

Internet - How it Evolved and Its Societal Implications

José Legatheaux Martins

Agenda

- Internet: structure and applications evolution
- Today's characterization of the Internet
- The economic model used by the main players
- Societal implications

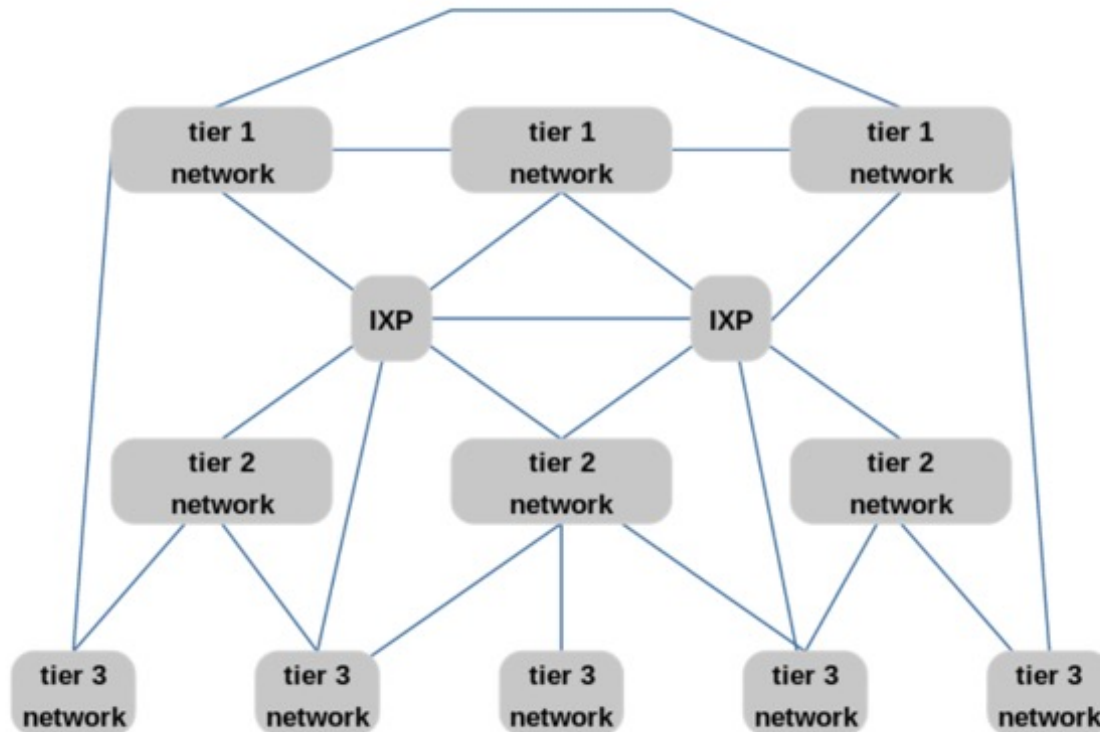
Original Technological Model of the Internet

- The original model:
 - Computers are the “first class citizens” using the network
 - The Network fabric is just an infrastructure allowing any two different computers to communicate
 - The IP protocol, global unique addresses and the DNS name system were the main unifying building blocks
- The Internet is a set of interconnected networks, known as autonomous systems
 - Each autonomous system is interconnected with its neighbours, which are peers or providers
 - All these independent networks cooperate to guarantee that any sent packet can reach its destination

