Body of European Regulators for Electronic Communications

BEREC

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Draft Report on Satellite Connectivity for Universal Service

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Contents

Executive Summary

This Report considers the potential of Satcom solutions to provide ubiquitous broadband connectivity for Universal Service.

Several geostationary (GSO) and non-geostationary (NGSO) satellite networks and systems are available or become available with the 2022-2025 timeframe which can provide Satcom broadband services to end-users that use appropriate customer premises equipment.

A questionnaire was issued to all BEREC Members and Participants without voting rights and the key results are as follows: Of the twenty-nine responses received, two NRAs indicate that Satcom solutions contribute to universal service presently, two NRAs are studying Satcom solutions for same, while the remaining respondents set out that they have no firm plans or do not envisage such a role for Satcom solutions.

This Report is structured as follows:

- **Chapter 1** sets out some relevant background, observing that Satcom solutions may contribute to Universal Service.
- **Chapter 2** provides an overview of relevant Satcom solutions and key important aspects such as pricing, service quality, expected role in the market, available satellite capacity and demand as well as important regulatory considerations.
- **Chapter 3** provides an overview of the results of the questionnaire which provides some information on how the subject of Satcom solutions for Universal Service is considered in some European countries.
- **Chapter 4** sets out BEREC's preliminary position namely, that there are a number of regulatory issues having a national dimension, which supports a case-by-case approach to Satcom solutions for Universal Service.

BEREC would welcome stakeholder's views in relation to any of the material presented in the Report, as well as any feedback on any other relevant considerations / emerging issues that should be identified. The final Report is intended to be give interested parties a brief overview of the current thinking in BEREC on the use of Satcom for USO. BEREC looks forward to informing itself of developments in the sector so that European consumers can benefit from relevant types of connectivity solutions.

1. Background

On December 20, 2018, Directive (EU) 2018/1972 of the European Parliament and of the Council of December 11, 2018 on the European Electronic Communications Code (the "EECC") came into force. Due to the requirements of the EECC, a revision of the national regulations on universal service is required in many EU countries. In Article 84, paragraph 1, the EECC expands the universal service entitlement to an "available adequate broadband internet access service…", which must be available at a fixed location at an affordable price, whereas under the previous European legal framework only functional internet access had to be guaranteed. For its part, BEREC has also reported on Member States' best practices to support the defining of adequate broadband Internet Access Service (IAS) [1], which sets out insights into the practices of in nine countries that introduced broadband under a US obligation.

In this context, the supply of broadband internet access services to remote locations (e.g. remote settlements or hermitages) appears to be particularly challenging. A potential solution could be to serve these locations via satellite communications solutions "Satcom solutions", as an alternative to the currently most common connection technology using terrestrial fixed or mobile networks. In addition, Satcom solutions could fill gaps in coverage from terrestrial services.

The EECC enshrines an "adequate broadband internet access service" in the universal service mechanism. Bringing broadband internet to remote or underserved areas is particularly crucial for ubiquitous access. At the same time, it is a challenging task due to factors such as high costs for the service provision. Broadband internet via Satcom solutions can be a promising solution, especially against the background of new systems in the low and medium earth orbit as well as geostationary orbit (new high throughput networks).

The European Commission recognises the potential of Satcom solutions and has taken first steps towards a European space-based connectivity initiative (link).

In this context and given the central role of NRAs in the implementation of Universal Service obligations, this Report considers the potential of Satcom solutions for ubiquitous broadband connectivity in an objective and technology neutral way.

[11] See also BEREC Document BoR (20) 99 drafted in close cooperation with the European Commission, in particular with regard to the data sources referenced in the report. The Report takes into account the outcome of the public consultation

2. Overview

2.1. Satellite System Overview on satellite connectivity for the Universal Service

Several geostationary (GSO) and non-geostationary (NGSO) satellite networks and systems are available or become available with the 2022-2025 timeframe which can provide broadband services to end-users who use appropriate customer premises equipment (such as an outdoor antenna plus an indoor router/modem), which is easy to install and with typical antenna size of about 50-77 cm. There have been many recent improvements in the size and complexity of CPE equipment. The equipment is relatively easy to install and small in size. Such satellite networks for broadband services typically use nowadays Ku-band and/or Ka-band frequencies for connecting the satellite(s) and end-users. Satellite gateways (also named satellite access nodes) are used on the other side of the connection between the satellite(s) for providing the linkage to terrestrial backbone or backhaul networks. For several technical reasons, such networks may require a number of gateways for GSO networks. For NGSO mega-constellation networks, such network gateways need several antennas for e.g. handover between NGSO satellites and to support links to several NGSO satellites within the radio visibility simultaneously. More complex arrangements can even make use of inter-satellite links between e.g. NGSO satellites.

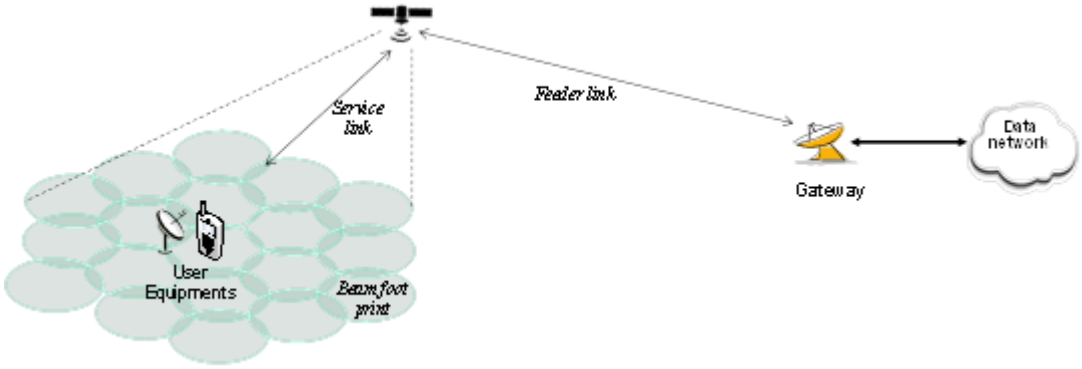

Figure 1: Schematic overview of Satcom communication

2.1.1. Geostationary Satellite Networks

2-way broadband solutions via GSO satellite have already existed for considerable time (IP-based since around 15-20 years) and there are more than 30 GSO satellite networks over Europe over which universal broadband services can be provided. This includes inter-alia Eutelsat (KONNECT, KONNECT VHTS), SES Broadband (ASTRA Connect, ASTRA 3B, ASTRA 2E), Avanti Communications (HYLAS 2, HYLAS 2B (ASTRA 5B), HYLAS 3, HYLAS 4, Viasat (KA-SAT, ViaSat-3). New HTS (High Throughput Satellites) GSO satellites for universal broadband services provide many spotbeams and can re-use the available frequencies increasingly up to the full consumption of their available payload power which can go up for the most powerful GSO satellites to 25 kW (note that satellite services to small customer premises antennas are fundamentally power-limited radio links, i.e. available

satellite payload power is a decisive factor for the usable capacity of such satellite communications).

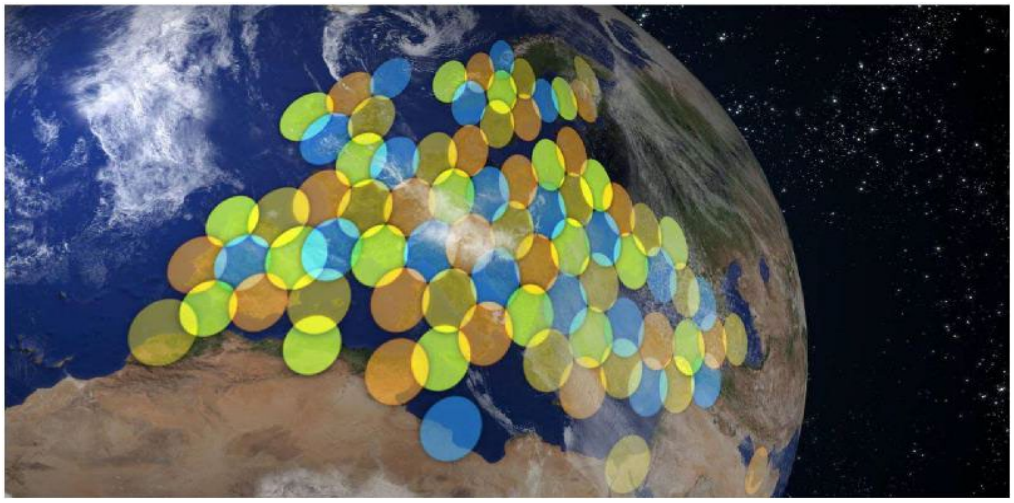

Figure 2: Spotbeam example: KA-Sat 9E (spot beams are coloured for illustrative purposes only,for example re-use of same colours may inadicate frequency re-use).

