

Three themes:

- Role of hyperscalers
- Situation of 5G
- Filling the gap between network and verticals

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1) Status quo: connectivity in the flat Internet

"HyperScalers reach over 76% of the Internet without traversing the Tier-1 and Tier-2 ISPs, more than virtually every other network"

[2] T. Arnold, J. He, W. Jiang, M. Calder, I. Cunha, V. Giotsas, and E. Katz-Bassett. *Cloud Provider Connectivity in the Flat Internet*. IMC, 2020

Hyperscalers

Tier-1

Tier-2

2015			2020		
#	Network (AS)	Reachability (%)	#	Network (AS)	Reachability (% change)
1	Level 3 (3356)	43,413 (83.4%)	1	Level 3 (3356)	61,154 (90.2%, 6.8%)
2	Google (15169)	42,347 (81.7%)	2	HE (6939)	58,981 (87.0%, 6.2%)
2	HE (6939)	41,876 (80.8%)	3	Google (15169)	58,922 (86.9%, 5.2%)
4	Cogent (174)	39,113 (75.5%)	4	Microsoft (8075)	57,357 (84.6%, 22.0%)
5	StackPath (12989)	39,068 (75.4%)	5	IBM (36351)	55,714 (82.2%, 10.4%)
6	WV Fiber (19151)	38,756 (74.8%)	6	Cogent (174)	55,049 (81.2%, 5.7%)
7	RETN (9002)	37,796 (73.0%)	7	Zayo (6461)	54,489 (80.4%, 11.5%)
8	NTT (2914)	37,543 (72.5%)	8	Telia (1299)	54,324 (80.1%, 8.9%)
9	IBM (36351)	37,203 (71.8%)	9	GTT (3257)	53,388 (78.7%, 8.7%)
10	IPTP (41095)	37,048 (71.5%)	10	SG.GS (24482)	53,157 (78.4%, 9.7%)
11	Telia (1299)	36,906 (71.2%)	11	COLT (8220)	52,256 (77.1%, 12.9%)
12	iiNet (4739)	36,846 (71.1%)	12	G-Core Labs (199524)	51,820 (76.4%, 27.4%)
13	Init7 (13030)	36,814 (71.1%)	13	NTT (2914)	51,374 (75.8%, 3.3%)
14	MTS PJSC (8359)	36,786 (71.0%)	14	Wikimedia (14907)	51,204 (75.5%, 25.7%)
15	Telstra (10026)	36,322 (70.1%)	15	Core-Backbone (33891)	51,110 (75.4%, 12.7%)
16	GTT (3257)	36,238 (70.0%)	16	WV FIBER (19151)	51,083 (75.3%, 0.5%)
17	PCCW (3491)	36,109 (69.7%)	17	TELIN PT (7713)	50,919 (75.1%, 18.6%)
18	TDC (3292)	36,001 (69.5%)	18	Amazon (16509)	50,867 (75.0%, 17.3%)
19	Swisscom (3303)	35,772 (69.1%)	19	Swisscom (3303)	50,758 (74.9%, 5.8%)
20	Zayo (6461)	35,686 (68.9%)	20	IPTP (41095)	50,606 (74.6%, 3.1%)
62	Microsoft (8075)	32,436 (62.6%)			
206	Amazon (16509)	29,905 (57.7%)			

Table 1: Comparison of hierarchy-free reachability for the top 20 networks, from September 2015 and September 2020.

