Viasat

August 2023

RADIO SPECTRUM POLICY GROUP

Reference: **Draft Radio Spectrum Policy Group Opinion: The development of 6G and possible implications for spectrum needs and guidance on the rollout of future wireless broadband networks.**

Viasat welcomes the opportunity to provide the following comments on the Draft RSPG Opinion addressing the development of 6G and possible implications for spectrum needs and guidance on the rollout of future wireless broadband networks.[1] We submit these comments to address broadband satellite contributions to connectivity and further consider the implications for spectrum needs and guidance on the rollout of future wireless broadband networks, some of which are as soon as World Radio Conference 2023 (WRC-23).

Viasat is a global leading provider of communications solutions across a wide variety of technologies, both satellite and terrestrial. We provide hundreds of millions of high-speed, satellite-powered broadband connections every year to households, businesses and passengers in Europe[2], North America, Central America, Latin America and Australia, including internet services with speeds up to 100 Mbps and more. Our European broadband connectivity offering is growing very quickly via major acquisitions and investments in the latest and most advanced satellite constellations.

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1 *See* https://radio-spectrum-policy-group.ec.europa.eu/system/files/2023-06/RSPG23-026final-draft_RSPG_Opinion_on_6G_development_with_Annexes.pdf.

2 *See Viasat's Expansion in Europe Helps Bridge the Gap to Faster Broadband (video),* https://corpblog.viasat.com/viasats-expansion-in-europe-helps-bridge-the-gap-to-faster-broadband/; *Viasat Affirms Commitments to Bring its Powerful ViaSat-3 Satellite to Europe*, https://www.viasat.com/news/viasat-affirms-commitments-bring-its-powerful-viasat-3-satellite-europe; *KLM Introduces Viasat In-Flight Wi-Fi on European Flights, https://www.viasat.com/about/newsroom/press-releases/klm-introduces-viasat-flight-wi-fi-european-flights/* (April 22, 2021); *Viasat Completes Acquisition of Remaining Stake in its European Broadband Joint Venture, inclusive of the Ka-Sat Satellite and Ground Assets* (April 30, 2021), https://www.viasat.com/about/newsroom/press-releases/viasat-completes-acquisition-remaining-stake-its-european/; *Viasat Ramps Satellite in the Middle East and Western Europe Ahead of ViaSat-3 Launch; Signs Ka-Band capacity Lease Deal with Avanti Communications* (June 3, 2021), https://investors.viasat.com/news-releases/news-release-details/viasat-ramps-satellite-services-middle-east-and-western-europe.

Viasat's European footprint

In 2016, Viasat and Eutelsat jointly invested in the European satellite KA-SAT. In 2019, Viasat took complete ownership of the KA-SAT satellite and its existing wholesale business. The KA-SAT network provides high-speed, satellite fixed and mobile internet connectivity for Europe and Mediterranean markets.

In May 2023, Viasat acquired Inmarsat[3]. With this addition to the Viasat family, Viasat is enhancing its scale and scope of innovation in the global satellite broadband connectivity sector, offering new and improved capabilities to customers that will address the ever-increasing speed, capacity, flexibility, reliability, coverage and security. The closing of the Inmarsat acquisition enables the combined companies to bring together spectrum, satellite, and terrestrial assets, including 19 satellites in space spanning Ka-, L-, S- and C-bands. These complementary assets are already delivering connectivity and key safety services across maritime, aviation, government and consumer markets with the speed and reliability that our users rely on.

In S-Band, following the European Union award of a portion of the 2 GHz Mobile Satellite Service (MSS) spectrum in 2009, Inmarsat, together with its complementary ground component partner, Deutsche Telekom, built the European Aviation Network (EAN). This has become a globally unique success story from a commercial and from a regulatory perspective. In its fourth year since the partner airlines made the EAN service commercially available to passengers, more airlines and more passengers are using the service than ever before. Commercial services over EAN are now operational on more than 300 aircraft across four airlines: Iberia, British Airways, Vueling and Aegean Airlines. We are in advanced negotiations with a variety of additional airlines to provide EAN to aircraft, which will take the total number of equipped aircraft to above 500. With our project partners, we have invested more than €350 million into the EAN project to date. EAN has a very wide European footprint Thanks to EAN, passengers maintain connectivity when in the air and can use their time efficiently, whether for cloud-based work, keeping abreast of breaking news developments, or staying connected with family and friends.

The ViaSat-3 constellation is our next generation of ultra-high-capacity Ka-band satellites, expected to increase our global coverage and network capacity — bringing affordable, high-quality connectivity where, when, and how it is needed most. ViaSat-3 is planned to be a global satellite constellation consisting of three high-capacity (1-terabit-per-second or more) Ka-band satellites with one covering Europe.

When fully operational, the network is expected to enable billions of connections per year— in homes and businesses, on planes and at sea, and in communities that have limited or no connectivity — to provide people the connectivity they need. We have already started development of ViaSat-4 which will offer 5 to 7 times more throughput.

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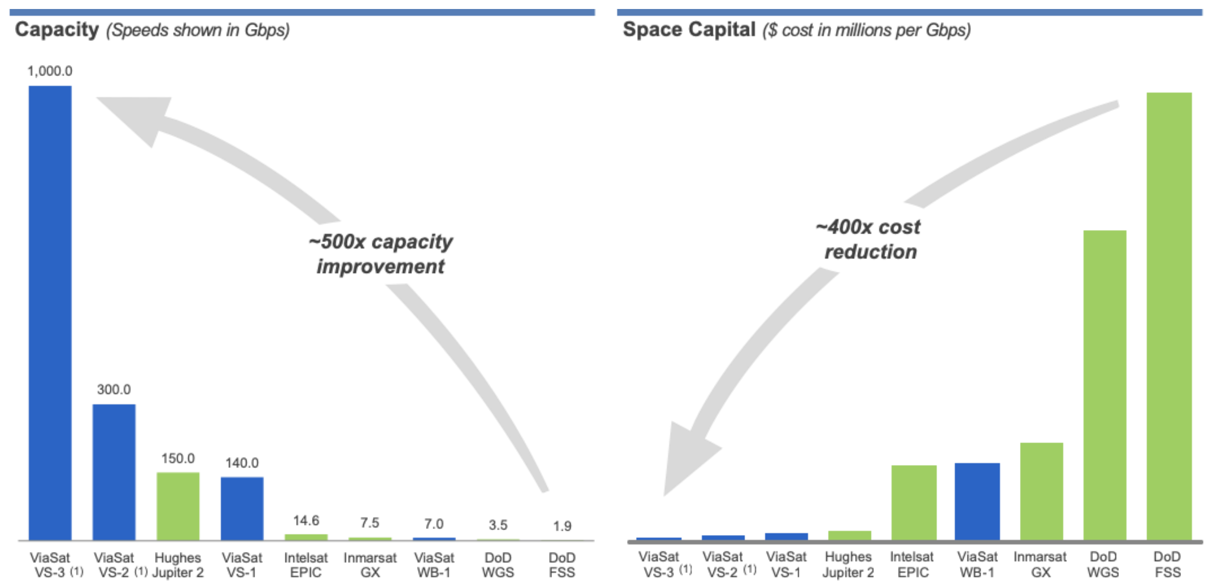
3 *See Viasat's Acquisition of Inmarsat Proceeds to Close* (May 25, 2023), https://news.viasat.com/newsroom/press-releases/viasat-acquisition-of-inmarsat-proceeds-to-close.

