BT Group

The integration of terrestrial and space-based communications – UKNOF51

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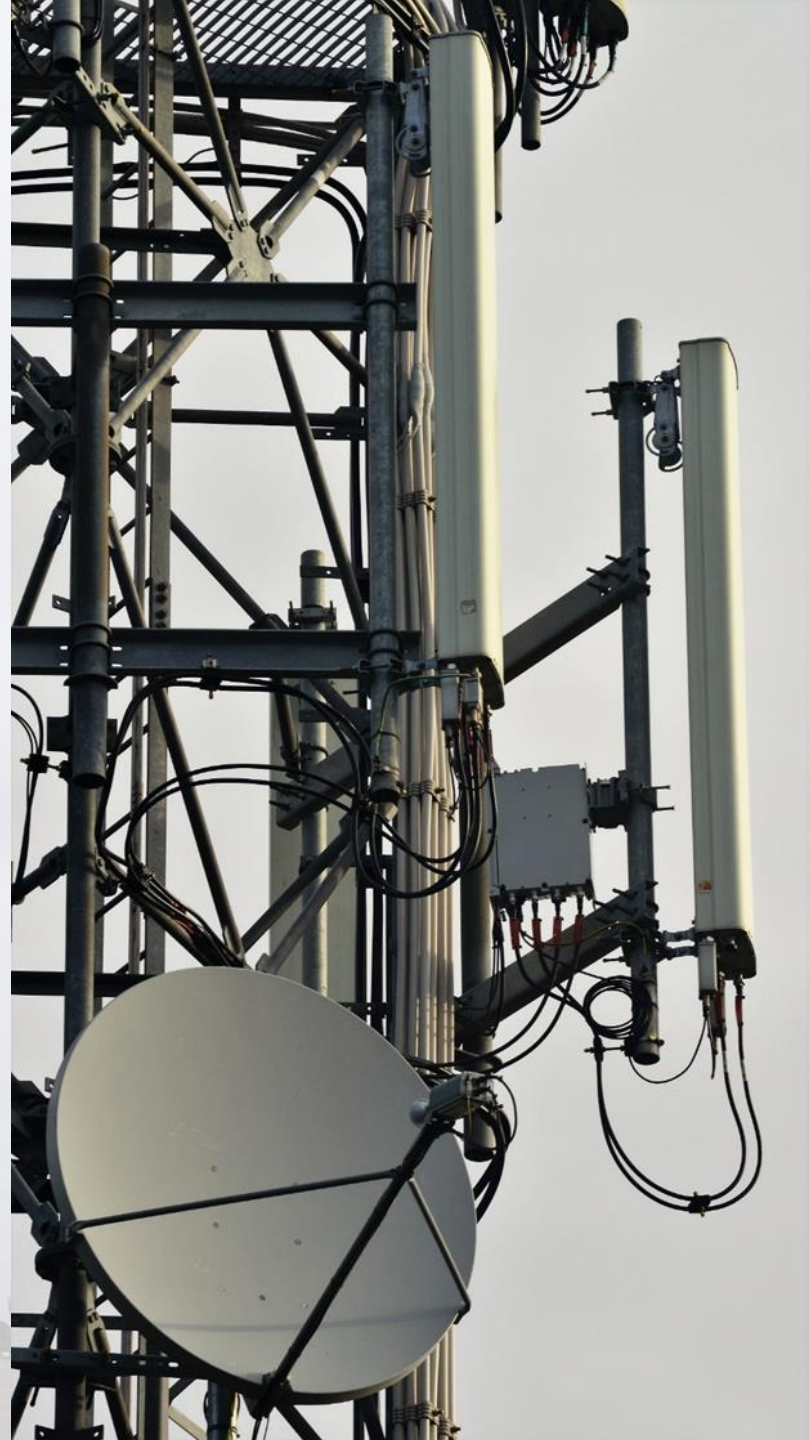


