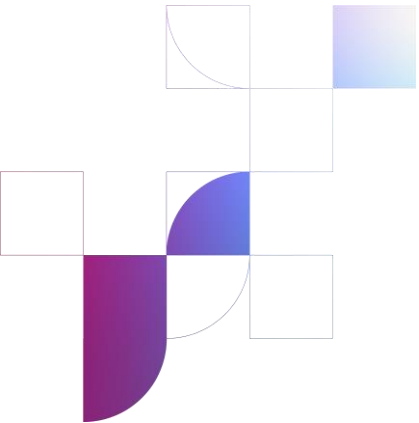
BEREC
Body of European Regulators for Electronic Communications

BoR (24) 151

Summary report: BEREC External Workshop about the Usage of Satellite Technologies in Mobile Communications, 22 May 2024



3 October, 2024

Content

1. Executive Summary

The goal of this hybrid external workshop (the "workshop") was to equip BEREC and NRAs with a better understanding of relevant trends in Satellite Communication and potential opportunities and challenges.

The workshop was supported by previous relevant studies and reports by BEREC. In particular, BEREC's report on satellite connectivity for universal service was an important building block, as BEREC concluded that satellite communications (SatCom) can be an integral part of providing connectivity to remote locations where terrestrial networks are unable to reach and/or serve populations economically[1]. In addition, the workshop built on earlier insights from another workshop held in 2023 on secure and reliable connectivity from low earth orbit ('LEO') satellite fleets held in 2023.[2]

In particular the focus of the workshop was on the potential regulatory issues associated with Non Terrestrial Networks ('NTN') in the context of extension of mobile/fixed communication networks (roaming, handover, numbering, interoperability and non-discrimination, market access and authorization, lawful interception, emergency calling, competition, consumer security and environmental sustainability).

The workshop consisted of several segments, which included interactive exchanges with speakers and audience, as follows:

- Opening statements (from relevant associations and the host BNetzA).
- Status of Non-Terrestrial Networks and introduction to today's regulatory challenges
- Deeper dive into market access trends and the direct-to-device ecosystems
- Future opportunities and challenges
- Closing remarks

BEREC would like to thank the presenters, participants and host NRA (the BundesNetzAgentur) for their participation.

BEREC's next steps will fall under the BEREC Work Programme 2025, where a proposal to have a peer exchange (internal only) of information with experts from the Radio Specturm Policy Group is foreseen.

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[1] https://www.berec.europa.eu/en/document-categories/berec/reports/report-on-satellite-connectivity-for-universal-service
https://www.berec.europa.eu/en/document-categories/berec/reports/report-on-the-outcomes-of-public-consultation-on-the-report-on-satellite-connectivity-for-universal-service

[2] https://www.berec.europa.eu/en/events/berec-events-2023/berec-workshop-on-secure-and-reliable-connectivity-from-leo-satellite-fleets,
https://www.berec.europa.eu/en/document-categories/berec/reports/summary-report-berec-workshop-on-secure-and-reliable-connectivity-from-leo-satellite-fleets-13-april-2023

2. Introduction: Workshop materials

2.1. Agenda: BEREC External Workshop about the usage of satellite technologies in mobile communications

The workshop agenda is set out here and not repeated in this summary report. The biographies of the speakers are also set out the web page BEREC external workshop about the usage of satellite technologies in mobile communications | BEREC (europa.eu) together with the definitive version of the speakers presentations.

2.2. Key points of Presentations from expert speakers

- Non-terrestrial networks (NTN) and direct-to-cell (D2C/D2D) satellite communications may become crucial in providing ubiquitous connectivity, providing and bringing supplementary coverage to remote areas that do not have access to terrestrial networks. This is particularly crucial for life-saving situations in remote areas. Satellite networks are less vulnerable to terrestrial disasters or network outages and can provide redundancy.
- Newer LEO satellite constellations can provide much lower latency than traditional GEO satellites, similar to the latency experienced on terrestrial networks. Optimized cellular protocols can enable seamless roaming and handovers between terrestrial and satellite networks. Cellular protocols for NTN allow mobile users to access satellite networks as just another node in the cellular ecosystem. Those protocols allow satellite networks to leverage existing 3GPP cellular standards and interoperate with terrestrial networks. By adopting cellular protocols, satellite communications can leverage the extensive work done in standardizing these protocols for global compatibility and interoperability without the need to modify the user terminals.
- Early applications focus on emergency SMS and low-data two-way messaging, but the market holds significant promise for expansion into voice, data, and additional Internet of Things (IoT) services, creating business opportunities for the satellite Direct-to-device market.
- There are two main approaches for Satellite Network Operators (SNOs) for entering into the direct-to-device (D2D) or direct-to-cell (D2C) market by using spectrum designated for Mobile Satellite Services (MSS) or - in the other mode - by using frequency spectrum allocated for International Mobile Telecommunication (IMT) and licensed to an MNO with which the SNO established a partnership for a shared spectrum access outside of the coverage area of the MNO. Whereas the first case may require adaptations of the user phones, the advantage of the second case is the usability of market available phones without any modification.
- The successful deployment of D2D services requires global standards. Notably, the adoption of 3GPP Release 17 has been instrumental in facilitating seamless integration between terrestrial and non-terrestrial networks (NTN).
- The Federal Communications Commission (FCC) has newly adopted a regulatory framework for the USA, called Supplemental Coverage from Space (SCS). This framework will allow collaboration between satellite operators and wireless providers to enable satellite connectivity directly to consumer unmodified handsets using spectrum previously reserved for terrestrial wireless service.