GSO Networks Are Already Providing High Quality Internet Services

One of the biggest misconceptions about modern broadband satellite systems is reflected in Section 6.1 of the RSPG Draft Opinion, in which questions are raised about the suitability of satellite services to provide internet connectivity due to constraints in capacity and latency.

Both capacity and latency are affected by how a particular network is designed and loaded. All broadband networks are susceptible to capacity and latency-related issues---both terrestrial and satellite. In this respect, it bears emphasis that the way satellite networks scale to increase capacity is conceptually no different than how terrestrial networks scale to do the same. Over the past onmade or so, individual GSO satellites alone have demonstrated orders of magnitudes of increases in capacity, as depicted below:



Source: Publicly available information and Company estimates
(1) Expected capacity and cost per Gbps following launch

Of course, multiple GSO satellites can be used to serve a given area, with a corresponding multiplier effect, and each of our next-generation ViaSat-4 satellites under development will offer 5-7 times the amount of throughput of our ViaSat-3 design.

Moreover, it bears emphasis that a variety of other factors also affect quality of service on all broadband networks, including jitter, packet loss, service interruptions/availability, and end-to-end latency, including transmission time, queuing delays, processing time at the source, destination, and intermediate switches, buffering delay at nodes, and packet retransmission.

Viasat would like to highlight the following points to address the focus in one part of the Draft Opinion on link latency, or propagation delay, in the path to and from an end user to a satellite. Focusing on one limited element of latency, such as link or propagation delay over one discrete element of a network is not an accurate assessment of the internet users' experience. That experience needs to be analyzed within the full context of the entire network path. Viasat emphasizes that the potential exists for introducing latency at every point in the communications path to and from the internet. The Roberson Report[4] (see Annex 1) details how latency can be introduced at many points in the communications path of all modern communications systems, regardless of the technology that is used. The components of end-to end latency include transmission time, number of hops in an end-to-end communications path, queuing delay at nodes, processing time at source destination and switches, propagation, buffering delay, and packet retransmission delay. Modern satellite systems, including geostationary (GSO) systems, are designed to offset the impact of latency on the user experience with a number of innovations, including addressing congestion with unprecedented increases in capacity, network management tools, including machine learning and artificial intelligence, and increasing VoIP quality using scheduling traffic algorithms and enhancing the codec to efficiently encode/decode signals. Moreover, it should be noted that most applications, including video that dominates internet traffic, are not latency sensitive at all.

<u>The Role of NTN Networks</u>

In the Draft Opinion, RSPG recognizes the role of, and need for, non-terrestrial networks to play a role in terrestrial 6G development and to further current initiatives on terrestrial 5G.

RSPG outlines the following possible roles of non-terrestrial networks:

- interim or disaster relief solution;
- for 5G and 6G specific applications with high data rates the use is limited, use as fall back for 4G kind of applications in case of emergency may be a valid scenario;
- providing coverage to isolated/underserved areas;
- broadband connectivity in worldwide logistics, transport and energy sectors;
- certain IoT applications;
- redundancy purposes; and
- backhauling.

RSPG identifies possible roles of non-terrestrial networks (NTN) in the 6G context but not all the use cases identified above are specific to terrestrial 5G and 6G. Most of these are also used in 3G and 4G. RSPG concluded that NTN **could** become an important connectivity layer while “License exempt spectrum can be used to complement mobile networks in individually licensed spectrum”. Viasat urges RSPG to reconsider this approach, especially considering the current connectivity offering from Viasat and the plans for the European satellite constellation Iris. Satellite services **are already** providing the following critical services around the globe, including in the European Union:

- competition in urban, suburban and rural areas;
- safety of life and emergency services;
- disaster relief;
- coverage to underserved and unserved areas;
- connectivity to worldwide logistics, transport and energy sectors;
- IoT applications;

[4] *See, “*Assessment of Geostationary Satellite (GSO) Capabilities vs. Alternative Internet Access Technologies,” prepared by Roberson & Associates" (“Roberson Report”) (15 August 2022).

- redundancy purposes; and
- backhauling.

One of the key objectives of 6G is to provide ubiquitous coverage and deliver multi-gigabit connectivity to parts of the world which are difficult to connect such as oceans – this is clearly an area where satellite-based NTN are best placed to achieve this objective.

Global usage of the 28 GHz bands

In its Draft Opinion, RSPG recognizes that 5G implementation is ongoing in the primary and pioneer bands identified for 5G and, in particular, that the 24.25-27.5 GHz (26 GHz) band is subject to different timing and implementations in Member states. RSPG also recognizes, in Section 1.c. of the Draft Opinion, that the band does not provide good coverage due to its different propagation characteristics as compared to the other bands used since the launch of mobile technology for 5G. It is widely understood that the 26 GHz band will not provide national coverage for mobile technology and will be limited, at best, to local use. However, satellite technology, in the 27.5-29.5 GHz (28 GHz) band, provides national, pan-European and worldwide coverage. In Section 6.3, RSPG recalls the need to protect satellite receivers and earth stations. We welcome this conclusion and invite the RSPG, in its conclusions with regards to implications for spectrum needs and guidance on the rollout of future wireless broadband networks to ensure protection of satellite services.

ITU RR Article 22 and Resolution 76 Foster Investment and Innovation for Satellite Broadband

Global validation of satellite broadband use at ITU World Radio Conferences has provided global regulatory confidence to support those investments. The result of that global regulatory support is that GSO satellite networks are being designed, built and deployed around the world in reliance on the protection from NGSO unacceptable interference provides by the ITU Radio Regulations (RR) Article 22 equivalent power flux density (EPFD) limits on NGSO system transmissions into GSO networks, as well as the important aggregate NGSO limits contained in ITU Resolution 76.

In recognition of the continued expanded use of the Ka and Ku bands for satellite-powered connectivity at WRC-19, the global community approved additional studies on further extensive use of the Ka and Ku bands for satellite-to-satellite links (WRC-23 Agenda Item 1.17) and NGSO earth stations in motion (NGSO ESIM) (WRC-23 Agenda Item 1.16). Notably, NGSO satellite-to-satellite links and ESIM transmissions are subject to the limits on unacceptable interference that may be generated by NGSO systems into GSO networks, as defined by ITU RR Article 22 and aggregate limits in Resolution 76.

Viasat respectfully urges the RSPG Member States and the EC to take note that satellite operators have made substantial investments on existing spectrum services in reliance on Article 22 and Resolution 76. There is no question that the intention of the international community is make the 28 GHz band a "core" satellite broadband frequency band. There is a vast amount of other spectrum being made available for terrestrial services that is yet to be deployed to any substantial level, including in much more cost-effective lower frequency bands (*e.g.*, below 6 GHz). Predictable spectrum licensing and conditions encourages long-term network investment. Therefore, the framework defined under ITU RR Article 22 and Resolution 76 must remain unchanged. Instead, the important work that needs to be done is already ongoing in ITU Working Party 4A on how the Article 22 EPFD limits are implemented to better model NGSO systems and the potential interference that can cause to GSO systems if the EPFD limits are not respected.