Figure 3: StarLink Terminal 50 cm (at Leeheim Satellite monitoring station of the Federal Network Agency in Germany, measured performance: DL: 100 Mbit/s, UL: 25 Mbit/s, latency: 44 ms typical)

2.1.2. Non-geostationary Satellite Systems

Since 2021, solutions via NGSO satellite systems have served the European market or are in process of being built-up in the near future: StarLink (SpaceX), OneWeb, Amazon Kuiper, Telsat Lightspeed, others. In early 2022, StarLink has already been authorised for their services in more than 20 European countries, having already around 2,000 low-earth-orbit (LEO) satellites in operations and OneWeb is preparing for market access. StarLink and OneWeb have been studied for spectrum compatibility in CEPT (ECC Report 271 and ECC Decision (17)04). Amazon Kuiper is advancing and has already procured the satellite launch services for their mega-constellation of more than 3,200 satellites. The advent of these LEO constellations will increase the capacity in the sky which can be used for universal service provisioning, though it should be noted that not all constellations may address the market and end-users in the same way and some may target other uses, such as airborne use on board aircraft or maritime use on board vessels.

2.1.3. Product Pricing

Costs to European end-users (home use-case) varies greatly: between €40 to €60 (geostationary networks) or €99 (Starlink, LEO/NGSO) monthly costs plus €330 to €600 non-recurrent costs for installation and wiring in Germany. GSO solutions tend to restrict monthly data volumes to around 50 GB/month in the basic offering (no real flatrate), while Starlink provides > 100 GB/month.[2] Furthermore, the electricity cost for customer premises equipment which can transmit to a satellite (not the same receive-only equipment such as direct-to-home TV antennas) is not negligible. In the case of StarLink, this can account for €300 per annum.

2.1.3.1. Available subsidized Satcom solutions outside the EU (examples)

In the USA, the FCC has published in January 2021 the results of a Rural Digital Opportunity Fund Phase I auction, to bring internet connections to under-served rural areas on the wrong side of the digital divide. This resulted in 885 million USD earmarked for SpaceX for Starlink to address this purpose.

In Europe, Switzerland has implemented a scheme operated by the incumbent telecommunications operator under which satellite communications are subsidized when providing solutions at rural and underserved locations that cannot be reached by fixed or mobile means.

2.1.3.2. Technology-neutral broadband Universal Service (Recent EU example, Greece)

Another country Greece has recently set out the terms for broadband universal service but notably on a technology neutral basis (see also sections 3.1.2 and 3.1.3). The universal

[2] Please see also Article 85 of the Code on “Provision of affordable universal service” which sets out certain obligations on National Regulatory Authorities, other competent authorities and Member States as regards provisioning USO.

service in Greece had already been set on a neutral basis, but until recently it included only voice telephony .[3] This is not the only service neutral approach that may include satellite.[4]

2.1.4. Services

The main applications studied for the universal services include internet access, video-streaming, home office, VPN connections or cloud services with authentication, remote desktop, and video conferencing (i.e. not remote sensing or IoT backhaul etc).

2.1.4.1. Disaster Relief considerations

Satellite services may serve as an immediate fall-back in case of terrestrial network breakdown (e.g. for disasters relief purposes but also to provide network access to the people in disaster-struck areas). Satellite solutions are normally used only on an interim basis until the restoration of the operation of mobile/fixed network services takes place. Satellite terminal equipment must be available beforehand on standby and good planning is a pre-requisite in order to be able to bring the equipment into the locations where it is needed quickly.

2.1.5. Data rates and data volumes

A study commissioned in Germany estimates a data volume increase from 59.5 GB/month to 86.5 GB/month within 2021-2025 per average user and based on a 10 Mbit/s speed. The distribution between forward and return channel of private use is dominated by downloads and streaming. Predominant use is in the forward channel to the user. Almost symmetrical use for data exchange and conferences, across all types of use approx. 2/3 forward channel and 1/3 reverse channel. The available forward channel capacity therefore limits the number of possible satellite users.

2.1.6. Service quality

The impact of latency (nearly 600 ms round-trip-delay for geostationary satellites) has an impact on quality of service and the smooth running of applications over GSO systems.

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[3] Recently, (end of March 2022) a governmental decision, following NRA's proposal, included in the universal services the broadband connection with the following characteristics:

- Minimum nominal throughput: 10Mbps (download), 1Mbps (upload)
- Minimum real throughput: 4Mbps (download)
- Data limit: 30Gbyte/month when there is not a flat rate offer
- Additionally, US should include unlimited voice calls to land lines or 1500min/month to all networks if the voice service is not provided through a land line.

The monthly cost for the US end-user cannot exceed the amount of 27 Euro, while the cost, up to 1500 euros, of the installation /connection, is covered by the US provider.

[4] Slovenia has already implemented technology neutral USO, which includes satellite.

Reduced call quality (mouth-to-ear delay) is recognizable when using GSO communications and other uses like remote work, VPN or cloud services might suffer negatively from high round-trip-delay.

To date, no restrictions are observed on low-earth orbit satellites (Starlink, OneWeb) since latency is similar to terrestrial networks and the same transport protocols can be used. Those communications are one-to-one comparable with terrestrial networks.

2.2. Satellite Capacity Demand

2.2.1. Capacity demand estimates

In Germany, the Federal Network Agency has commissioned studies to see how terrestrial networks (fixed and mobile) and satellite networks would satisfy the demand for broadband services (> 10 Mbit/s). The estimate is that the remaining addressable market for satellite solutions out of more than 50 million households and businesses in Germany would accumulate to around 100,000 customers, which cannot be served by terrestrial means within the foreseeable future.

2.2.2. Available capacity

In a German study (conducted by Fraunhofer Institute, commissioned by the Federal Network Agency), the capacity of all available satellite systems is estimated to 48,000 users in 2021 and 175,000 users in 2025 over Germany. The existing customer base for satellite end-user products for universal service access was around 23,000 in 2021 but increase is expected to come in in Germany and also elsewhere in Europe with the availability of Eutelsat CONNECT VHTS, ViaSat-3, StarLink, etc. in the coming years 2022-2024. It seems that the available capacity in orbit matches the demand. In general, the available GSO and NGSO capacities in the coming years seem to be sufficient to address those needs assuming an increase of capacity in 2020 to 2025 to about 10 times of the capacity.

The study considers that the situation in other comparable European countries may not be much different, while the addressable and capturable market share for satellite solutions depends heavily on the availability of terrestrial network solutions in a given country. These numbers also demonstrate that satellite solutions will not capture a mass market role in the European market. The available data throughput capacities in the sky seem to point to niche / limited role as can be seen in the following section based on a German case study.

2.2.3. Trends – Case Study (Germany)

The estimated maximum capacity of GSO satellites over Germany in Gbit/s towards customer premises equipment (Source: Fraunhofer Study 2021 commissioned by BNetzA[5]):

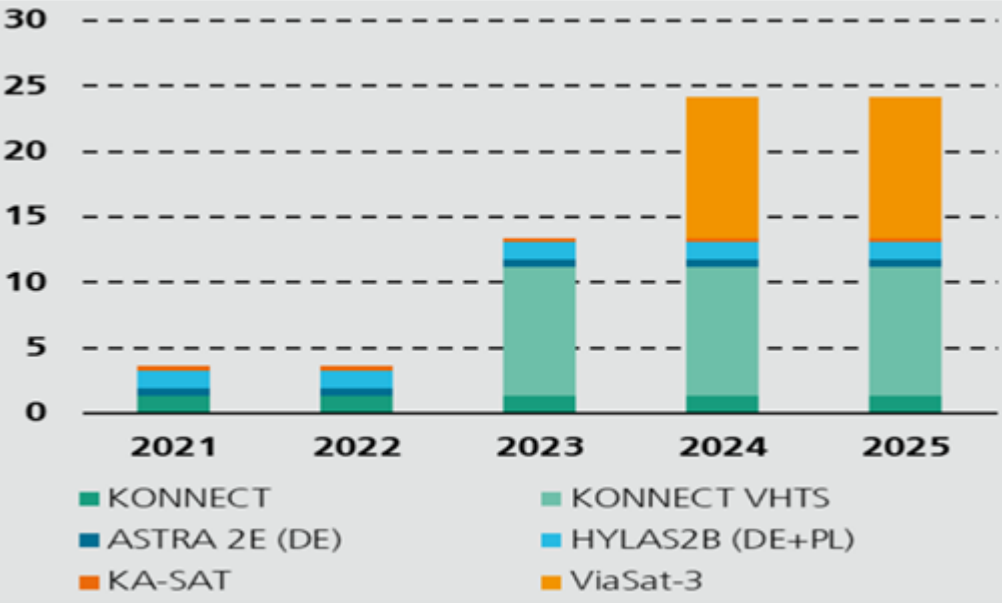

Figure 4: Maximum capacity of GSO satellites over Germany in 2021-2025

Simulations have been performed based on available data taking into account inter-alia real link budgets, orbit use and path courses (NGSO), visible satellites, coverage, frequency bands, sharing of frequencies amongst various satellite systems and also by adjacent countries (geographically) and available power well as traffic load assumptions. Satellite communications represent a resource which is shared by several users and excessive use by a few can result in data rate drops for everyone. Therefore, capacity reserves are required to compensate for statistical fluctuations in demand.

[5] Available in German language under the following link: https://www.BNetzA.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Grundversorgung/Gutachten_fraunhofer_Satellitenfunk.pdf?__blob=publicationFile&v=2.