- SatCom operators who adopt the approach of using terrestrial frequencies, as set out in the FCC framework, are committed to collaborating with local regulators to address national issues (under Art 4.4 of the International Telecommunication Union (ITU) Radio Regulations (RR)), and where mobile network operators (MNOs) lease rights of use.
- The upcoming 2027 World Radiocommunication Conference (WRC-27) offers an opportunity to take a step towards a global framework for satellite-based connectivity. Agenda Item 1.13 will focus on considering studies on possible new allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage.
- The European Commission's review of the 2 GHz band Mobile Satellite Services (MSS) regulatory framework, expiring in 2027, will benefit from the valuable input of the Radio Spectrum Policy Group's (RSPG) high-level opinion.
- While satellite constellations generally operate globally, the services they provide can be subject to varying regulations in different countries. This highlights the need for harmonized regulations across the European Union to avoid a patchwork approach and ensure rapid service deployment.
- Harmonizing spectrum allocation and related technical conditions, and preventing interference across neighboring countries remain the biggest regulatory challenge for D2D communications. This requires coordination across multiple jurisdictions, potentially leading to deployment challenges and complex operations.
- The space sector's carbon footprint exceeds that of the digital sector and is likely to grow significantly in the future. The surge in the deployment of low earth orbit (LEO) mega-constellations may put the space sector on an unsustainable trajectory.
- Cybersecurity is a major concern for satellite communication systems. There is a need for a coordinated approach to ensure the security of these systems.

2.2.1. Rohde & Schwarz: Challenges and Measurements in terrestrial and non-terrestrial networks

Rohde & Schwarz have done preliminary scanner measurements of a LEO satellite network transmitting a standard LTE signal, and noted the potential quality of service issues due to propagation loss, signal delays, round-trip latency, packet loss, packet delay variation and Doppler shift, since LEO satellites are moving at 8 km/s. They have also noted potential roaming issues with various satellite constellations, operator cooperation and SIM/eSIM in unmodified devices.

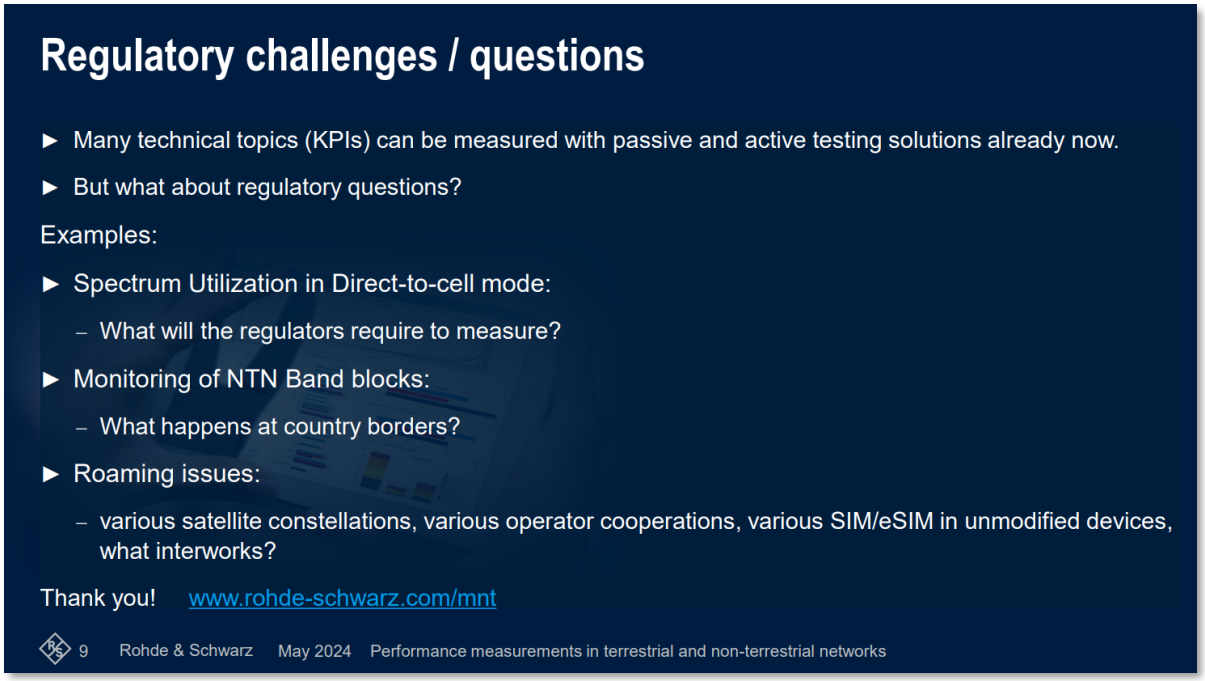

Figure 1: Regulatory challenges mentioned in one of the slides of the Rohde & Swarz presentation

2.2.2. Nokia: 3GPP Non-Terrestrial Networks (NTN)

Nokia noted that NTN use of terrestrial spectrum with the existing 3GPP devices (working in accordance with 3GPP pre-release 17), requires network compensation for NTN-specifics like Doppler shift and timing drifts.

Nokia is of the opinion that future 3GPP releases 17-19 could lead to performance improvements in throughput, capacity, mobility and battery life by making end-user devices responsible for time/frequency synchronization, providing satellite assistance information about serving and neighbor NTN cells and information on Terrestrial Network (TN) coverage within NTN cells, and mobility schemes relying on deterministic satellite movement including conditional handover and satellite switch with unchanged Physical Cell Identity (PCI).