1) Status quo: **off-net** footprints of hyperscalers

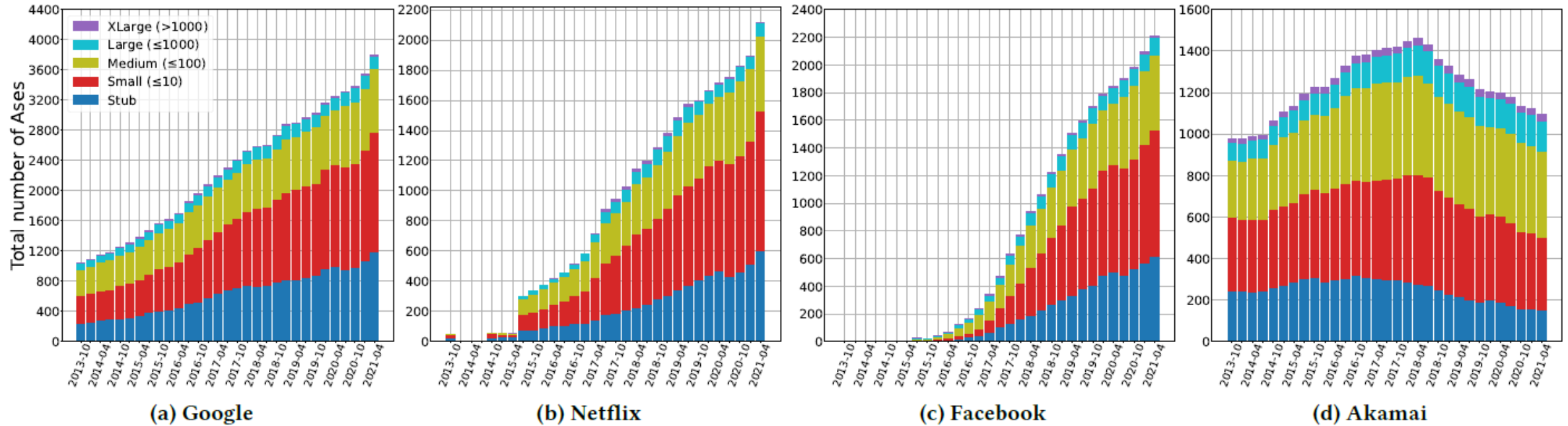
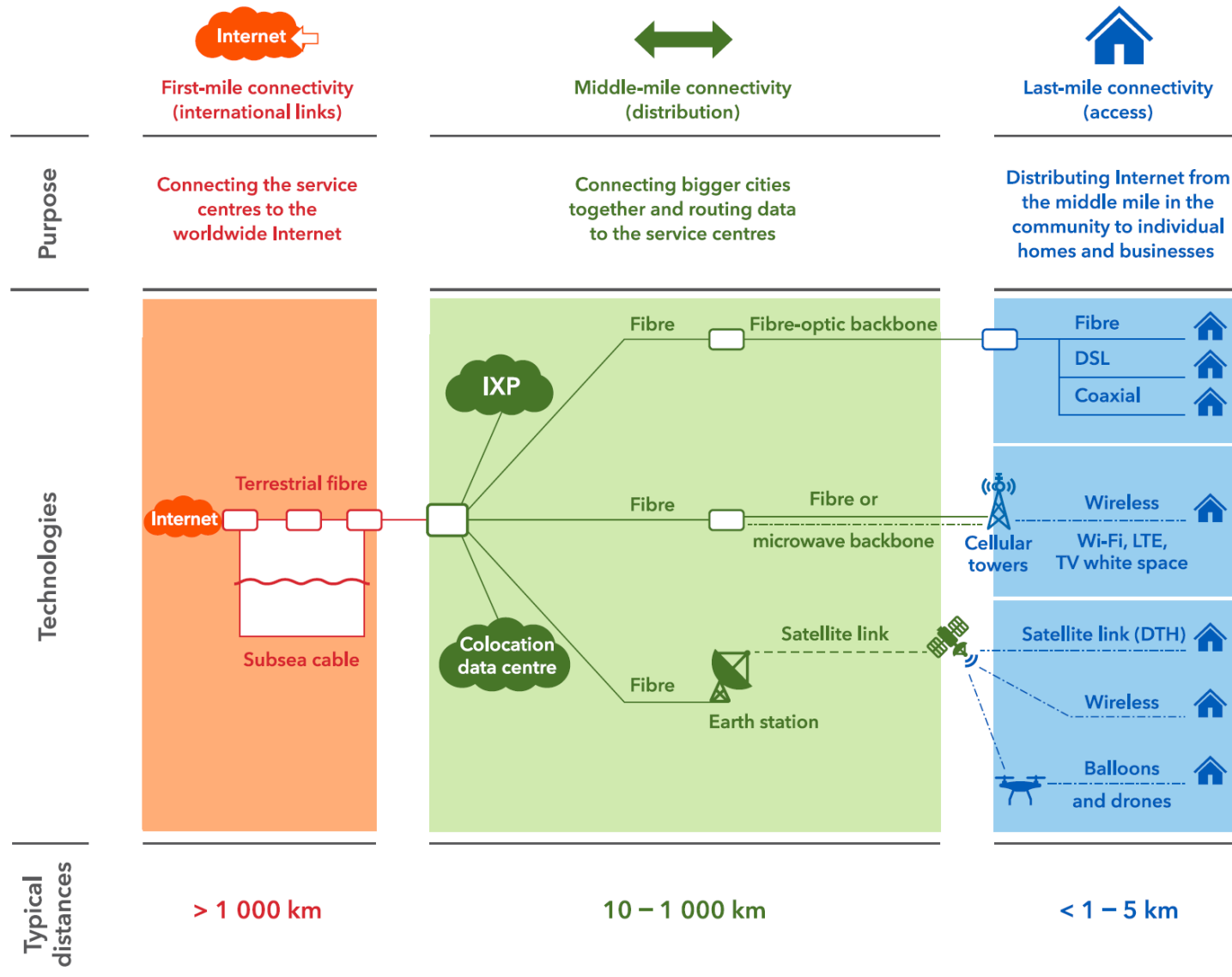


Figure 5: Growth of top-4 HGs' off-net footprints grouped by AS customer cone size. (note: y-axis scales differ)

In 2023, for the first time, telecoms operators spent more on external cloud and IT providers than on their own in-house services

