

New Space: The future of satellite communications

18 July 2024

Welcome

The hybrid event will start at **7:00pm** at the Atrium, University of Suffolk and via Microsoft Teams.

Introduction: Kevin Foster FIET, Chairman, IET Anglian Coastal Local Network.

Presenter: Prof Andy Sutton, BT Fellow & Principal Network Architect - Wireless Access

Questions: Please type in your questions to the Q&A feature in Teams or be ready to ask them in the Atrium and these will be taken at the end of the presentation.

Close: Approximately 8:15pm



BT Group



New Space: The future of satellite communications



Andy Sutton MSc CEng FIET FITP FBCS

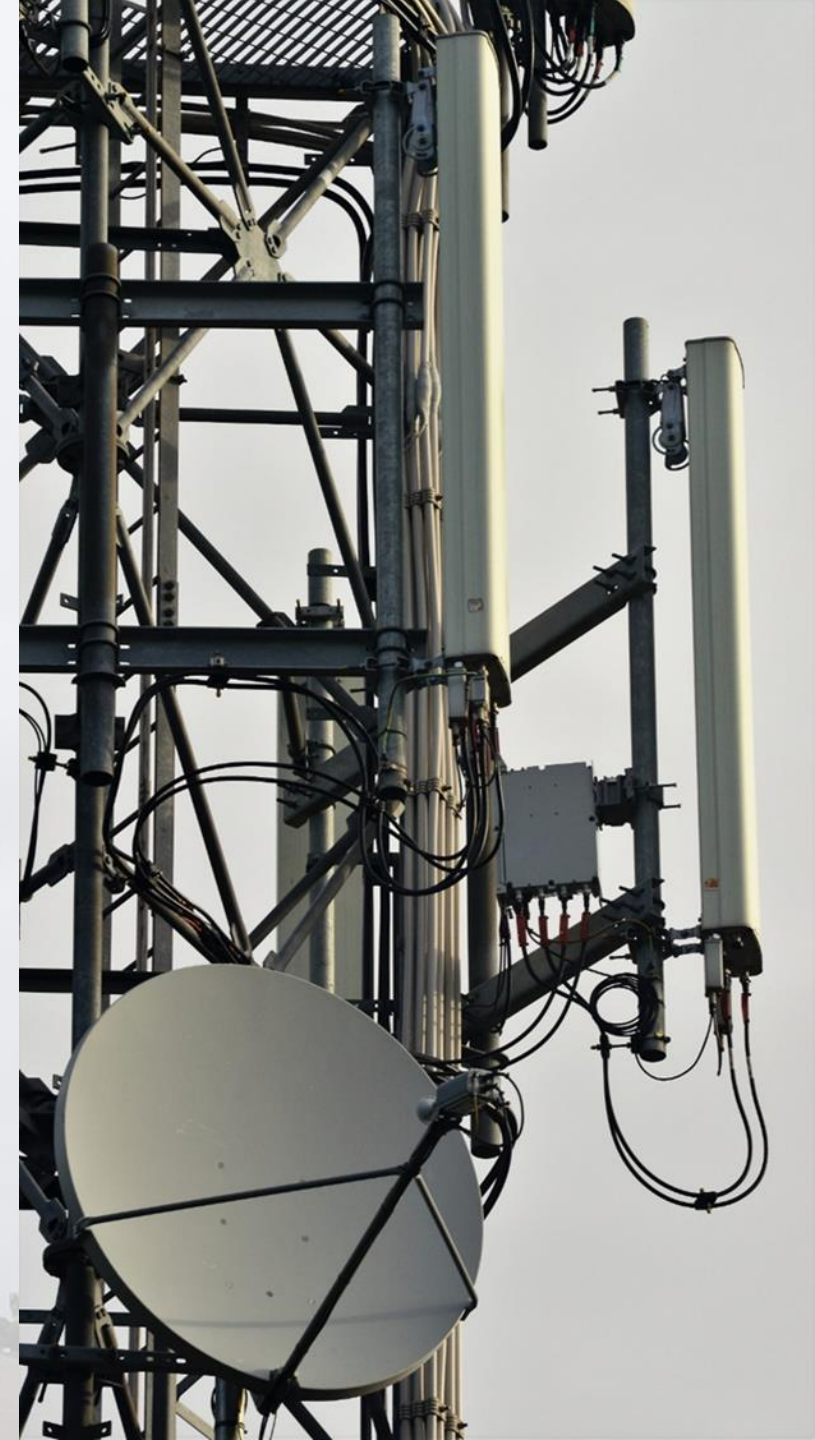
BT Fellow & Principal Network Architect - Wireless Access

Visiting Professor - University of Liverpool & University of Salford

18th July 2024

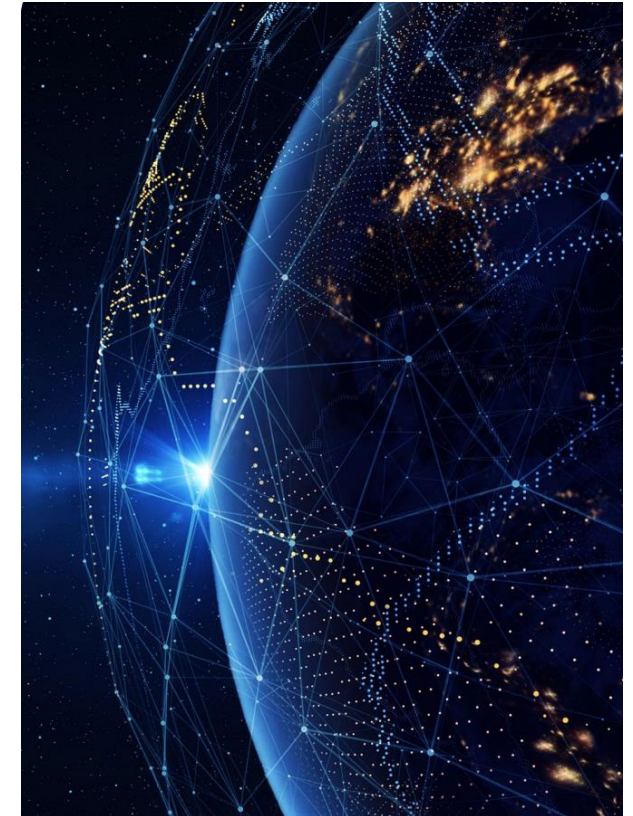
Contents

- BT's Space Strategy
- Access to Space
- Satellite orbits
- GEO use cases and satellites
- Mobile backhaul via satellite
- Satellite broadband providers
- New Space and LEO mega constellations
- Apple and Globalstar
- 3GPP Non-Terrestrial Networks (NTN)
- 3GPP NTN for IoT and direct to device
- 3GPP NTN satellite operators
- High Altitude Platform Systems (HAPS)
- Summary



04 JULY 2022

To Infinity and Beyond: How BT is supporting the UK's national and defence space strategy



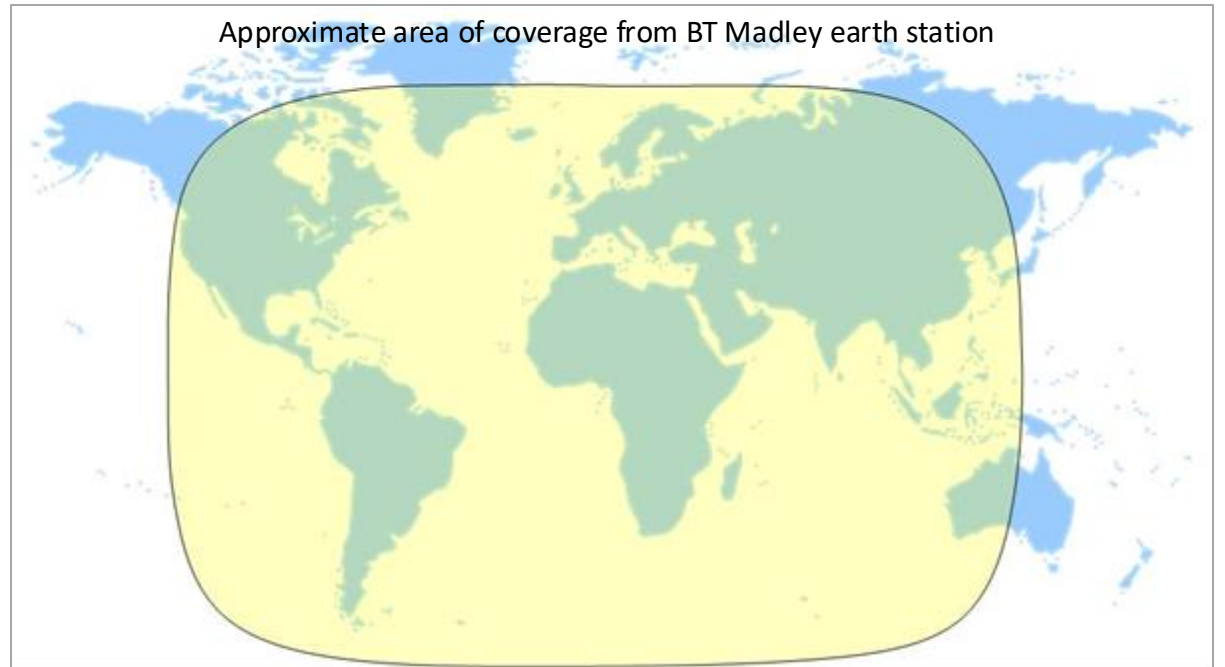
Madley

A strategic UK CNI asset

- There are more than 60 satellite antennas operating at Madley, ranging from 32m diameter to 75cm
- The site incorporates several air-conditioned equipment halls housing many racks of customer equipment
- All environmental plant is 1: n redundant, offering high levels of resilience
- Equipment room facilities are spacious, air conditioned and secure - the site has extensive internal and external opportunities for further growth, utilising an excellent infrastructure foundation
- Madley is a 63 acres site within existing security fencing and is situated in a physical bowl formed by the Black Mountains and Malvern Hills, giving good shielding from radio interference



Approximate area of coverage from BT Madley earth station





But why now..?