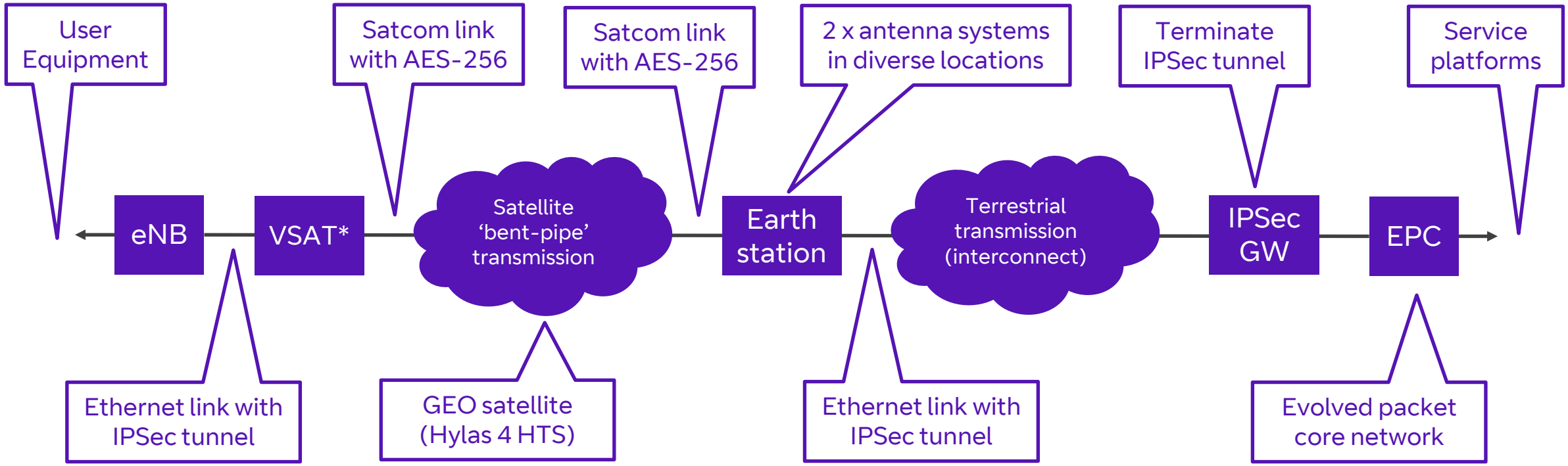
BT has a rich history and extensive experience in the space sector

Broad range of use cases for GEO satellite access

Current use cases for satellite mobile backhaul

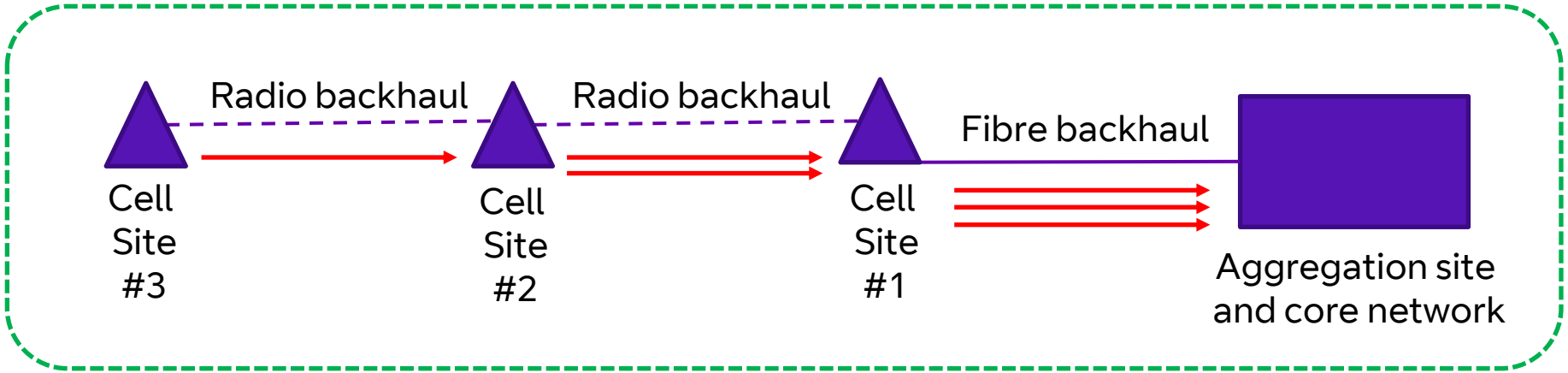
- Network availability uplift
- Extreme rural coverage - no terrestrial solution available
- Rapid deployment - while awaiting terrestrial delivery
- Disaster recovery
- Tactical coverage
- Special events
- Future - direct to device comms?