Internet Epochs

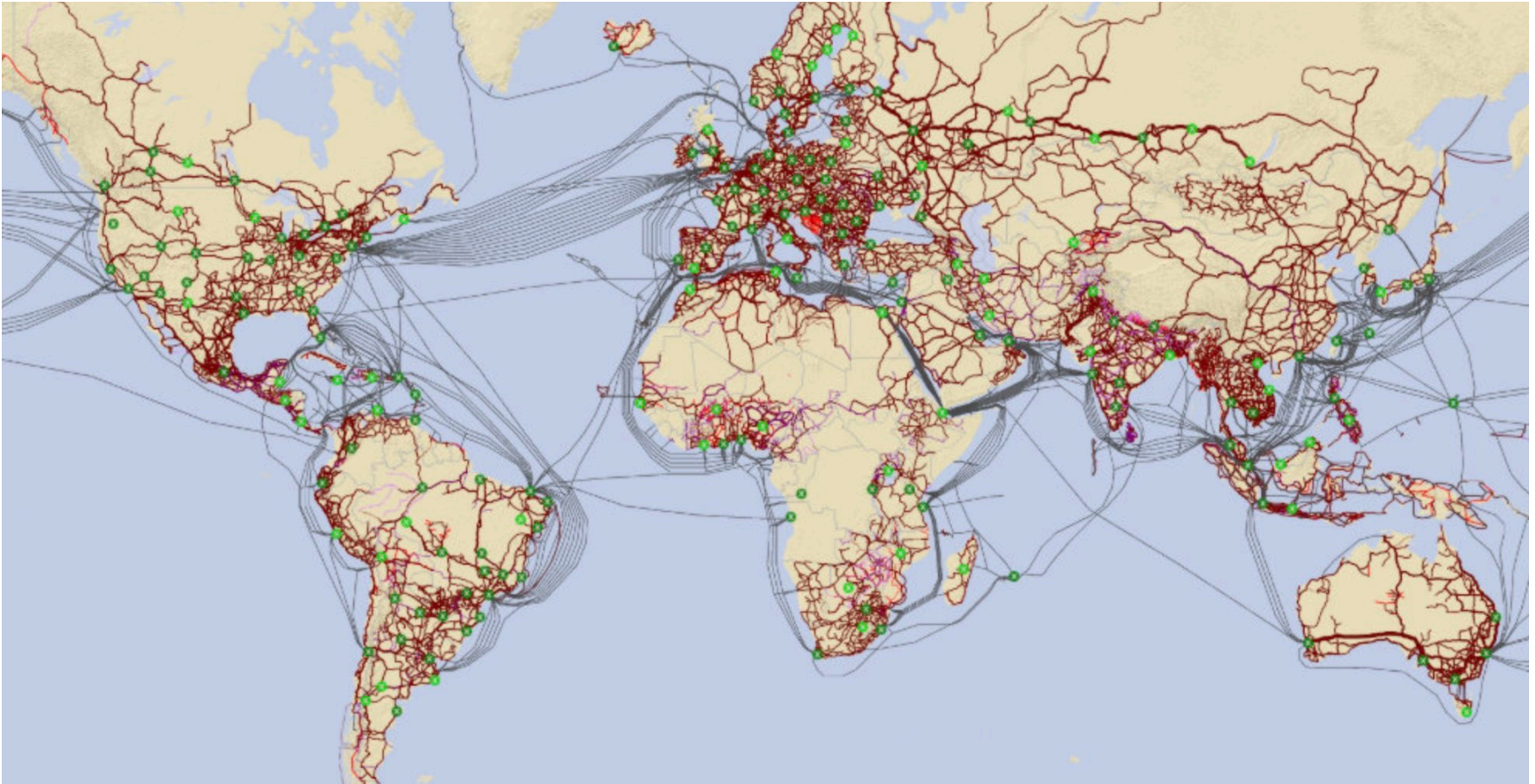
Epoch	Applications	What is new	Link capacities (access / core)	Application Support
Pioneers Internet (<1990)	File transfer, email, remote login	People access remote computers	< 56 Kbps / 1 Mbps	Mainframes and minicomputers shared by several users
Adds a new application - The Web (1990 – 2000)	Browsers mostly access static data Interactive applications start to appear	The notion of service appears	1 Mbps / 1 Gbps	Personal computers with phone modems Servers and servers clusters

Logical Structure of the Internet (around 2000)



Selling connectivity was the dominant Internet Economic Activity

"Core" - Tier 1 and Tier 2 Operators



Fonte: ITU

2000 - 2010: The First Planet-Scale Applications

Epoch	Applications	What is new	Link capacities (access / core)	Application Support
Global platforms support new global services (2000 – 2010)	Web search Resource sharing and resource streaming Some applications grow up to several millions of users	Interactive services and person to person communications	< 1 Mbps / 10 Gbps	+ smartphones (iPhone 2007) Big data centres

Internet of Today

Users, devices, link capacities	Applications	Computational Support
<p>> 5.000.000.000 users</p> <p>> 20.000.000.000 devices</p> <p>Access data rates: [10 Mbps, 1 Gbps [</p> <p>Core data rates: [N x 100 Gbps, N x 400 Gbps [</p>	<ul style="list-style-type: none">+ Web access e Web search+ All kind of client / server applications+ Electronic commerce+ Interactive applications with millions of users+ Person-to-person interaction (messaging, games, RV)+ Streaming+ IoT and data acquisition+ Remote control+ ...	<ul style="list-style-type: none">+ Giant data centres+ Private data centres with millions of cores and specialized hardware for AI+ Architectures and applications massively parallel+ Pervasive caching, Machine learning and localized data centres