Access to Space



- Recent advances in technology and reusable launch vehicles has significantly reduced the cost of access to space, investments from tech entrepreneurs has driven the eco-system in recent years
- Space X and Blue Origin are leading commercial providers while many nations are working on space access and launch capabilities, often as public-private partnerships
- 2023 was a record year for space with 211 successful rocket launches to orbit - the most ever, and 31 more than in 2022

LEO mega-constellations become a game changer...

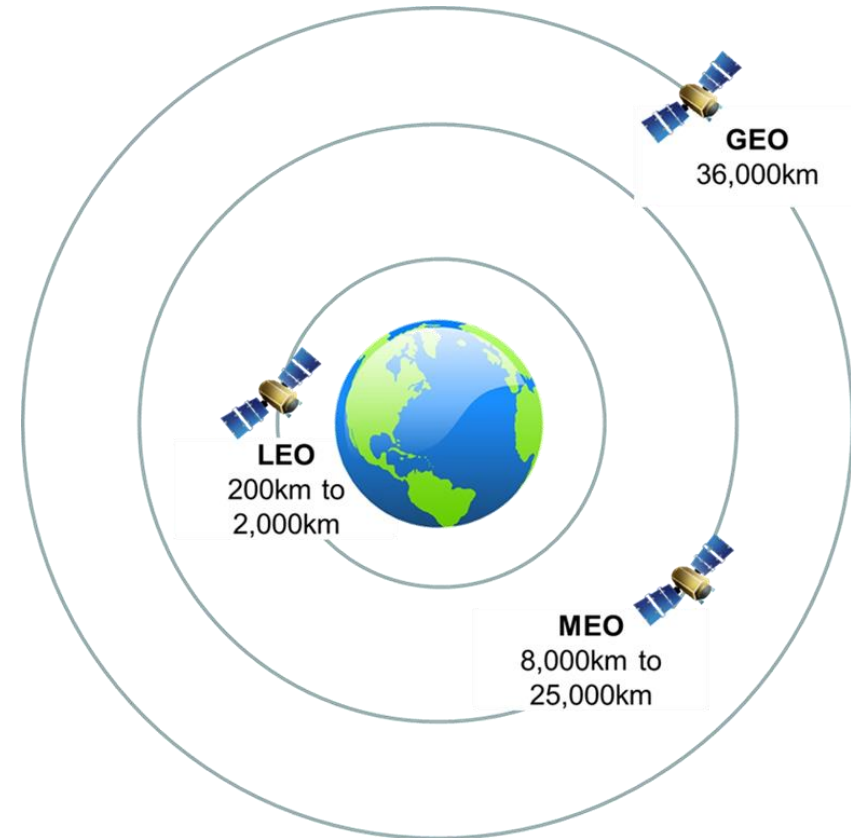
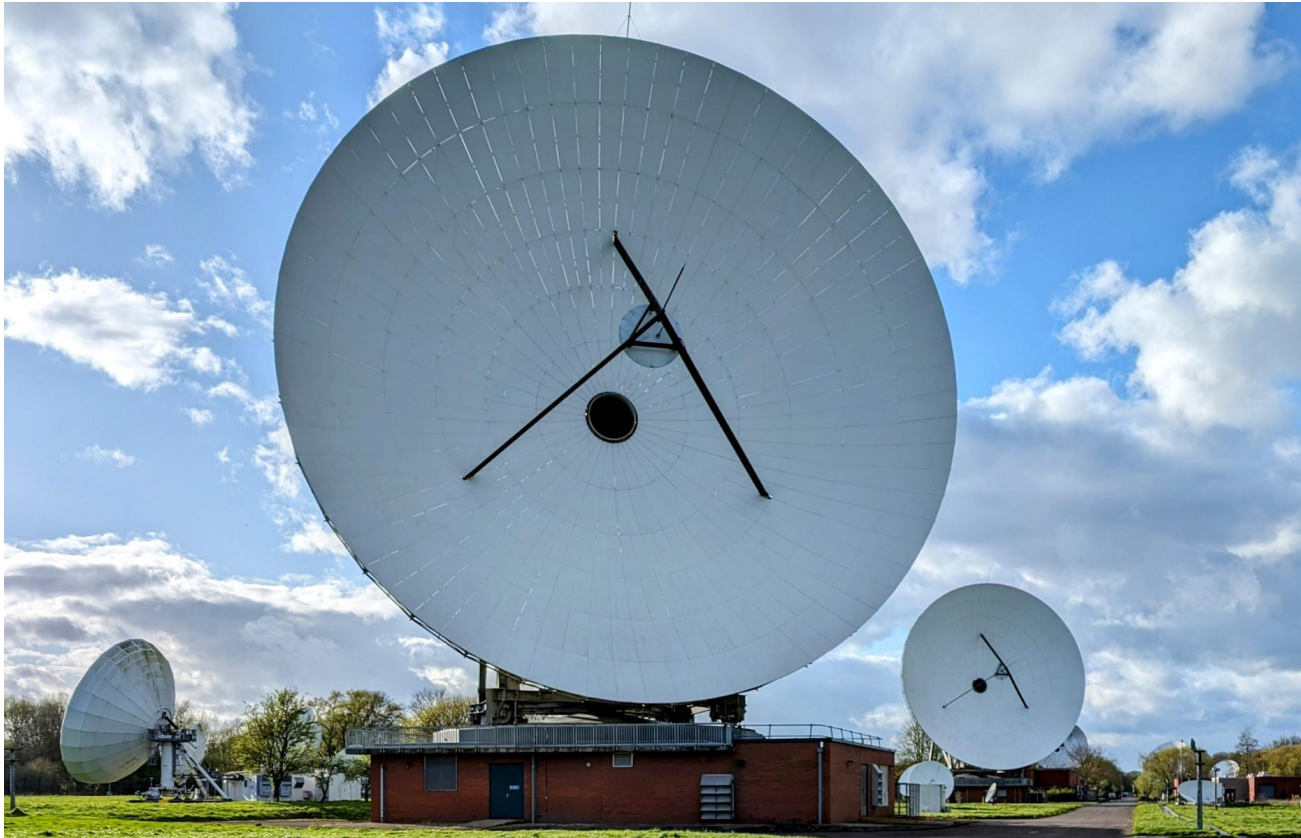


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Attribution: Google Earth Globe Image: ©2020 Landsat / Copernicus. Data: SIO, NOAA, U.S. Navy. NGA, GEBCO IBCAO U.S. Geological Survey.