Thus, in line with the scope of the RSPG report to address the possible implications for spectrum needs and guidance on the rollout of future wireless broadband networks, Viasat urges RSPG to preserve the 28 GHz band for the satellite broadband services under the ITU Radio Regulations Article 22 and Resolution 76 framework to ensure that NTN will achieve the 6G objectives. Viasat and other operators have invested billions of Euros in the development and deployment of satellite broadband services in this frequency band and in reliance on the protection provided by Article 22 and Resolution 76 from interference from NGSO systems.

Viasat acknowledges the experience of the RSPG membership and importance of the decisions being made on spectrum management and encourages RSPG to base those decisions on ensuring long-term regulatory certainty and a favorable investment environment for the EU economy, ensuring that Member States benefit from modern satellite broadband connectivity.

Viasat appreciates RSPG's consideration of the information above. We remain at your disposal to answer any further questions or provide further details as requested.

Annex 1

“Assessment of Geostationary Satellite (GSO) Capabilities vs. Alternative Internet Access Technologies,” prepared by Roberson & Associates" (“Roberson Report”) (15 August 2022)

Assessment of Geostationary Satellite (GSO) Capabilities vs. Alternative Internet Access Technologies

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15 August 2022

Roberson and Associates, LLC
Technology and Management Consultants ®

Executive Summary

- Proven GSO technology is a reliable way to expand broadband connectivity and provide universal service.
- No single technology solution uniformly dominates the others along various metrics.
- There is no one size fits all solution for broadband deployment for all of the European Union.
- Decisions regarding optimal technology solutions are best made on a regional or local basis.

Assessment Approach

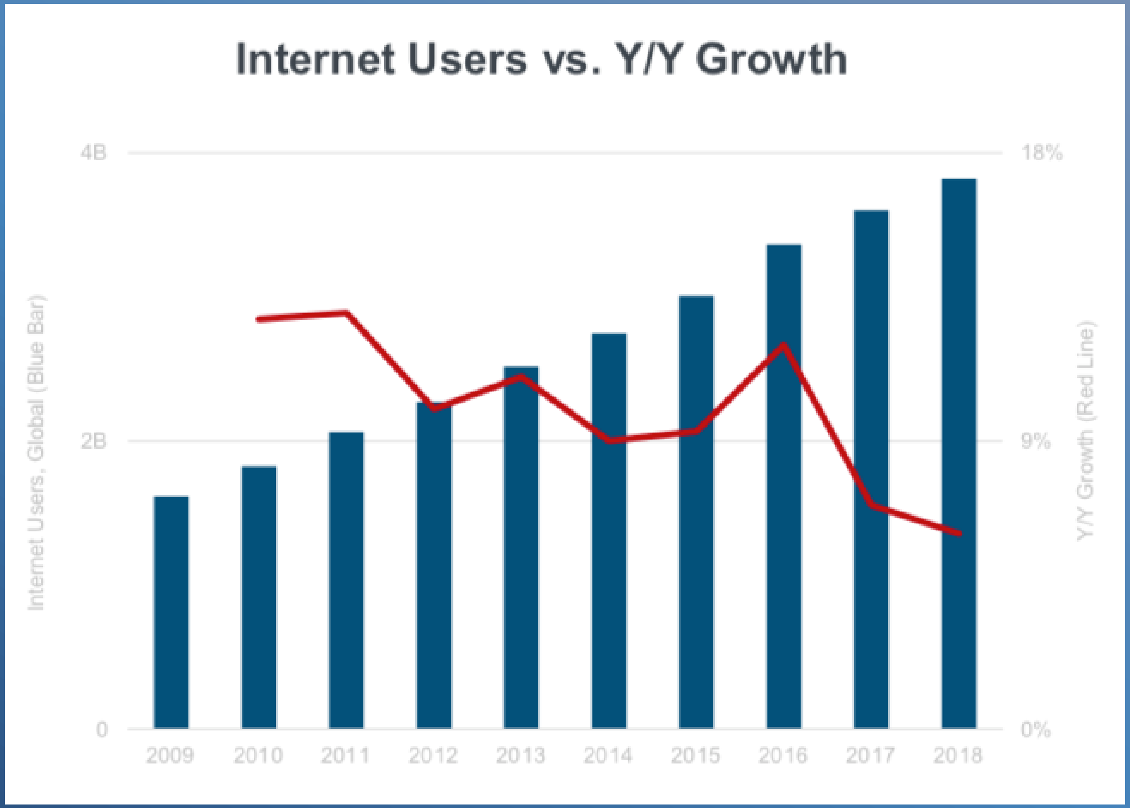
- Analyze Internet Application Categories and Identify Technical Requirements
- List and Compare Technical Characteristics of Internet Access Technologies
- Assess Internet Access Technologies Ability to Meet Application Requirements
- Conclusion

Application Categories: Internet Trends

Internet Trends

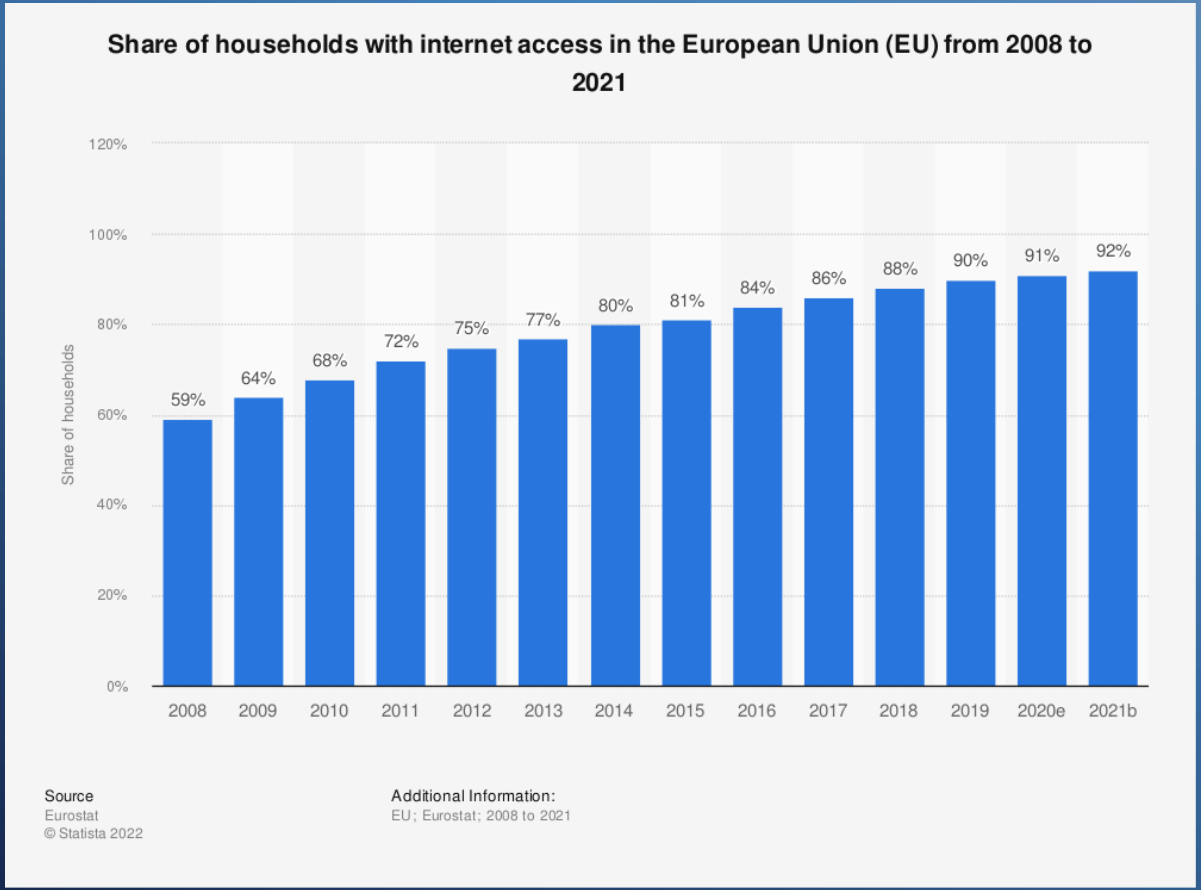
- Users
- E-Commerce
- Usage …
- Freemium Business Models
- Data Growth
- …Usage
- Work
- Education
- Immigration
- Healthcare