Internet Today == Communications + Cloud Computing

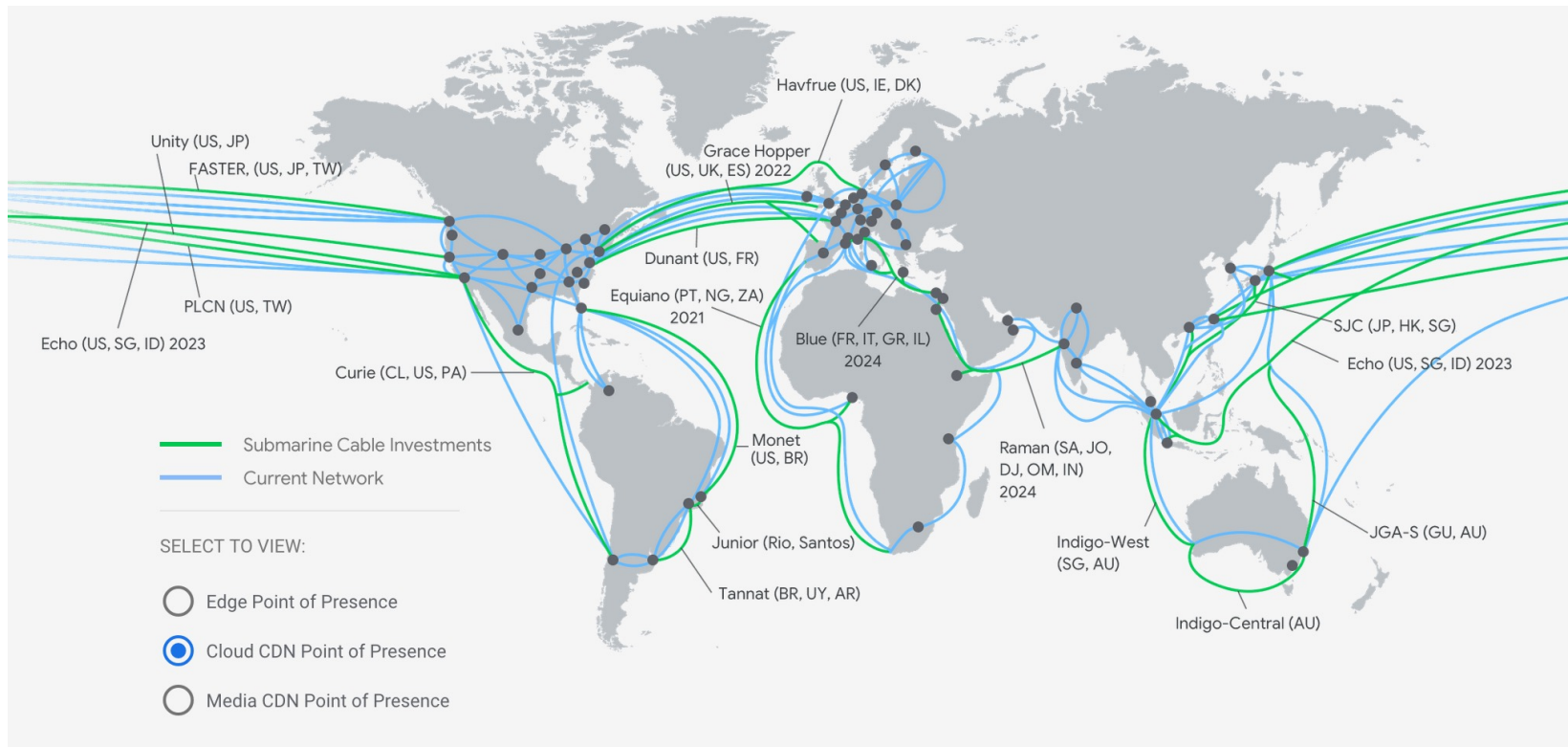


Fonte: Google datacenter

Applications Needs Served "Outside" The Public Internet

- Mostly based on massive parallel architectures inside giant data centres
- Complemented with "(reverse) application proxies" near the users
- With points of presence inside access networks (off-net servers) or close to them
- All interconnected by worldwide private networks

Example of a Private Network



Continuation



Cloud-based Sites Protection

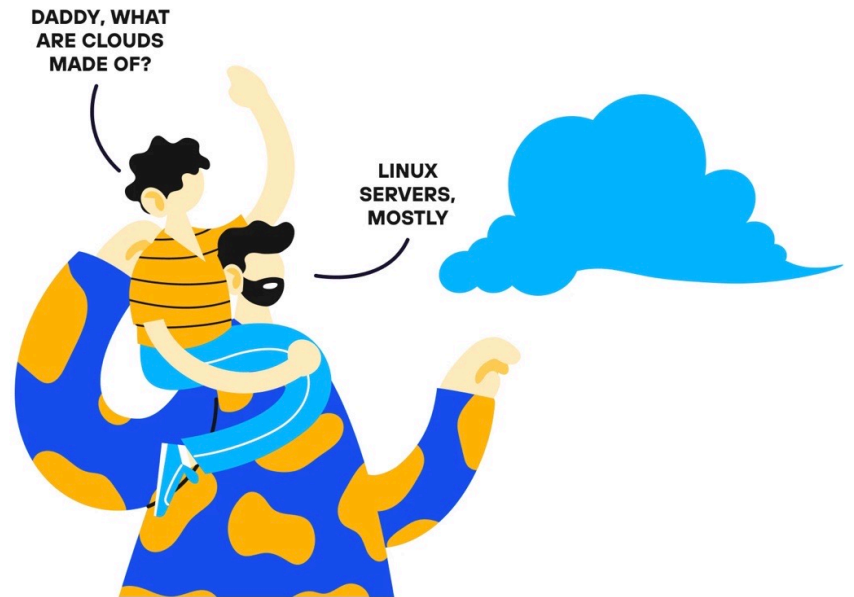


Examples: Cloudflare, Fastly, Limelight

Fonte: <https://www.cloudflare.com>

Cloudflare example:

- > 100 data centers around the world
- Directly connected to more than 10000 access networks and mega data centers
- Their servers filter customer traffic directed to web sites