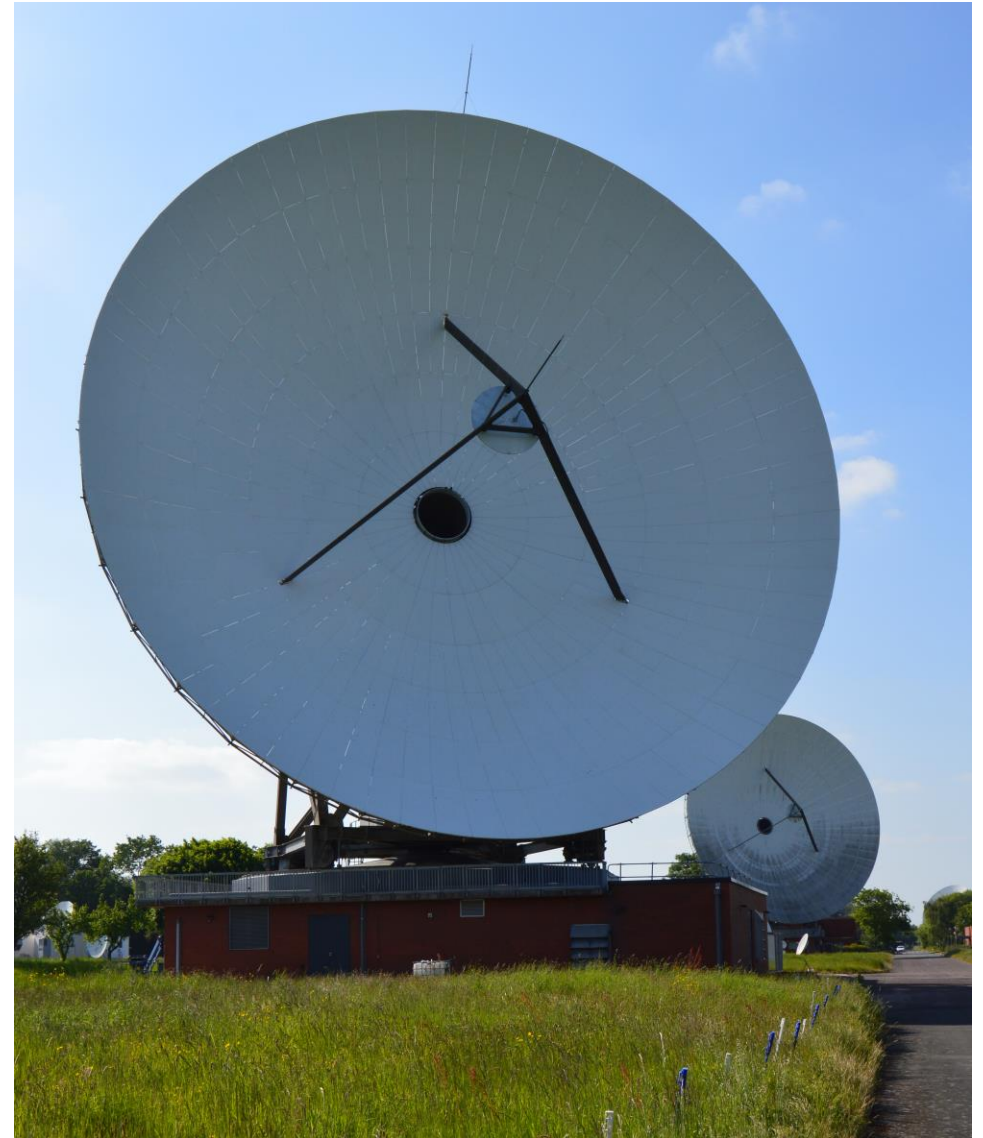
13 MAY 2024

Delivering a multi-orbital and multi-constellation space strategy



There are six pillars to BT's Space Strategy:

1. Provide a strong downstream voice into the UK Government and space industry as the nation's leading telco
2. Proactively engage with those in the space ecosystem to collaborate on relevant research and commercial opportunities
3. Explore the role emerging space technologies could have in the delivery of services to our customers
4. Become thought leaders in terrestrial and non-terrestrial convergence
5. Foster disruptive thinking and solutions to promote the UK as global thought leader in space
6. Leverage our world-class research capabilities at Adastral Park and our satellite communications centre of excellence at Madley



Government and industry are working together to shape the future...



<https://www.gov.uk/government/organisations/uk-space-agency>



<https://www.ukspace.org/>

...and we are still members of ESA - The European Space Agency! 😊

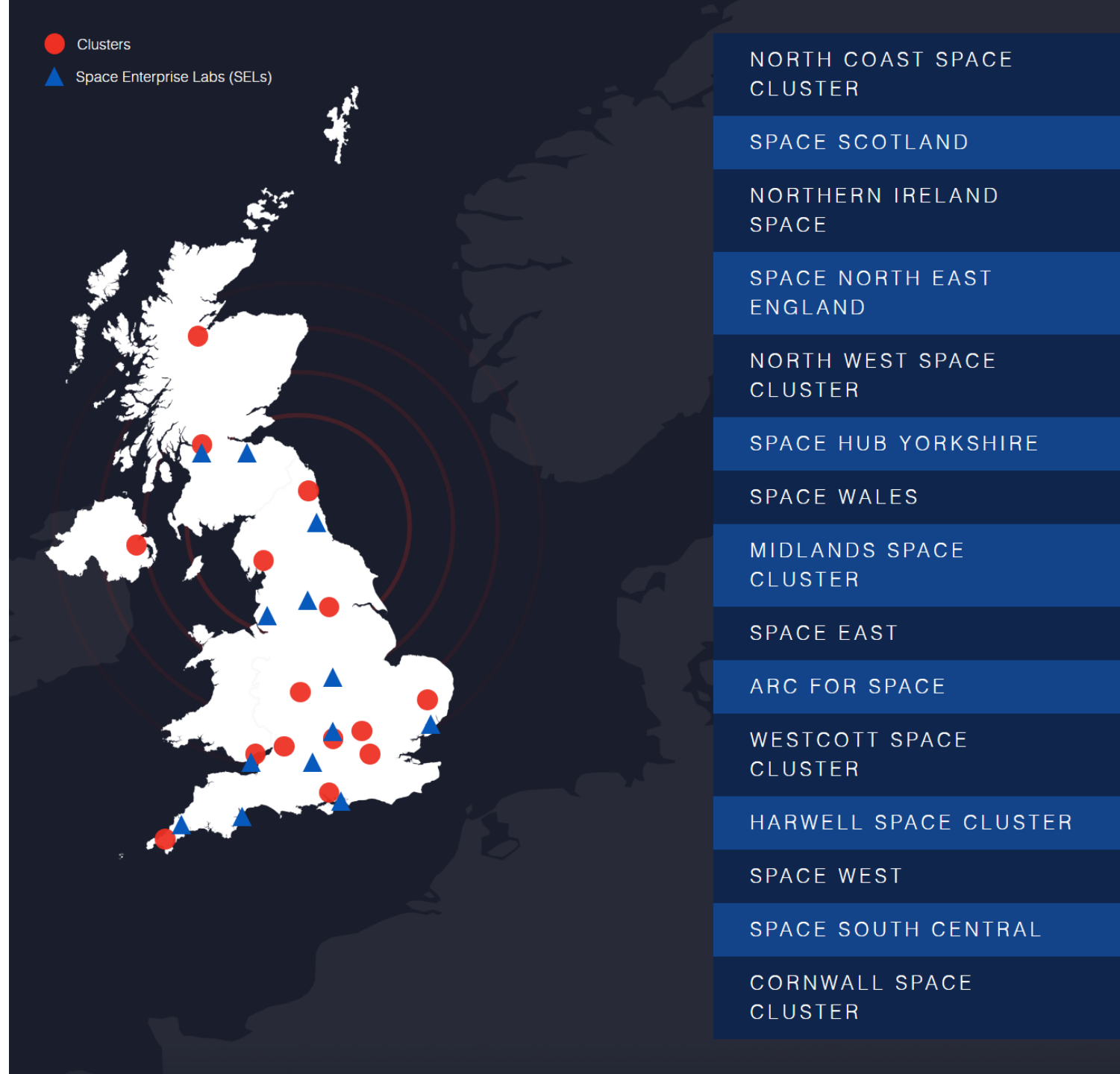


<https://www.esa.int/>

Satellite Applications Catapult

<https://sa.catapult.org.uk/>

- The Satellite Applications Catapult is at the heart of the satellite services revolution, driving take-up of space technology and applications to shape, and sustain, the world of tomorrow
- We're driven by how our actions help the organisations we work with, both large and small, bring new services to market
- By connecting industry and academia we get new research off the ground and into the market more quickly

