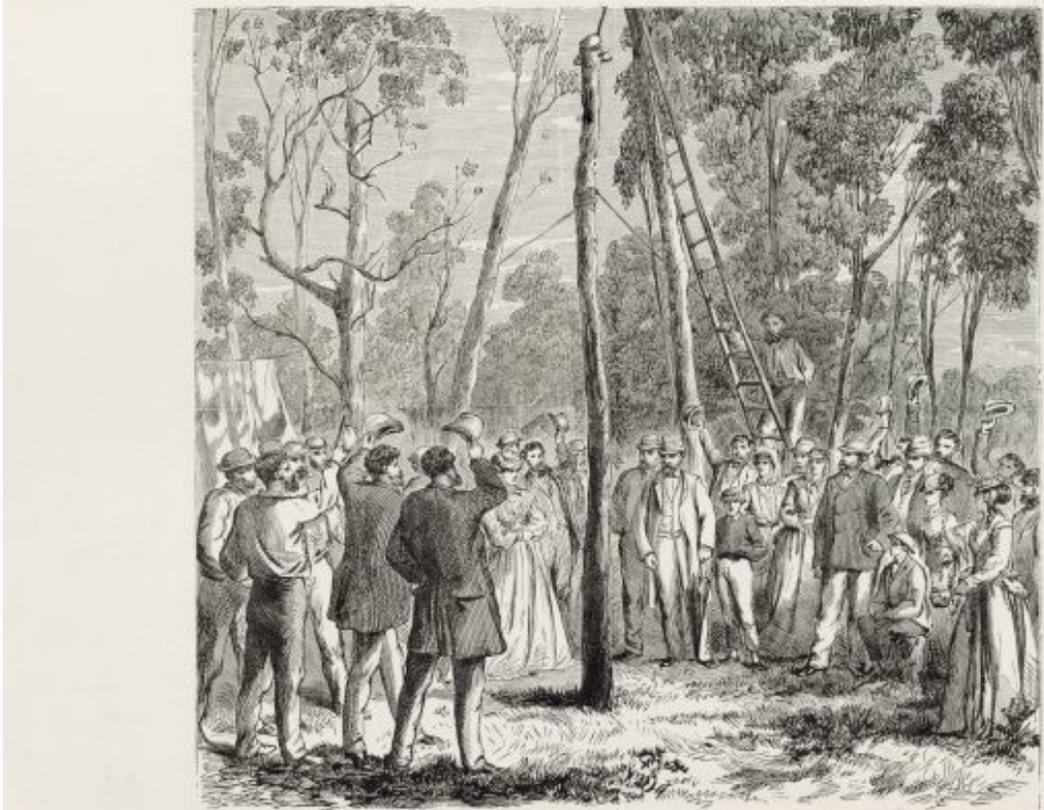
Most of the initial international investment activity was from the UK – by 1882 British companies owned and operated two thirds of the world's telegraph cables.

In the US newspapers expanded 5-fold in the period 1840 – 1860 as 50,000 miles of telegraph cable were installed

When combined with the railway this became an effective means for the projection of power and control – enterprises saw opportunities in extensive reach, creating private monopolies to complement the older state-sponsored monopolies



# Australia: The Overland Telegraph

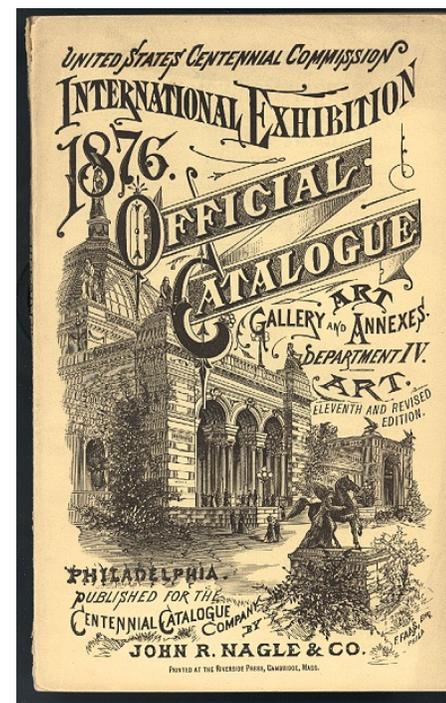


*Planting the first pole on the Overland Telegraph Line to Carpentaria*

- Spanning 3,200kmm, and completed in 1872, it was the greatest engineering feat of 19<sup>th</sup> century Australia
- The first message sent directly from London to Adelaide occurred on 22 October 1872.
- A thirty word telegram:
  - cost the equivalent of 3 weeks working man's wages
  - Had a 30% error rate due to transcription errors at repeater stations
  - Could not use compression or encryption
- Even so, the impact in Australia was transformational

# The Next Wave: the Telephone

- First shown to the world at the 1876 World Exposition at Philadelphia, its invention triggered a struggle to the death between Western Union's telegraph and Bell's telephone
- Although Western Union never fully appreciated that the telephone was an existential threat to the telegraph until it was simply too late.
- Thousands of regional telephone companies appeared all over the world in the following years



# The Formation of the Telephone Cartel

- Theodore Vail - President of American Telephone and Telegraph (twice!) - oversaw the construction of a national monopoly masquerading as a public utility through the Kingsbury Commitment with US Congress in 1913
- AT&T divested itself of Western Union Telegraph and in return created a substantial private monopoly under the catch cry of “one policy, one system and one universal service”
- Other countries emulated this transformation from competition to national monopoly in just a few years, using existing telegraph monopoly to subsume telephone operators into public utility structures



# And then the telephone story stopped

- The telephone network was constructed to match the human voice
  - And that's all it did
- Almost nothing changed: Telephone innovations were deployed early on in the story of telephone
  - The Storer Automatic Exchange was invented in 1891
  - The Fax dates back to 1843
  - And there was the Speaking Clock of course
  - And not much else!
- While telephone companies monopolized technology, they did so in a defensive stance
- Meanwhile, the phone companies' research labs invented the transistor, switching, DACs, packet networking, ciphers, radio astronomy, television, solar cells, C, Unix, microprocessors

**Meanwhile...**

# Computer Networks

ON  
OFF

HALT  
INH

W.D.T.