Hypergiants Off-Nets Footprint

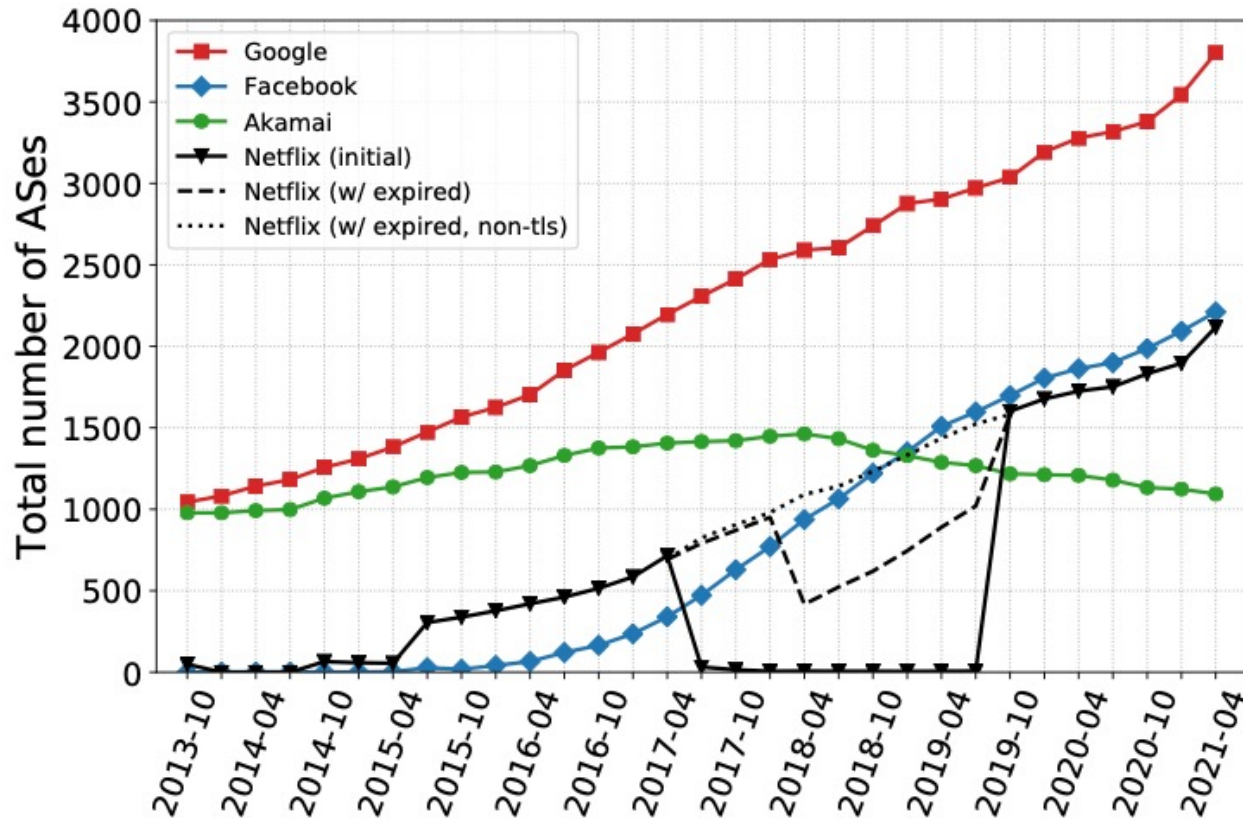


Figure 3: Off-net footprint growth for top-4 HGs over time.

Source: Petro Gigis et al., "Seven Years in the Life of Hypergiants' Off-Nets," SIGCOMM'21, August 2021, USA virtual event

Reaching Users



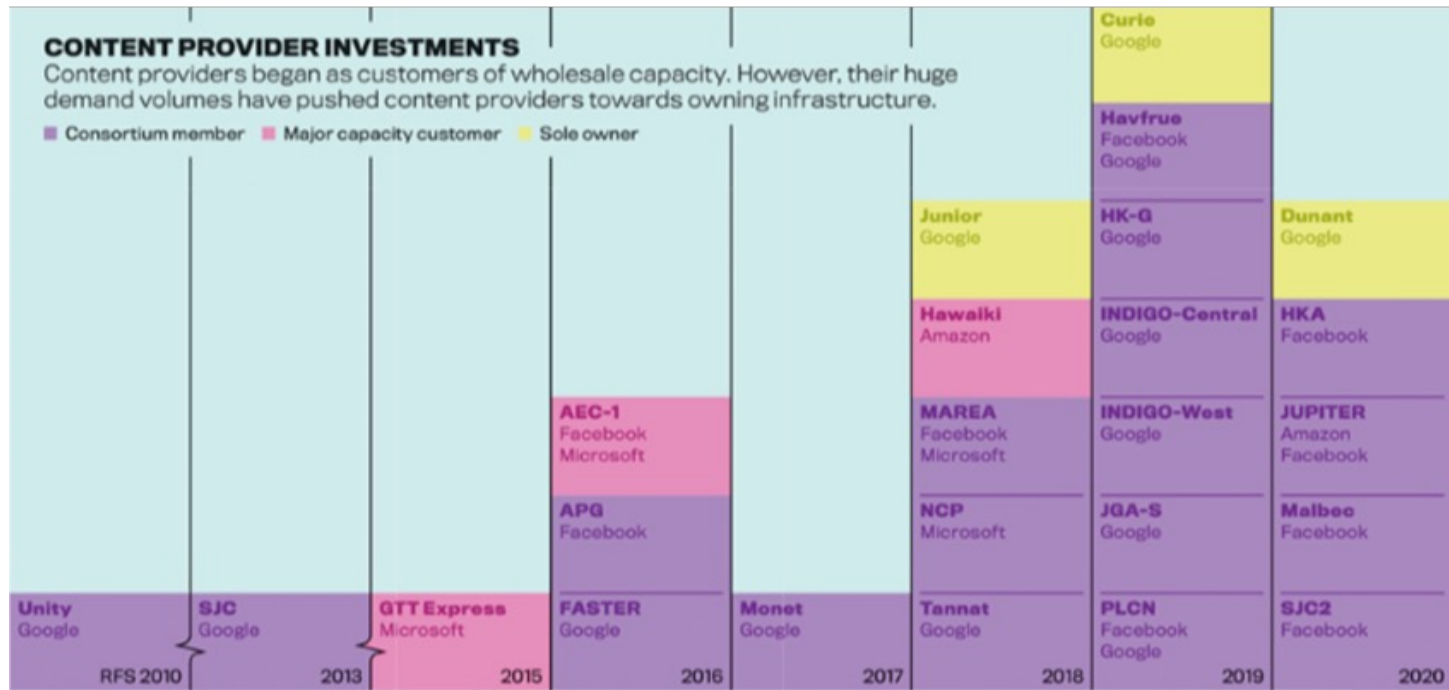
Figure 8: Percentage of a country's Internet users within the customer cones of ASes hosting Google off-net servers (April 2021).