Global Internet User Growth = Solid But Slowing +6% vs +7& Y/Y



>> The last Internet Trends report by Meeker opens by noting that Internet User growth is steady…

Application Categories: In the EU, Digital Media Usage is Strong



https://www.statista.com/statistics/377585/household-internet-access-in-eu28/

Table 1 Use of internet services indicators in DESI

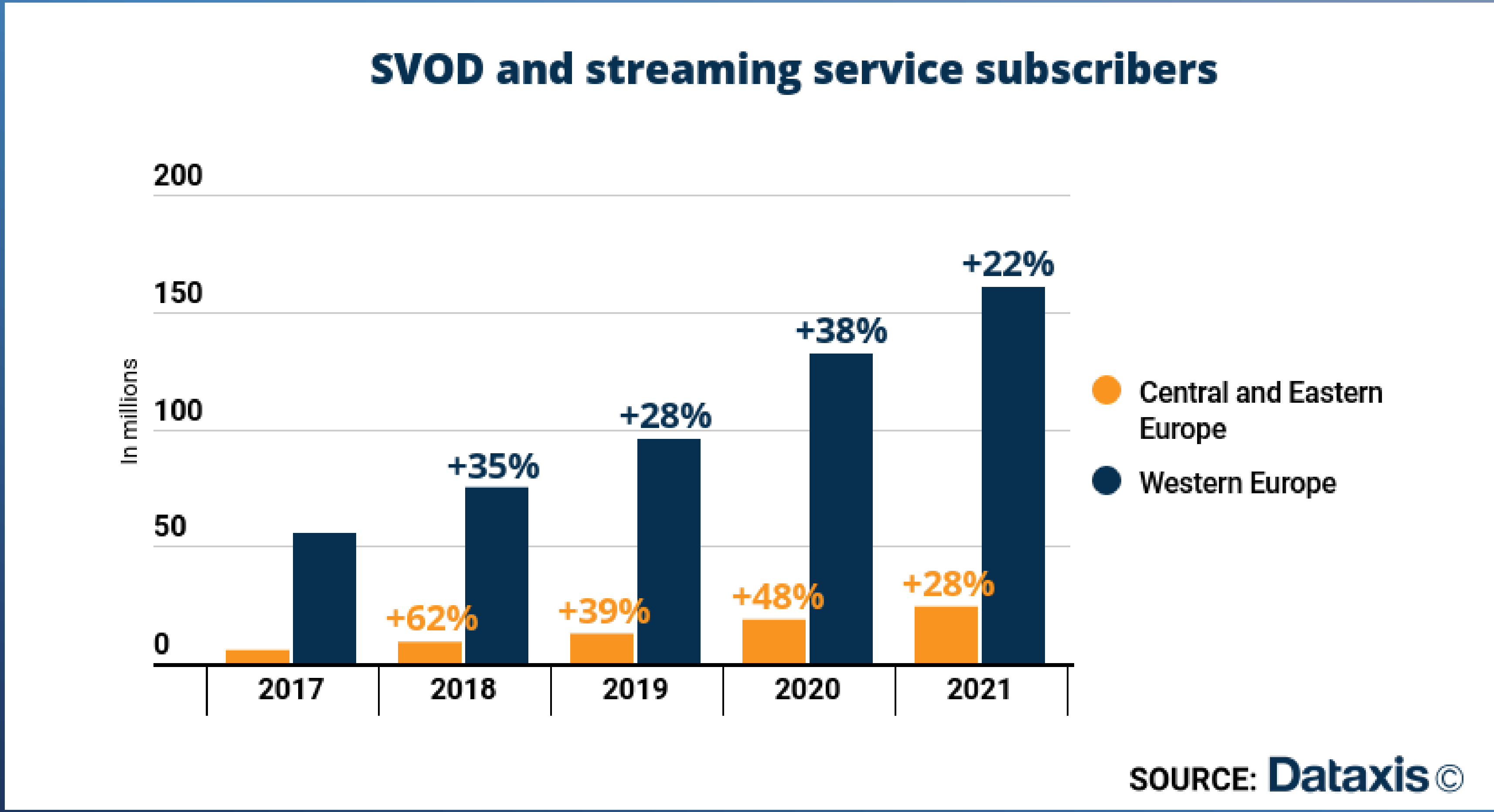
	EU		
	DESI 2018	DESI 2020	
3a1 People who have never used the internet % individuals	**13%** 2017	**9%** 2019	
3a2 Internet users % individuals	**81%** 2017	**85%** 2019	
3b1 News % internet users	**72%** 2017	**72%** 2019	2
3b2 Music, videos and games % internet users	**78%** 2016	**81%** 2018	1
3b3 Video on demand % internet users	**21%** 2016	**31%** 2018	
3b4 Video calls % internet users	**46%** 2017	**60%** 2019	
3b5 Social networks % internet users	**65%** 2017	**65%** 2019	
3b6 Doing an online course % internet users	**9%** 2017	**11%** 2019	
3c1 Banking % internet users	**61%** 2017	**66%** 2019	
3c2 Shopping % internet users	**68%** 2017	**71%** 2019	3
3c3 Selling online % internet users	**22%** 2017	**23%** 2019	

Source: DESI 2020, European Commission.

Digital Economy and Society Index (DESI) 2020
https://digital-strategy.ec.europa.eu/en/policies/desi-use-internet

>> and digital media is consumed as it is integrated into more category offerings.