AUTO  
RSTRT

MEMORY  
PRCTCT

13

14

15

16

17

18

19

20

21

22

23

24

IMP STATUS PANEL

## INTERFACE MESSAGE PROCESSOR

Developed for  
the Advanced Research Projects Agency  
by Bolt Beranek and Newman Inc.



T1

1

T2

2

T3

3

T4

4

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A

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PI

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ML

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EA

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DP

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MP

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15

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RESET

ON

OFF

POWER

PFI

PFH

1

2

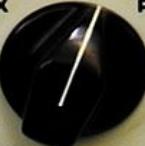
3

4

SENSE

X

OP



REGISTER

MASTER

CLEAR

STORE

FETCH

P

P+1

MA

RUN

S1

START

OPERATION

# Computer Networks

The original concept for computer networks was 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

There is a story about the protocol wars of the late 1980's but that's a story for another day – let's just fly over that with the observation that IP won!

# Internet Architecture

Inverted network design:

- The network switching function was stateless
  - No virtual circuits, no dynamic state for packets to follow
- Single network-wide addressing and routing model
- Simple datagram unreliable datagram delivery paradigm
- **All functionality was removed from the network and relocated to the end device**

# The Result was Revolutionary!

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

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

But it was more than just a technology shift

It was a revolution!

# The Stages of Revolution

- Disruption of the Ancien Regime



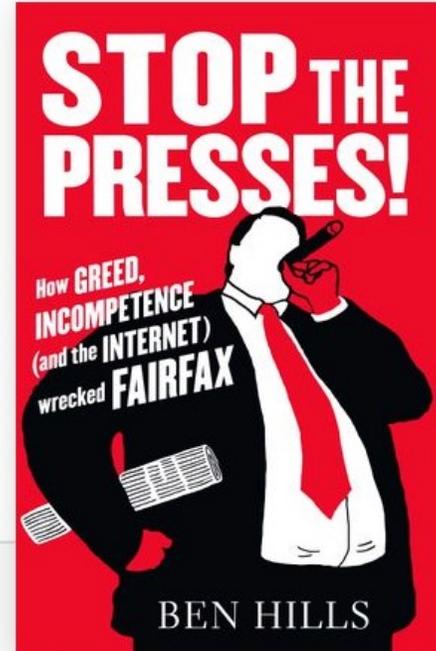
# Demise of the Old Order

Maybe only the incumbents saw the existential threats in the early days, but the threats were very real

- The waning of free-to-air broadcast television
- The decline of the press
- Reshaping retail channels

**BARRON'S**

## Amazon Is Catching Up With Walmart and Could Be the King of All Retail in Just a Few Years



## Can Media Giants Survive the Decline of TV?

By [Nicholas L. Johnson](#) on February 26, 2018



After years of predictions on the decline of TV, the day may finally be here.

According to a [report](#) from Bloomberg this week, TV advertising sales fell 7.8 percent to \$61.8 billion last year. Per the report, this is the steepest drop outside of a recession in more than 20 years. Even ad sales at cable networks slowed, for the first time in nearly a decade.

The more worrying news? Television ad sales are declining even as global advertising spending grows.

# The Stages of Revolution

- Disruption of the Ancien Regime
- The Chaos of Revolution



# The New Digital Economy

- The Internet enabled a shift in the way goods and services were traded, enabling the single person global entrepreneur
- Massive reach across global markets no longer requires huge resources
  - In 1997 Telstra served ~5M customers with 77,000 employees
  - Facebook has 2.3B users and 30,000 employees