Source: Petro Gigis et al., "Seven Years in the Life of Hypergiants' Off-Nets," SIGCOMM'21, August 2021, USA virtual event

According to TeleGeography.com Reports

- Long-haul bandwidth and IP transit prices are falling 15% to 30% each year - margins are very low
- 60% of inter country bandwidth is serving private data centres interconnections and this trend is increasing
- According to some observers, a low portion of end user traffic comes from the Public Internet, i.e. from the traditional transit core or IXPs
- And a significant part of this "outside" traffic comes from data centres, close to the edge, directly connected to IXPs

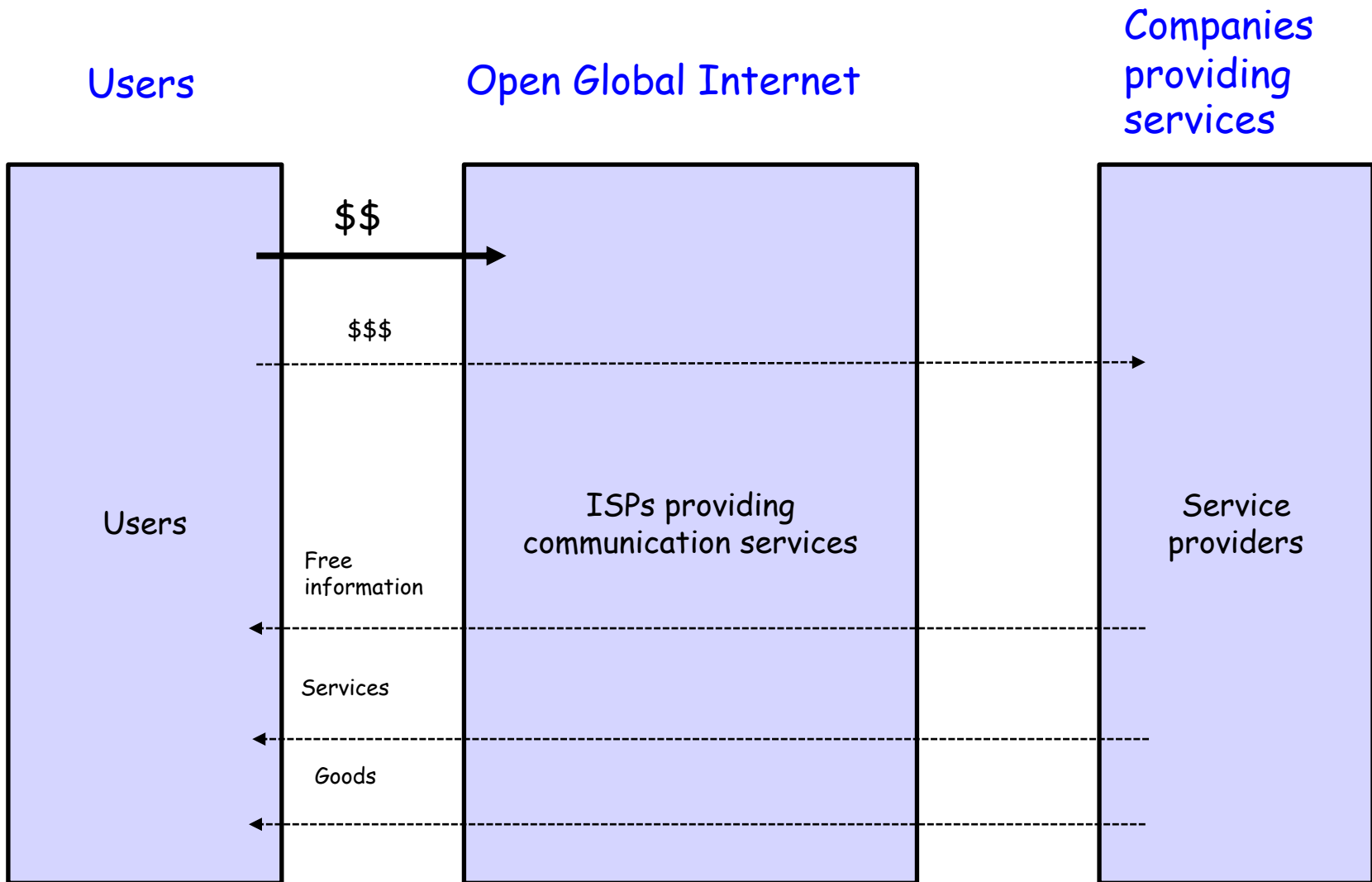
Fiber Owners



The Public Internet is Being Replaced by a Set of Private Hypergiants Networks

- According to this model, standardized protocols are only needed to connect customer devices to the points of presence (front ends) of the private hypergiants networks
- Nevertheless, this new architecture has been used to provide a set of innovative services:
 - Caching,
 - Flow termination and reduced latency,
 - Load balancing,
 - Massive content diffusion,
 - Improved security,
 - Improved name to resource binding, ...