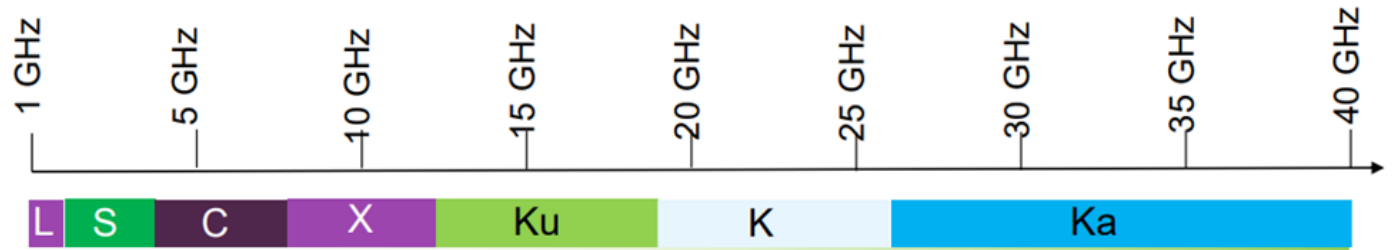




The integration of terrestrial and non-terrestrial networks



Radio Frequency Spectrum





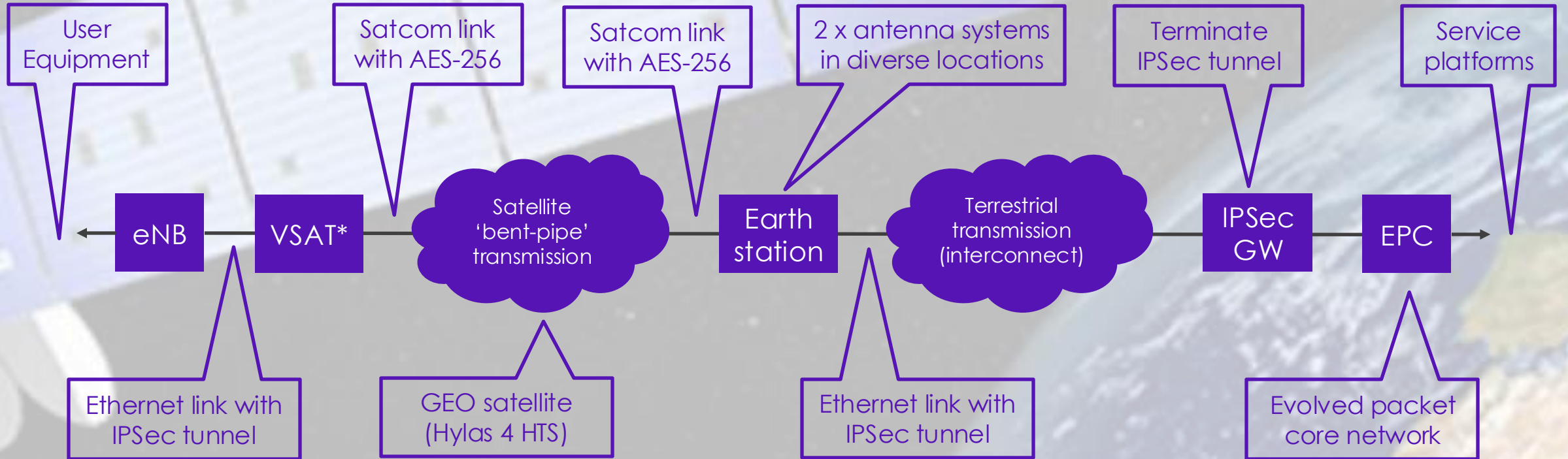
GEO satellites for broadband access

- Traditional GEO satellites have evolved significantly with the introduction of high-throughput satellites (HTS)
- GEO solutions provide broadband access to fixed terminals with near-global coverage
- Typical use cases include IP connectivity in areas with no terrestrial access networks, resilience to back-up terrestrial transmission and access to markets such as maritime and aviation, along with off-shore platforms and TV outside broadcast
- The delivery of satellite TV was a huge market for GEO satellites however this is reducing as providers switch to IPTV, typically delivered over terrestrial broadband...



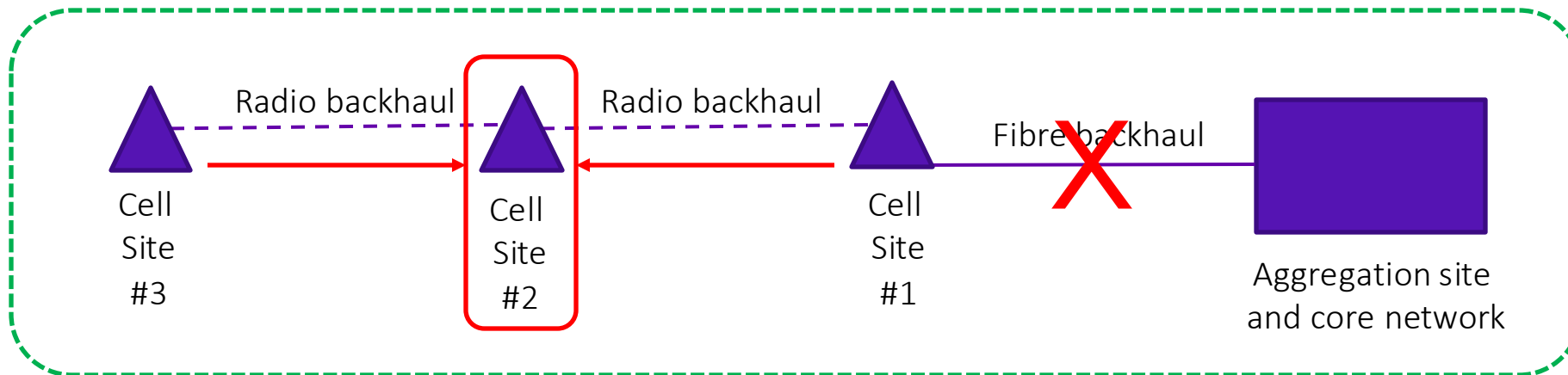
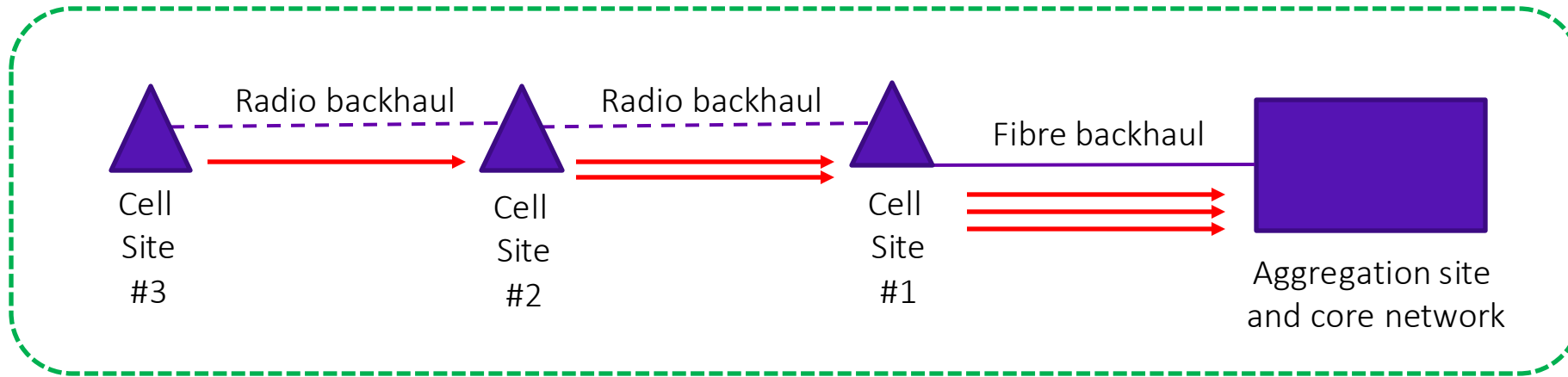
Extremely rural connectivity - GEO satellite backhaul

High level network architecture for mobile backhaul over GEO satellite



*VSAT block includes Gilat SkyEdge II-c Capricorn-Pro modem (with TCP acceleration and IPSec/AES-256 plus Ka band radio transceiver and offset fed parabolic antenna)

Addition of satellite communications to enhance service availability - backing up terrestrial transmission for mission critical communications



Rapid Response Vehicles and Emergency Response





HYLAS (Highly adaptable satellites)

HYLAS 4:

- Orbital Slot = 33.5 W°
- Propulsion = Hybrid chemical and electric
- Life = minimum 15 years
- Beams = 64 fixed and 4 steerable
- Payload power = >8 kW
- Capacity = circa 32 GHz

Coverage:

- Countries = 36
- Total land area = 17.4m sq.km
- Population = 665 Million



AVANTI HYLAS 4

Broadband and satellite providers 2023

Operator	Satellite system (deployed)	Spectrum	Technology	Operational	Services
Space X (Starlink)	12000+ (3580)	Ku-band	Proprietary	Yes	Broadband
OneWeb	648 (542)	Ku-band	Proprietary	TBD	Broadband
Kuiper	3236 (0)	Ka band	Proprietary	Estimated 2024	Broadband
Galaxy Space	1000 (7)	Q/V spectrum	Proprietary	TBD	Broadband
Boeing	147 NGS0 (1)	V band	Proprietary	TBD	TBD
Inmarsat	14 GEO (14)	TBD	Proprietary	TBD	Broadband to IoT
Telesat	188 (2)	C, Ku, Ka bands	Proprietary	TBD	Broadband
Echostar	10 GEO (10)	Ku, Ka, S bands	Proprietary	Yes	Broadband
HughesNet	3 GEO (2)	Ka band	Proprietary	Yes	Broadband
Viasat	4 GEO (4)	Ka band	Proprietary	Yes	Broadband