Massive Change, Vancouver



oh fuck what now

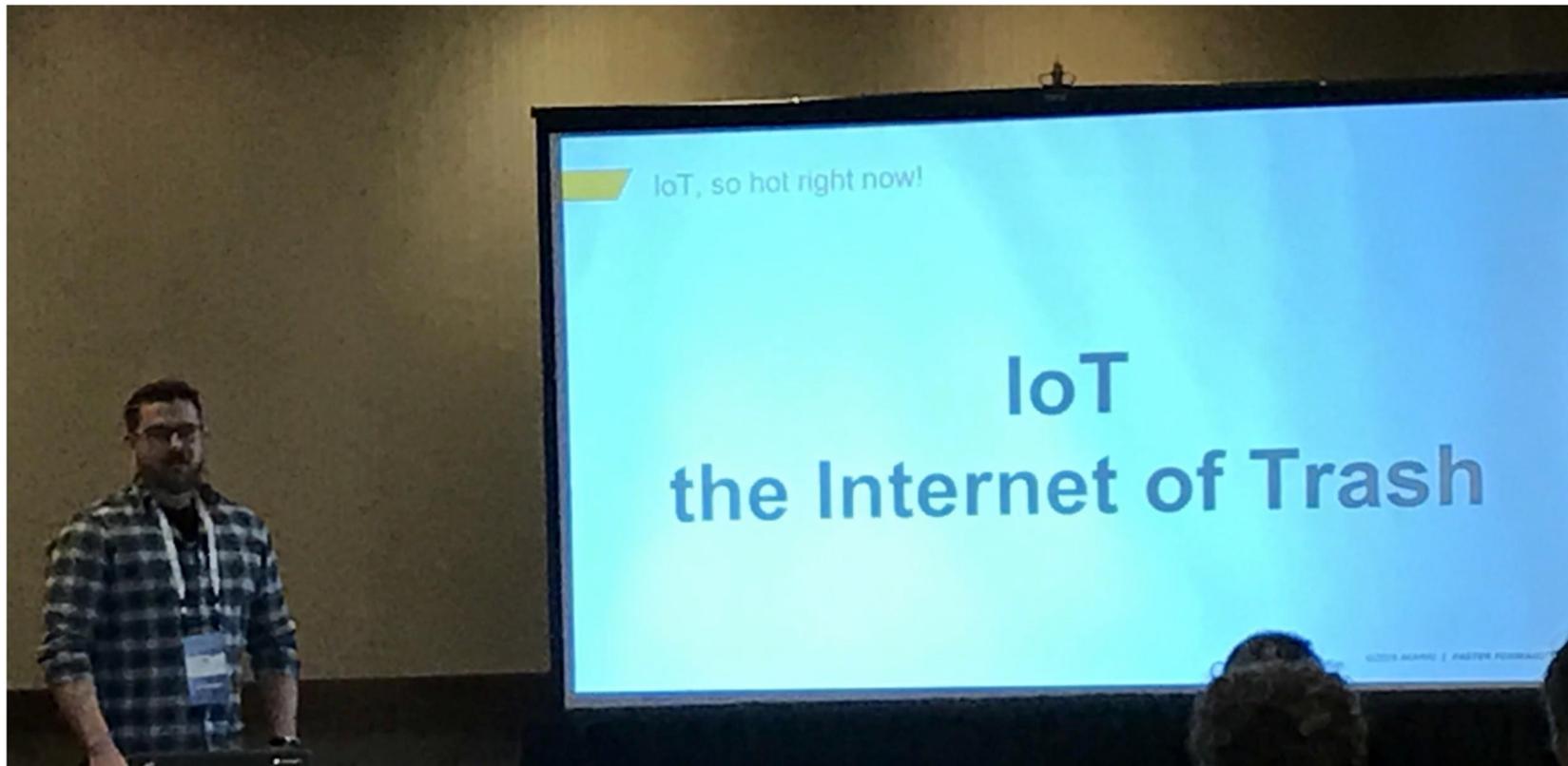
# The Darker Side of Digital Chaos

- Social Networking turns sour with allegations of stolen elections
- DDOS attack turns on terabit intensity
- Hacking turns to organised crime
- Cyber warfare turns real
  
- The Internet's basic security framework is ineffective against well resourced nation state attackers practising sophisticated digital disruption attacks
- The Internet is now a toxic wasteland that glows in the dark!

**It will only get worse**

The S in IoT is for Security.

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# The Stages of Revolution

- Disruption of the Ancien Regime
- The Chaos of Revolution
- Consolidation through Tyranny



# The Rise of 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 providers 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

# 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

- *The content folk resolved this fight by going "over the top" and created relationships directly with end users*
- *content* model in the Internet – both network providers settle between themselves. To a content provider, content is just another client

- Content should pay for carriage, just like any other client

# Content vs Carriage

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

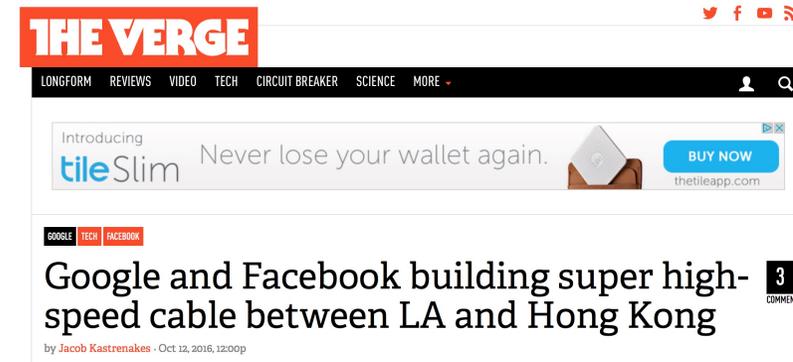
This shift has some profound implications for the Internet

# 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



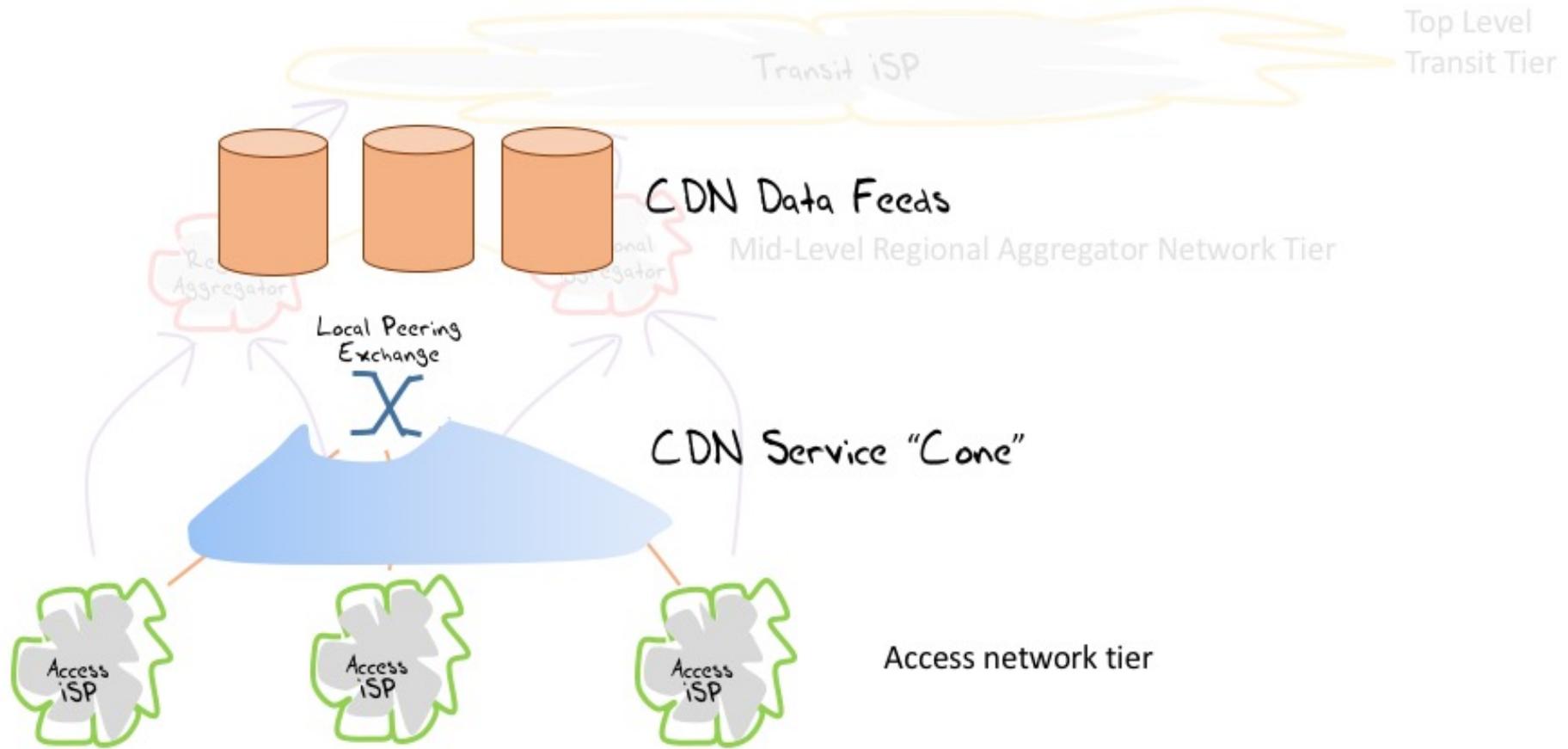
# Today's Internet Architecture

We've split the network into **clients** and **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



# Find the Network!

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

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 the Internet we thought it was meant to be!