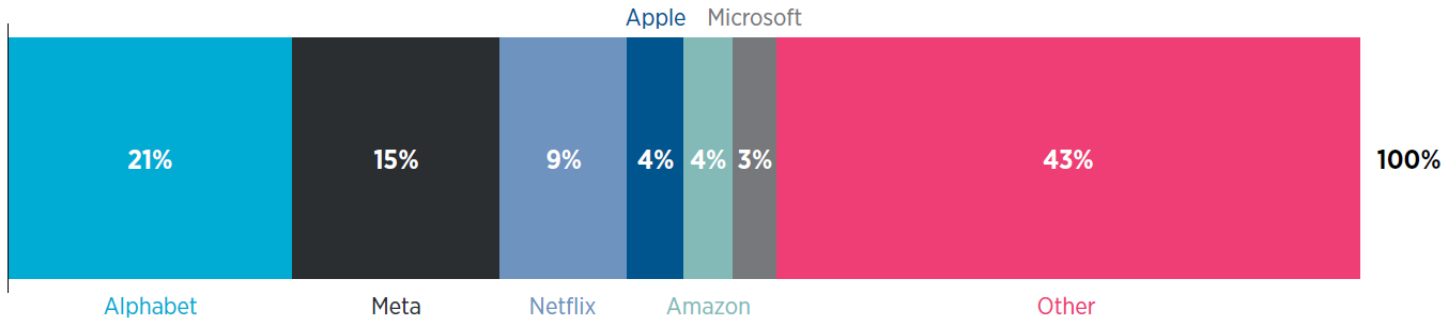
[1] Petros Gigis et al.: Seven years in the life of Hypergiants' off-nets, Proceedings of the 2021 ACM SIGCOMM 2021 Conference

1) Status quo: first and middle-mile connectivity



Hyperscalers are expanding in the first mile (e.g. about 70% of traffic in submarine cables, which account for 95+% of intercontinental traffic) and in the middle mile

1) Status quo: traffic

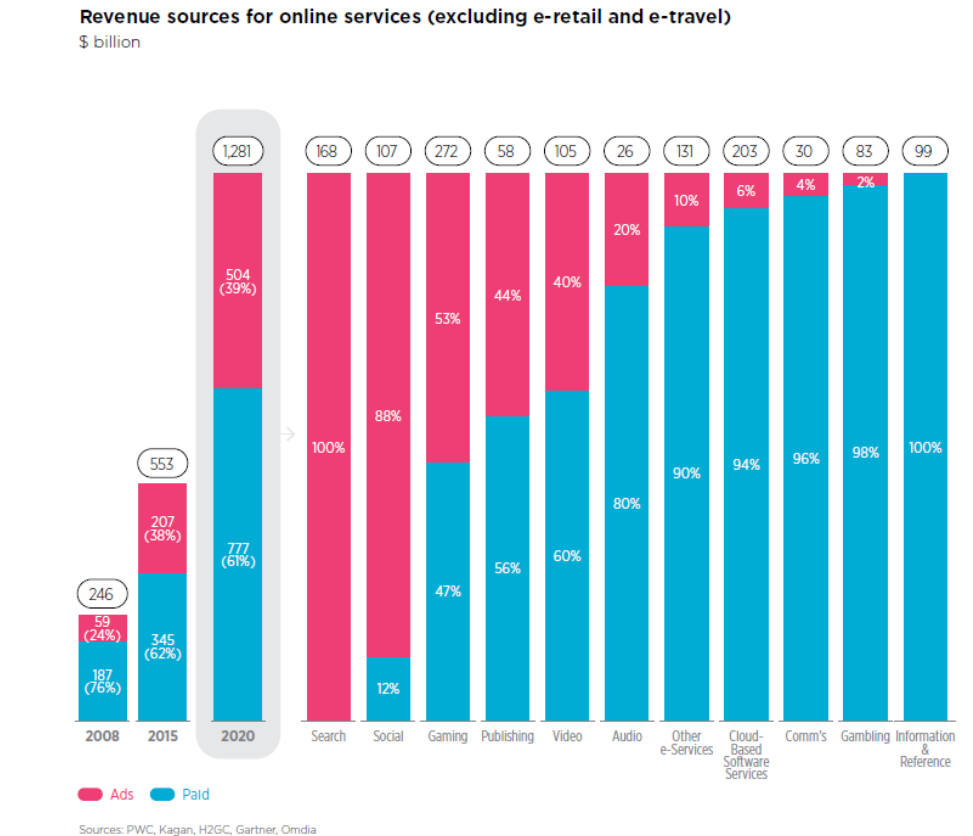


Source: Sandvine Global Internet Phenomena Report, January 2022

Combined **traffic of hyperscalers (six companies)** is 56% of the **total**, more than all the rest combined (up to 80% for mobile networks, <https://www.visualcapitalist.com/>)