LEO mega-constellations

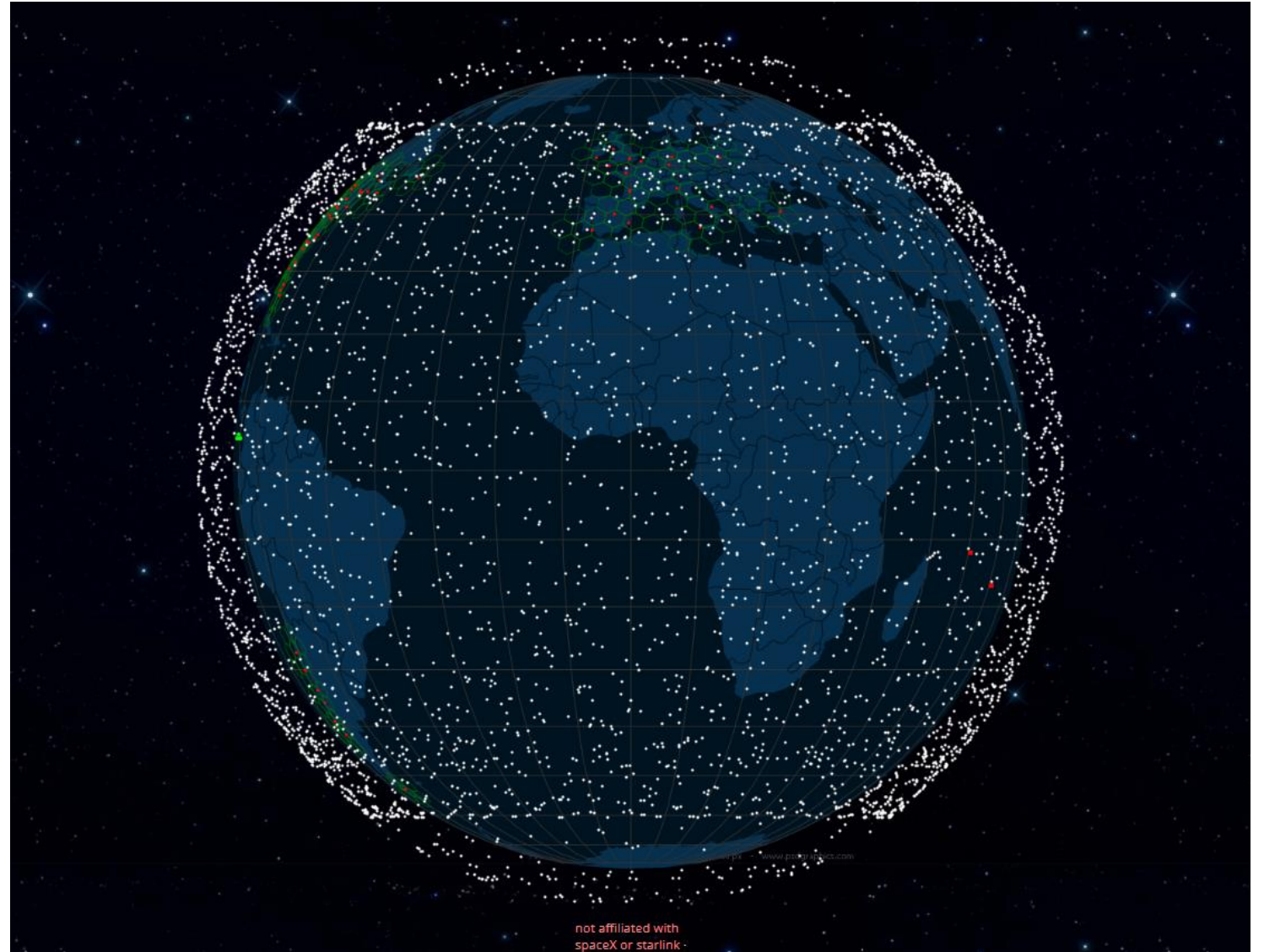
- There are two new LEO constellations currently offering service - OneWeb & Starlink
- LEO satellites operate at altitudes between 200 and 2,000km (Starlink ~550km, OneWeb ~ 1200km)
- OneWeb has over 630 satellites in its phase 1 constellation, and more planned for a second phase - each satellite currently provides 7.8Gbps of capacity
- Starlink has >6,000 satellites in operation as of May 2024 - each satellite provides 16Gbps of capacity
- Earth stations - OneWeb currently in Italy, Portugal, Norway & Sweden - Starlink currently at 3 sites in UK
- OneWeb has a UK gateway in planning...
- BT has a direct 10Gbps interconnect with OneWeb to ensure E2E QoS and Starlink is open to direct interconnect...



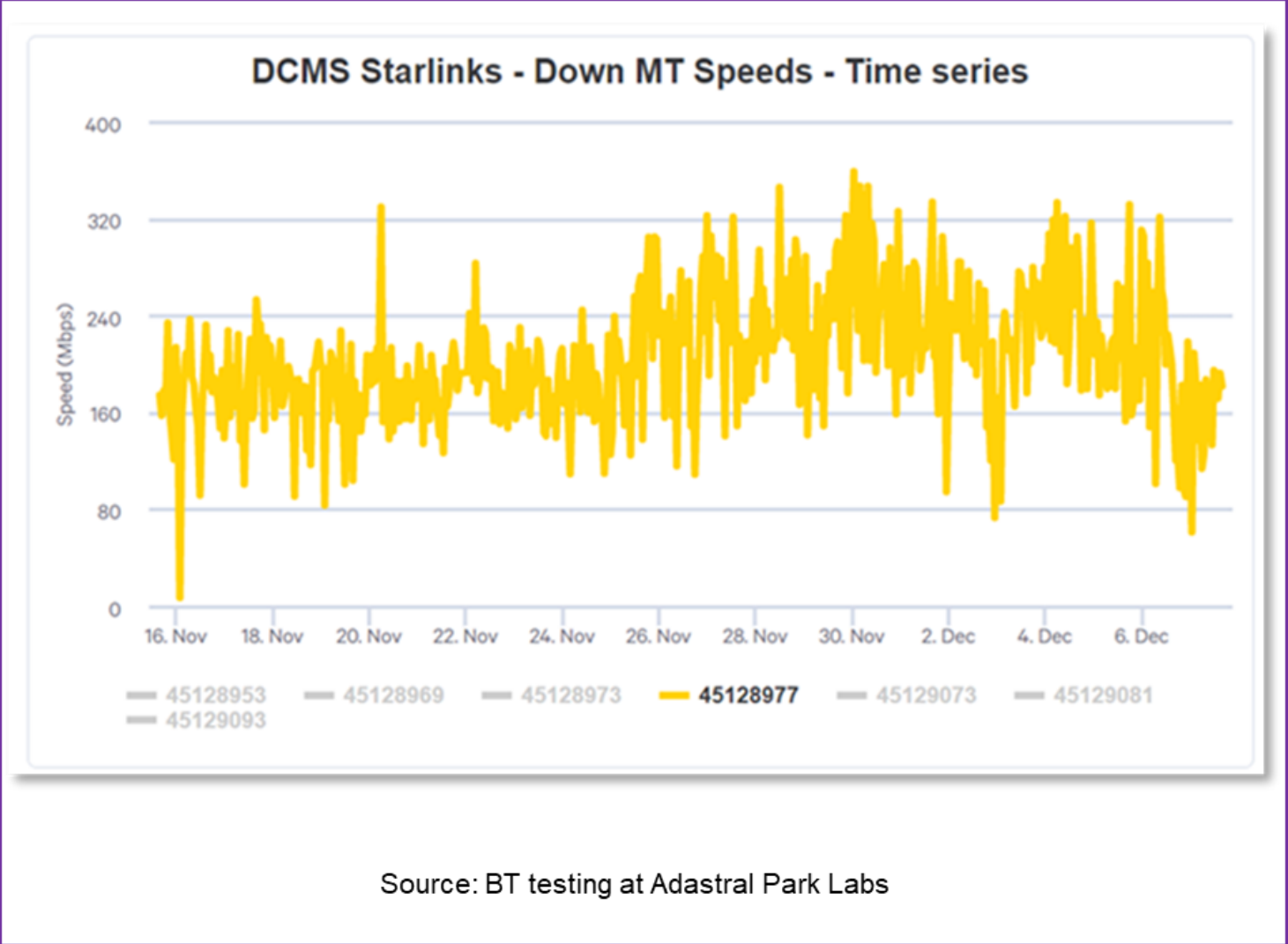
LEO is a huge and exciting addition to the space portfolio