## It's something else completely

- 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
- Most of the data passed off the network is streaming video

# 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 oversight

BBC

future**now**

The global internet is disintegrating.  
What comes next?

# The Stages of Revolution

- Disruption of the Ancien Regime



- The Chaos of Revolution



- Consolidation



- Incumbency of the New Regime



# 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 a small set of content providers as the dominant actors in the Internet?

# The Large and the Largest

	Company	Market Cap (B)
	Microsoft	904
	Apple	895
	Amazon	874
	Alphabet	818
	Berkshire Hathaway	493
	Facebook	475
	Alibaba	472
	Tencent	440
	Johnson & Johnson	373
	ExxonMobil	342

The world's 10 largest publicly traded companies, as ranked by their market capitalization, Q1, 2019

# 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.

# Consolidation?

Alphabet is primarily  
an advertising  
company that  
dabbles in blue-sky  
technology projects.

**N**ever in the history of the world has a single company had so much control over what people know and think. Yet Washington has been slow to recognize that Google's power is a problem, much less embrace the obvious solution: breaking the company up.

Google accounts for about 90 percent of all Internet searches; by any honest assessment, it holds a monopoly at the very gateway to information in the modern world. From there, the company's power radiates outward, dominating everything from maps to smartphone operating systems to video distribution — vacuuming up huge quantities of highly specific data about users along the way.

Boston Globe , June 14 2018

# 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?

# Competition or Cartel?

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

Or do these enterprises set their own terms of engagement with users, and even with the public?