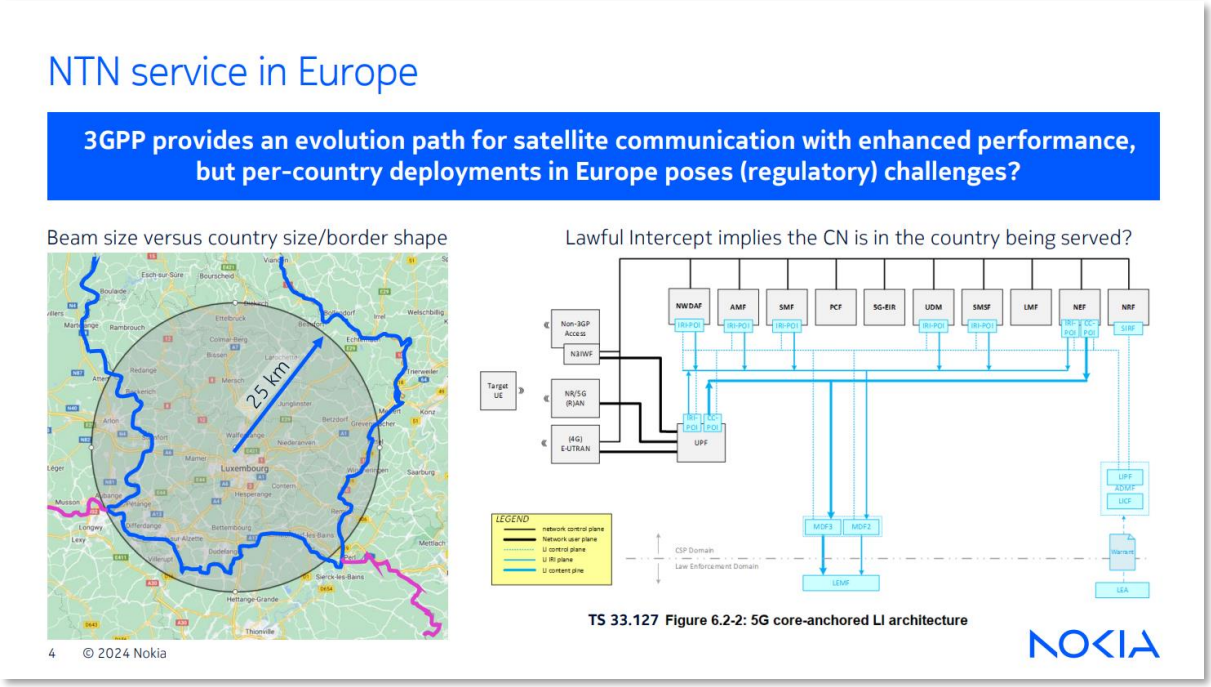

Figure 2: Regulatory challenges mentioned in one of the slides of the Nokia presentation

2.2.3. European Commission

The representative Julija Varnaitė-Kamstra stressed the importance and potential of satellite connectivity and the review of the EU regulatory framework for Mobile Satellite Services (MSS) in 2GHz band beyond 2027 as the MSS national authorization's expires in May 2027.

In order to avoid fragmentation in the internal market, the Commission and Member States should, by the end of Q2/2025, reach a sufficient understanding on a future band usage and segmentation scenario, as well as next procedural steps.

In regards to D2D connectivity and coordinated EU policy approach, the European Commission recognizes opportunities in supporting innovation, creating commercial opportunities, enabling new applications/services and stimulating competition, challenges in creating technology inclusive regulatory frameworks, EU roaming, integration of SatCom into Radio Access Electronic Communication Services (RA-ECS) and handover between NTN and terrestrial RA-ECS.

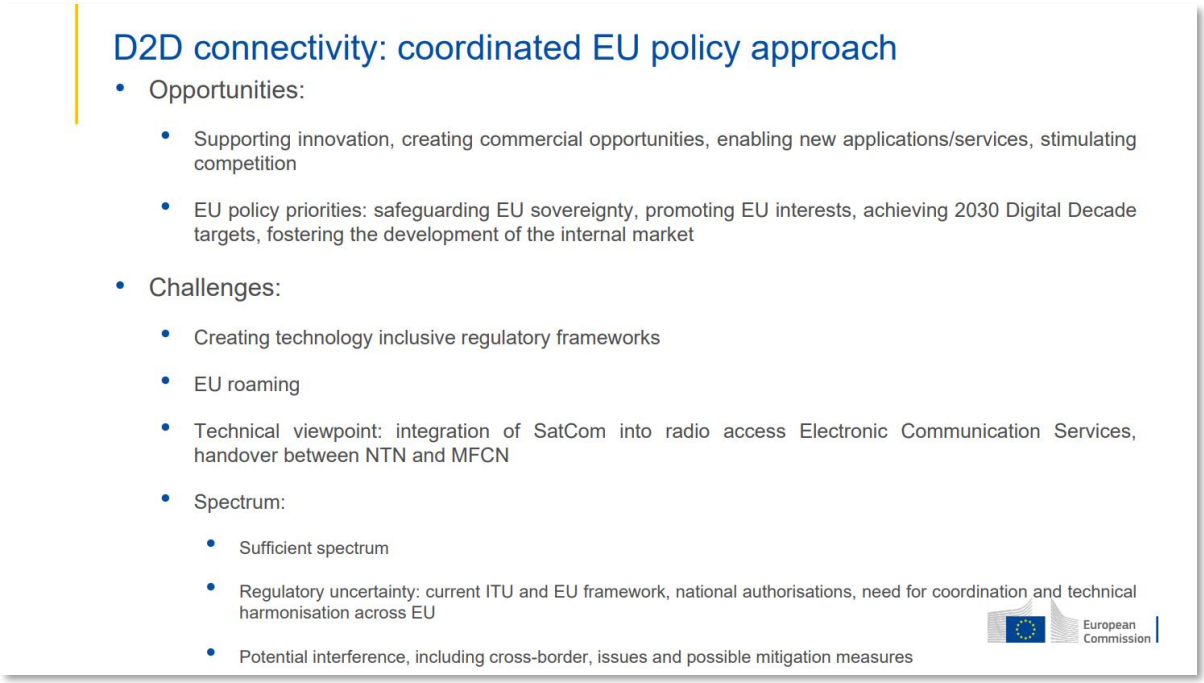

Figure 3: Regulatory challenges mentioned in one of the slides of the EC presentation

2.2.4. Iridium

Iridium shared its plans to implement 5G NB-IoT on their current constellation and noted the following D2D regulatory considerations: increasing demand for satellite D2D, bringing innovative services to countries without creating regulatory barriers, need for local gateway and presence requirements, emergency service (machine-to-machine, human involvement) and roaming and lawful intercept.