Starlink's constellation



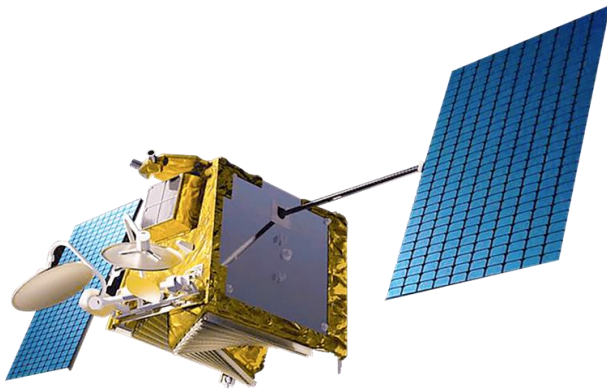
Starlink download speeds



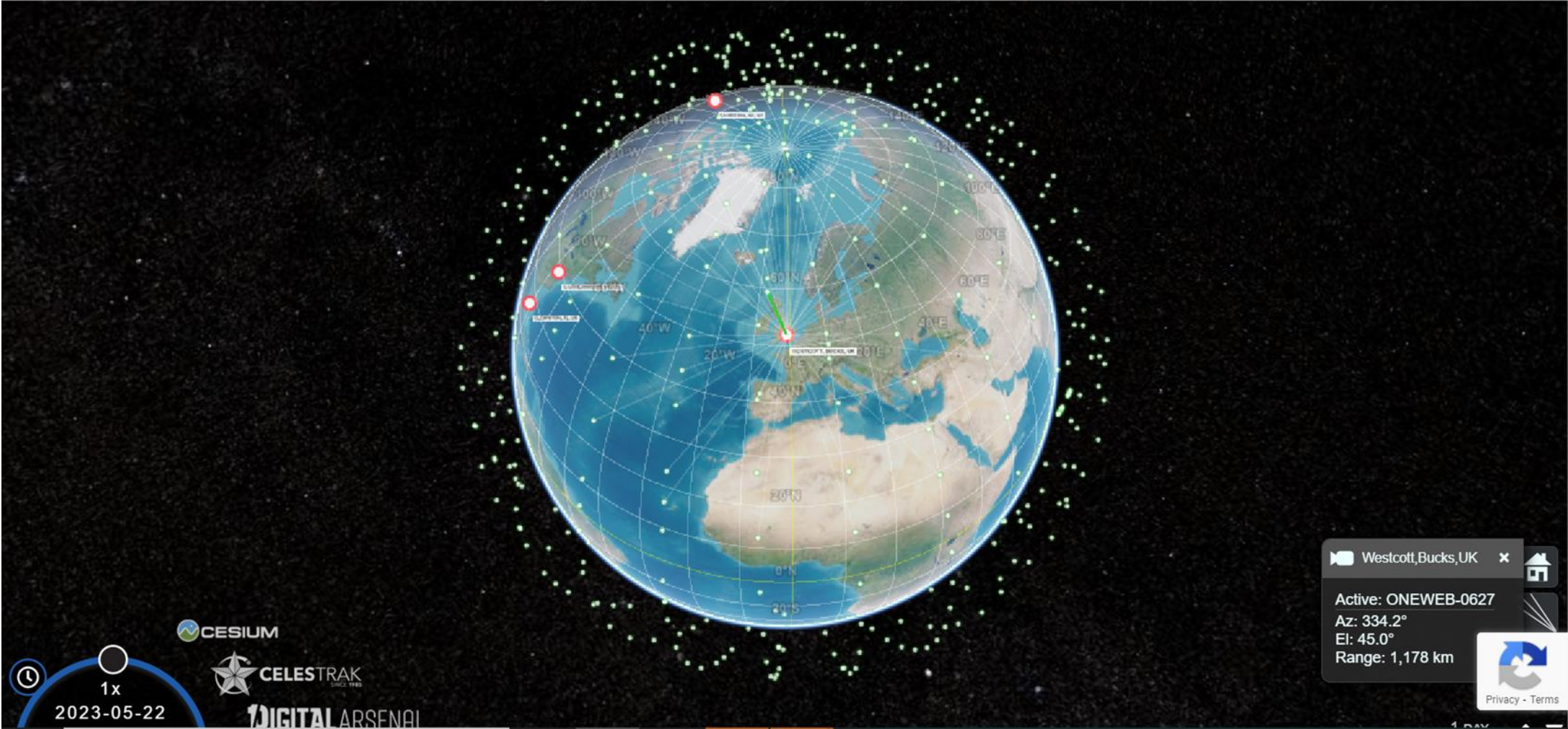
Source: BT testing at Adastral Park Labs

OneWeb (B2B)

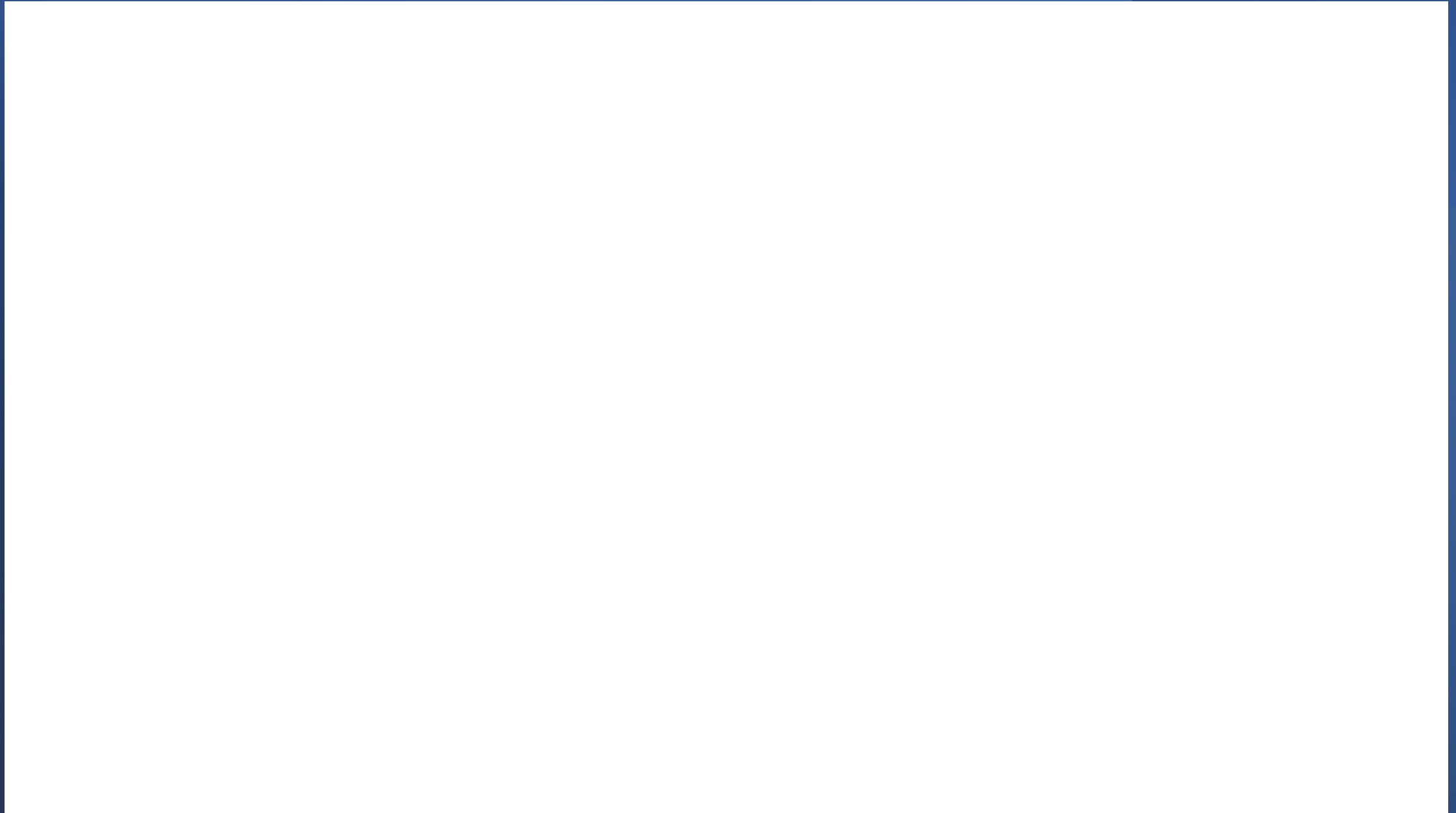
- 12 orbital planes (polar orbit)
- 49 working satellites per plane
588 in-service satellites
- Full global coverage was realised early in 2024
- Experimenting with inter-satellite links



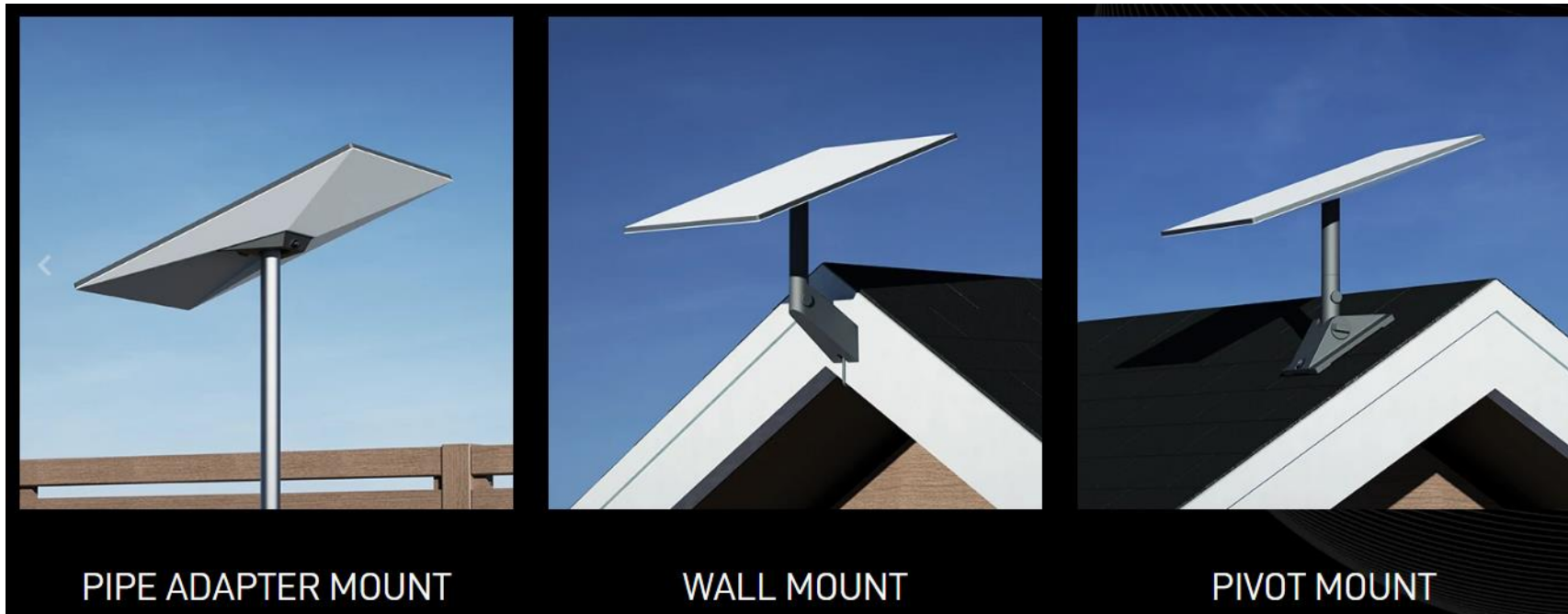
<https://oneweb.net/orbit>



Lundy Island LEO based rural broadband trial



Flat panel antennas offer enhanced deployability...