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

# 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

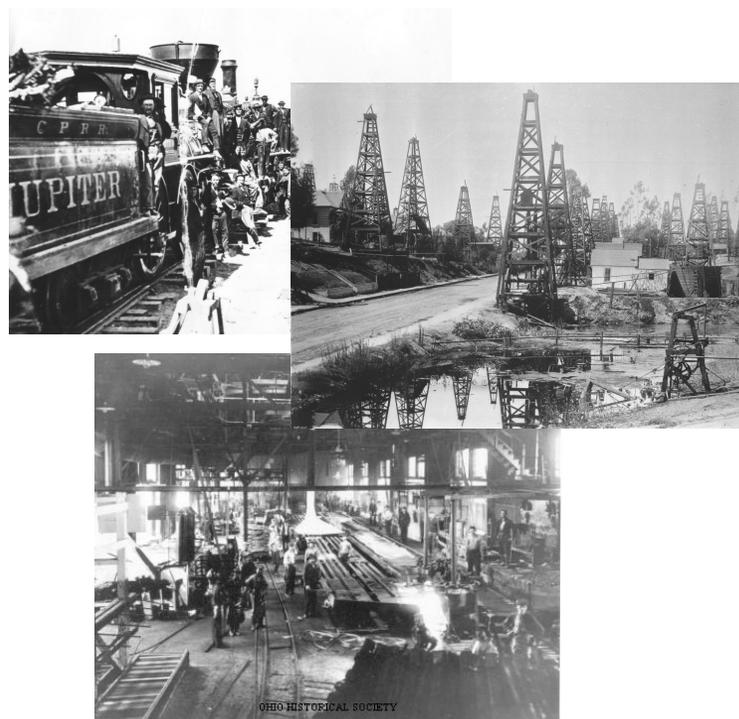
John Rockefeller - Standard Oil

Theodore Vail - AT&T

George Westinghouse – Rail Brakes

Thomas Edison – General Electric

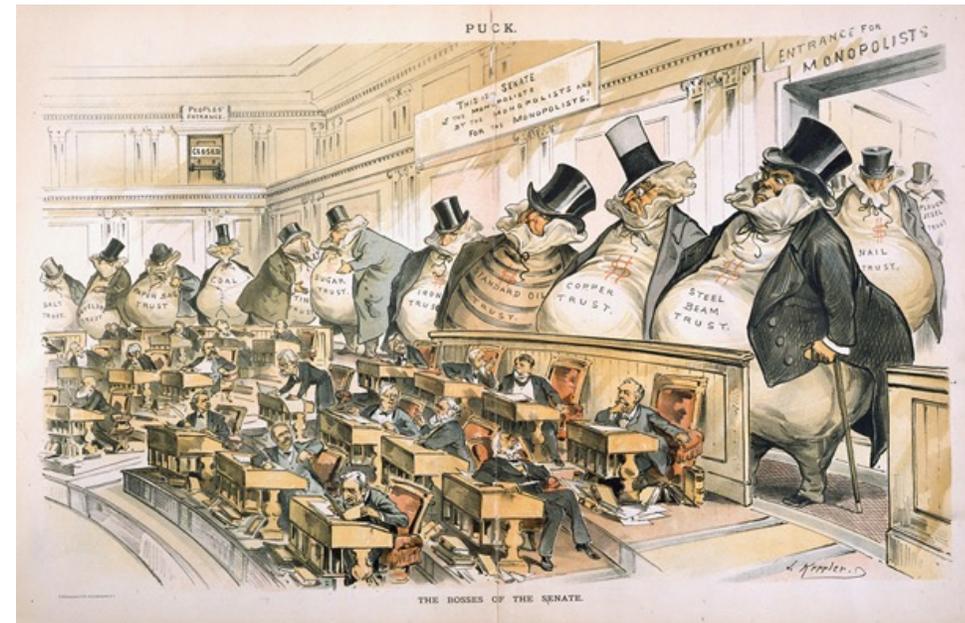
J P Morgan - Banking



# The Gilded Age

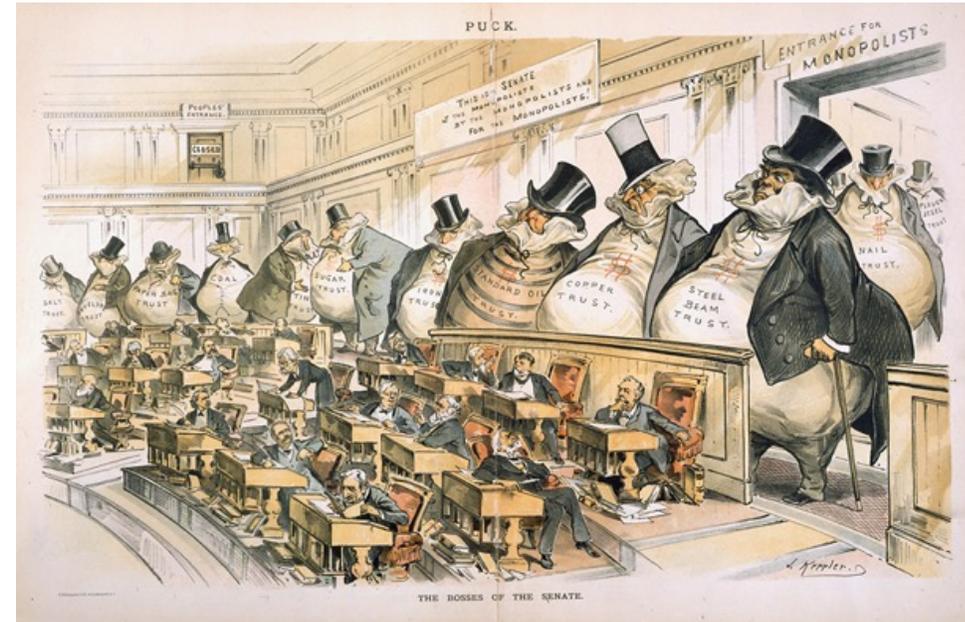
During this period in the United States the dominant position within industry and commerce was occupied by a very small number of players who were moving far faster than the regulatory measures of the day.

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.



## Tech Giants Amass a Lobbying Army for an Epic Washington Battle



Catlin O'Neill, right, listening to Facebook's chief executive, Mark Zuckerberg, testify before a House committee on the protection of user data last year. Ms. O'Neill is now director of United States public policy for Facebook after serving as Speaker Nancy Pelosi's chief of staff. Tom Williams/CQ Roll Call, via Getty Images

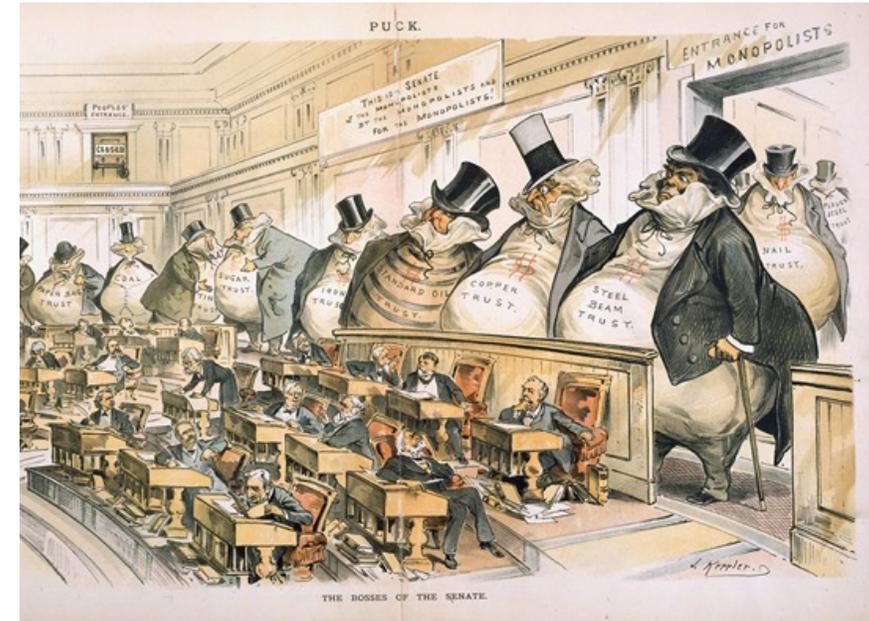
By Cecilia Kang and Kenneth P. Vogel

June 5, 2019



WASHINGTON — Faced with the growing possibility of antitrust actions and legislation to curb their power, four of the biggest technology companies are amassing an army of lobbyists as they prepare for what could be an epic fight over their futures.

# .1ded Age



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# Tech Giants Amass a Lobbying Army for an Epic Washington Battle

# .lded Age

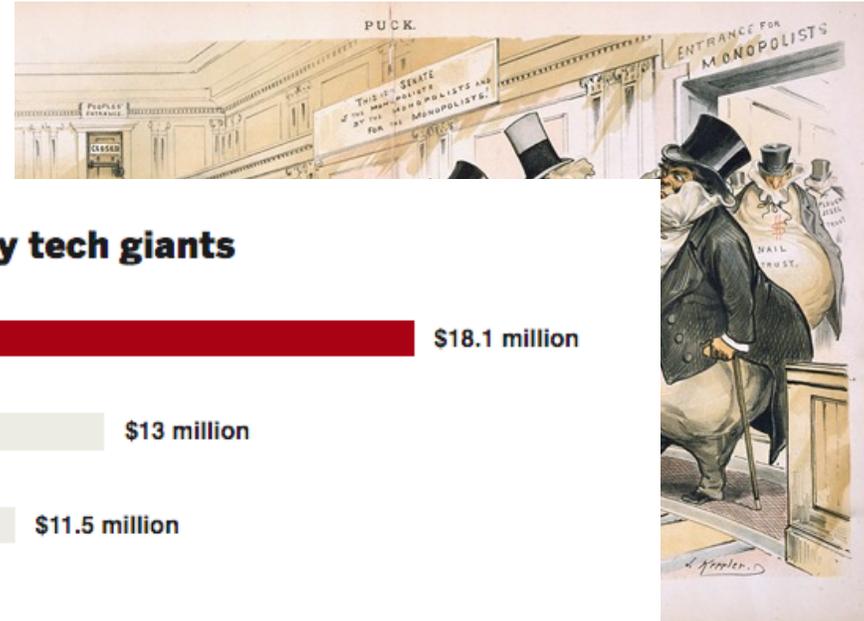


Catlin O'Neill, right, listening to committee on the protection of t policy for Facebook after servin Tom Williams/CQ Roll Call, via Gett