"CDNs" account for almost all consumer traffic

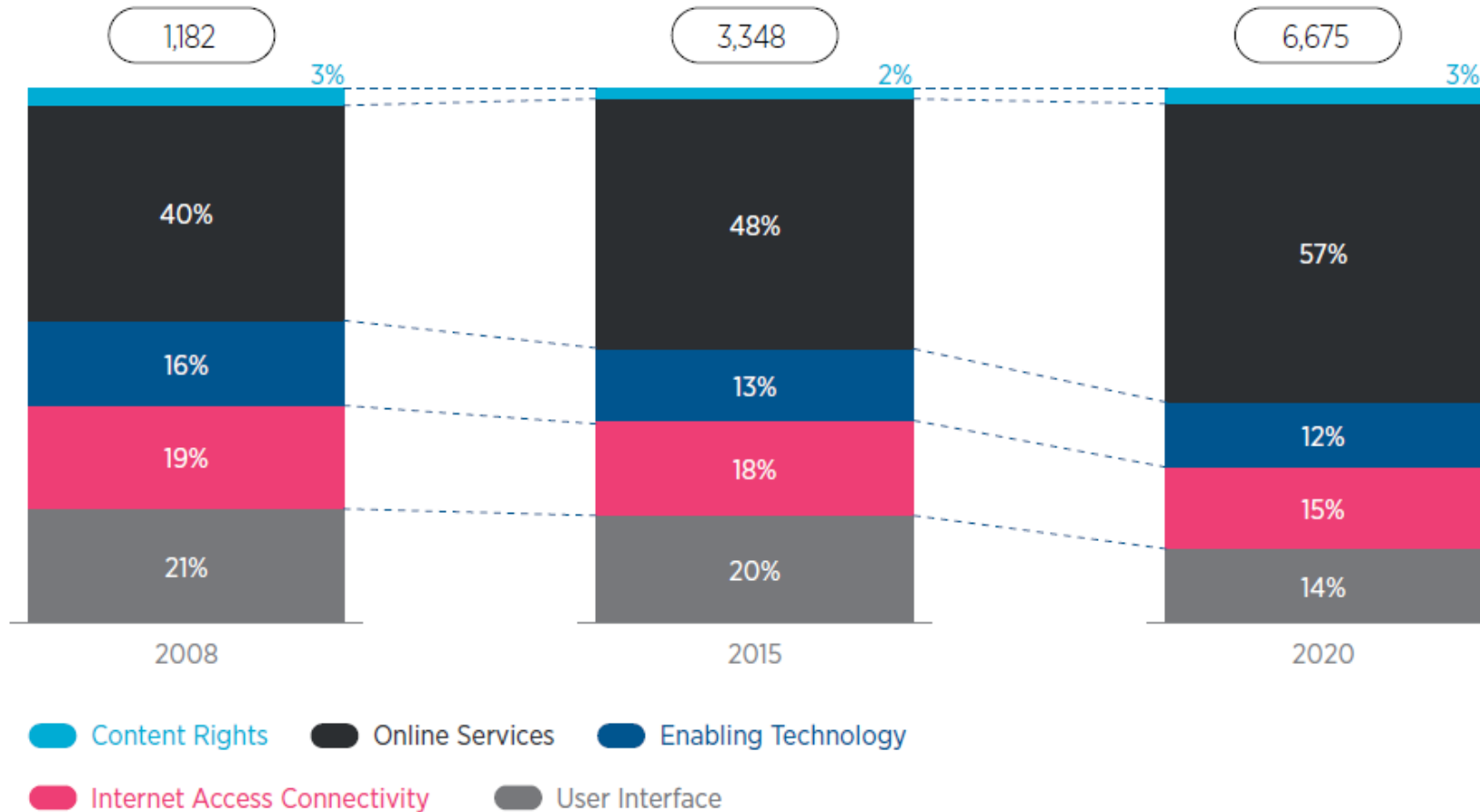
Revenues from advertising up to 39% (very large effect on privacy and economics of several sectors)



ITU Global Connectivity Report 2022

1) Status quo: **changing weight** of stakeholders

Segment size comparison



ITU Global Connectivity Report 2022

4) Check on 5/6G: a new generation needs new devices and new applications/services