High level network architecture for mobile backhaul over GEO satellite

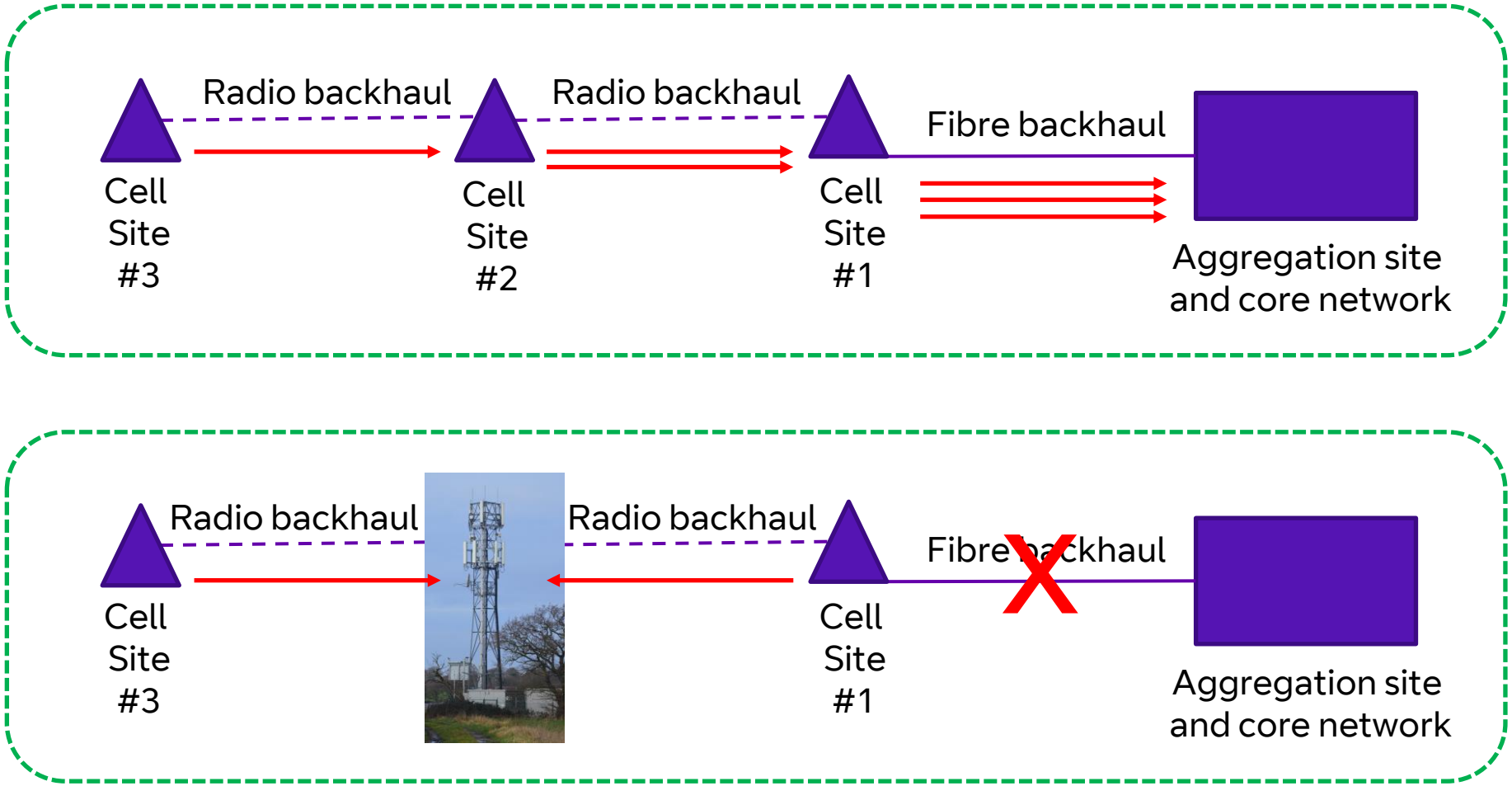


*VSAT block includes Gilat SkyEdge II-c Capricorn-Pro modem (with TCP acceleration and IPSec/AES-256 plus Ka band radio transceiver and offset fed parabolic antenna)