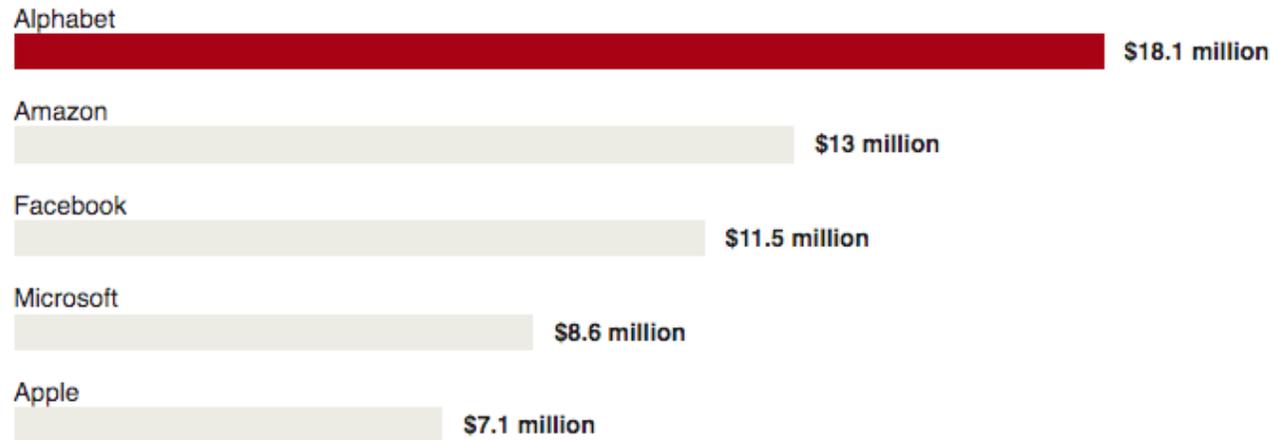
By Cecilia Kang and K

June 5, 2019

WASHINGTON - **SOURCE: Open Secrets**  
actions and legislaon to curb their power, four of the biggest technology companies are amassing an army of lobbyists as they prepare for what could be an epic fight over their futures.



## Total 2017 federal lobbying spends by tech giants



# The Internet's Gilded Age

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

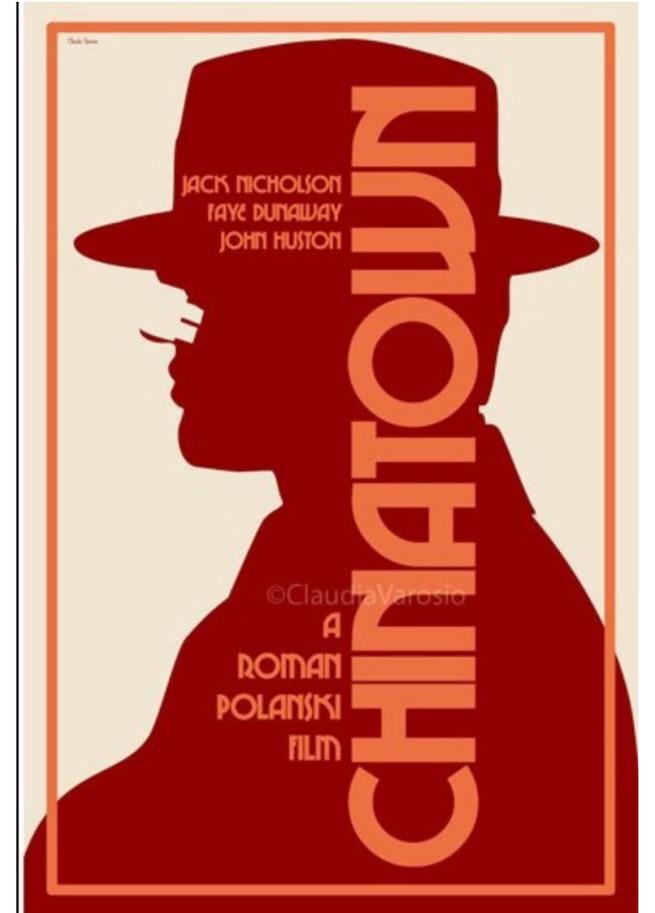
- Users,
- Each other,
- Third party suppliers,
- Regulators and Governments

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)



# 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.

And we should admit the possibility that we are too late to have this conversation in any case!