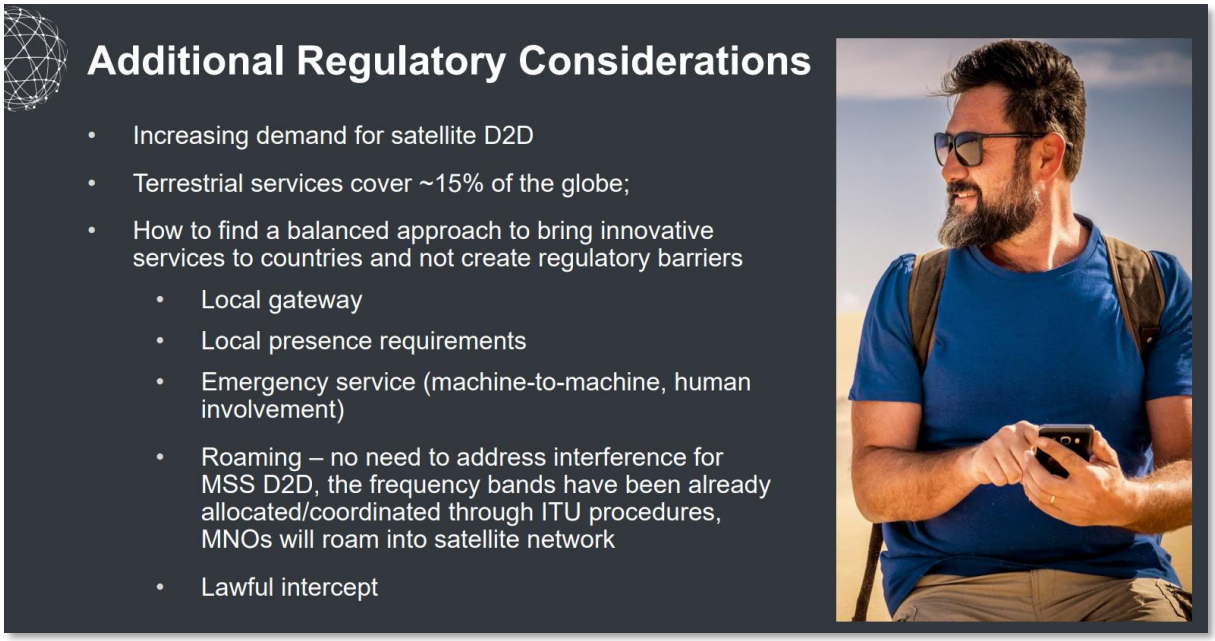

Figure 4: Regulatory challenges mentioned in one of the slides of the Iridium presentation

2.2.5. Apple

Apple presented its „Emergency SOS via Satellite“ service, that is available for iPhone 14 and iPhone 15 to connect directly to a satellite of the Globalstar network, enabling messaging with emergency services when outside of cellular or Wi-Fi coverage. This service is fully compliant with existing allocations and MSS licensing rules.

Emergency SOS via satellite includes a simple questionnaire to help quickly assess a user’s situation and relay vital information directly to the Public safety answering point (PSAP) where text to emergency services is supported, or to ground stations staffed by Apple-trained specialists when it is not.

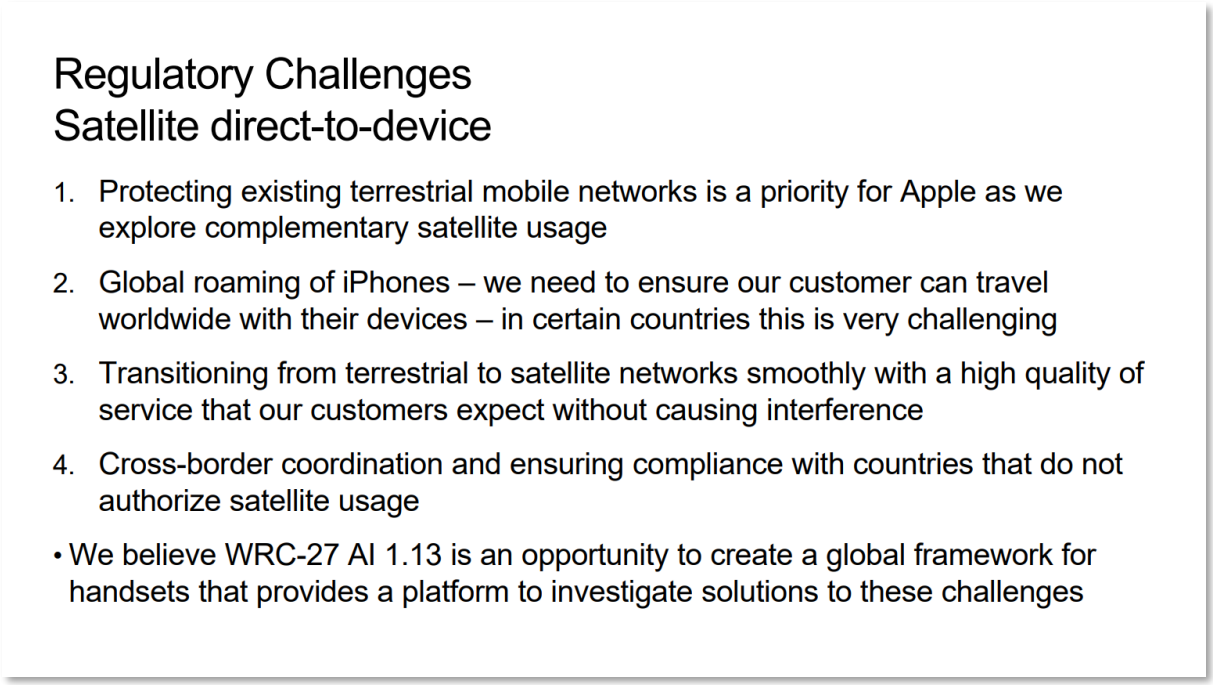

Figure 5: Regulatory challenges mentioned in one of the slides of the Apple presentation

2.2.6. Viasat

Viasat (including now Inmarsat) promoted the use of 3GPP NTN in MSS bands in their presentation. Benefit of the concept would be that it can be implemented within the existing regulatory framework as an evolution from existing dedicated MSS services. MSS Spectrum is already allocated and more MSS spectrum will be considered at WRC-27. Consideration was given to solutions, which can be overlayed by MSS operators on their existing services without interference into IMT or existing MSS services.

2.2.7. Federal communications commission (FCC)

In March 2024, the FCC voted to adopt a licensing framework for direct-to-device capabilities, which it calls Supplemental Coverage from Space (SCS). The FCC’s SCS framework contemplates a partnership between a terrestrial MNO and a SNO under which the satellite

operator uses the MNO’s exclusive mobile spectrum holdings to extend mobile network coverage in unserved areas and areas impacted by natural disasters.