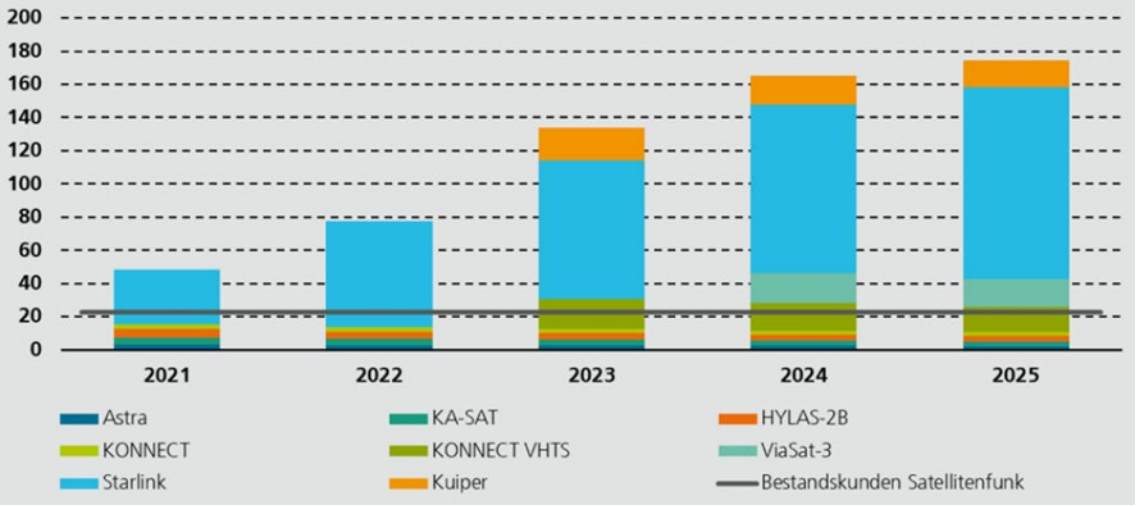

Figure 5: The Estimated maximum capacity of all satellites over Germany in Gbit/s towards customer premises equipment (Source: Fraunhofer Study 2021 commissioned by BNetzA).

The main contribution to satellite capacity growth is made by two new "Very High Throughput Satellite" systems, each with more than 10 Gbps net capacity over Germany and a planned start of operations in 2022 (Eutelsat KONNECT VHTS) and 2023 (ViaSat-3). The “mega-constellations” formed from a large number of near-Earth satellites provide an additional 10 Gbps over Germany in the first year of the planning horizon. Available capacity is growing at a rate of 10 Gbps per year to around 60 Gbps in 2025. The offer is dominated by SpaceX Starlink and from 2023 also by the expected offer from OneWeb (although targeting end user customer as business/vertical segment user) and from 2024 on also by Amazon Kuiper.

In terms of capacity, demand and supply seem to match sufficiently. EU project plans for secure connectivity are noted at the present time but will not come to the market within the next 5 years (therefore, excluded in relevant considerations for the moment in the German study).

2.3. Some regulatory considerations for Satcom based universal services

The use of Satcom based universal services needs resolution of several pre-conditions:

- an available frequency authorisation in a given jurisdiction. Such an authorisation could be provided in different formats such as:

  - a satellite network authorization (individual authorization – such as for a fixed satellite earth station or transportable earth station or for a large teleport facility[6]) while user terminals are under the control of the network are typically freed from the need to obtain individual authorisation;

[6] A facility having more than one transmit antenna

- a general authorization, also often called license-exempt authorisation;
- authorisation by appropriate reference in the frequency utilization plan[7].

- efficient and interference-free use of the satellite network as this may require other considerations, in particular the greater use of NGSO constellations may increase the need for coordination between nearby ground stations but the availability of technical studies in CEPT/ECC is considered helpful in this regard as are the use of highly directional antennas;

- use in line with National telecommunications law and universal service regulation. This may include provisions that require legal interception possibilities based on National law. Some NRAs may also require routing their end customers to gateways within their jurisdiction or at least within the EU;

- legal challenges have to be resolved in certain countries where the authorisation process for network requires e.g. a public consultation or other checks considering enforcement possibilities in case of non-European satellite network operators;

- conformity of Satcom equipment, including end user terminals coming onto the European market, with all relevant regulations such as the Radio Equipment Directive 2014/53/EU;

- some administration request for specific satellite networks that coordination with their own satellite and terrestrial networks is completed before awarding an authorisation to the concerned satellite network; and

- some aspects of the satellite licensing process are supranational, in particular the licensing of space components but this is beyond the scope of this Report.[8]

As a result, BEREC observes that there is a large national dimension to each of the regulatory issues identified, which supports a case-by-case approach to Satcom solutions for universal service.

[7] The International Telecommunication Union (ITU) makes recommendations on allocation of spectrum for satellite services, with the Radio Regulations defining primary and secondary allocations. Within Europe, the European Conference of Postal and Telecommunications Administrations (CEPT) carries over ITU recommendations.

[8] Rights to operate a satellite network over certain frequencies and geographical area are essentially granted by the ITU on a first-come first-served basis.

3. Questionnaire

BEREC members and participants without voting rights were issued a questionnaire to illicit preliminary views and on several relevant topics set out at sections 3.1.2 to 3.1.11 below (see also Annex 2.0). A number of discussion points are summarised in this chapter. The questions were interpreted flexibly to allow respondents provide high-level views where detailed answers were not possible. As a result, the categorisation of answers provided is set out at a high-level.

3.1.1. Overview

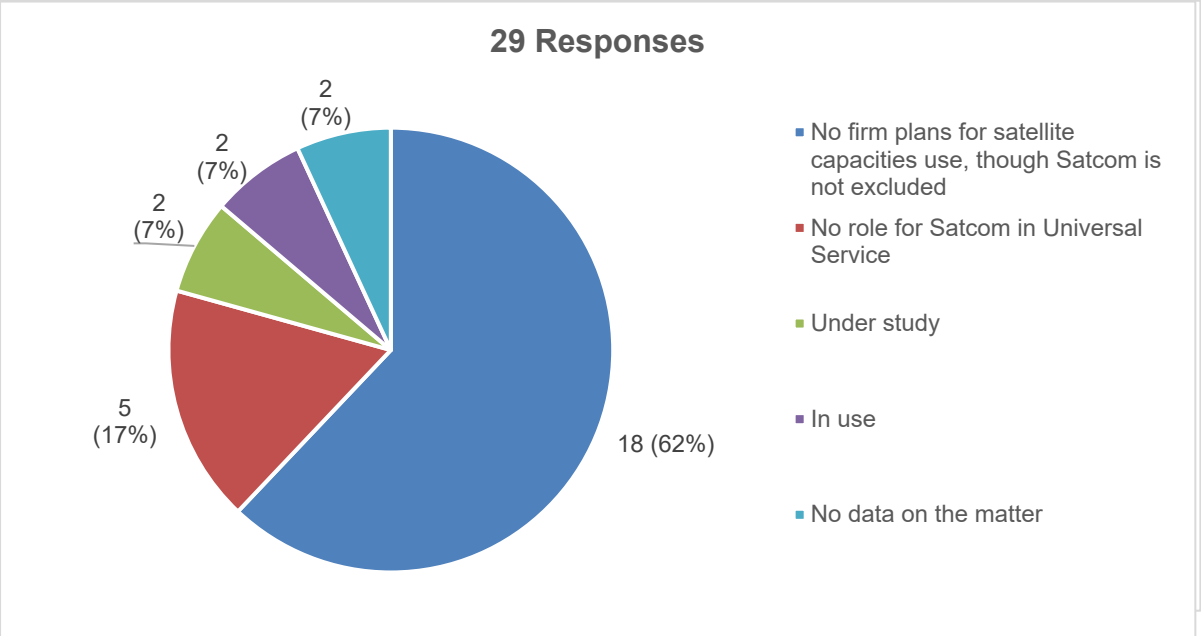

Figure 6: Overview of the questionnaire results

29 NRAs provided a response to the preparatory questionnaire to inform this BEREC Report on Satellite Connectivity for Universal Service. 2 NRAs indicated that they could not provide an Answer. It seems that for the majority (18) of the NRAs, that there exist no firm plans on using satellite connectivity for the universal service, though Satcom is not specially excluded from any universal service provision in their case. This is reflected in the position for many MSs that operator who is designated to provide universal services should be able to freely decide which technology to use for this purpose (technology neutrality). 5 NRAs indicated to not envisage a role for Satcom in any universal service provisioning. From this, it seems that the subject is not an urgent issue for many MSs.

Only two NRAs have investigated the subject through dedicated and detailed commissioned studies:

- Germany: link
- Sweden: link

Two NRAs confirmed to use Satcom for universal service provision: Iceland and Greece.

Advantages of the satellite solution were seen for the service provision on an interim basis until a terrestrial solution would become available, in disaster relief situations, as redundancy, or simply a swift tool that is universally everywhere available in a country (less planning needed).

Main disadvantages stated would be price and the availability of end user equipment.