# The Economist

JANUARY 20TH–26TH 2018

The next space race

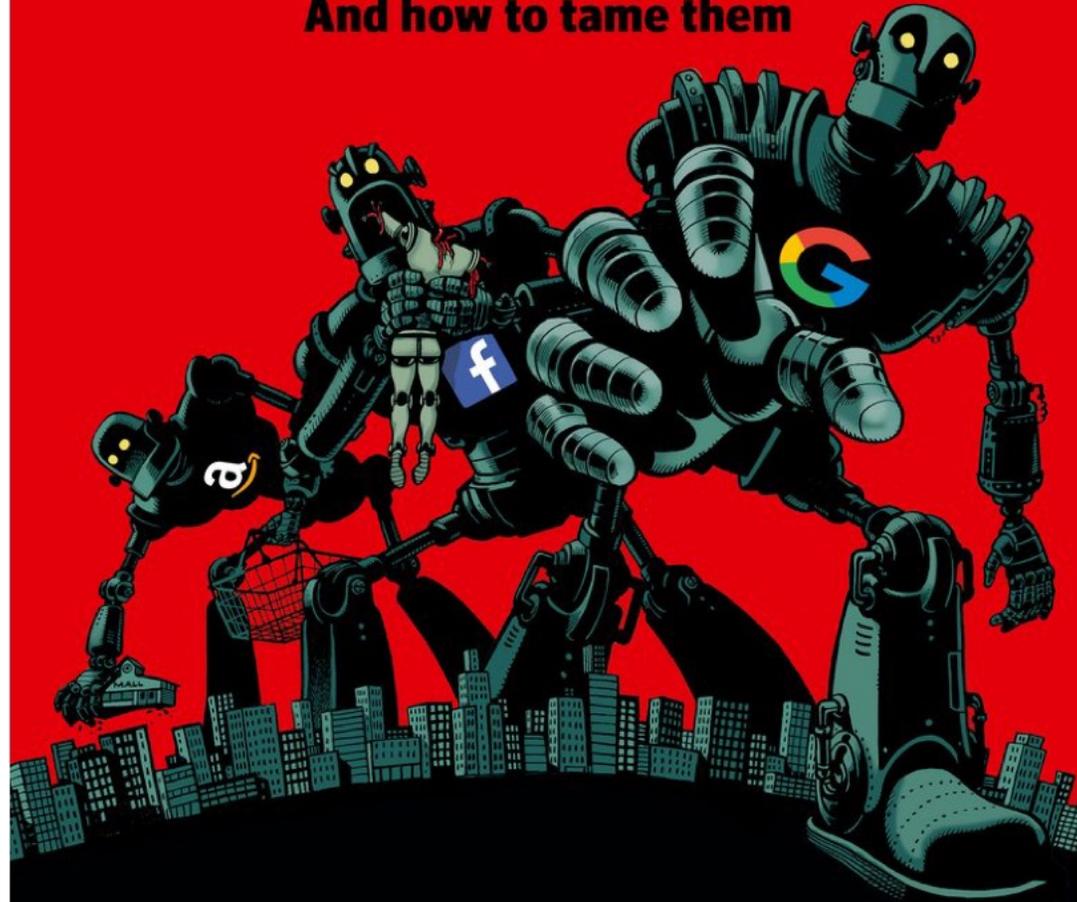
Immigration's poisonous politics

Something's coming: Bernstein at 100

Our Big Mac index

## The new titans

And how to tame them



# What's the problem?

Is it that these enterprises are:

- so big?
  - exploitative of their workers?
  - distorting markets?
  - extracting monopoly rentals from consumers?
  - not providing consumers what they want?
- 
- No – its none of these ...

# It's actually giving us what we want!

- It seems that these enterprises have focussed very sharply on giving users precisely what they want
- The ability to customise a solution to a market of 1 and still bring economies of scale to that market underlies their success
- So we all use these services – because they work for us!

# But there are side-effects

- In order to understand what each consumer wants, the service provider needs to understand the consumer
- Which brings us to...

# Surveillance Capitalism

- Much of the wealth and impact of these activities is built upon a foundation of aggregation of individual user behaviour and construction of personal profiles
- It also has benefitted from a cavalier attitude towards data security and privacy concerns and the absence of regulatory imposts that attempt to safeguard some basic common aspects of personal privacy



Is this what we want?



**Samsung SMART TV**  
**TV has never been this Smart**



# Is this what we



## Samsung SMART TV TV has never been this Smart

### Technology

## Not in front of the telly: Warning over 'listening' TV

9 February 2015 | Technology

Share



**Samsung is warning customers about discussing personal information in front of their smart television set.**

The warning applies to TV viewers who control their Samsung Smart TV using its voice activation feature.

When the feature is active, such TV sets "listen" to what is said and may share what they hear with Samsung or third parties, it said.

Privacy campaigners said the technology smacked of the telescreens, in George Orwell's 1984, which spied on citizens.



# Is this what we

Technology

## Not in front of the telly: Warning over 'listening' TV

# Amazon's Alexa recorded private conversation and sent it to random contact

The company, which has insisted its Echo devices aren't always recording, has confirmed the audio was sent



TV has never been this smart

Share



...ssing personal information in

their Samsung Smart TV using its

" to what is said and may share said.

ked of the telescreens, in George



# Is this what we

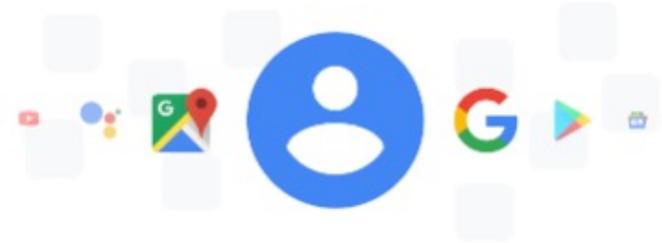
## Amazon's Alexa recorded private conversation and sent it to radio contact

The company, which has insisted its Echo devices are not recording, has confirmed the audio was sent to radio contact

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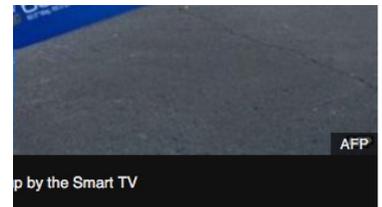


TV has never been this smart



## My Google activity

The activity that you keep helps Google make services more useful for you, like helping you rediscover the things that you've searched for, read and watched.



ssing personal information in

their Samsung Smart TV using its

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# What we might want

There is a common view that this is a classic case of market failure

Markets don't normally correct themselves in times of failure – normally the public sector is there to regulate behaviours in markets to protect the public interest

# Some questions

An effective regulatory regime should be able to provide clear answers to these questions:

- Who owns my personal profile data?
- Where is it stored?
- What regulatory regime protects it?
- Should I be informed when my profile is sold?
- Do I have an informed valuation of my personal profile?
- Who is at fault if my personal data is leaked?

# Where are we?

Its clear we're not in Kansas any more

And whatever the Internet may be, it's not a telephone network for computers

Its now a platform of the projection of unprecedented power across the entire landscape of human activity by a small clique of savvy operators

# Where are we?

- We are now communicating with a computer-mediated environment rather than with each other
- The network itself is largely incidental to this evolving story, and this is not really about the Internet any more
- It's about a set of revolutionary social changes on a par with the industrial revolution that have been triggered by abundant computing, storage and comms
- And its dominated by a very small cartel of monopolists

# Where are we?

- We are now communicating with a computer-mediated environment rather than with each other

“Every monopoly and all exclusive privileges are granted only at the expense of the public interest”  
Andrew Jackson, 1830

- Industrial revolution that have computing, storage and comm

- And its dominated by a very small number of monopolists



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dant

# Where are we?

- We are now communicating with a computer-mediated environment rather than with each other