The FCC's order adopts a secondary national MSS allocation that supplement Mobile Service allocations in a set of initial spectrum bands. It selected these bands because they feature nationwide, exclusive terrestrial licensees and no other co-channel users in the United States, making licensing and coordination less complex. At the same time, the FCC noted that satellite operators partnering with a terrestrial mobile operator may apply to use other mobile service bands for SCS upon a request for a waiver and a non-interference showing.

Regardless of whether the SCS satellite operator seeks a space station license or files for market access, the SCS order requires it to include with its application a lease agreement demonstrating that the mobile network operator has authorized it to use the spectrum to provide SCS.

For SCS operations in the United States, the FCC requires an operator to have a spectrum access agreement with a mobile network operator that has exclusive spectrum rights. For international operations, the SCS framework contemplates granting satellite operators authority to provide SCS in foreign markets subject to receiving an authorization to provide SCS each local market.

For SCS operations in foreign markets, the FCC establishes a framework that balances its role as licensing authority with its acknowledgement that national regulators are in the best position to authorize direct-to-device partnerships in their markets. Specifically, rather than pre-approving each supplemental coverage partnership in a foreign market, a US-licensed space-station operator may first obtain local authority to provide supplemental coverage from the local regulator, and then certify to the FCC that they have received such authority and will comply with the terms of local rules and authorizations.

Regarding user equipment authorizations in the United States, the FCC's final order does not require a re-certification of such devices already brought into the market as long as the provision of service to such existing devices would not require technical modifications. Accordingly, for purposes of equipment authorization, the FCC establishes an administrative procedure to recognize terrestrial devices under the SCS framework.

To protect other users, the Commission generally requires satellite operators providing SCS to comply with terrestrial limits, such as field strength limits at borders or other limits that have been coordinated between terrestrial operators and administrations. Because terrestrial limits were designed with base stations in mind, the FCC applies these adapted limits at the surface of the earth rather than at the transmitter.

Regarding 911 Call and Text Routing via SCS and Wireless Emergency Alerts the FCC establishes, on an interim basis, a requirement that terrestrial providers must route all SCS 911 voice calls and texts to a Public Safety Answering Point (PSAP) using either location-based routing or an emergency call center.

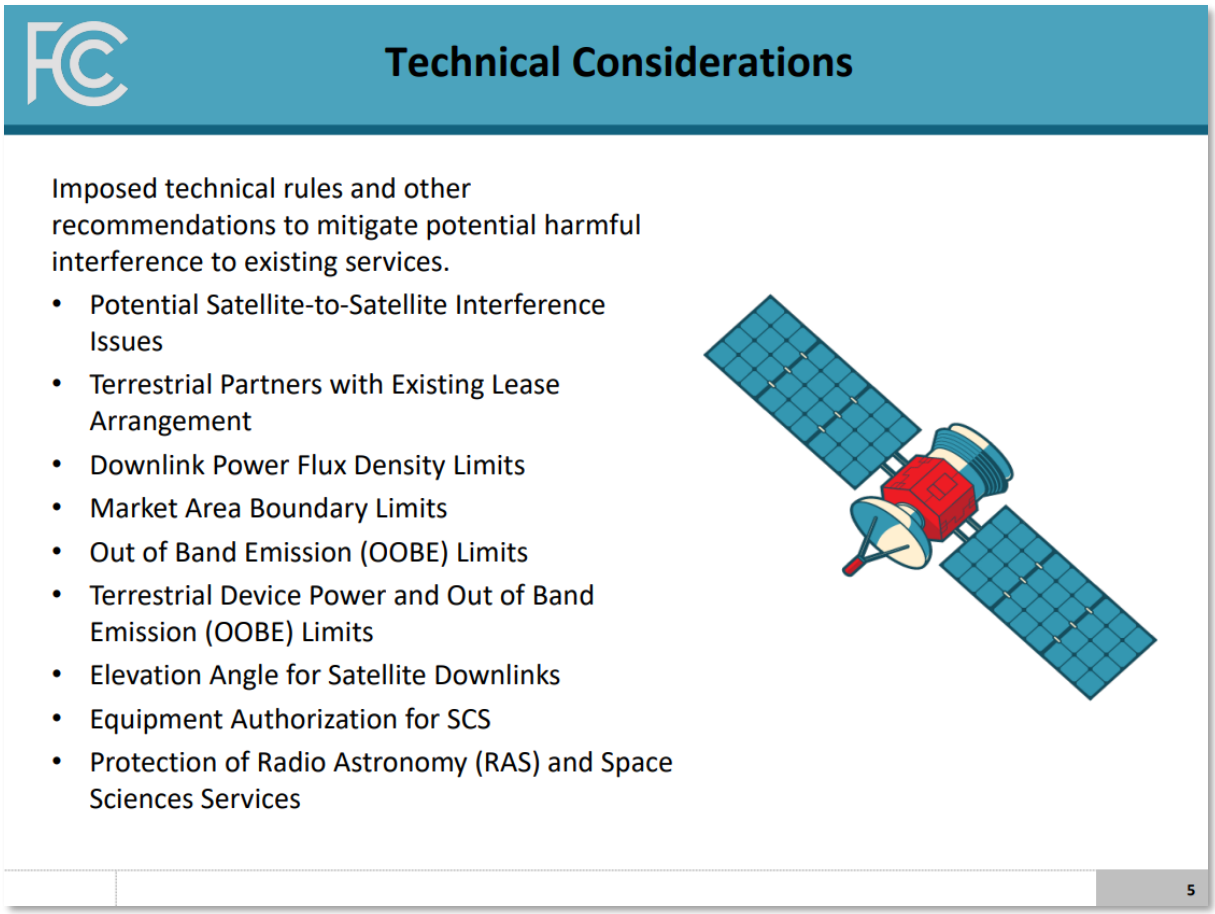

Figure 6: Technical considerations mentioned in one of the slides of the FCC presentation.

2.2.8. SpaceX

The SpaceX representative presented Starlink direct to cell, that covers a range of terrestrial mobile frequencies to close mobile dead zones, thus extending coverage when terrestrial networks are unavailable.