3.1.2. Q1: Regulatory steps needed

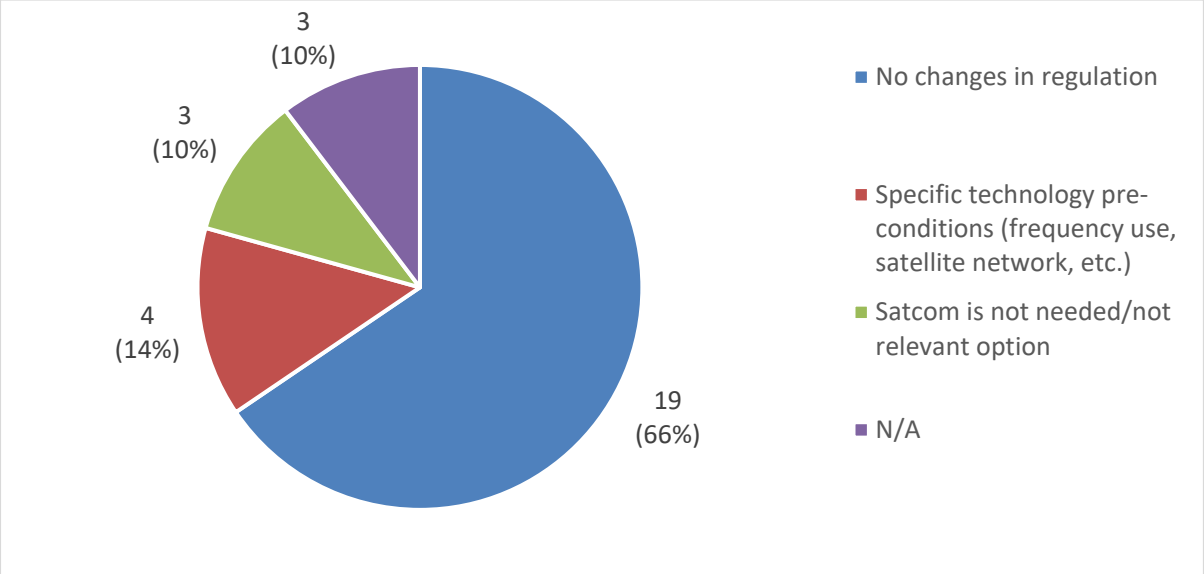

Figure 7: Regulatory steps needed

For most of the countries (AT, BG, CZ, ES, FI, HR, IT, IE; LI, LT, ME, MT, NL, NO, PT, SE, TR) no changes in regulation are needed in the event that Satcom would be used for universal service pursuant to the technological neutrality principle anchored in the EECC (e.g. recital 214): "There should be no limitations on the technical means by which the connection is provided, allowing for wired or wireless technologies, nor any limitations on the category of providers which provide part or all of universal service obligations."[9] The only regulatory measure to enable the use of Satcom would be, as mentioned by some NRAs (BE, CZ, ES, LI), to follow the standard procedure in force for selecting a US provider. For Serbia, the existing Rulebook on universal service would have to be updated to include satellite providers and services.[10]

Italy reported that a regulatory intervention aimed at defining the services included in the universal service and performance parameters must be guaranteed rather than a specific regulatory intervention for the use of Satcom.

[9] Although in Austria universal service is provided in competition, provision via satellite would not be excluded.

[10] The Rulebook on Universal Service is available at: https://www.ratel.rs/uploads/documents/empire_plugin/blob/5b62cefdb28f8_Pravilnik%20o%20univerzalnom%20servisu,%20SGRS%2024-12.pdf

Slovenia and Liechtenstein also outlined that the use of the corresponding frequencies must be applied for and allocated nationally.

In Germany, specific pre-conditions related to the technology itself must be fulfilled. In particular, the issue of frequency use authorisations and efficient and interference-free use of the satellite network.

On the other hand, 2 NRAs (EL, IS) answered that they have already used Satcom for US. More specifically, the regulatory steps taken in Greece include technological neutrality, specific spectrum reserved for satellite service[11] and regulatory licensing of internet "satellite dishes". Additionally, Greece also reported the following aspects that could be taken into consideration:

- Rights and obligations of administrations in obtaining access to the spectrum/orbit resources in terms of international coordination and interference identification and mitigation.
- Supervision and control mechanisms on space networks.
- Additional / adequate terrestrial base stations licensing.
- Regulation on operation in secondary basis for customer premises equipment.

Whilst 3 NRAs (DK, EE, LV) declared that Satcom either is not needed or does not seem like a relevant option to provide universal service, considering the better capabilities and lower costs associated with terrestrial services.[12]

It should be noted that some of the respondent countries (BG, DE, ES, EL) are still in a process of amending secondary legislation related to the universal service. Against this background, the answers provided are preliminary considerations, not allowing for final conclusions regarding the universal service rules.

3 NRAs (SK, FR, HU) did not provide an answer to this question (see Figure 7).

[11] Greece has already granted the MSS 2 GHz spectrum (1980-2010 MHz and 2170-2200 MHz) for mobile satellite services, as well as rights of spectrum use in the 3800-4200 MHz bands, for the terrestrial satellite base stations in districts of Nemea and Thermopylae, securing adequate guard-bands from neighbouring MFCN.

[12] In Estonia, universal service is not provided since 2011. Existing terrestrial networks are providing services exceeding USO terms (Annex V of the EECC) with reasonable price.

3.1.3. Q2: Projected Satcom capacities

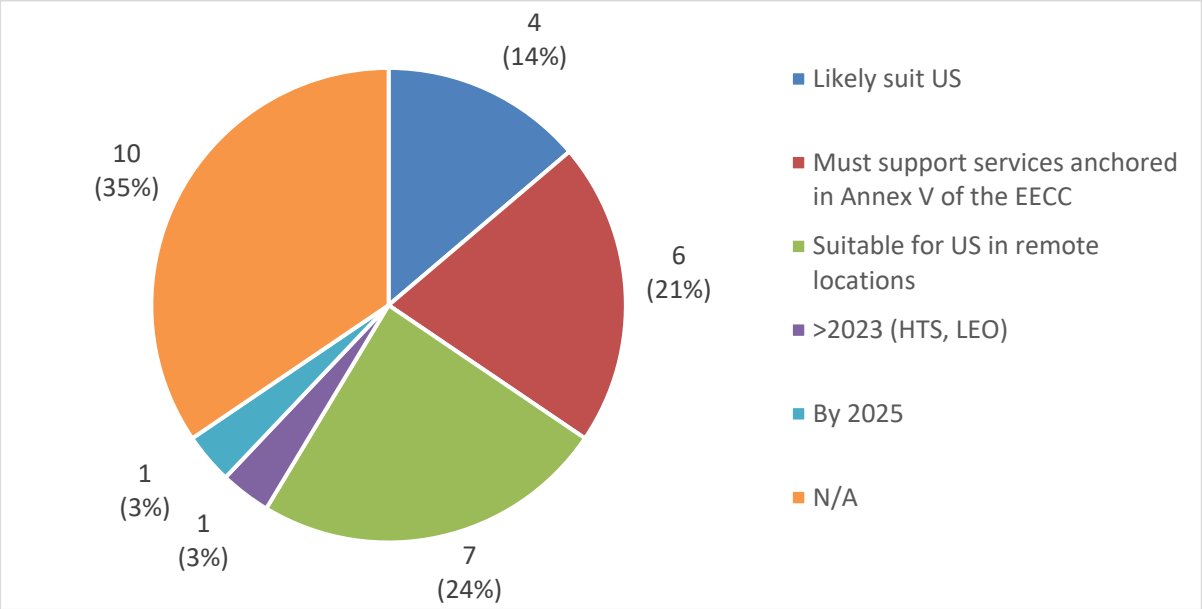

Figure 8 Projected Satcom capacities

NRAs were also asked on how may projected Satcom capacities (geostationary as well as non-geostationary) suit the Universal Service. As depicted in Figure 8 below, a part of the respondent countries could not give their preliminary view on this question since they have currently no information available regarding Satcom capacities for US (AT, BE, BG, SK, TR, EE, IE, MT, FR, HU).

In 4 countries (CZ, HR, LI, NL), it is assumed that most of the available services would technically meet the conditions for the provision of US. 2 of those countries (LI, NL) note, however, that retail prices would probably not meet the affordability criteria. Also, 3 NRAs (NO PT, ES) pointed out that as long as Satcom capacities support services anchored in Annex V of the EECC, such capacities will generally suit universal service. Spain additionally specified the available and projected GSO (EUTELSAT, S.A, HISPASAT, S.A., EURONA WIRELESS TELECOM, S.A. and VIASAT EUROPE SARL) and NGSO (STARLINK SPAIN, S.L. UNIPERSONAL) operators.

NRAs from 3 countries (IT, FI, RS) expressed the view that Satcom can be used as a complementary technology for the provision of universal service in more remote locations with limited scale, and in such a case the capacity is believed to be sufficient. In this respect, there are however 3 NRAs (LV, LT, DK) that emphasized that it would be challenging for Satcom to compete with existing networks in their markets.

In Iceland, although GSO networks can play an important role to connect users in remote areas with up to 200 Mbps downlink capacity, the NRA outlined they would be more useful as trunk connections. Additionally, Iceland´s NRA pointed out new LEO satellite systems are expected to work better to serve the end user and trials will be made in the next months in this respect.

The NRA from Greece mentioned that currently the universal service requirements include only voice telephony and is provided by an operator that can offer it via satellite. That provider offers commercially broadband service limited to 10GB of data per month in a data rate which is adequate for social and economic participation in society. Recently, (end of March 2022) a governmental decision, following NRA's proposal, included in the universal services the broadband connection. The NRA considers that the existing satcom capacity will be adequate to satisfy aforementioned amendment. A call for a new US provider (following legislative amendments) is expected to be completed within the current year.

2 NRAs responded stating the data rate considered to be sufficient for universal service. More specifically, ME reported a download speed of at least 2Mbps and the upload speed of at least 256Kbps, while SI mentioned a download speed of at least 10 Mbps and capacity of 100 GB/month.