Old Economic Model (< 2005)



(Hyper) Giant Market Presence

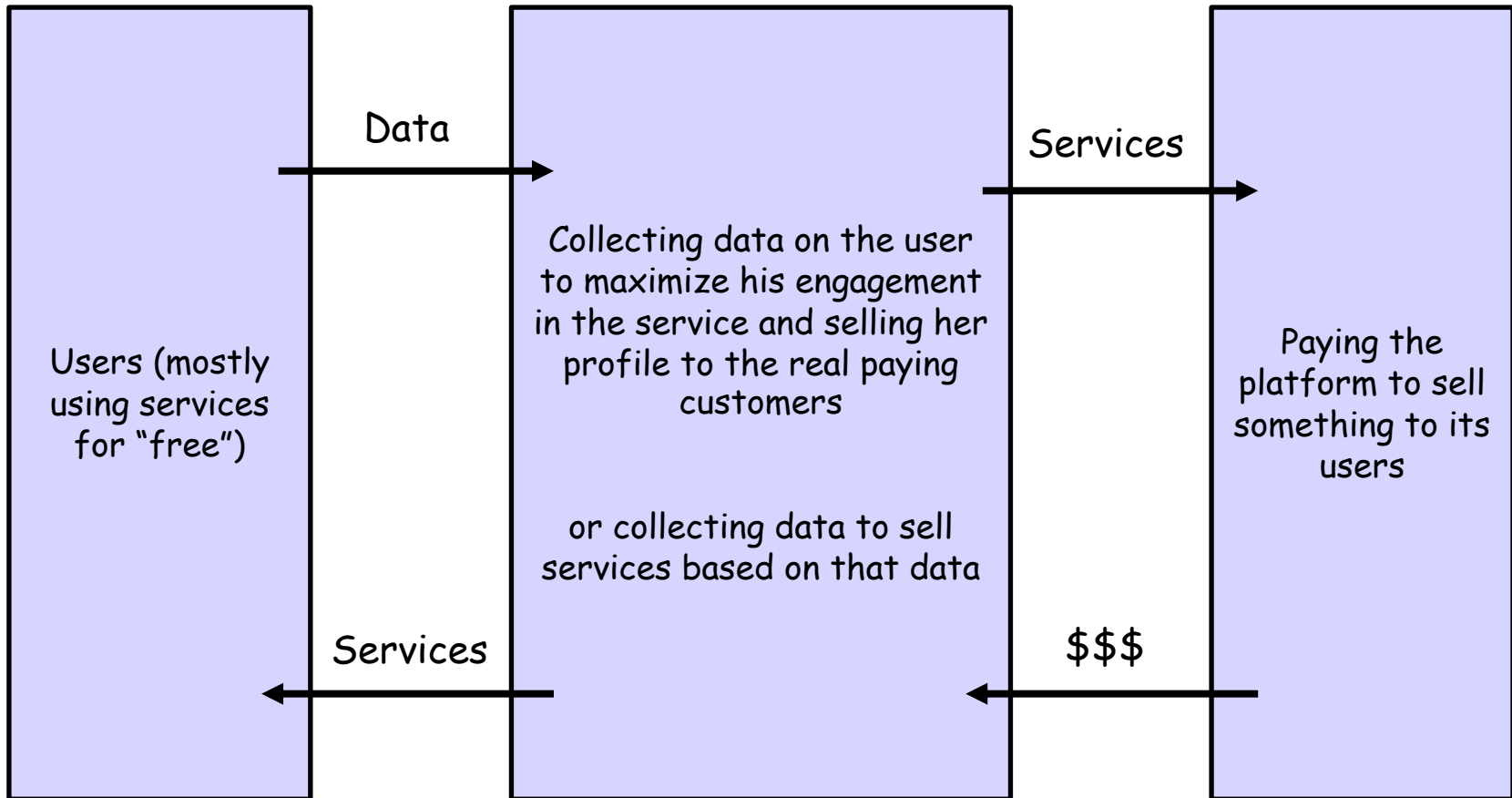
Market	Source	Market Power Distribution (excluding the Chinese market, except in publicity)
Search	https://statcounter.com	Google - 92%
Social Media	https://statcounter.com	Meta / Facebook - 75%, Twitter - 7%,
Publicity	emarketer.com	Google - 38%, Facebook - 29%, Alibaba - 9%, Amazon - 9%, ByteDance - 7%, Tencent - 3%, ...
Cloud	statista.com	Amazon - 33%, Microsoft - 22%, Google - 9%, ...
Email	w3techs.com	Google - 20%, Microsoft - 12%, N. Digital Group - 4%, GoDaddy - 4%,
Security	w3techs.com	CloudFlare - 80%, Fastly - 7%, Amazon - 6%, ...
Browser (software)	https://statcounter.com	Google - 65%, Apple - 19%, Microsoft, Firefox, ...
Personal Devices Operating System (software)	https://statcounter.com	Google - 43%, Microsoft - 29%, Apple - 23%, ...