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

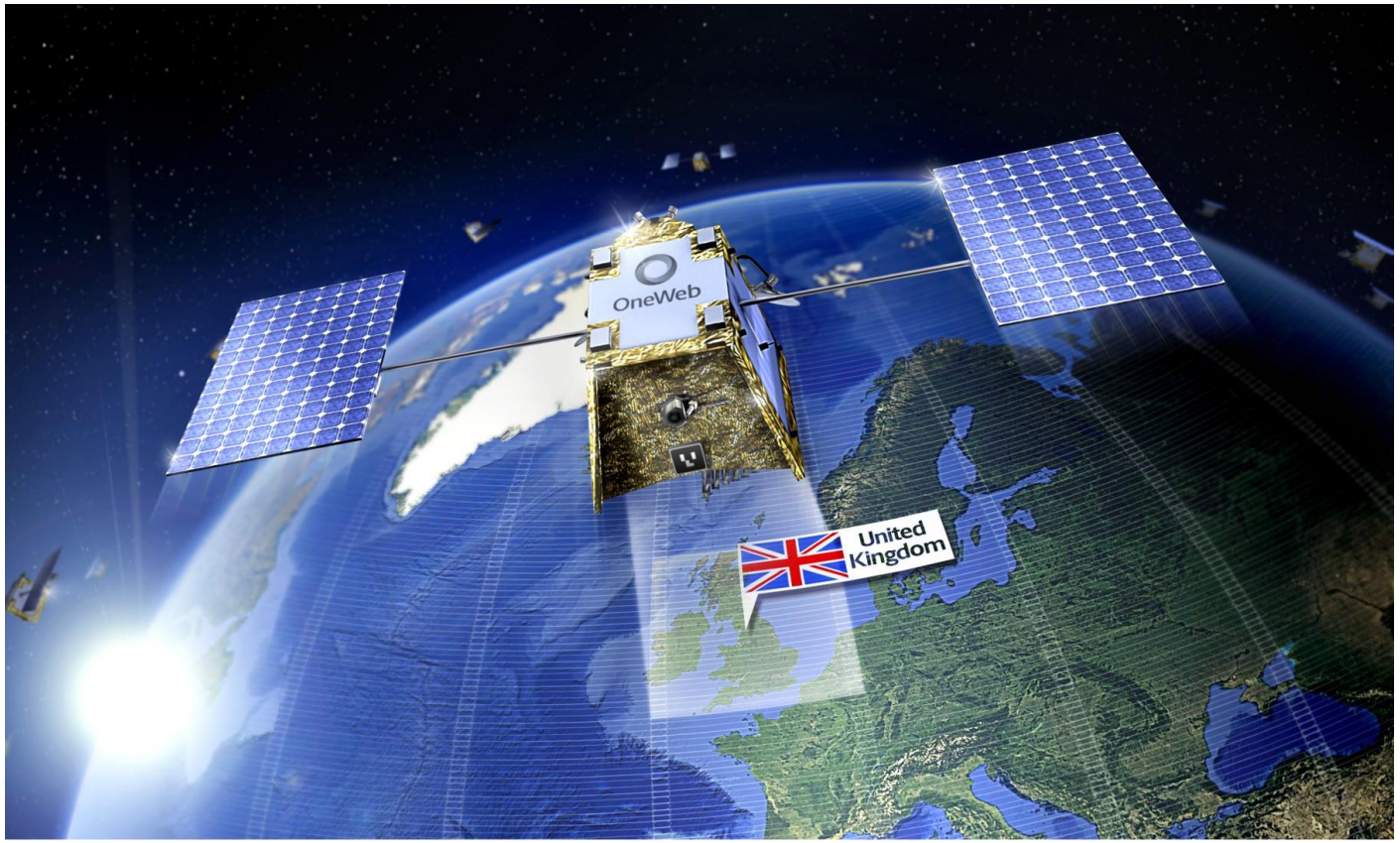


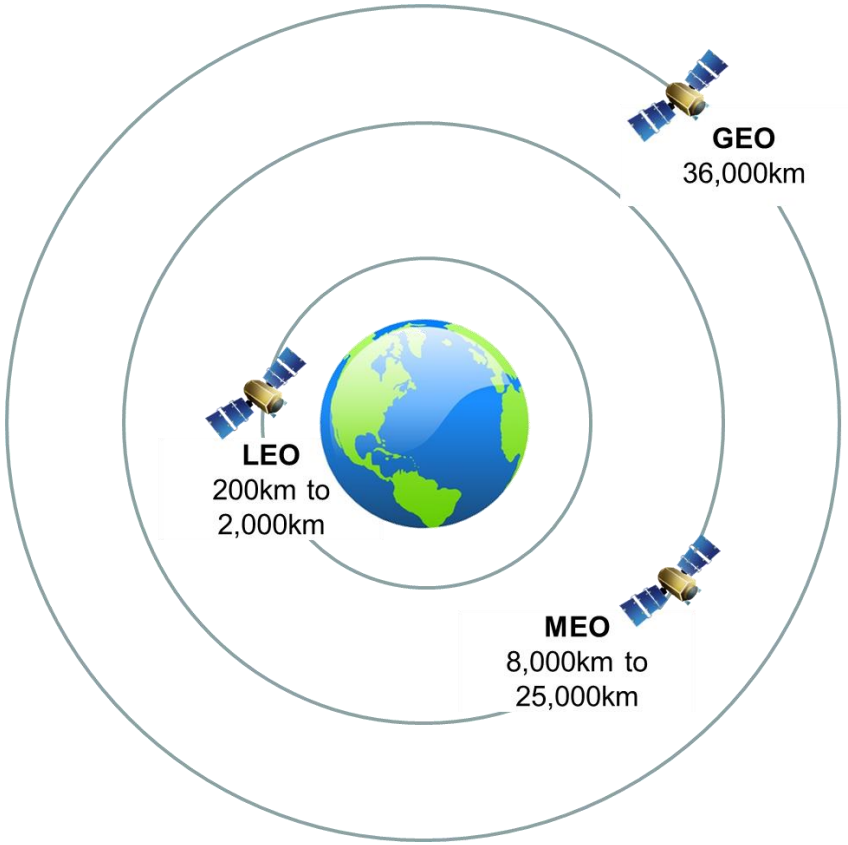
Addition of satellite communications to enhance service availability - backing up terrestrial transmission