Out of all responses received only 2 countries (DE, SE) provided specific information with regards to the suitability of satellite capacities based on recently conducted studies on satellite-based internet connections on their respective markets. The suitability depends on the expected usage intensity, particularly with respect to the data volume required by the user per month.

According to the study conducted by PTS[13], it is foreseen Satcom capacities with 100Mbps by 2025 provided by operators such as Eutelsat, Viasat or Starlink.

In Germany, according to the results of the report conducted by Fraunhofer IIS in 2021, the initial situation (as of end 2020/early 2021) was assessed as very tight. Only an aggressive overbooking allows distributing the 23,000 existing German customers on the three systems currently available (ASTRA, KA-SAT, HYLAS). Although contracts with sufficient monthly volume are available from all three providers, the monthly data volume included in most of the contract options offered is lower than the need determined for normal usage. In the course of 2021, with new offers from Eutelsat KONNECT and SpaceX Starlink including a monthly volume of well over 100 GB, backed by additional capacity, the situation is expected to ease. This evolution will continue presumably as of 2023, with the expected further capacity from *KONNECT VHTS*, *ViaSat-3* and *Amazon Kuiper*. From this point on, capacity for more than 100,000 new customers will be available assuming normal usage. It should be noted that there will be capacity bottlenecks (with the other systems) until the end of 2022 if the Starlink offer is only used by a small number of customers.

Another study commissioned by BNetzA estimated that around 100,000 customers cannot be served by terrestrial means. In this respect, Fraunhofer concluded in its report that even though satellite solutions can only serve a small fraction of the total market and not millions of households, the available GSO and NGSO capacities in the coming years seem to be sufficient to address those needs.

[13] Title in Swedish: Satellit: en möjlighet till snabbt bredband 2025, PTS-ER-2022:18

3.1.4. Q3: Suitability of internet access via satellite

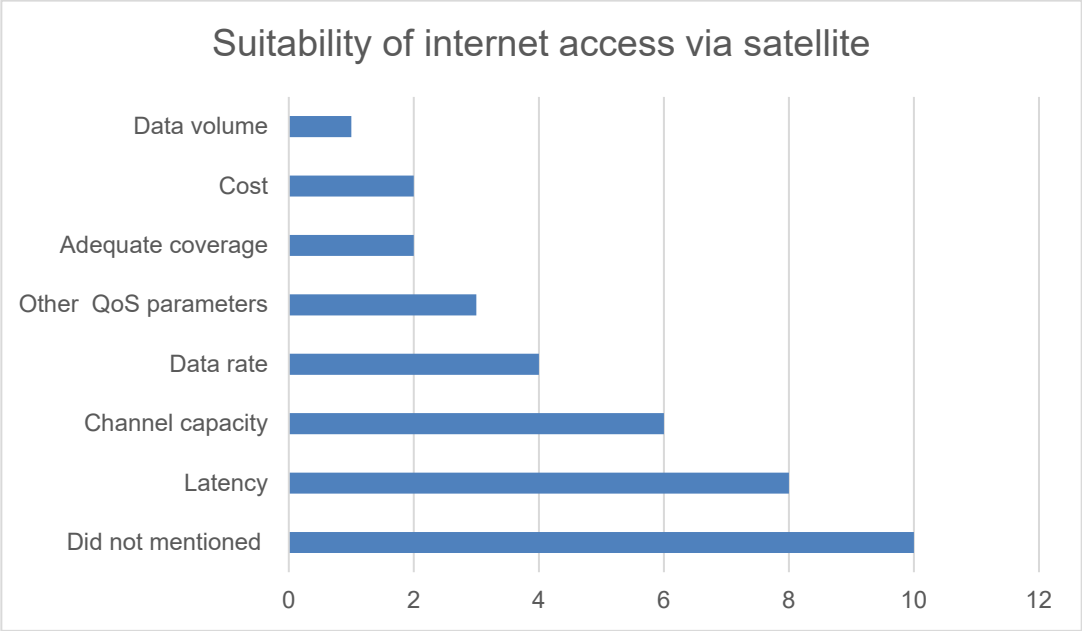

Figure 9: Suitability of internet access via satellite

When it comes to assessing the suitability of internet access services via Satcom, the most common technical requirement outlined by NRAs (NO, FI, NL, DE, IS, IT, PT, SI) is the latency requirement, followed by the capacity requirement stated by 6 countries (IT, NL, RS, DE, DK, MT) and the data rate which is reported in 4 countries (EL, IS, LT, PT). Other QoS parameters are also stated by 3 NRAs (EL, MT, LT), while 2 NRAs (MT, LT) mentioned an adequate coverage. The data volume and cost were also reported by 1 (DE) and 2 NRAs (NL, EL) respectively, as shown in figure 9.

In addition to the pure capacity requirement, Germany noted that the available forward channel capacity limits the number of satellite users. As regards latency requirements, some NRAs (DE, FI, IS, SI) also mentioned that mega-constellations in orbit significantly closer to Earth (MEO, LEO) meet the latency requirements due to its low latencies, as opposed to GEO satellites, which have inherently high latency for physical reasons, and therefore being suitable only for certain individual peripheral locations (DE). Other countries specified the data rate required for universal service. Lithuania´s NRA considered at least 10 Mbps of download and at least 1 Mbps of upload. In Portugal, it is required download speed of 12Mbps and upload speed of 2Mbps. Meanwhile in Iceland the networks currently have up to 200 Mbps speed. In Greece, the current USP offers commercially speeds up to 20 Mbps download and up to 6 Mbps upload, with a data use limit of 10 GB/month. New Greek legislation demands a download minimum real speed of 4Mbps (10 Mbps download and 1 Mbps upload minimum nominal speed) and a data limit of 30GB/month (when there is no unlimited data flat rate)

Concerning other QoS parameters, Greek NRA also proposed other specific requirements in the ongoing process of updating terms and conditions of the US (see Table 1).

Table 1 QoS targets for universal service in Greece.

QoS targets for universal service in Greece	TARGET
Supply time for initial connection	3 weeks for the 80% of orders. 9 weeks for the 95% of orders. 12 weeks for the 99% of orders.
Fault rate per 100 access line per year	13.5
Fault repair time	70% in 36 hours 85% in 72 hours 95% in 144 hours
Bill correctness complaints	0.2 %

Table 1 QoS targets for universal service in Greece.

NRAs from 5 countries (AT, SE, HR, EE, MT) responded that for internet access service via Satcom to suit universal service requirements they must meet as a minimum, the functional characteristics of an available adequate broadband internet access service to support of the services anchored in Annex V of the EECC. Furthermore, some NRAs (CZ, ES, LT) reported that the quality-of-service conditions for standard internet access services will apply for Satcom.

10 NRAs (BE, BG, LI, SK, TR, IE, LV, ME, FR, HU) did not provide an answer to this question. Either the NRA does not envisage a role for Satcom in US (BE, LV) or does not have sufficient knowledge to give a view on this issue (BG, LI, SK, TR, IE, ME, FR, HU).

3.1.5. Q4: Improvements to be expected in Satcom

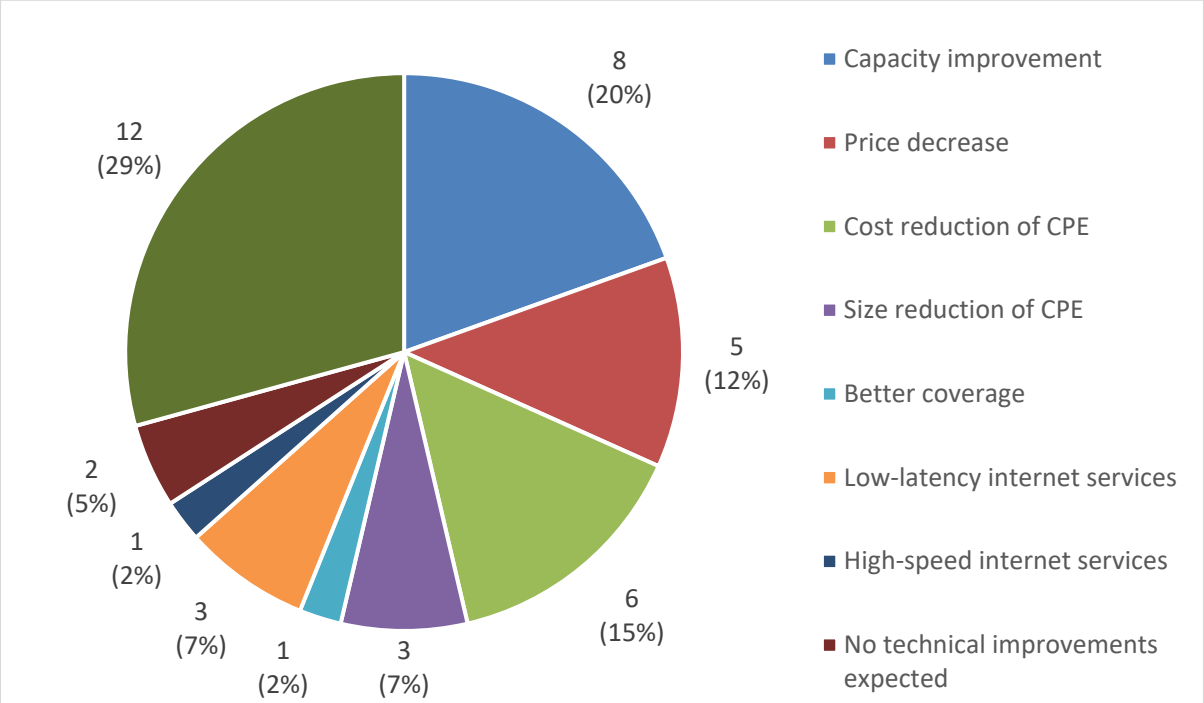

Figure 10: Technical improvements to be expected for Satcom over time.