- Radio is a medium

User Devices



Applications/Services

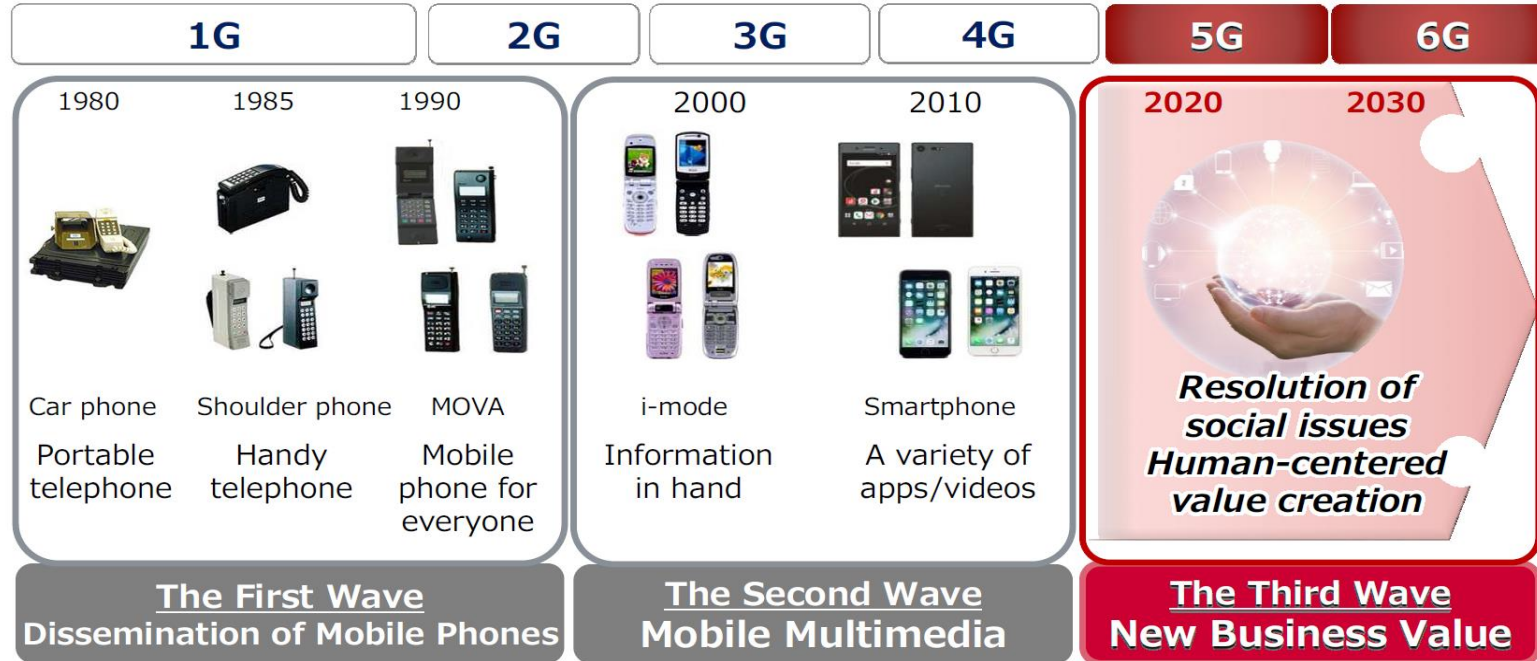
? (e.g. for VR/HR)

5G

? (e.g. cloud/AI based)

4) Check on 5/6G

Technology evolution (every 10 years)



Creating new value for markets (every 20 years)

1-2 circuit telephony
(analog/digit)

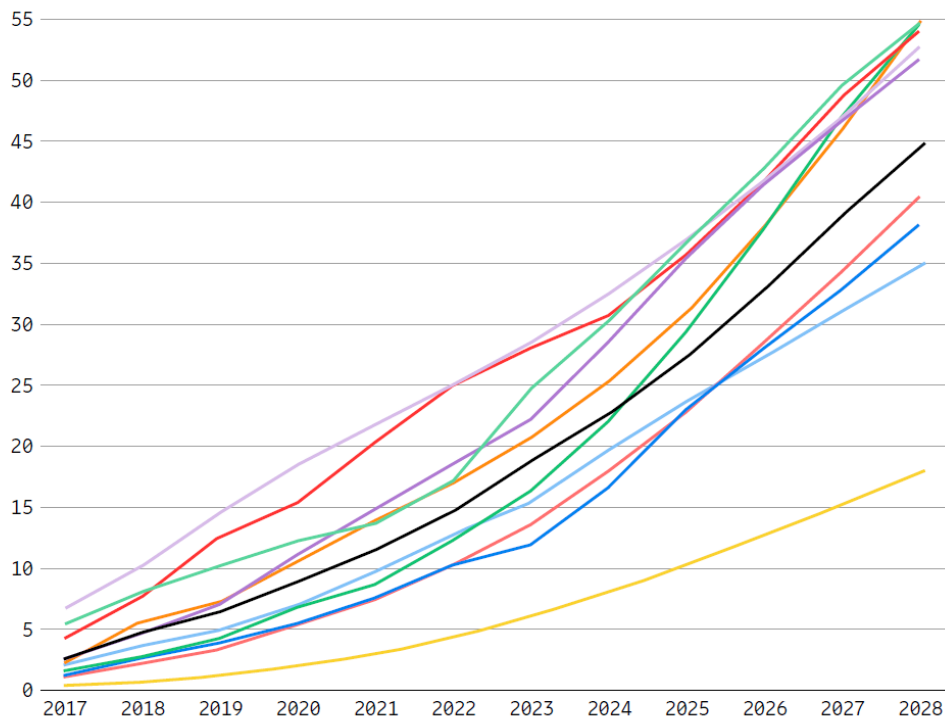
3-4 data, video
(2Mb->100Mb)

5-6 software/cloud+AI
(+IoT)