On January 8 2024 Starlink successfully sent text messages over satellites in the USA. SpaceX as of May 5 is operating 38 direct-to-cell satellites in orbit.

SpaceX D2D will begin providing service to mobile subscribers on partner networks with SMS messaging planned in late 2024 for its initial mobile partners, and plans to roll-out voice and low data throughput applications in 2025 and onwards. SpaceX has publicly announced partnerships with seven MNOs across four continents. In addition to Salt in Switzerland, this includes T-Mobile in the United States, Optus in Australia, One NZ in New Zealand, KDDI in Japan, Rogers Wireless in Canada, and Entel in Chile and Peru. SpaceX is working collaboratively with MNOs to augment existing terrestrial networks and to extend connectivity to previously unreachable areas.

Figure 5: Regulatory remarks mentioned in one of the slides of the SpaceX presentation

2.2.9. Deutsche Telekom

Deutsche Telekom's existing assets in the space segment in Europe are Galileo Navigation System (Galileo MPLS Data Distribution Network and IT services to manage Galileo core systems), Copernicus Data Access (Design and operation of the infrastructure systems for Copernicus since 2012), and EAN (LTE-based complementary ground network for EAN since 2018, integrated with Inmarsat's S-band satellite to deliver a truly seamless service).

The Deutsche Telekom representative introduced a number of WRC-27 agenda items in regards to allocations for MSS:

1.12: to consider, based on the results of studies, possible allocations to the mobile-satellite service and possible regulatory actions in the frequency bands 1 427-1 432 MHz (space-to-Earth), 1 645.5-1 646.5 MHz (space-to-Earth) (Earth-to-space), 1 880-1 920 MHz (space-to-Earth) (Earth-to-space) and 2 010-2 025 MHz (space-to-Earth) (Earth-to-space) required for the future development of low-data-rate non-geostationary mobile-satellite systems, in accordance with Resolution 252 (WRC-23);

1.13: to consider studies on possible new allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage, in accordance with Resolution 253 (WRC-23); Range: 694/698 MHz and 2.7 GHz;

1.14: to consider possible additional allocations to the mobile-satellite service, in accordance with Resolution 254 (WRC-23); Bands: 2010-2025 MHz (E2S), 2160-2170 MHz (S2E), 2120-2160 MHz (S2E);

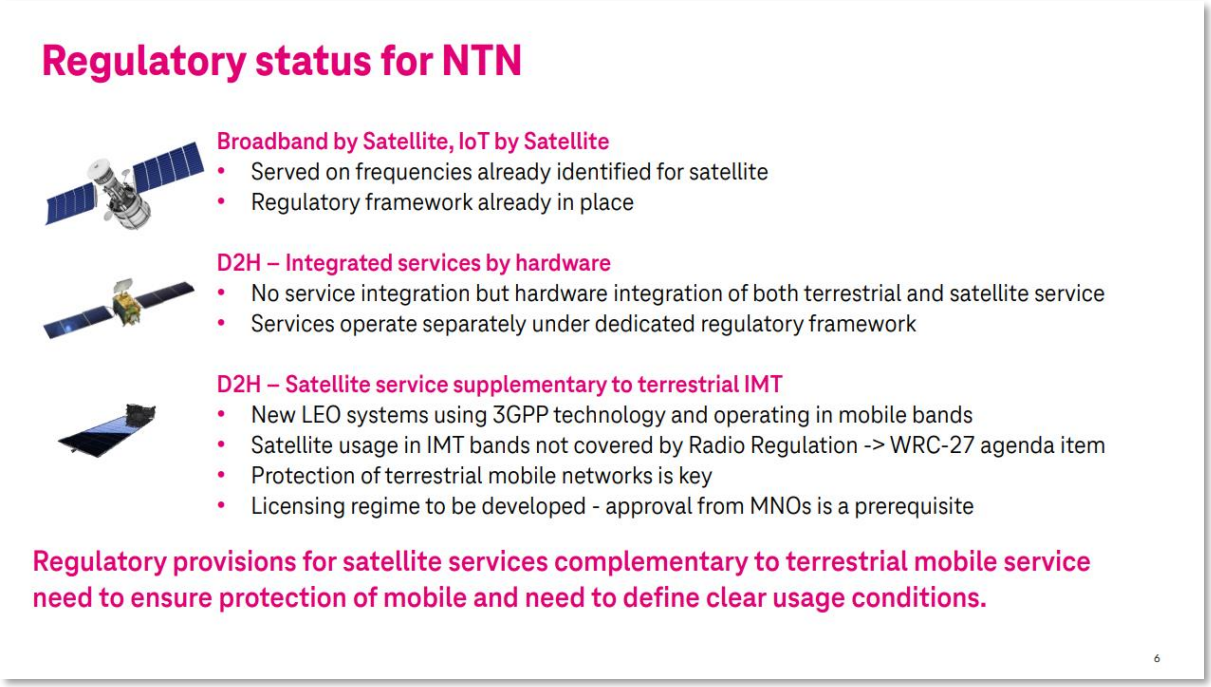

Figure 8: Regulatory status mentioned in one of the slides of the Deutsche Telekom presentation.

2.2.10. EchoStar Mobile Limited (EML)

EML has been offering commercial Mobile-Satellite Services (MSS) throughout Europe since 2017 using its Echostar 21 satellite. Because of its high capacity and its 18-meter antenna, E21 is designed specifically to enable D2D communications. In November 2022, EML launched a Pan-European Satellite IoT network for direct-to-sensor satellite connectivity to address the emerging market demands in Satellite IoT. In Germany, EML, partnering with SkyFive and Airbus, provides a hybrid MSS/CGC connectivity for command and control in urban air mobility applications. A smaller LEO network focused on IoT applications called LYRA is to be launched in late 2024/early 2025, as well as its NTN-LEO network with a planned launch in 2026/2027. EML foresees using the 2 GHz MSS band for wideband NTN Mobile-Satellite Services.