Figure 10 sets out the main elements discussed by respondents to this question.

In terms of technological improvements expected as a result of new forms of implementation, NRAs from 8 countries (DE, ES, HR, IT, NL, IS, RS, SE) stated that there will be an increase in available capacity both due to the launch of further geostationary satellites (HTS GSO) and the construction and expansion of the "megaconstellations" of near-earth satellites (MEO and LEO).

Based on the Fraunhofer study, Germany provided the estimated capacity for universal service of GEO satellites and near-Earth satellites over their market over the period 2021-2025. As shown in section 2.3, massive additional capacity can be expected in the following years.

For most of the countries, these new forms of implementation (i.e. GEO or LEO HTS) will lead to more favourable cost structures to end-users. In particular, price reduction in terms of cost per bit is expected by 5 NRAs (DK, ES, IT, LT, SE), while 6 countries (HR, LT, ME, IS, EL, RS) foresee lower prices of customer premises equipment (CPE).

In relation to the CPE, 3 NRAs (IS, EL, RS) reported that smaller antenna dishes are expected in the near future. Greece and Italy also mentioned improvements in delivering high-speed, low-latency internet services. In Norway, LEO satellite systems are expected to give better coverage and have a significantly lower latency compared to GEO satellites.

Although cost reductions can be expected, some NRAs (SE, DK, CZ, RS, SK) pointed out that Satcom will still be a relatively expensive technical solution unable to compete cost-wise with fixed and mobile broadband services.

NRAs from 2 countries (MT, SI) stated that technical improvements are not currently envisaged, while the remaining respondents (AT, PT, BE, BG, FI, IE, LI, TR, LV, EE, FR, HU) did not mention anything with regard to this issue.

3.1.6. Q5: other relevant dimensions

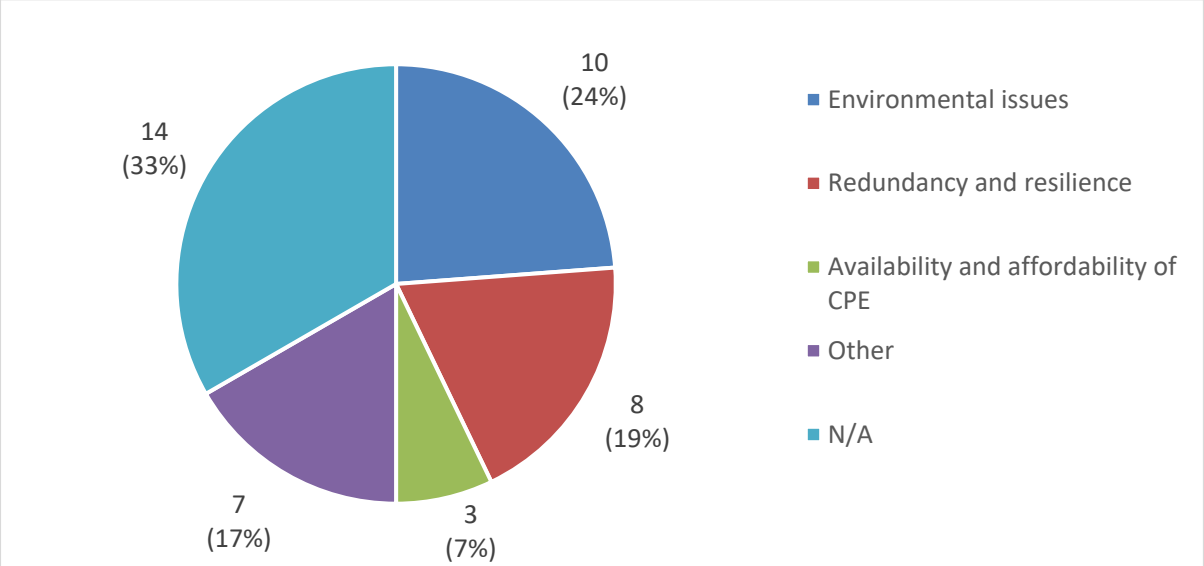

Figure 11: Other relevant dimensions

As presented in Figure 11, in 10 of the countries (ES, EL, HR, IT, MT, NL, NO, PT, SI, RS) the NRAs considered that environmental issues (whether terrestrial or outer space itself) are particularly relevant.[14] In Portugal, the environmental dimension is already contemplated at the level of the licensing process of space activities[15]. In addition to the space debris concern due to the high number of satellites and relative low lifespan of equipment related to LEO, 1 NRA (NL) also outlined the energy use of the end user equipment.

Italy also reported the versatility of use and speed of implementation as distinctive elements of satellite infrastructures. Whilst some countries (ES, EL, HR, MT, NO, NL, PT, RS) pointed on the importance of redundancy and resilience of satellite networks to ensure provision of service.

Other relevant dimensions mentioned by Greece include blanket coverage by high number of small satellites, antenna licensing regime and spectrum usage fees. Network security is also considered to be of relevance for 2 NRAs (PT, IS). Availability and affordability of end user equipment, as well as limited power consumption of CPE, are also important for acceptance in the market as reported by 3 countries (DE, NL, SE).

Furthermore, Germany raised the economic dimension that arise when using Satcom, notably for peripheral areas that are difficult to connect, as it has the potential to avoid (or mitigate) the negative effects on private-sector rollout. Netherlands stated that the availability of (artificial) cheap Satcom offers may slow down the extension of coverage of fixed and mobile networks in rural areas.

For Estonia, it is important to note that satellites can improve service quality providing that terminals normally using terrestrial networks can be connected to satellite networks. The Finland´s answering to this question emphasized the need to consider the GOVSATCOM initiative.

However, in most of the NRAs (AT, BE, BG, DK, IE, LI, SK, TR, LV, LT, CZ, ME, FR, HU) there is no information available in relation to this question.

[14] Not included specifically in the written responses, but from desk research other potential impacts might emerge. For example, ground-based astronomers (using the visual part of electromagnetic spectrum) have raised potential light pollution concerns which have led some LEOs to introduce non-reflective coatings on space based equipment.

[15] See Article 7(1) (c) and 7(3) of the Dec. Law No. 16/2019 of January 22 (https://www.anacom.pt/render.jsp?contentId=1466788), and Articles 15(1) and 22(1) of the Regulation No 697/2019 of 5 September (https://www.anacom.pt/render.jsp?contentId=1482883).

3.1.7. Q6: Availability of satellite capacity (for universal service)

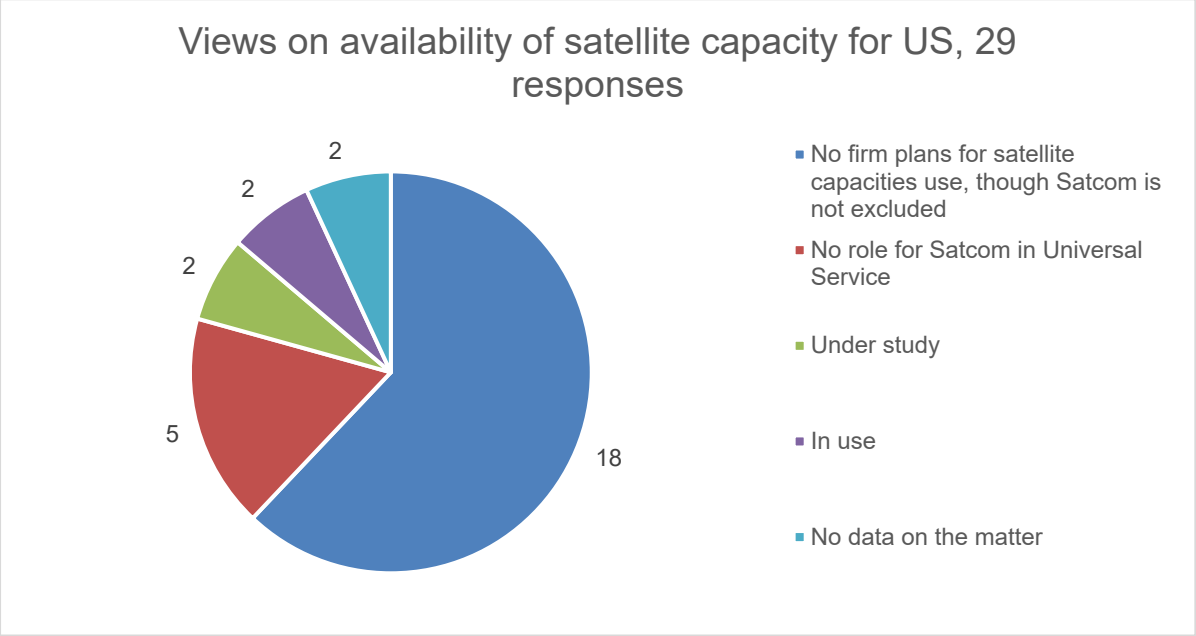

Figure 12: Views on availability of satellite capacity for universal service

No firm plans for satellite capacities use, though Satcom is not excluded

The following countries have no firm plans to include Satcom in the Universal Service, though it is not excluded as an option in AT, BG, CZ, ES, FI, HR, IE, IT, LI, LT, ME, NL, NO, PT, SK, SI, RS, TR.