Source: NTT DOCOMO, 2020

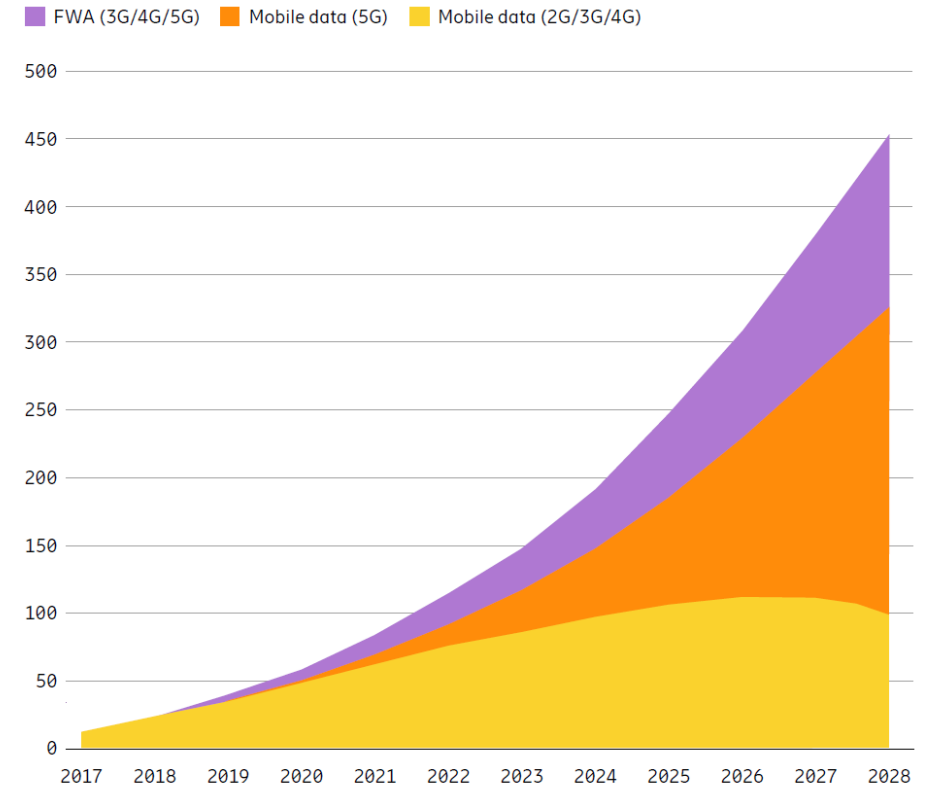
4) Check on 5/6G: traffic grows

Figure 20: Mobile data traffic per smartphone (GB per month)



Ericsson Mobility Report, November 2022

Figure 19: Global mobile network data traffic (EB per month)



1. Excessive cost competition
2. “Unfair” competition with hyperscalers in terms of legislation and regulation
3. Spectrum costs (by October 2023, European operators had spent a total of EUR26 billion for principal 5G bands)
4. Growing energy costs
5. Lack of readiness to offer evolved services

These trends are global but affect more the EU market

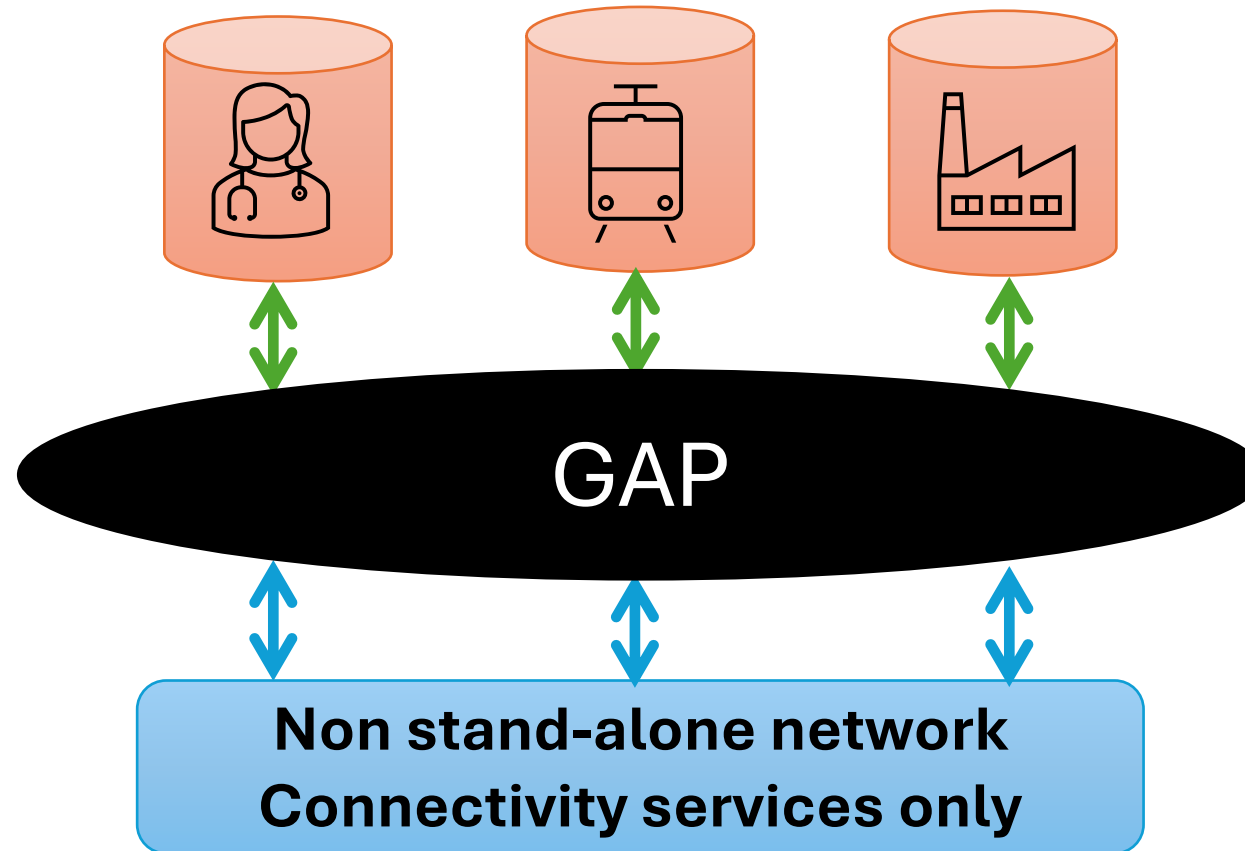
- Europe counts 45 large mobile operating groups, compared with 8 in the USA, 4 in both China and Japan, and 3 in South Korea