2.2.11. AST SpaceMobile

AST SpaceMobile plans a 700+ Bluewalker satellite fleet based on partnerships terrestrial MNOs. Using prototype BlueWalker 3 test satellite, in April of 2023 they have conducted 2G Voice Call tests and in June 2023 using AT&T cellular spectrum, they tested smartphones to BlueWalker 3 4G LTE connection with download speeds of 10+ Mbps.

In September 2023 AST SpaceMobile demonstrated space-based 5G connectivity by placing a call from Maui, Hawaii, USA, to a Vodafone engineer in Madrid, Spain, using AT&T spectrum.

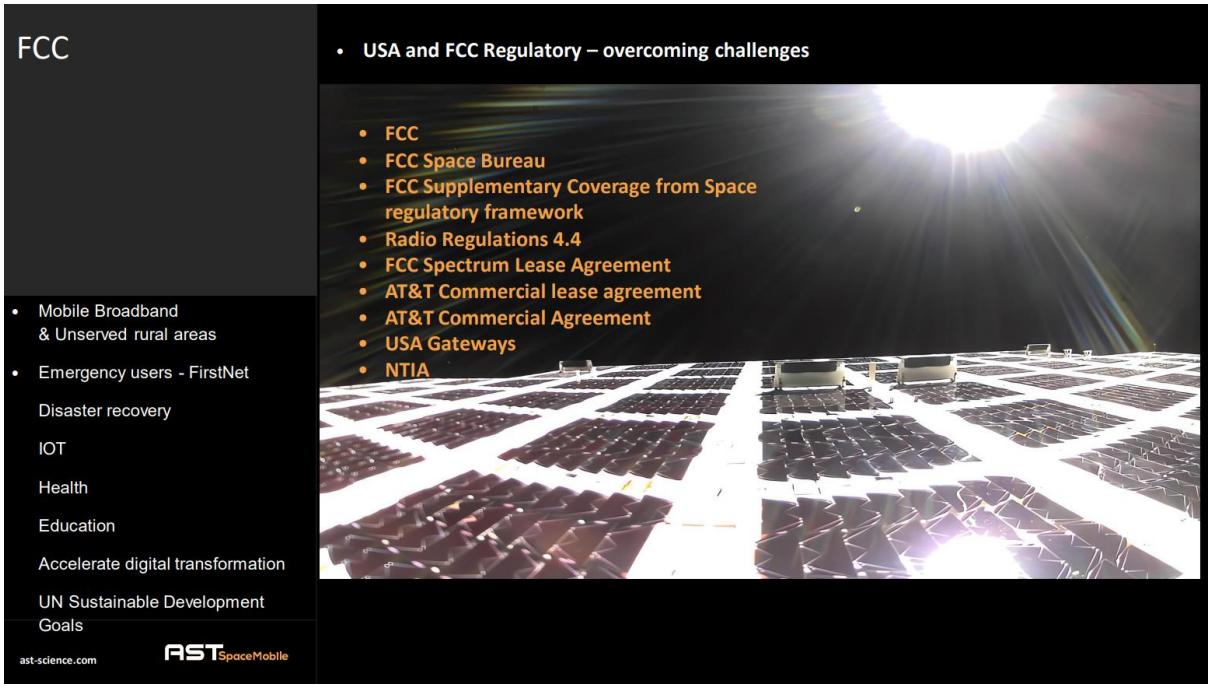

Figure 9: Regulatory challenges for USA/FCC mentioned in one of the slides of the AST SpaceMobile presentation.

2.2.12. Vodafone

Vodafone provided remarks about the importance of unmodified handsets in the context of NTNs. Vodafone also set out that it partnered with AST space mobile for satellite connectivity and had conducted relevant tests.

2.2.13. The Shift Project

The Shift Project is the think tank advocating the shift to a post-carbon economy. They presented information regarding satellite networks climate footprint and place in the digital system.

In 2022, LEO constellations represent as much as the rest of space activities, of which 94% due to Starlink and OneWeb. The prediction for 2021-2050 is an increase by a factor of nine.

Shift recommendations are to make the deployment of constellations conditional on climate impact studies in parallel with work on reducing the uncertainties of "non-CO2" effects and slow down until we know the environmental impacts, make current connectivity strategies compatible with our carbon budgets and carry out an in-depth review of telecommunications missions as part of discussions on decarbonisation trajectories for the space and digital sectors at European and world level.