In order to take into account the use of Satcom for universal service, availability, data transfer rates and other Quality of service (QoS) parameters would have to be on par with that offered by the terrestrial networks. In addition high pricing of the customer premises equipment together with monthly fee for the sufficient throughput, could be an issue in future implementation.

No role for Satcom in Universal Service

Since available terrestrial services can meet existing end users Universal Service needs, the following countries do not envisage a role for Satcom BE, DK, EE, LV, MT.

Under study

The following study commissioned by German (DE) regulator BNetzA (Link), shows that maximum estimated capacity of satellite networks and systems over Germany, for the period 2021-2025 will significantly grow thus enabling better availability and data transfer rates.

In Sweden (SE) a study (title in Swedish: Satellit: en möjlighet till snabbt bredband 2025, PTS-ER-2022:18. Link) has just been conducted by Swedish regulator PTS to investigate the potential and the possibilities of Satcom as a provider of broadband services to end-users.

In use

Currently, in Greece (EL), the universal service requirements include only voice telephony and are met by one operator. Internet access service by the same operator, with maximum throughput of 6/20 Mbps offered on a commercial bases.

In Iceland (IS) older generation satellite networks have been used to provide connections to users in remote areas, but the result was not good in most cases, and at the moment there are no satellite connections being used for Universal Service. New LEO satellite systems are expected to work better to serve the end users. The trials will take place in the coming months.

No data on the matter

France and Hungary (FR, HU) have provided no data on the matter in question.

3.1.8. Q7: Meeting needs with existing capacity

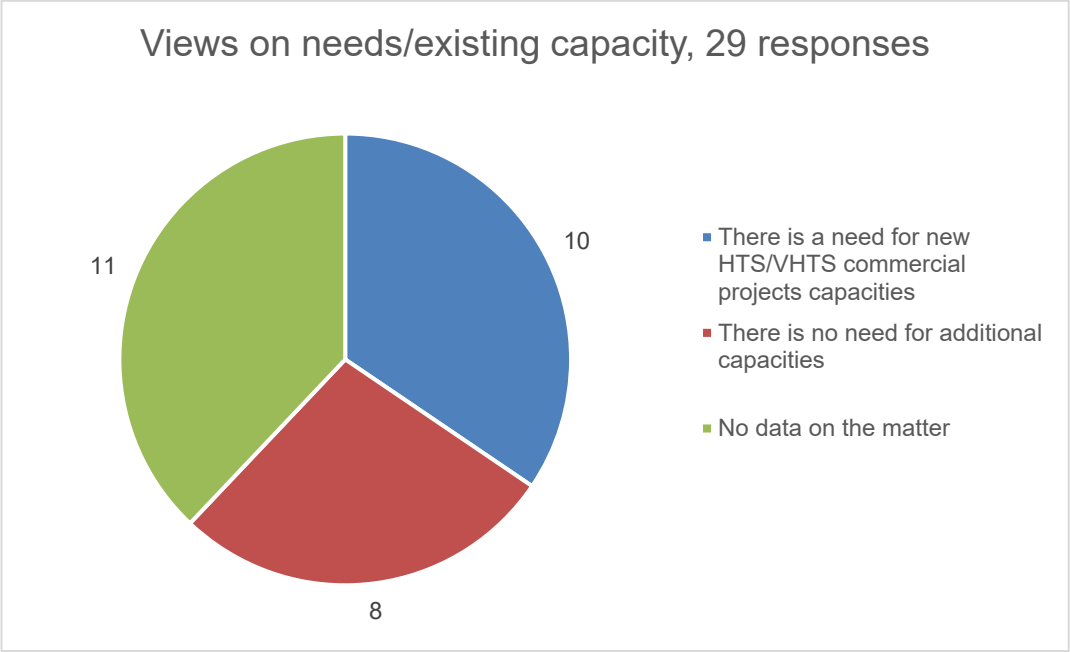

Figure 13: Views on capacity needs

There is a need for new HTS/VHTS commercial projects capacities

The following countries AT, DE, ES, FI, IE, IT, IS, LI, LT, NO, would welcome new HTS/VHTS commercial capacities if QoS and availability of service is within Universal Service requirements. As noted by the Spanish NRA CNMC high-speed networks are concentrated in the most densely populated areas, while in areas with low population density, such infrastructure is not yet available. The increase in the coverage of areas not yet covered implies higher investment costs, either because they are far from the transmission networks already deployed, or because they are areas of complicated terrain which require the

installation of more network elements than in other areas commercial satellite projects can be a potential solution to bring broadband connection everywhere.

If new commercial satellite projects could provide Internet access services at the competitive price level, they could establish solid competition to existing technologies, to a minor degree in urban and to a larger degree in rural areas.

There is no need for additional capacities

In DK, EE, HR, LV, MT, NL, SI, SK, the needs are already met by the currently existing capacity, so they are of the opinion that there is no need for additional ones.

No or small gap between the needs and the current/projected capacities.

The following countries CZ, DE, DK, EE, HR, LT, LV, MT have reported no gap between supplied and demanded capacities.

In the Netherlands (NL), there is a small gap of a few thousand end users that have access to data throughput of less than 30 Mbps.

Under study

In addition to the study in DE summarized above (see 2.2.3) the matter is under study in SE. In IS the matter of needs and capacity is being examined.

No data on the matter

The following countries BE, BG, CZ, FR, EL, HU, ME, PT, RS, SE, TR have provided no data on the matter in question.

3.1.9. Q8: If there's a needs gap does a coordinated approach between Member States make sense

Coordinated approach between Member States could make sense to create the additional capacities

Greek regulator (EETT) has stated that member states could implement coordinated policies into simplifying and expediting licensing of ground base stations and satellite networks, as well as their optical fiber networks investment, that connect and transmit broadband signals to the satellite network and that additional ground stations would enhance expected geographical coverage. In addition, further coordination among member states, in spectrum licensing, safeguarding as well as orbit positioning may expedite satellite broadband enhancement.

On the specific matter of coordinated approach between Member States to create the additional capacities, the EU project plans for a broadband satellite network constellation providing secure connectivity (GOVSATCOM, Link) have been mentioned by German and Finnish regulator (BNetzA and Traficom respectively), although as BNetzA have noted the GOVSATCOM project will not come to the market within the next 5 years.

For example, in Finland (FI), at the moment there are no satellite LEO or MEO providers suitable for providing universal service, so Satcom hasn't been taken into detailed consideration. Some GEO based capabilities exists, but their QoS or availability are insufficient. Capability to provide coverage in the arctic and in high latitudes by LEO or MEO constellations shall be coordinated via GOVSATCOM initiative by EU. (see also question 7.0)

No data on the matter

The following countries AT, BE, BG, ES, FR, HU, IE, IT, LI, NO, PT, RS, SK, TR have provided no data on the matter.

3.1.10. Q9: Satellite systems as fallback to transmit disaster warnings

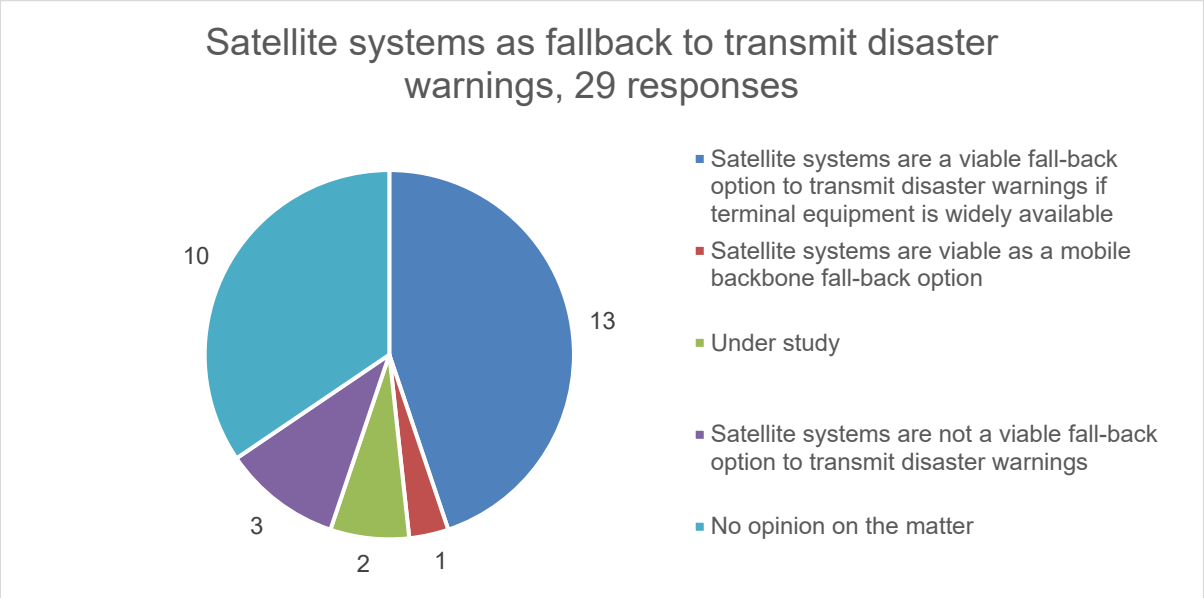

Figure 14: Views on satellite systems as a fall back to transmit disaster warnings.