This situation requires

- Consolidation/stronger collaboration of operators
 - Consolidation is painful to achieve, it implies anyhow a transition period, and it is not certain that it will solve the issues, as similar trends are observable in the US and China
- Improved legislation and regulation to make the sector sustainable
- Evolved value chains
 - Operators offering rich data, cloud, and AI functionality and dynamic connectivity options, incl. private networks
 - Operators adapting to an evolving environment: tower companies, system integrators, utilities, municipalities, public bodies, neutral hosts, private networks, industries of other sectors and big systemic vertical companies, which are deploying their own communication networks; otherwise, all these actors will try to fill the void left by operators, as they started to do
- Technical progress
 - Dynamic delivery of tailored-made offerings to the customers, and maximization of the usability / programmability / exploitation of the infrastructure, through the establishment and wide-spread use of intent-oriented mechanisms and of exposure APIs

A void to be filled

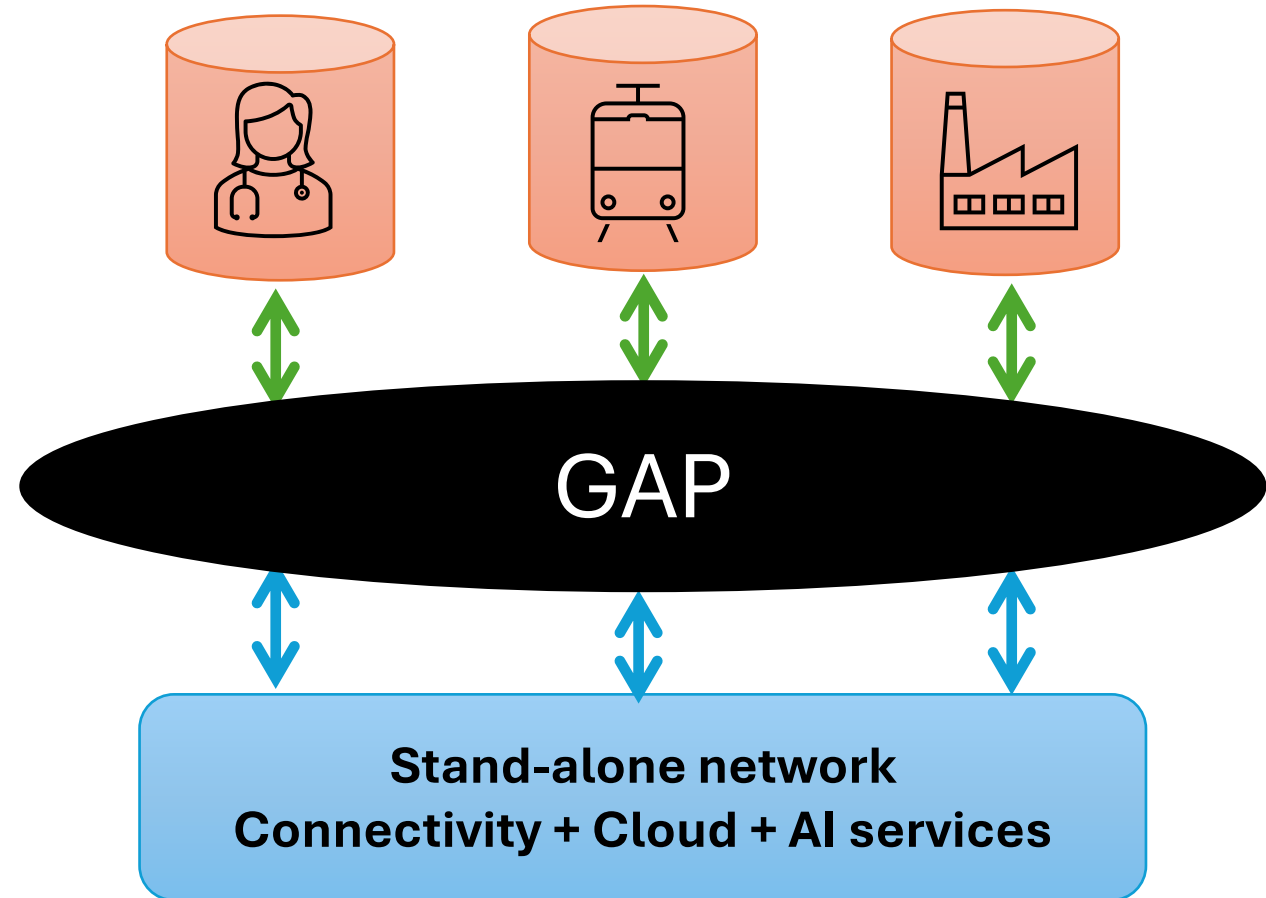
Verticals (e.g. Hospital, Subway, Industry)