New Economic Model

Users

N x Private Platforms and a
smaller public Internet

Companies -
customers of the
platforms



Hyper Giants Market Presence

Market	Paying Model	Market Power Distribution (excluding the Chinese market, except in publicity)
Search	Free for users, indirectly paid by publicity	Google - 92%
Social Media	Free for users, indirectly paid by publicity	Meta / Facebook - 75%, Twitter - 7%, ...
Browser (software)	Free for users, indirectly paid by publicity	Google - 65%, Apple - 19%, Microsoft, Firefox, ...
Personal Devices Operating System (software)	Mostly free for users, indirectly paid by publicity	Google - 43%, Microsoft - 29%, Apple - 23%, ...
Cloud	Paid by companies	Amazon - 33%, Microsoft - 22%, Google - 9%, ...
Email	Free for users, indirectly paid by publicity	Google - 20%, Microsoft - 12%, N. Digital Group - 4%, GoDaddy - 4%,
Security	Paid by companies	CloudFlare - 80%, Fastly - 7%, Amazon - 6%, ...
Digital publicity	Paid by companies	Google - 38%, Facebook - 29%, Alibaba - 9%, Amazon - 9%, ByteDance - 7%, Tencent - 3%, ...

Implications

- Services are fully dependent of a small set of providers
- Security, reliability and stability of the Internet very dependent of these companies
- Lack of diversity is a big danger for the reliability
- Many services are provided using a “walled-garden” approach
- **Splinternet** is a reality:
 - Due to geopolitics implications
 - Due to the “walled-garden” approach
 - Hypergiants compete / do not cooperate

What Justifies this Situation?













- The network effect - the value of a network grows exponentially with the number of its users
- That implies that the "winner takes it all"
- In order to acquire users quickly, platforms offer them free services
- The aim is to become a monopoly in its market
- Then, the real customers, i.e. the enterprises that pay to reach customers, are fully dependent of the platform

Value = Future Gains Expectations

- Each Provider aims at being a monopoly in its branch of business
- No one can beat the margins of monopolies
- Business model based on massive acquisition of data
 - Platforms need to collect massive amounts of data
 - Data analysis methods and infrastructures are key
 - Control of the knowledge and people allowing this data acquisition and analysis

Stock Exchange Market Value

2010

Fourth quarter ^[69]	
	ExxonMobil ▲368,711.5
	PetroChina ▲303,273.6
	Apple ▲295,886.3
 	BHP Billiton ▲243,540.3
	Microsoft ▲238,784.5
	ICBC ▲233,369.1
	Petrobras ▲229,066.6
	China Construction Bank ▲222,245.1
 	Royal Dutch Shell ▲208,593.7
	Nestlé ▲203,534.3


2020

Fourth quarter	
	Apple ▲2,254,000 ^[21]
	Microsoft ▲1,682,000 ^[22]
	Amazon ▲1,634,000 ^[23]
	Alphabet ▲1,185,000 ^[24]
	Facebook ▲776,590 ^[25]
	Tencent ▲683,470 ^[27]
	Tesla ▲668,080 ^[26]
	Alibaba Group ▼628,650 ^[30]
	TSMC ▲565,280 ^[31]
	Berkshire Hathaway ▲544,780 ^[28]

2021

Fourth quarter	
	Apple ▲2,913,000 ^[21]
	Microsoft ▲2,525,000 ^[22]
	Alphabet ▲1,922,000 ^[24]
	Amazon ▲1,691,000 ^[23]
	Tesla ▲1,061,000 ^[26]
	Meta ▼935,640 ^[25]
	Nvidia ▲732,920 ^[29]
	Berkshire Hathaway ▲668,630 ^[28]
	TSMC ▲623,930 ^[31]
	Tencent ▼559,900 ^[27]

2022

Fourth quarter	
	Apple ▼2,066,000 ^[25]
	Microsoft ▲1,787,000 ^[26]
	Alphabet ▼1,145,000 ^[27]
	Amazon ▼856,940 ^[28]
	Berkshire Hathaway ▲681,770 ^[30]
	UnitedHealth ▲495,370 ^[31]
	Johnson & Johnson ▲461,840 ^[33]
	ExxonMobil ▲454,240 ^[35]
	Visa ▲439,950 ^[38]
	Tencent ▲405,090 ^[37]

Top-10 Stock Exchange Market Valuation

Company	Activity Sector	Country	Value in millions of millions of dollars (31/12/2021)
Apple	Internet and Hardware	EUA	2913
Microsoft	Internet	EUA	2525
Alphabet (Google, YouTube, ...)	Internet	EUA	1922
Amazon	Internet and commerce	EUA	1691
Tesla	Electric cars	EUA	1061
Meta (Facebook, Instagram)	Internet	EUA	936
Nvidia	Integrated circuits	EUA	733
Berkshire Hathaway	Investment fund	EUA	669
TSMC	Integrated circuits	Taiwan	623
Tencent	Internet	China	560
Alibaba	Internet	China	615 (as of 30/6/2021)

Margins: ISPs versus Hypergiants

- The *GAFAM* tech giants are in the Top-10 list
- ISPs are very far from them
- In the list of top-1000 highest valued public companies we find Verizon (49), Comcast (51), AT&T (71), T-Mobile (76), China Mobile (84), Deutsche Telekom (111), China Telecom (303), Vodafone (357), Telefónica (565), Swisscom (580), ...

Internet and Society

Internet == Everyone can Reach All Humanity Knowledge



Michelangelo's "The Creation of Adam." (Wikimedia)

A kind of idealistic vision ...