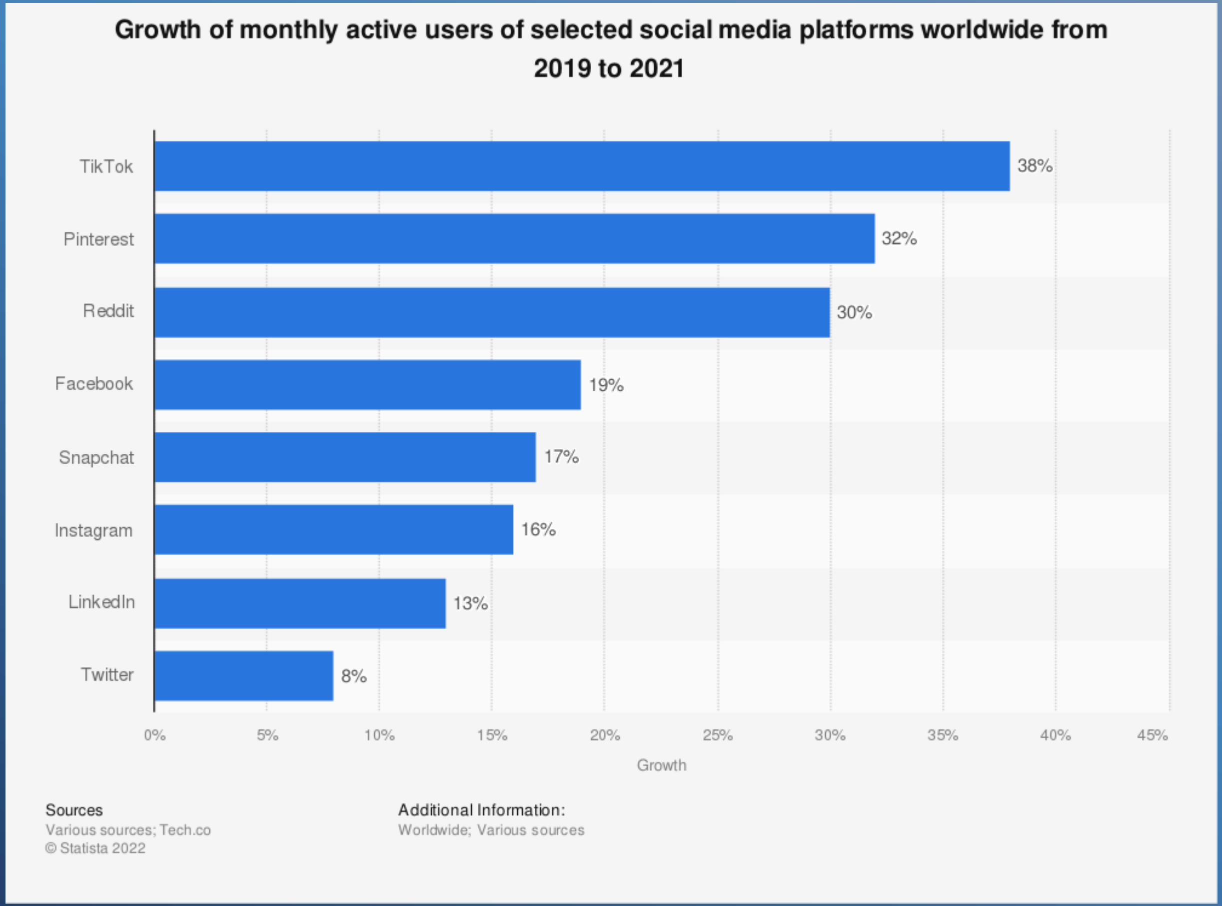
Application Categories: In the EU, Digital Media Usage is Strong



https://dataxis.com/researches-highlights/680634/the-streaming-war-intensifies-in-cee/

And, video on demand and streaming service subscribers are growing strongly.

Application Categories: On-line Platforms and Internet Tasks



https://www.statista.com/statistics/1219318/social-media-platforms-growth-of-mau-worldwide/

Global growth of social media platforms is strong

Application Categories: On-line Platforms and Internet Tasks

On-line Platforms

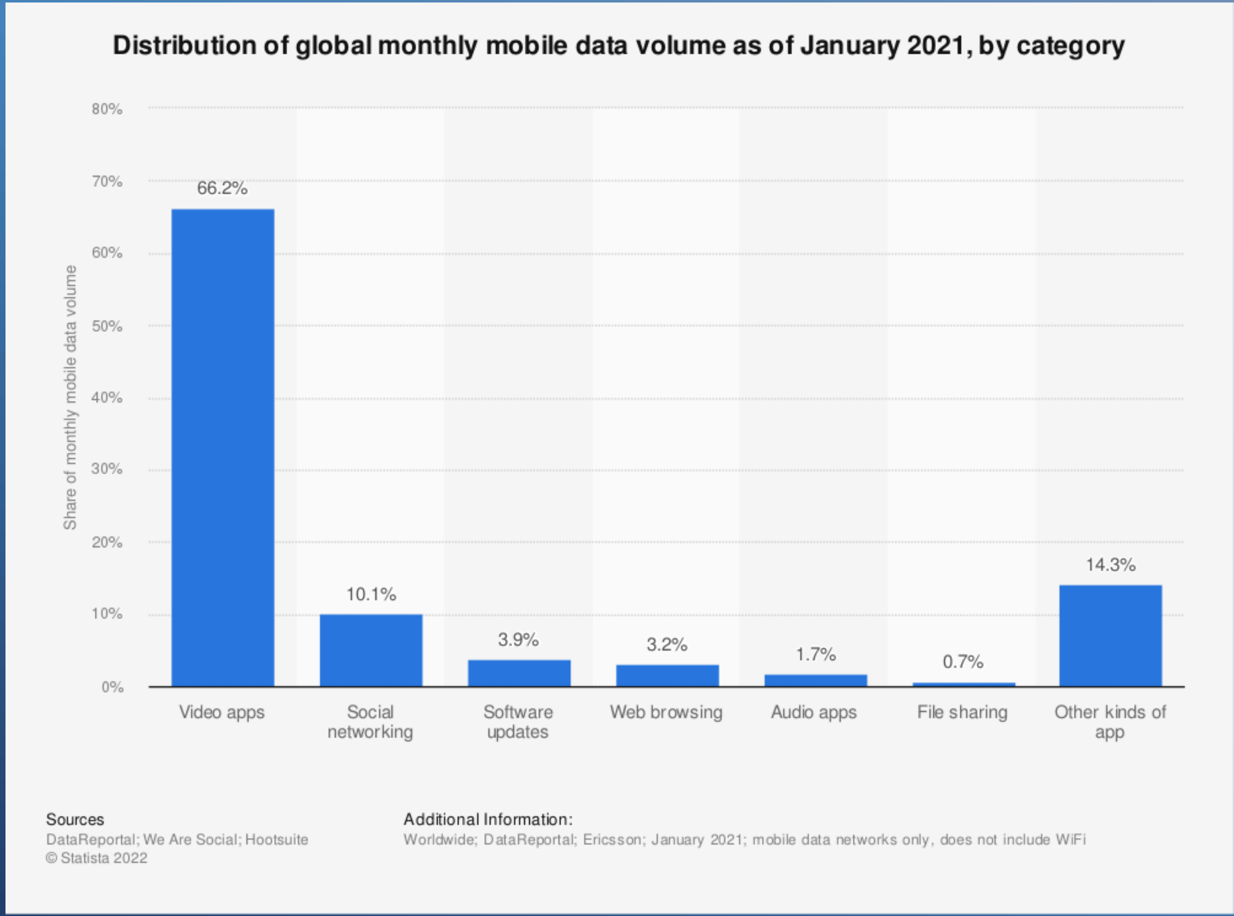
- TikTok
- Pinterest
- Reddit
- Facebook
- Snapchat
- Instagram
- LinkedIn
- Twitter