Rapid Response Vehicles

New Space – the dawn of LEO mega-constellations…

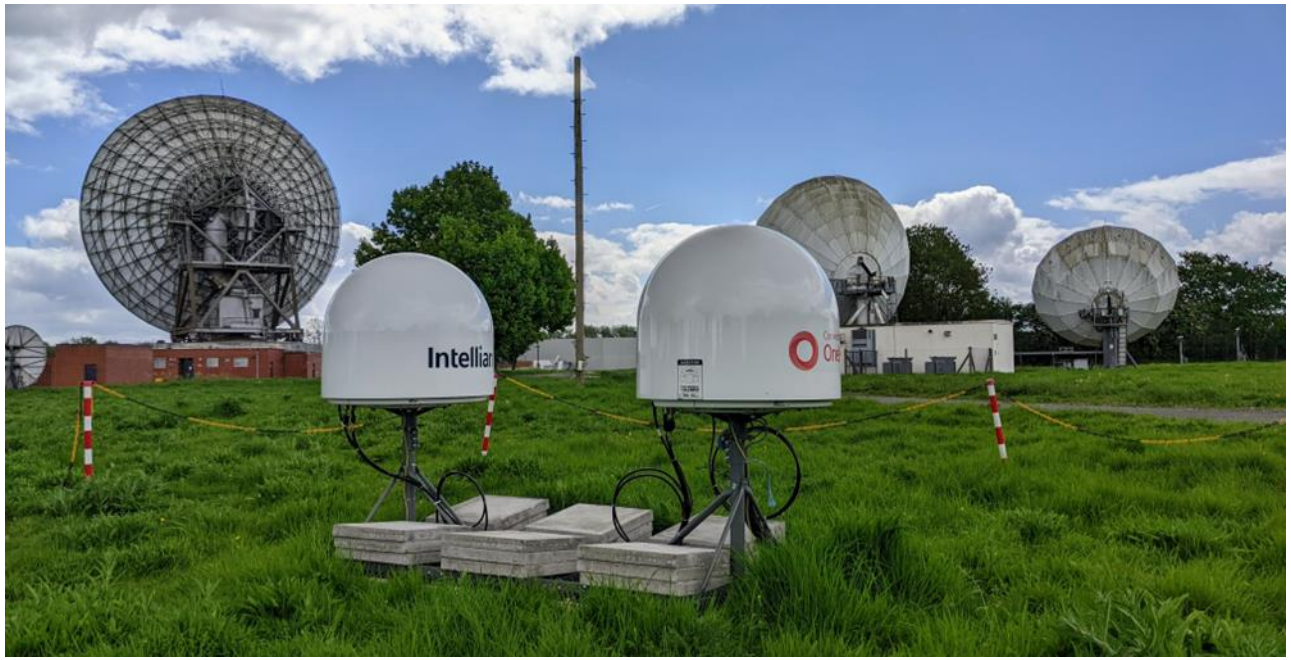




LEO mega-constellations

- There are two new LEO constellations currently being deployed - OneWeb & Starlink, two others in the planning and testing stage - Telesat Lightspeed & Amazon Kuiper
- LEO satellites operate at altitudes between 200 and 2,000km

  (Starlink ~550km, OneWeb ~ 1200km)
- OneWeb is planning on 648 satellites in phase 1 and >6,000 in a second phase - each satellite currently provides 7.2Gbps of capacity