Source: <https://www.starlink.com/gb/roam>



Source: <https://www.hughes.com/what-we-offer/satellite-services/managed-leo>



Source: <https://www.intelliconnect.com/en/news/newsroom/intelliconnect-unveils-latest-flat-panel-terminals-at-satellite-2023/#>

Yet more to come...

- **Telesat** has developed a highly innovative global network composed of 188 state-of-the-art Low Earth Orbit (LEO) satellites, seamlessly integrated with on-ground data networks
- With our 50-year heritage of technical expertise and proven track record of innovation, Telesat will deliver the most advanced network with unmatched speed and performance
- **Project Kuiper** is an initiative to increase global broadband access through a constellation of 3,236 satellites in low Earth orbit (LEO)
- Kuiper's mission is to bring fast, affordable broadband to unserved and underserved communities around the world



Source: <https://www.telesat.com/leo-satellites/>



Source: <https://www.aboutamazon.com/what-we-do/devices-services/project-kuiper>

...and another - Rivada Space Networks



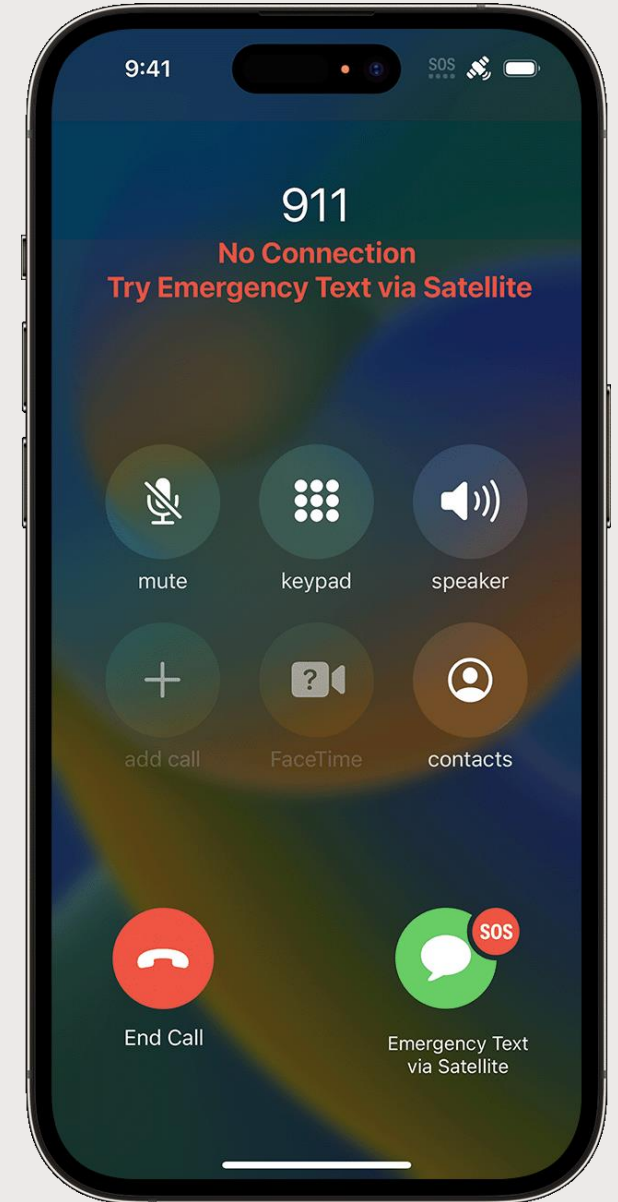
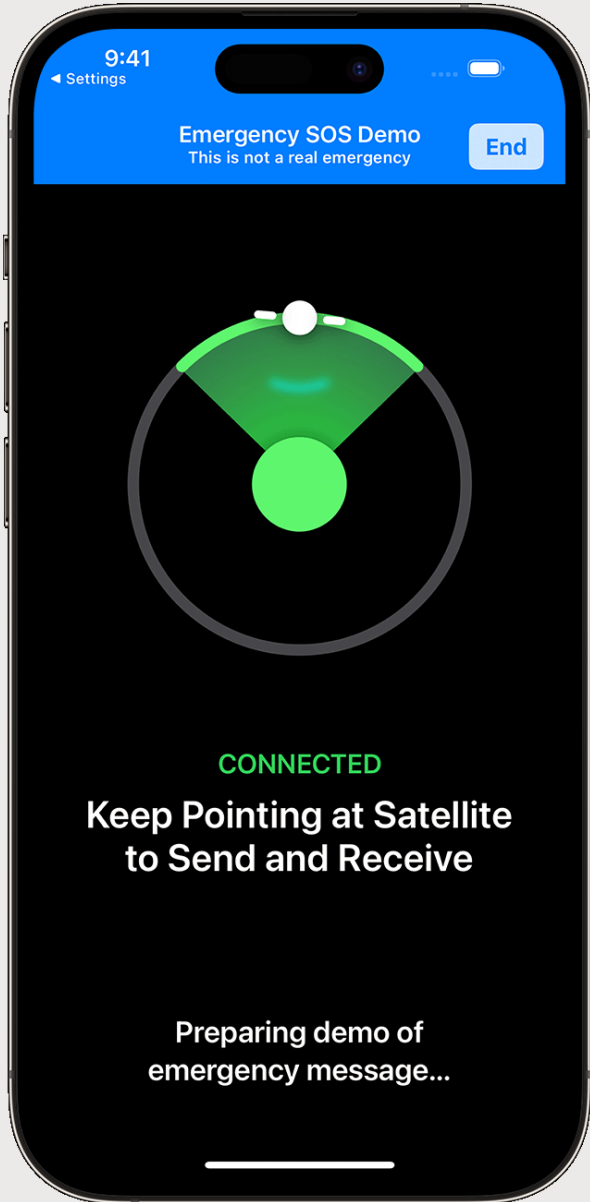
- 600 satellites - all in near-polar low-earth orbits, moving together to keep you connected
- 24 orbital planes - covering the globe with seamless connectivity
- 2400 inter-satellite links - to create a perfect mesh in the sky
- 1050 km -flight altitude

Rivada is proposing to provide government communications, maritime and aviation connectivity, enterprise networking, and backhaul services for telecommunications networks. Rivada plans to launch an initial constellation of satellites by July 2026, with the intention of launching more satellites by July 2028.

Direct to device with Apple & Globalstar

With iPhone 14 and iPhone 14 Pro models, you can use Emergency SOS via satellite to text emergency services when you're out of cellular and Wi-Fi coverage

You can also use the Find My app to share your location with people via satellite



Roles for Non-Terrestrial Networks in 5G system

- Thanks to the wide service coverage capabilities and reduced vulnerability of space/airborne vehicles to physical attacks and natural disasters, Non-Terrestrial Networks are expected to:
 - Foster the roll out of 5G service in un-served areas that cannot be covered by terrestrial 5G network (isolated/remote areas, on board aircrafts or vessels) and to upgrade the performance of limited terrestrial networks in a cost-effective manner
 - Reinforce the 5G service reliability by providing service continuity for M2M/IoT devices or for passengers on board moving platforms (e.g. passenger vehicles-aircraft, ships, high speed trains, bus) or ensuring service availability anywhere especially for critical communications, future railway/maritime/aeronautical communications and to enable 5G network scalability by providing efficient multicast/broadcast resources for data delivery towards the network edges or even user terminal

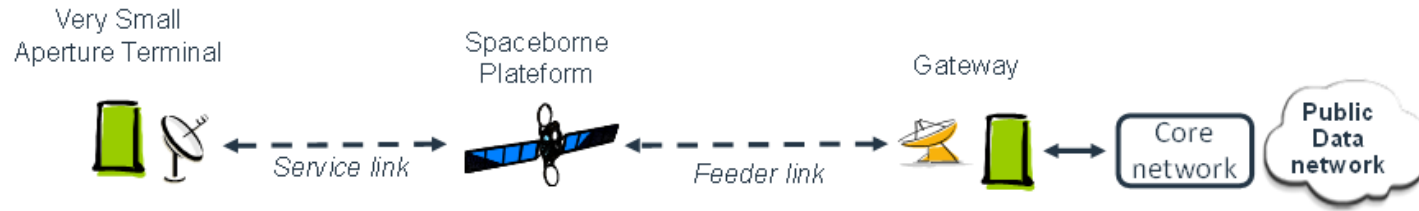


Figure 4.3-1: Satellite access network (without ISL) with a service link operating in frequency bands above 6 GHz allocated to Fixed and Mobile Satellite Services (FSS and MSS)