Internet Related Tasks

- Video
  - -- Streaming (unicast, multi-cast, broadcast)
  - -- Conferencing Tools
  - -- Integrated in On-line Platforms
- Interactive Applications
- Web Browsing
- Messaging (email, SMS, DM, images, chat)
- Mixed Reality: AR/VR
- File Transfer
- Audio
- Internet of Things
- Interactive Haptic/Tactile

>> …common internet related tasks shows that On-line Platforms commonly access four key tasks

Application Categories: Mobile Data Volume



https://www.statista.com/statistics/383715/global-mobile-data-traffic-share/

>> The top four categories produce 83.4% of mobile data volume.

https://www.visualcapitalist.com/the-worlds-most-used-apps-by-downstream-traffic/ Sept 20, 2021

Application Categories: Video is everywhere

"Our data show in the first half of 2021 bandwidth traffic was dominated by streaming video, accounting for 53.72% of overall traffic, with YouTube, Netflix, and Facebook video in the top three. "

The Global Internet Phenomena Report, January 2022, page 12-13

CATEGORY TRAFFIC SHARE

TOTAL TRAFFIC

	Category	Total Volume
1	Video	53.72%
2	Social	12.69%
3	Web	9.86%
4	Gaming	5.67%
5	Messaging	5.35%
6	Marketplace	4.54%
7	File Sharing	3.74%
8	Cloud	2.73%
9	VPN	1.39%
10	Audio	0.31%

GLOBAL APP TRAFFIC SHARE

TOTAL TRAFFIC

	Category	Total Volume
1	YouTube	14.61%
2	Netflix	9.39%
3	Facebook	7.39%
4	Facebook video	4.20%
5	Tik Tok	4.00%
6	QUIC	3.98%
7	HTTP	3.58%
8	HTTP Media Stream	3.57%
9	BitTorrent	2.91%
10	Google	2.79%

>> The top four categories produced 82% of all traffic.

Technical Requirements: Interactive User Experience

User Attention	Gold Standard
The end-user feels that the system is reacting instantaneously. Applies to direct manipulation interactions such as data/text entry and drop/dragging.	100 ms
The end-user's flow of thought stays uninterrupted, even though they will notice the delay. Applies to local application functions such as large table sorting.	1 second
The end-user's attention stays focused on the dialogue. Applies to steps within a coherent task.	10 seconds

>> The standard for interactive response times for various tasks has been well established.

Nielsen, Jakob, Usability Engineering, 1993
https://www.nngroup.com/articles/response-times-3-important-limits/

Internet Application Tasks: Technical Requirements

Internet Tasks	2-way Response Times (to the End-User)
Video - Broadcast Streaming - Two Way Conferencing	< 4 seconds for stream initiation Maintain 25-30 FPS video
Interactive Applications	< 100 ms for real time data/text entry apps < 2 seconds for clicks and browsing
Web Browsing	< 5 sec page load times
Messaging: Email, SMS, Social Media	< 2 sec for user acknowledgement < 10 sec for delivery
Mixed Reality: AR/VR	< 100 ms for low latency environments (e.g. shooter games, simulations)
File Transfer	< 2 sec acknowledging task initiation
Internet of Things	< 1 sec for Interactive displays < 10 sec for data collection

>> Based on those response times, GSO systems can serve the dominant share of internet traffic and provide good user experiences

Technical Characteristics of Internet Access Technologies

Estimates as of end of 4th Quarter 2023	GSO Satellite	LEO Satellite Constellation (Best case estimates for an evolving mega-constellation) (see Note 1)	Terrestrial Wireless FWA	Wireline (Fiber)
Capacity (over European Union)	> 1.5 Tbps	~ 1.1 Tbps (see note 7)	(20 X No. of 5G BS) Gbps @ 20 Gbps (DL)/10 Gbps (UL)	~ 130,000 Tbps
Speed per customer	150 Mbps	150 Mbps (see Note 8)	> 100 Mbps	> 1 Gbps
Link Latency (propagation only)	240 milli-seconds	3.66 - 8.84 milli-seconds (best case)	< 10 - 50 micro-seconds (ISD 6 - 30 Km)	5 micro-seconds per Km
2-way Latency	570 milli-seconds	~100 - 110 milli-seconds (best case)	60 - 80 milli-seconds (measured speed)	80 milli-seconds
Jitter	GSO end-to-end path typically use fewer hops and fixed route from source to destination. LEO constellations likely use multiple hops with varying path lengths resulting in potentially larger jitter.		10 – 100 micro-seconds	< 10 micro-seconds
Coverage (in European Union)	~ 100%	~ 100% (See Note 4)	~ 67 % households (Very High Capacity Networks) (Notes 5, 6)	
Mean <u>Link Interruption</u> Frequency (Note 2,3)	3.8×10^{-6} events/sec (1 event every ~3 days)	5.5×10^{-4} events/sec (1 event every 30 minutes)	1×10^{-5} events/sec	1×10^{-7} events/sec
Mean <u>Link Interruption</u> Duration (Note 2)	~60 seconds	~60-300 seconds	60 seconds	~ 10 seconds

Technical Characteristics of Internet Access Technologies - Notes

Note 1: a) Percentage of LEO satellites providing useful capacity over EU is assumed 1.25%. The surface area of EU is only 0.83% of earth's surface but a greater percentage is used for the inclination of orbital planes. Specifically a 50% increase in satellite coverage over EU is assumed. b) Satellite capacity is assumed to be 20 Gbps. The usable capacity will be considerably lower due to factors such as the size of the phased array antenna dimensions, size of solar power, available spectrum, frequency reuse limitations, density of covered locations and other LEO satellite parameters. c) Sunny case scenario, i.e., based on past record of launch and success is assumed with respect to launching and moving the LEO satellites into final operational orbits over the next 17 months (till end of 2023). The long-term challenge to consistently maintain and operate such large constellations, given the 5-year (or less) lifetime of each satellite, is ignored.

Note 2: Mean service interruption frequency and mean service interruption duration – The user experience is adversely impacted due to handover and line of sight issues at low terminal elevation angles (both satellite and terrestrial wireless systems). Wireline media (fiber) suffers service interruption due to factors such as fiber cuts. These factors manifest themselves in user experience acceptability.

Note 3: Subject to change as LEO constellations are fully deployed. Sampling of articles on user experiences are below.

a) https://blog.beerriot.com/2021/02/06/rural-internet-starlink-outage-data/
b) https://istheservicedown.in/problems/starlink
c) https://www.datacenterdynamics.com/en/news/spacexs-starlink-experiences-brief-but-significant-outage/
SpaceX's Starlink experiences "brief but significant" outage, April 11, 2022

Technical Characteristics of Internet Access Technologies - Notes Continued

Note 3: (continued)

d) https://downdetector.com/status/starlink/

e) https://www.cablefree.net/pdf/CableFree%20AN13%20Fibre%20Cuts.pdf

Note 4: Local capacity constrained by limits on frequency reuse and density of covered locations.