"Wrestling with Alligators" (*)

And the biggest ones are:

- Economic and Political Power Concentration
- The growing alliance between Hyper Giants and States
- Privacy and Human Rights in General
- Society Control by Means of Disinformation
- Platforms-Based Economy (Gig-Economy)
- Intellectual Property and Common Goods
- The Future of Human Relations
- Cybercrime
- Cyberwar



(*) As Vint Cerf puts it

Internet and Society - A Dark Image

- Stock markets reward winners and monopolies and finance their growth by competitors acquisition
- Competition in the Internet core businesses is now a chimera
- States prefer to pair with platforms by convenience, force or lack of alternative
 - China State is officially using their platforms for surveillance
 - NSA is for sure using some of the American platforms for unknown purposes
 - Dictatorial States require local platforms offices to behave according to their desires
 - EU wants that platforms survey paedophiles (and everybody else)
- More and more data on the real situation is going hidden: "who knows, who decides, and who decides who decides"

(*) Shohsana Zuboff em "O Capitalismo da Vigilância"

Challenge Example: Privacy

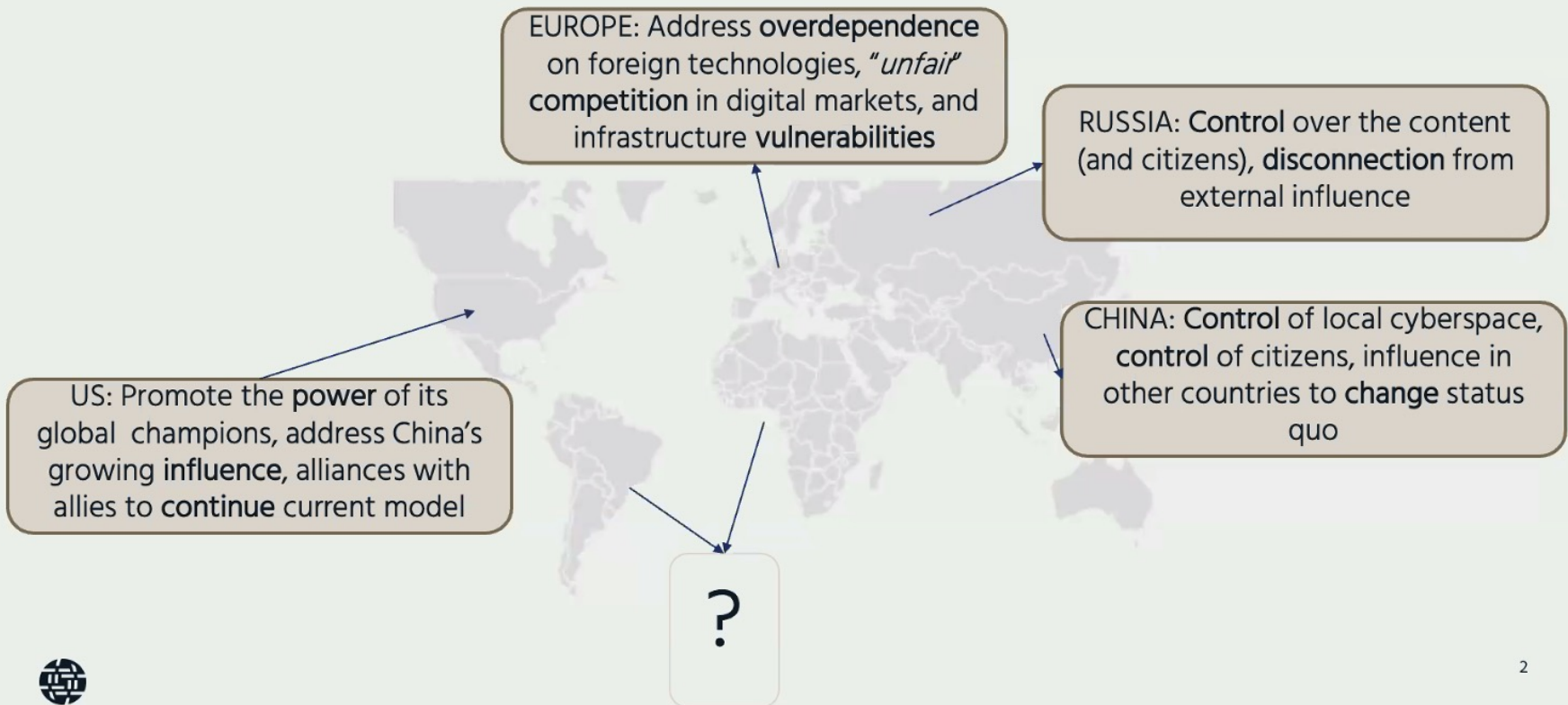
- Was the RGPD effective against hype giant platforms?
- Is it possible to impose users privacy and rights without touching the business model?
- Extreme example: the social punctuation of citizens in China
- In the West there are lots of private punctuation systems and many more are being build with AI features

Challenge Example: Artificial Intelligence

- False question: will machines dominate people?
- Real interesting question: are Artificial Intelligence and the platforms using it serving all people or are they being used to increase inequality and society dehumanization
- In fact, as always, the problem intersects with power and politics, the latter understood as "management of public affairs and relations in society"
- Is the Jurassic Park moment of some Technologies a reality?

Digital Sovereignty

Digital Sovereignty, a concept with different meanings



Question: what to do?