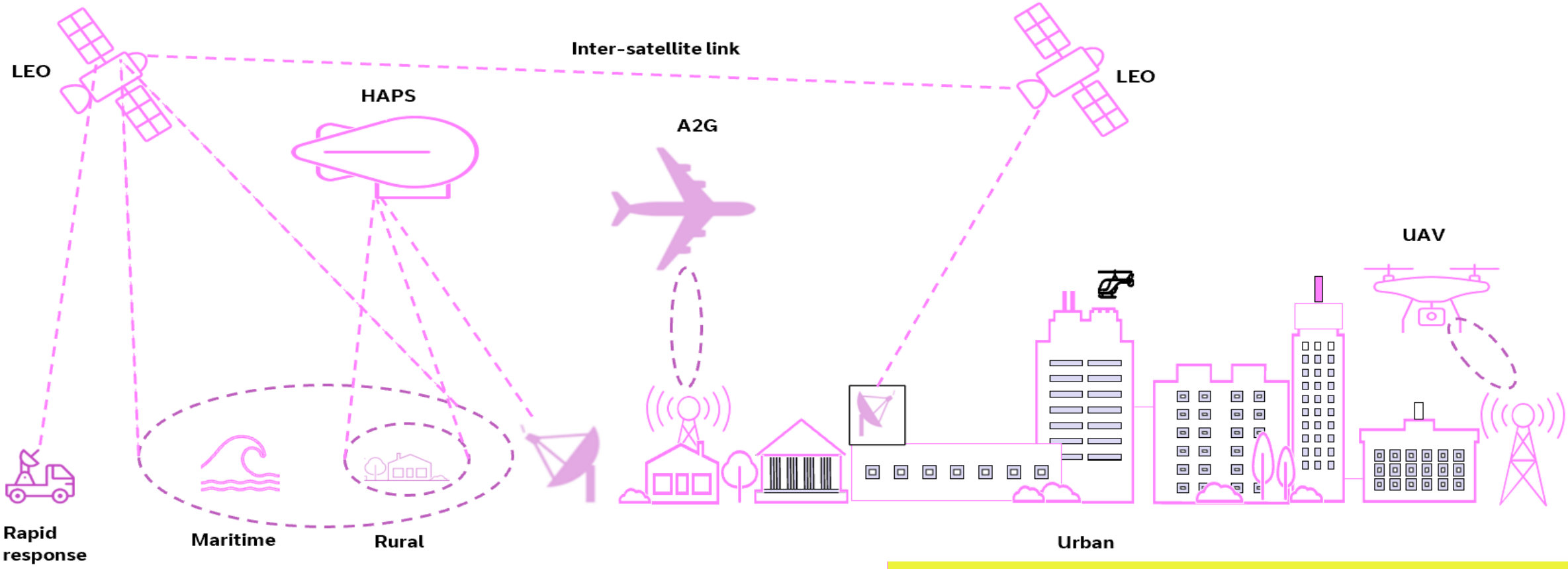


- Starlink has ~3,300 live satellites in orbit with permissions in place to grow to 12,000 - each ph1 satellite provides 16Gbps of capacity
- OneWeb (B2B) currently served from several European based ground gateways (for UK service) connected to a dedicated UK PoP - Starlink (B2C)currently at 3 ground gateway sites in UK

OneWeb's solution is fully integrated into the BT network

- Three lab based installation are being used to test and develop service offerings
- Direct n x 10Gbps interconnect established between OneWeb's UK PoP and two diverse 21C exchange locations
- Solution enables guaranteed end to end QoS and lowest possible latency
- Live OneWeb service on an operational 4G radio base station site, currently under-going testing prior to switching live traffic across, scheduled for later this month!
- Several friendly UK and global enterprise customer activations with significant rollout in planning phase

- Working collaboratively with OneWeb to deliver flat panel antennas to enhance deploy-ability and evolve towards comms on the move capabilities…



Non-Terrestrial Networks, including established GEO satellites

Enhancing Mobile Backhaul	Fibre first strategy but microwave radio is still essential	High-capacity microwave radio provides a 'fibre-like' reach extension	If terrestrial microwave radio impossible, GEO satellite backhaul is used	LEO offers increased capacity and lower latency on satellite backhaul	Flat panel LEO antenna systems will enhance deployability
Delivering direct-to-handset	3GPP working on Non-Terrestrial Networks (NTN)	In its widest context NTN includes satellites, HAPS and other airborne assets	Current NTN focus is on LEO satellite constellations	Services will be limited due to capacity constraints	HAPS offers an alternative solution with higher data rates and lower latency

Delivering a multi-orbital and multi-constellation space strategy

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)

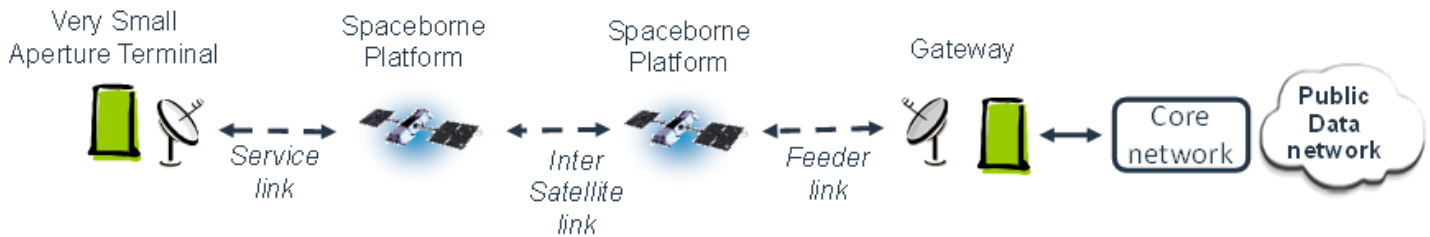


Figure 4.3-2: Satellite access network (with ISL) with a service link operating in frequency bands above the 6 GHz allocated to Fixed and Mobile Satellite Services (FSS and MSS)