Government by organised money is just as dangerous as government by organised mob  
Franklin D Roosevelt, 1936

he

industrial revolution that have  
computing, storage and comm

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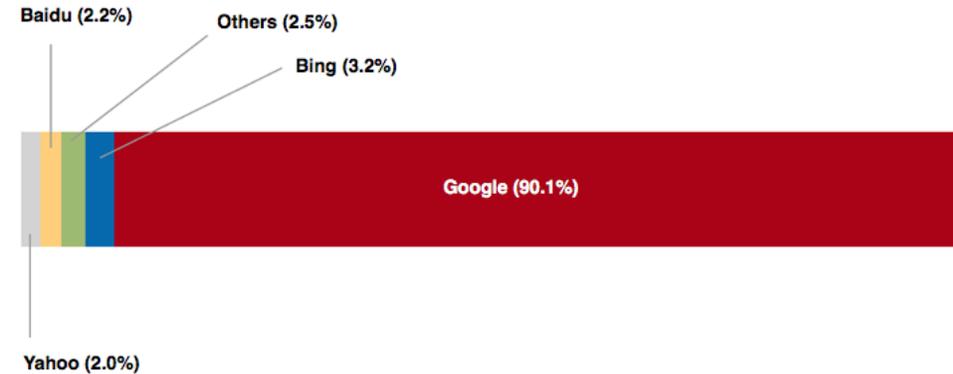


# Maybe its worse than that

- In a world of abundant content what do we choose to view?
- What do we choose to believe?
- *Search* becomes the arbiter of content selection and assumes a level of ultimate importance in this world
- What's the social outcome of *search* being dominated by a single entity?

Is it about what we buy or is this really about what we think?

Search engine market share in 2018



SOURCE: StatCounter

Share of search in US market

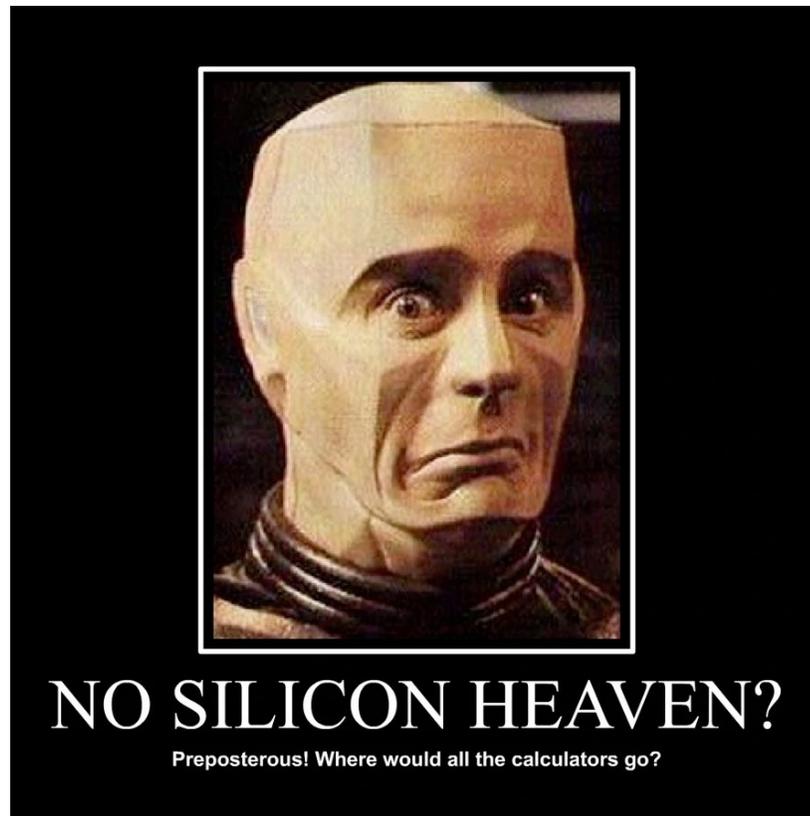
# Where does all this head?

*For our society, this rapid market-driven digitisation of our world has the potential to be incredibly empowering or incredibly threatening*

*Or both at the same time!*

# Wherever we're heading...

- It's not the Internet any more
- That has already died and gone to silicon heaven!



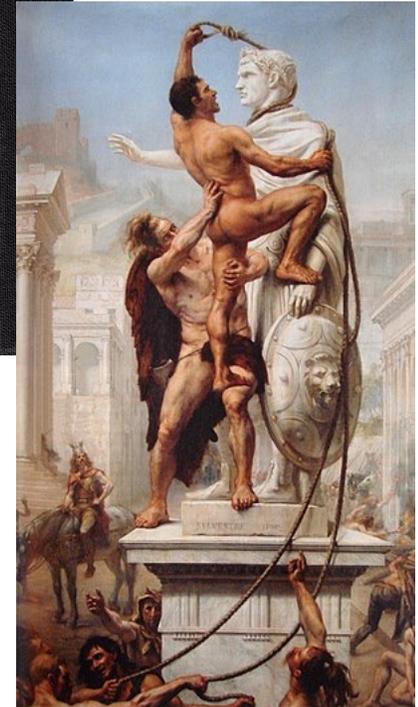
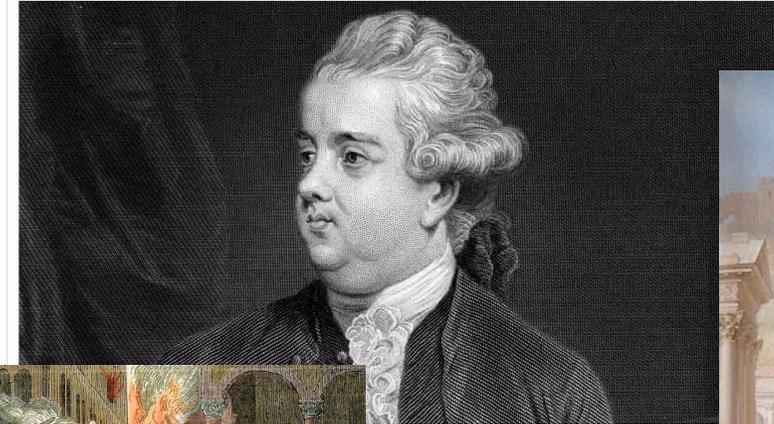
# Sic transit gloria mundi

In 1776 English historian Edward Gibbon published a mighty 6 volume work tracing the Roman Empire (and Western Civilisation) from the height of Empire to the fall of Byzantium

The seeds of of the empire's eventual decline and fall were sown early in its rise

## The 100 best nonfiction books: No 83 - The History of the Decline and Fall of the Roman Empire by Edward Gibbon (1776-1788)

Perhaps the greatest and certainly one of the most influential history books in the English language retains its power today



Thanks!