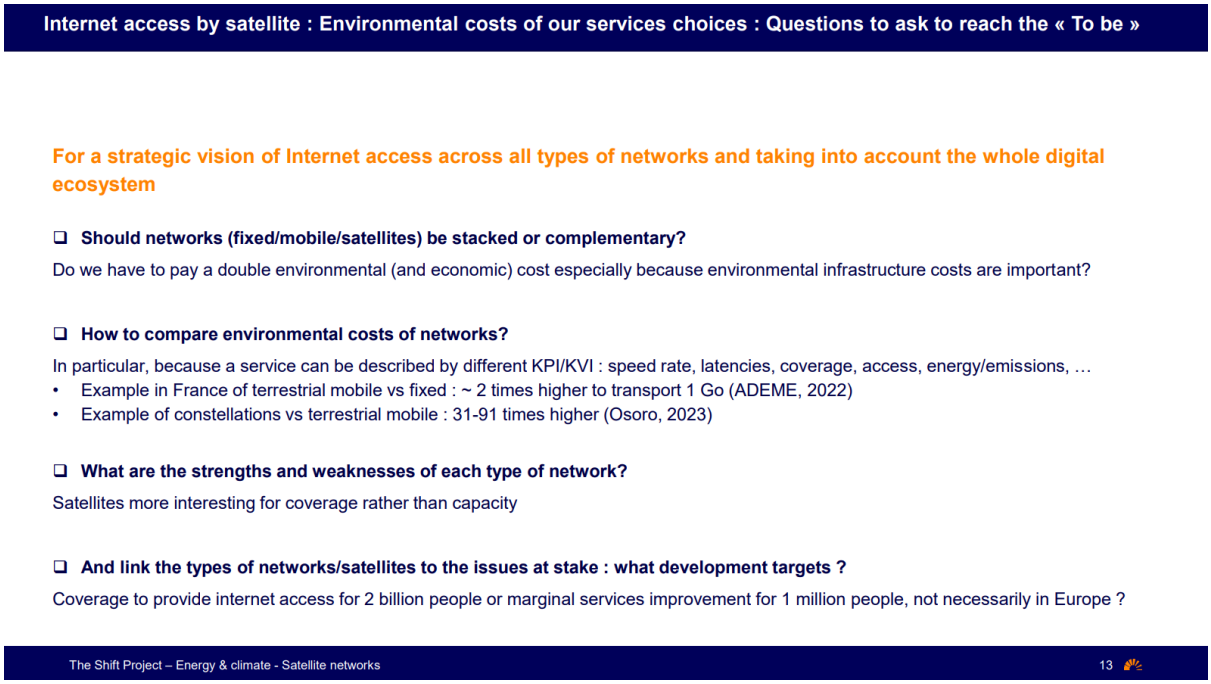

Figure 10: Challenges with regard to measuring environmental impact mentioned in one of the slides of the Shift Project presentation.

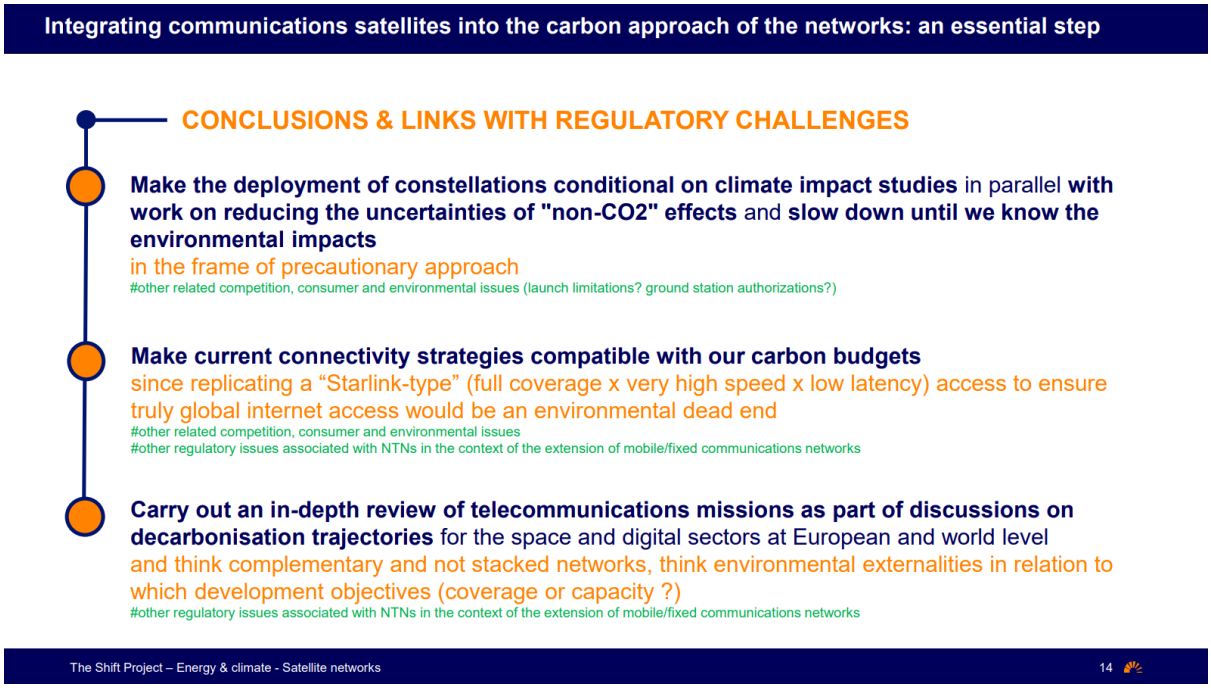

Figure 11: Regulatory challenges from an environmental perspective in one of the slides of the Shift Project presentation.

2.2.14. The European Union Agency for Cybersecurity (ENISA)

The ENISA representative presented cybersecurity associated technical risks in satellite systems including: degradation/outage of commercial services, information theft, forgery, hijacking of communication capabilities, damage or destruction of assets, as well as commercial risks such as: harm to the company reputation, loss/degradation of competitive advantage, loss of commercial capabilities and financial loss because of penalties

Cybersecurity challenges for satellite systems are: the shift from analogue to digital, the use of complex supply chains has exposed satellites to a spectrum of cyber threats ("standard" terrestrial and space specific), the difficulty to achieve a coordinated approach in satellite security (physical and cyber). An effective protection of satellites requires a risk based approach and security measures.

2.2.15. Amazon Project Kuiper

Project Kuiper is Amazon's low Earth orbit (LEO) satellite broadband mega-constellation network using more than 3,300 LEO satellites. The presentation included a showing of customer premises equipment supporting low-latency communications with download speeds above 100 Mbps, operating in Ka-band and 18x18cm dish size (smallest antenna type). Kuiper is for broadband services subscriptions; it does not intend to provide services towards smartphones. Services in Europe may commence in 2026.

2.2.16. AALTO

AALTO presented its High Altitude Platform Station (HAPS) concept and noted that the international rules for use of HAPS/HIBS have already been established (agreed at WRC23).

AALTO is of the opinion that flexible and streamlined approach to HAPS, including use of self-coordinated light licensing to enable efficient coexistence between incumbent ground-based fixed service and HAPS best supports this connectivity layer.

2.2.17. European Space Agency (ESA)

The ESA representative noted that there is a race in the use of satellite technologies in mobile communications, that 70 MNO/SNO partnerships across 42 countries have been announced, that Apple Emergency SOS is already operational in 16 countries across 3 continents (for free) and that Europe is lagging behind.

In order to stay in the race Europe has to mitigate technological and commercial risks, federate full value-chain: SNOs, MNOs, vendors, etc., trigger service procurement across business-to-business and business-to-consumer market verticals and address the regulatory framework with the best interest of European industry in mind.

3. Next steps and recommendations for further work

BEREC's next steps will fall under the BEREC Work Programme 2025, where a proposal to have a peer exchange (internal only) of relevant information possibly with experts from the Radio Spectrum Policy Group is foreseen.