Satellite systems are a viable fall-back option to transmit disaster warnings

The following countries AT, DE, DK, EE, ES, FI, EL, HR, LI, LT, ME, NL, PT are of the opinion that satellite systems are a viable fall-back for transmitting disaster warnings, if sufficient number of satellite compatible end user terminals are widely available.

Experiences in Germany have shown that satellite solutions provide quick and equal solutions in disaster relief operations, e.g. during floods in West German areas in the summer of 2021, and serve citizens needs on an interim basis until terrestrial networks are restored. In this case, available satellite terminals were provided to the public by the state and also by helping satellite operators within short notice.

Other option is to enable future compatibility of satellite systems with the end user mobile network terminals. This can be achieved, either through satellite systems being able to transmit directly to existing mobile phones, or by new generation mobile phones being compatible with satellite systems. Current standardisation activities in 3GPP for NTN (non-terrestrial networks) addresses this possibility. 3GPP Release-17includes new specifications

to support “non-terrestrial networks” (NTN), which aim to integrate satellite connectivity into the 3GPP ecosystem, including direct connectivity between satellites and handsets. It should be noted that this will rather support narrowband basic applications, e.g. individual messaging, alerting the public.

Satellite systems are viable as a mobile backbone fall-back option

Iceland (IS) is of the opinion that satellite systems can hardly reach the general public in the case of disaster taking into account the technology available today and that it could to some extent be used, to provide a backbone for mobile network fall-back.

Under study

In Sweden (SE) a study has just been conducted (see Q6) to investigate the potential and the possibilities of Satcom as a provider of broadband services to end-users.

In Norway (NO) satellite systems are currently not a viable option to transmit disaster warnings due to limitations in the national electronic communications infrastructure. They are in the process of implementing technology that would be able to facilitate such a fallback option in the future.

Satellite systems are not a viable fall-back option to transmit disaster warnings

In Malta (MT), satellite systems are not deemed a viable option for the transmission of disaster warnings, since the take-up of satellite services is considered to be extremely low.

In Slovenia (SI) satellite systems are not a viable fall-back, because they are not compatible with available mobile terminals.

In Serbia (RS) satellite systems are not deemed a viable fall-back in densely populated areas, but equipped with back-up batteries, can be used efficiently in rural areas.

No opinion on the matter

The following countries BE, BG, CZ, FR, HU, IE, IT, LV, SK, TR have provided no opinion on the matter.

3.1.11. Q10: Satellite systems as interim or disaster relief solution

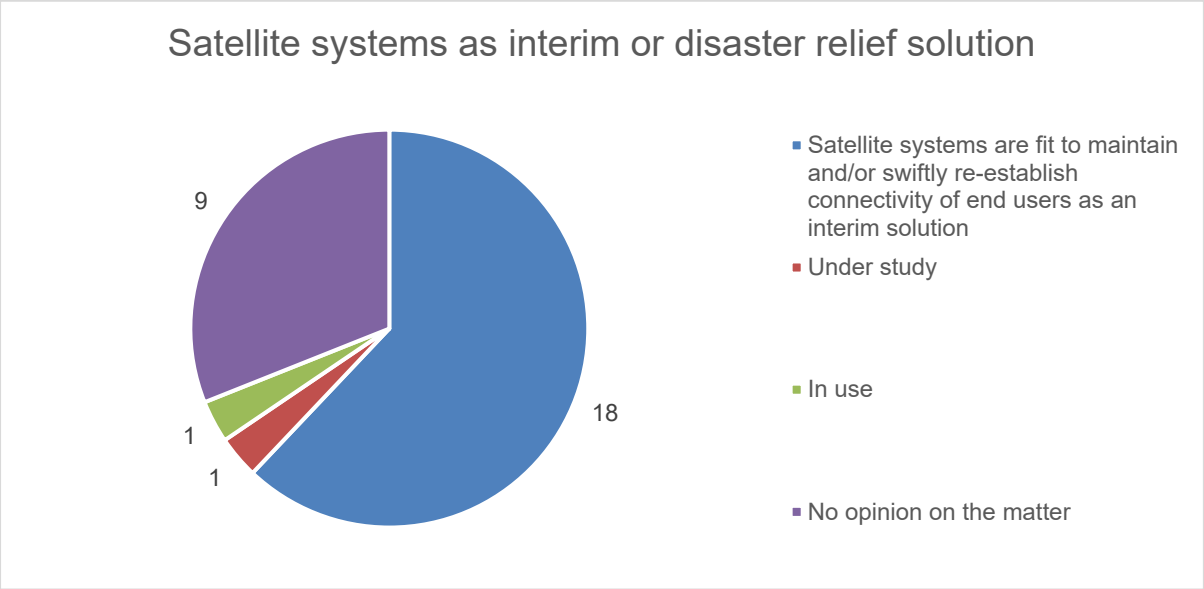

Figure 14: Satellite systems as interim or disaster relief solution.

Satellite systems are fit to maintain and/or swiftly re-establish connectivity of end users as an interim solution

The following countries AT, DE, DK, EE, ES, FI, EL, HR, IS, IT, LI, LT, ME, MT, NL, PT, RS, SI are of the opinion that satellite systems are a possible interim solution for re-establishing the connectivity in disaster areas, thus allowing the time needed for recovery of terrestrial systems.

This can be achieved (as already stated in Q9) by providing satellite terminals to the public by the state, enabling future compatibility of satellite systems with the end user mobile network terminals and by using satellite systems to provide a backbone for mobile network fallback.

Finlands (FI) NRA raised a concern regarding possible bottleneck for satellite services, due to limited capacities and high demand, even if those services are on a temporary basis.

Netherlands (NL) NRA is of the opinion that if a satellite systems are to be used as an interim solution in case of a disaster, they would have to be on the stand by and ready to use.

Slovenian (SI) NRA stated that satellite use is a good solution if connected to mobile operator network as redundant backhaul.

Austria (AT) NRA is of the opinion that solutions regarding the failure of infrastructure are closely linked to the specific root cause and must be dealt with on a case-by-case basis.

Under study

In Sweden (SE) a study has just been conducted (see Q6) to investigate the potential and the possibilities of Satcom as a provider of broadband services to end-users.

In use

In Norway (NO) some municipals have satellite backup systems/fall-back solutions in place if their areas are struck by major outages that affect electronic communications. Typically, these solutions are tied to the local municipal self-government which would allow them to communicate with the outside world in case they were isolated by the incident/disaster.

No opinion on the matter

BE, BG, CZ, FR, HU, IE, LV, SK, TR have provided no opinion on the matter.

4. BEREC's preliminary position

The purpose of this Report is to inform and provide an overview about the Satcom solutions and key important aspects such as pricing, service quality, expected role in the market, available satellite capacity and demand as well as important regulatory considerations. It provides an overview on how the subject is considered in a selection of European countries at the time of writing.

This Report underlines that there are a number of regulatory issues having a national dimension, which supports a case-by-case approach to Satcom solutions for universal service.

Annex 1: Abbreviations

Abbreviations for countries

Abbreviation	Country
AT	Austria
BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France

Abbreviation	Country
EL	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
LT	Lithuania
LV	Latvia
LI	Liechtenstein
ME	Montenegro

Abbreviation	Country
MT	Malta
NL	Netherlands
NO	Norway
PT	Portugal
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey

Annex 2: Questionnaire

Q1: What are the regulatory steps needed in the event that Satcom would be used for universal service in Member States?

Q2: How may projected Satcom capacities (geostationary as well as non-geostationary) suit Universal Service generally?

Q3: How is the suitability of internet access services via satellite communication to be assessed in the context of the amended universal service described above, especially with regard to the support of the services anchored in Annex V of the EECC? Are there any possible limitations with regard to the application scope?

Q4: What improvements in terms of technical performance (e.g. increase in available capacities, expansion of the service or application portfolio, technical advances with regard to cost and size of customer premises equipment) can be expected over time as a result of new forms of implementation (GEO HTS — High Throughput Satellites, as well as broadband MEO and LEO satellite systems)? To what extent do the new forms of implementation have more favourable cost structures for end users supply via satellite communication?

Q5: What other dimensions do Member States consider relevant and to what extent? (redundancy / resiliency / environmental issues)

Q6: What needs in terms of the availability of satellite capacity are seen in the Member States so that satellite-based solutions can be considered for the amended universal service requirement?

Q7: To what extent are these needs already met by existing capacity? What impact can be expected from commercial satellite projects that are already in operation or in the planning/construction phase?

Q8: If there is a gap between the needs and the current/projected capacities: Does a coordinated approach between Member States make sense to create the additional capacities? If so, what could such an approach look like?

Q9: To what extent are satellite systems a viable fallback option in case other technologies such as mobile networks fail to transmit disaster warnings? Specifically, can satellite systems be of an efficiency equal to that of cell broadcasting, even in cases of widespread power outages (possibly relying on back-up batteries)?

Q10: Specifically with regard to areas struck by or affected by disaster: To what extent are satellite systems fit to maintain and/or swiftly re-establish the connectivity of end users, even if only as an interim solution during the immediate aftermath of such events?