Note 5: A Closer Look at Fibre Penetration in APAC, EU and the USA, INSIGHT Magazine, 2022 from the Prysmian Group. https://www.prysmiangroup.com/en/insight/telecoms/nexst/a-closer-look-at-fibre-penetration-in-apac-eu-and-the-usa

Note 6: BEREC Guidelines on Very High Capacity Networks,, BoR (20) 165, October 1, 2020. https://www.berec.europa.eu/sites/default/files/files/document_register_store/2020/10/BoR_%2820%29_165_BEREC_Guidelines_VHCN.pdf

Note 7: This calculation assumes 4408 satellites distributed over multiple shells with each shell having an assumed number of orbital planes, number of satellites per plane and angle of inclination of the orbital plane. Addition of another 648 satellites (each 7.5 Gbps) in near-polar orbit (such as OneWeb) will contribute additional 0.04 Tbps capacity over EU.

Note 8: https://www.fcc.gov/document/fcc-rejects-ltd-broadband-starlink-bids-broadband-subsidies
FCC REJECTS APPLICATIONS OF LTD BROADBAND AND STARLINK FOR RURAL DIGITAL OPPORTUNITY FUND SUBSIDIES, Applicants Failed to Meet Program Requirements and Convince FCC to Fund Risky Proposals

Latency Explained

- Transmission Time (Packet Size / Capacity of Link)
- Queueing Delay at nodes
- Processing Time at nodes
- Propagation Time = distance / (α * speed of light)   α=1 (free space), 0.7 (fiber)
- Number of round-trip hops from source to destination (usually same as source)
- Buffering Delay at nodes
- Packet Retransmission delay (at link level and end-to-end) for reliable communication

Elementary Network Analysis 101*

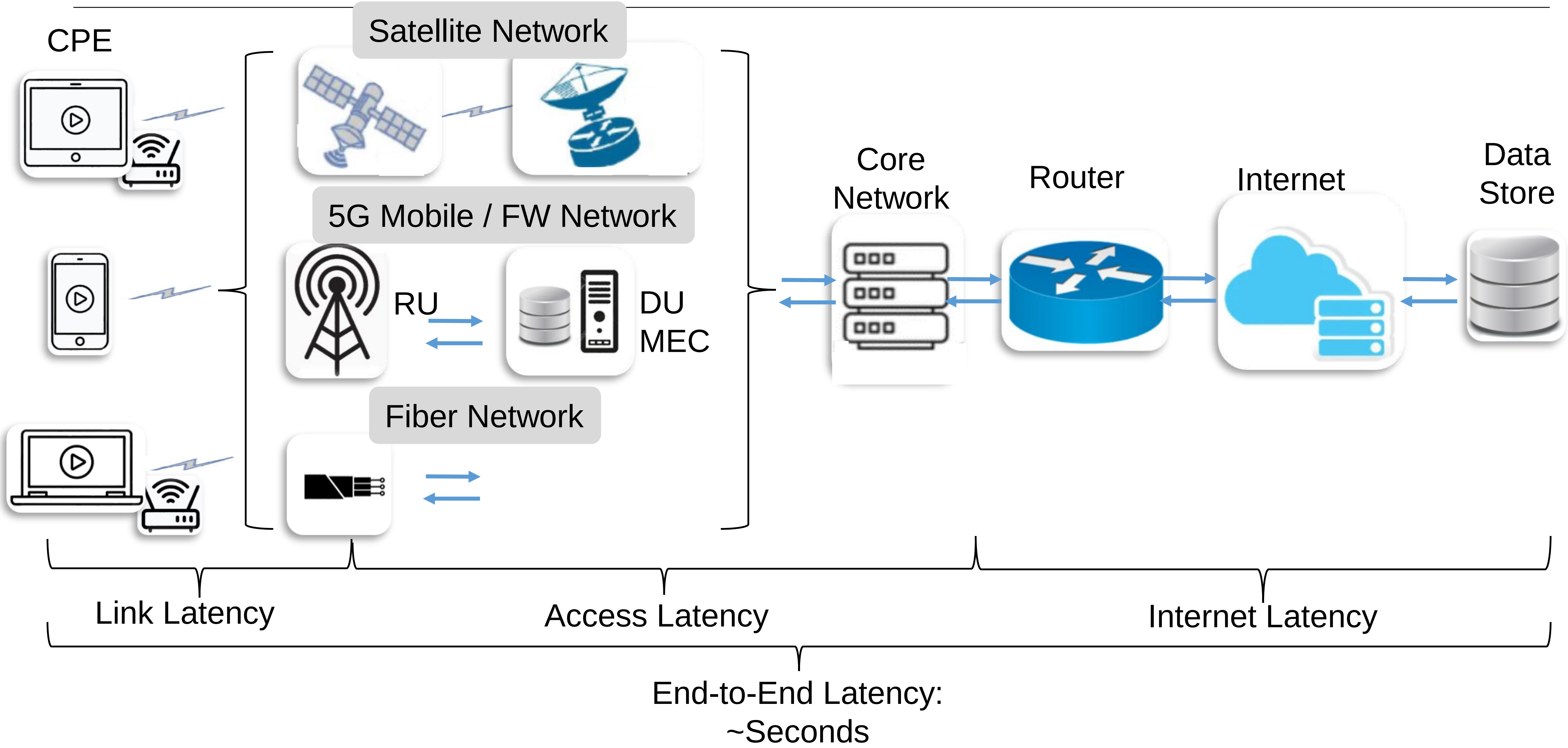
Notes

a) Application-level requirement for human acceptable latency is important which is the full 2-way latency rather than just one component (e.g. propagation time)
b) 2-way latency is application specific with mitigation techniques available to minimize impact