Network interfaces that require telco expertise to be used

Verticals (e.g. Hospital, Subway, Industry)

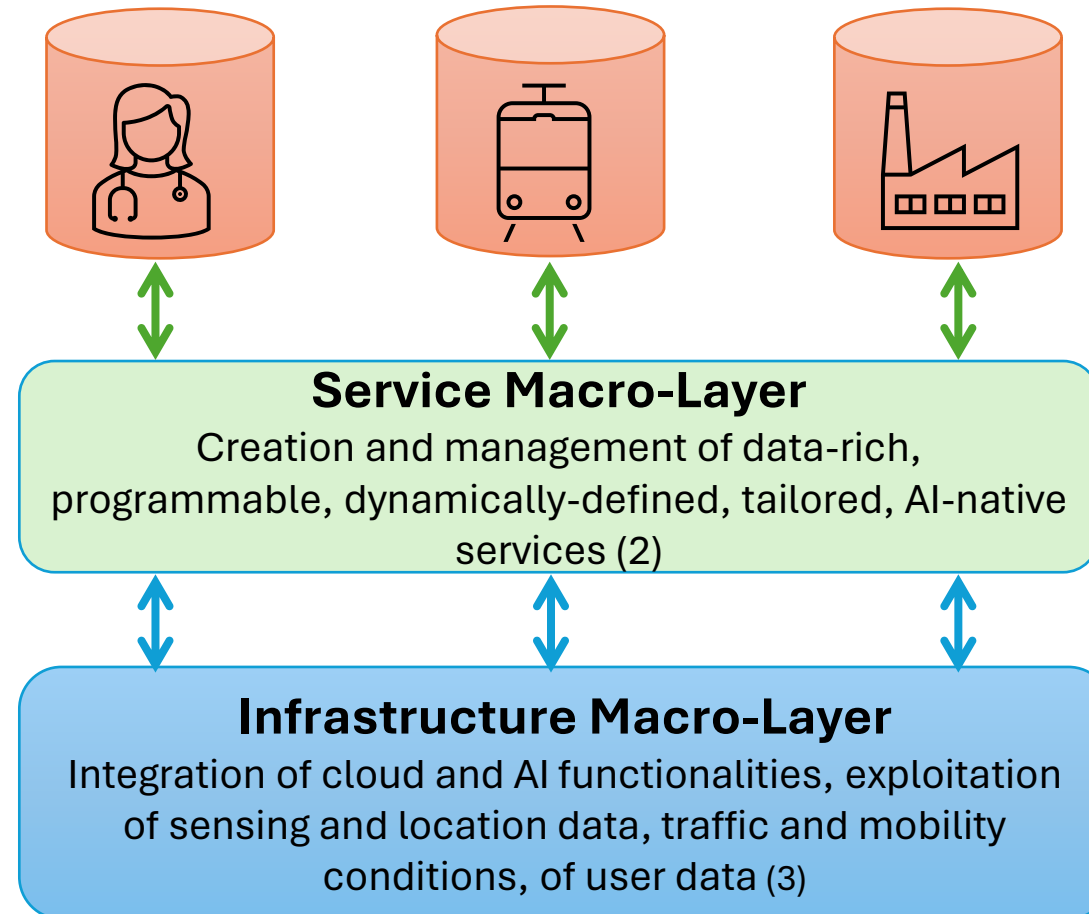
- Static, generic/standard offerings
- Network interfaces that require telco expertise to be used
- Network interfaces offering limited, control-plane only interactions



Verticals (e.g. Hospital, Subway, Industry)

AI-based interfaces, comprehensible to verticals without requiring them to oversee network infrastructures (1)

Interfaces capable of delivering insights, leveraging network-collected data (4)



services created bottom up, designed by the provider, or top down, with customers expressing their requests through AI-assisted intents

and also

- Scenarios of **private networks**, be them based on spectrum provided by operators or not, and **indoor environments**
- Role of AI (also in the tussle between operators and hyperscalers)

Thank you

- For inviting me to give this talk
- For your attention



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