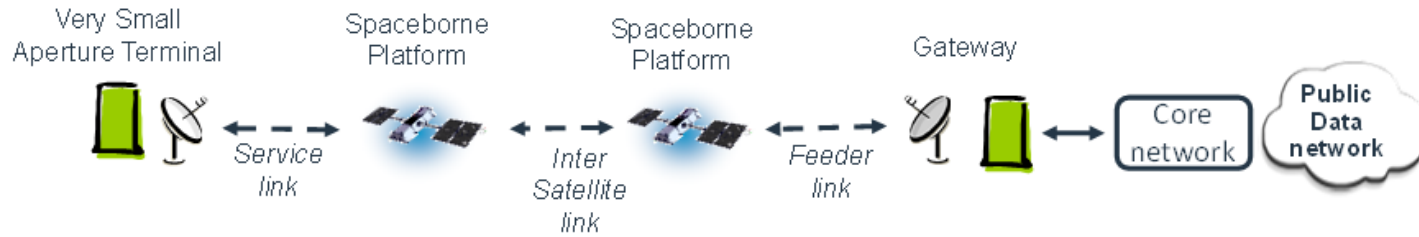


Figure 4.3-2: Satellite access network (with ISL) with a service link operating in frequency bands above the 6 GHz allocated to Fixed and Mobile Satellite Services (FSS and MSS)



Figure 4.3-3A: Satellite access network with a service link operating in frequency bands below 6 GHz allocated to Mobile Satellite Services (MSS)

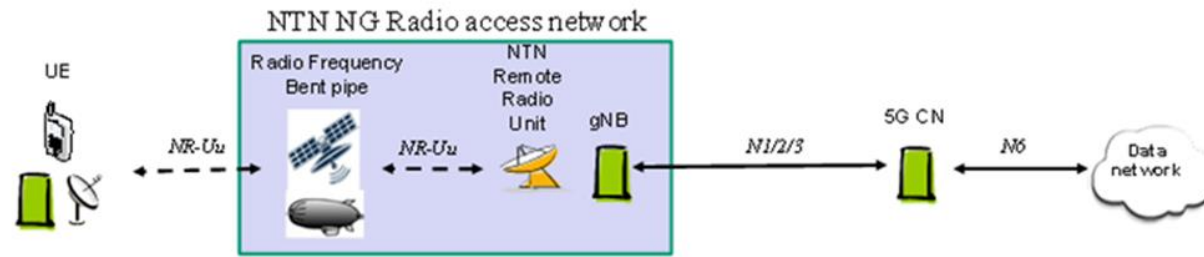


Figure 7.3.8.1.2-1: Mapping option 1 - NG RAN architecture in Non Terrestrial network with bent pipe payload

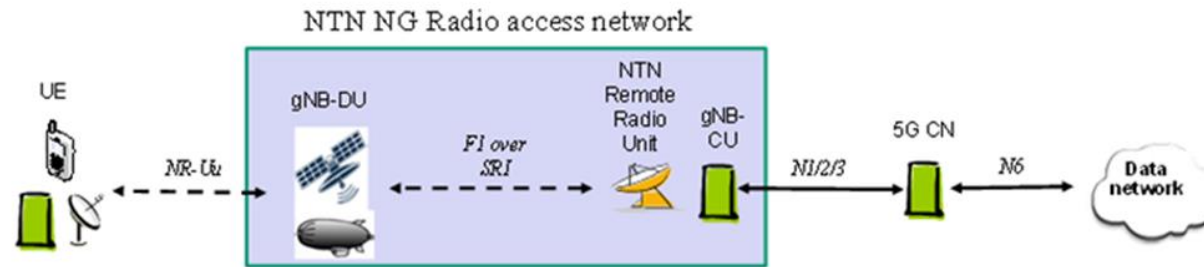


Figure 7.3.8.1.2-2: Mapping option 2 - NG RAN architecture in Non Terrestrial network with gNB-DU processed payload

NOTE: SRI refers to Satellite Radio Interface

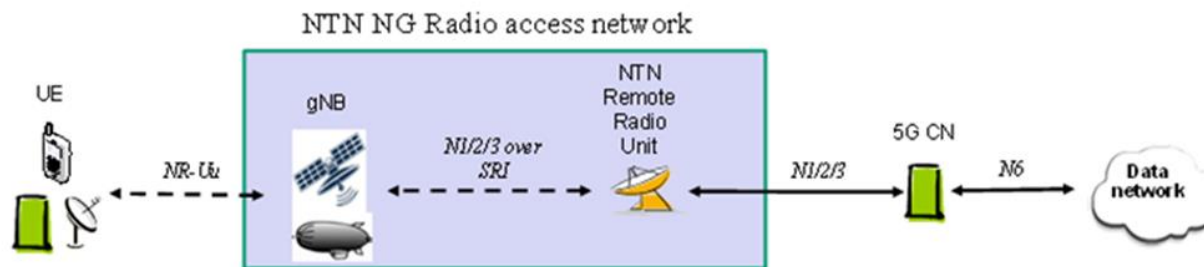


Figure 7.3.8.1.2-3: Mapping option 3 - NG RAN architecture in Non Terrestrial network with gNB processed payload

Conclusions from 3GPP NTN study item

The consensus and wider agreement on the key advantages of satellite networks which can add value to the 5G ecosystem are:

- Ubiquity: Satellite provides high speed capacity across the globe using the following enablers: capacity in-fill inside geographic gaps, overspill to satellite when terrestrial links are over capacity, general global wide coverage, backup / resilience for network fall-back and especially communication during emergency
- Mobility: Satellite is the only readily available technology capable of providing connectivity anywhere on the ground, in sea or air for moving platforms, such as airplanes, ships and trains
- Broadcast (Simultaneity): Satellite and aerals can efficiently deliver rich multimedia and other content across multiple sites simultaneously using broadcast and multicast streams with information centric networking and content caching for local distribution
- Resiliency: A key component of 5G is network resiliency. As satellite and aerial networks are not subject to the same weather and man-made disasters that happen to terrestrial communications systems, they bring to the network an important component of resiliency

IoT and Direct to Cell (device) D2C service providers 2023

Operator	Satellite system (deployed)	Spectrum	Technology	Operational	Services
Dedicated providers					
Space X	2016 LEO (0)	MNO spectrum/ 2GHz MSS	Pre Rel-17 3GPP	2024	Messaging, speech, broadband
AST SpaceMobile	243 LEO (1)	MNO spectrum	Pre Rel-17 3GPP	2024	Messaging, speech, broadband
Lynk	5000 LEO (3)	MNO spectrum	Pre Rel-17 3GPP	2Q2023	Messaging, LDR (low- data rate)
Satellite	250 LEO (1)	2.0GHz MSS	Rel-17 NB-IoT (NB-NTN)	TBD	NB-IoT
Iridium	66 LEO	L-band	Proprietary	Yes	LDR/Messaging
Orbcomm	31 LEO	137-150 MHz	Proprietary	Yes	Assets tracking
GlobalStar	24 LEO	L/S-band	Proprietary	Yes	Assets tracking
Ligado	1 GEO	L-band	Rel-17 NB-IoT (NB-NTN)	TBD	NB-IoT

Stratospheric platforms

- The stratospheric platform is an unmanned airship kept at a stratospheric altitude of about 20 - 25 km for broadcast and multimedia communications and Earth observation purposes
- January 2023: BT Group and Stratospheric Platforms Ltd (SPL) today announced they will test delivering mobile coverage using an innovative new antenna technology, designed to be mounted on a High-Altitude Platform Station (HAPS) aircraft
- The trials, being conducted at BT's global R&D headquarters at Adastral Park, aim to provide a solution to one of the final challenges of mobile connectivity - getting coverage to the hardest to reach areas.
- New antenna technology aims to deliver 4G and 5G from the air
- Technology could unlock connectivity for hard-to-reach areas in a more affordable and sustainable way



Summary

1. Space is cool - and a growing commercial opportunity...
2. “New Space” is a term used to differentiate from traditional space, in the context of business models, products and services
3. GEO still matters (and MEO, HEO etc...)
4. LEO will take a significant market share of ‘new space’ business
5. 3GPP NTN will be primarily LEO, as high latency and need for 5G compatibility will limit GEO applications
6. Below space we’ll see significant growth in airborne comms assets, such as stratospheric platforms - HAPS for NTN etc...
7. The integration of terrestrial and non-terrestrial networks will result in truly global heterogeneous networks, with high-availability for mission critical traffic



The Institution of
Engineering and Technology

Thank you for your attendance



IET Anglian Coastal Network



The following upcoming talks have been secured in our IET ACLN 2024 programme. Please check our IET EngX website for more details of our events and how to register:

<https://engx.theiet.org/local-networks/ea1>

- **Routes to Registration:** IET Registration & Standards Support Unit (RSSU) will present on the requirements of Professional Registration [Wednesday 25 Sept 2024, 6pm, ONLINE ONLY]

[HYBRID] events normally run from The Atrium, University of Suffolk, Ipswich and via Microsoft Teams.

For more details and how to register please visit: <https://engx.theiet.org/local-networks/ea1>

CPD Certificates for today's and previous Anglian Coastal Local Network talks can be found on this site.