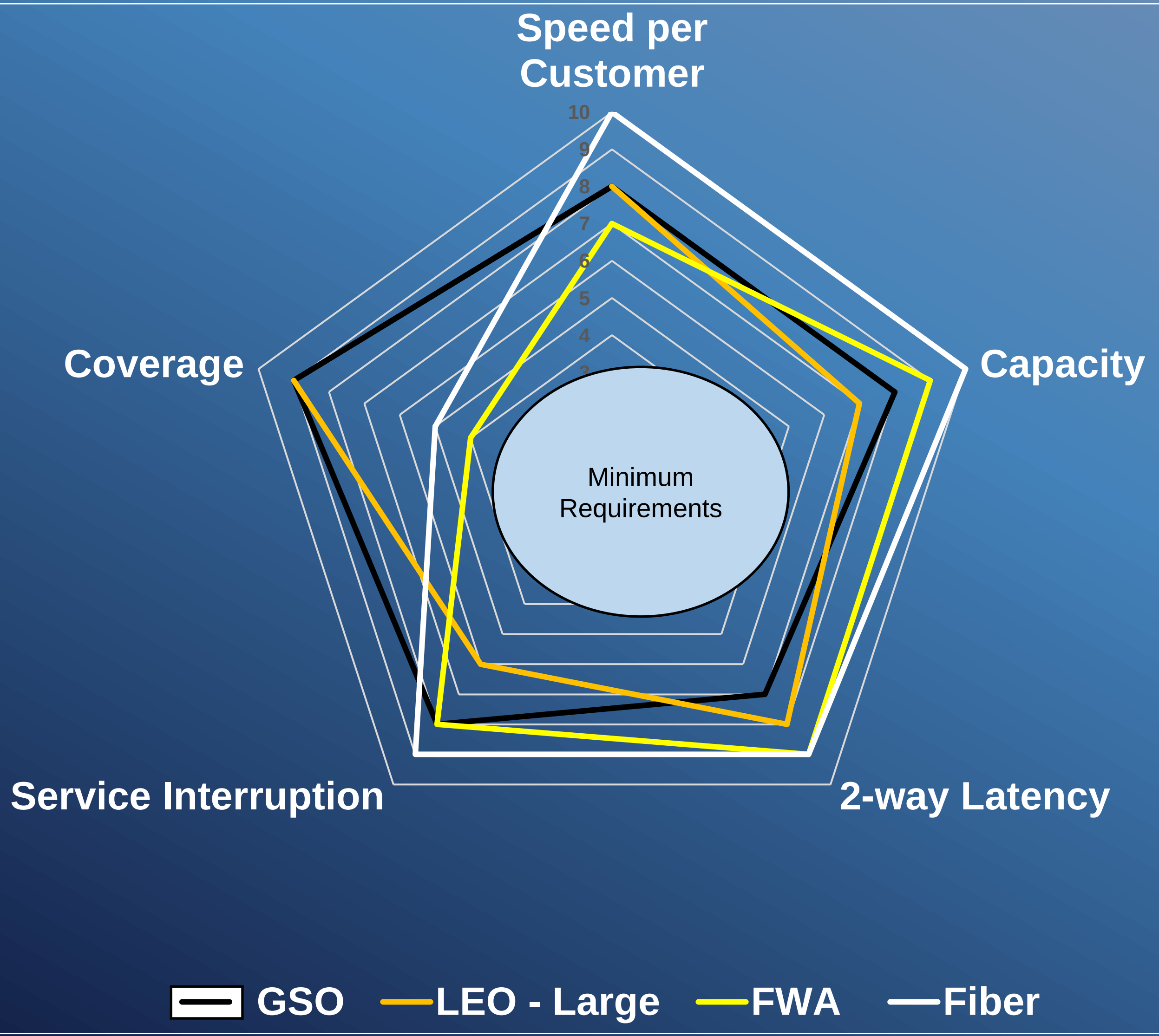
>> The key requirement Is that an Access Technology meets the human acceptable application requirement when all the delay elements are considered and accounted for. It is more than just meeting a number based on Link Propagation Time alone.

*L. Kleinrock Queueing Systems, Vol. I, Theory, Wiley Inter-science (New York), 1975.

Elements of End-to-End Latency



Internet Access Technologies – All Technologies Exceed the Requirements



>> There Is No Technology That Dominates All the Technical Performance Categories.

>> There is no clear winner.

Additional Characteristics of Internet Access Technologies

- System reliability (e.g., Service interruption frequency and duration due to line of sight and other factors)
- System availability
- Scalability and number of EU customers potentially served
- Relative deployment cost
- Maturity of service (How long has solution been in operation)
- People served globally since inception of service
- Robustness to environmental and/or natural catastrophes (geomagnetic storms, earthquakes, forest fire, blizzard, floods, tsunamis)

>> These Characteristics Are Just as Important to Users as Capacity and Throughput

Additional Factors in Comparison of Solution Alternatives

	GSO	LEO Large Constellations	Terrestrial FWA	Wireline (Fiber)
Satellite and System reliability (including. line of sight issues)	Reference 71, 74	Link Interruptions (handoffs, blockages)		
System availability		Partial deployment now; Likely improve in few years		
Scalability and number of EU Customers **potentially** served (having access to the technology)	~100%	~100%	198 Million (FTTP/FTTH /FWA)	
Relative deployment cost (in billions of Euros €)	~ 0.75 per HTS satellite	Expected to be few tens of billions		> €100
Maturity of service (How long has solution been in operation)	Since 1970's	Early stage of deployment	Nascent (use 5G cellular expertise)	Decades of urban deployment
Customers served globally since inception of service	Several Million	< 1 Million	Few million Rural | Urban	130 Million Rural | Urban
Robustness to environmental and/or natural catastrophes (geo- magnetic storms, earthquakes, forest fire, blizzard, floods, tsunamis)	Decades of deployment experience	Potential for disturbances in low altitude, politics, debris		
Time to Deploy broadband Internet	Now	Multiple years (for stable configuration and replacement launches)	Several years to reach all users	Many years to reach all users

Excellent (5)	Good (4)	Average (3)	Below Average (2)	Poor (1)

>> GSO Meets or Exceeds Service Requirements Compared to Other Technologies

Comparison of Internet Access Technologies and Application Requirements

Underlying Tasks	GSO	Large LEO	Terrestrial Wireless (FWA)	Wireline (Fiber)
Video - Broadcast Streaming -Two Way Conferencing	YES	YES	YES	YES
Interactive Applications	YES	YES	YES	YES
Web Browsing	YES	YES	YES	YES
Messaging: Email, SMS, Social Media	YES	YES	YES	YES
Mixed Reality: AR/VR -- moderate latency (e.g. strategy games) -- low latency (e.g. 1st person shooter)	YES NO	YES NO	YES YES	YES YES
File Transfer	YES	YES	YES	YES
Internet of Things	YES	YES	YES	YES

>> GSO Meets Requirements for All Applications Except Extremely Low Latency AR/VR and Shooter Game

Summary

- Terrestrial wireless and wireline offer high performance and capacity but are limited in coverage. These solutions, especially wireline fiber, are significantly more expensive and take much longer to deploy.

- GSOs offer performance and capacity for most applications and users and excel in coverage with proven capability to connect the unconnected in an economical manner.

- NGSO systems are new and immature (Ref. 1). They may ultimately offer adequate capacity for many applications and good coverage but take a long time to deployment (multiple years). Many serious challenges and risks remain:
  - Technical challenges (good and consistent quality of service)
  - Operational challenges (launch, grow and sustain a large constellation)
  - Successful business case

Ref. 1: https://www.fcc.gov/document/fcc-rejects-ltd-broadband-starlink-bids-broadband-subsidies

FCC REJECTS APPLICATIONS OF LTD BROADBAND AND STARLINK FOR RURAL DIGITAL OPPORTUNITY FUND SUBSIDIES, Applicants Failed to Meet Program Requirements and Convince FCC to Fund Risky Proposals

Conclusion

- Among satellite solutions, a critical comparison of High-Throughput (HTP) GSO and planned NGSO constellations reveals no definitive superiority of one over the other.
- HTP GSO can address most of the applications & use cases; unlike NGSO systems they carry little risk of technical viability or uncertainty of business success

- **In summary:**
  - **Proven GSO technology is a reliable way to expand broadband connectivity.**
  - **No single technology solution uniformly dominates the rest along various metrics.**
  - **There is no one size fits all solution for broadband deployment at a national scale.**
  - **Decisions regarding optimal technology solutions are best made on a regional or local basis.**

Thank You

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