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

Source: 3GPP TR 38.811 V15.4.0 (2020-09)

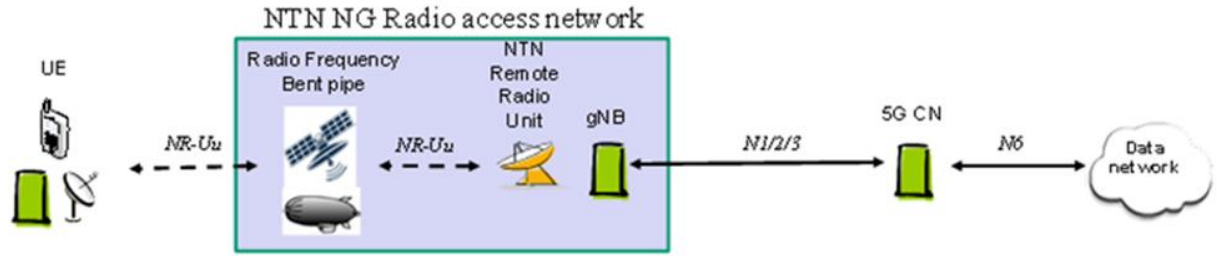


Figure 7.3.8.1.2-1: Mapping option 1 - NG RAN architecture in Non Terrestrial network with bent pipe payload

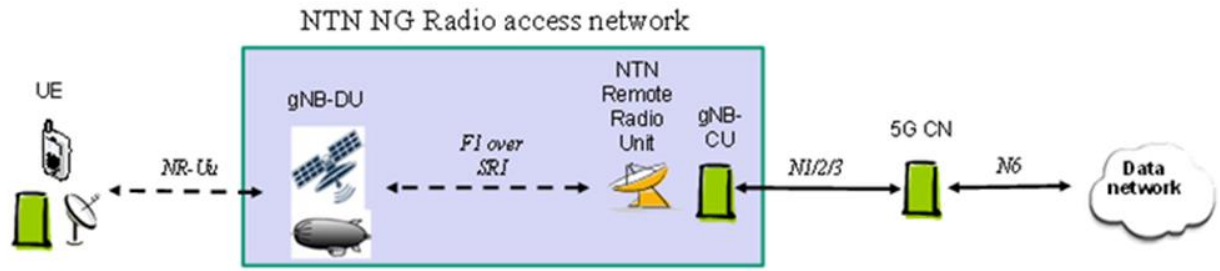


Figure 7.3.8.1.2-2: Mapping option 2 - NG RAN architecture in Non Terrestrial network with gNB-DU processed payload

NOTE: SRI refers to Satellite Radio Interface

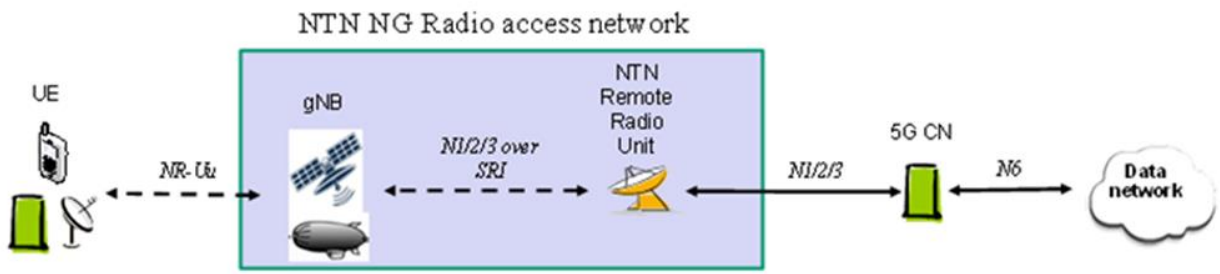


Figure 7.3.8.1.2-3: Mapping option 3 - NG RAN architecture in Non Terrestrial network with gNB processed payload

Source: 3GPP TR 38.811 V15.4.0 (2020-09)

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:

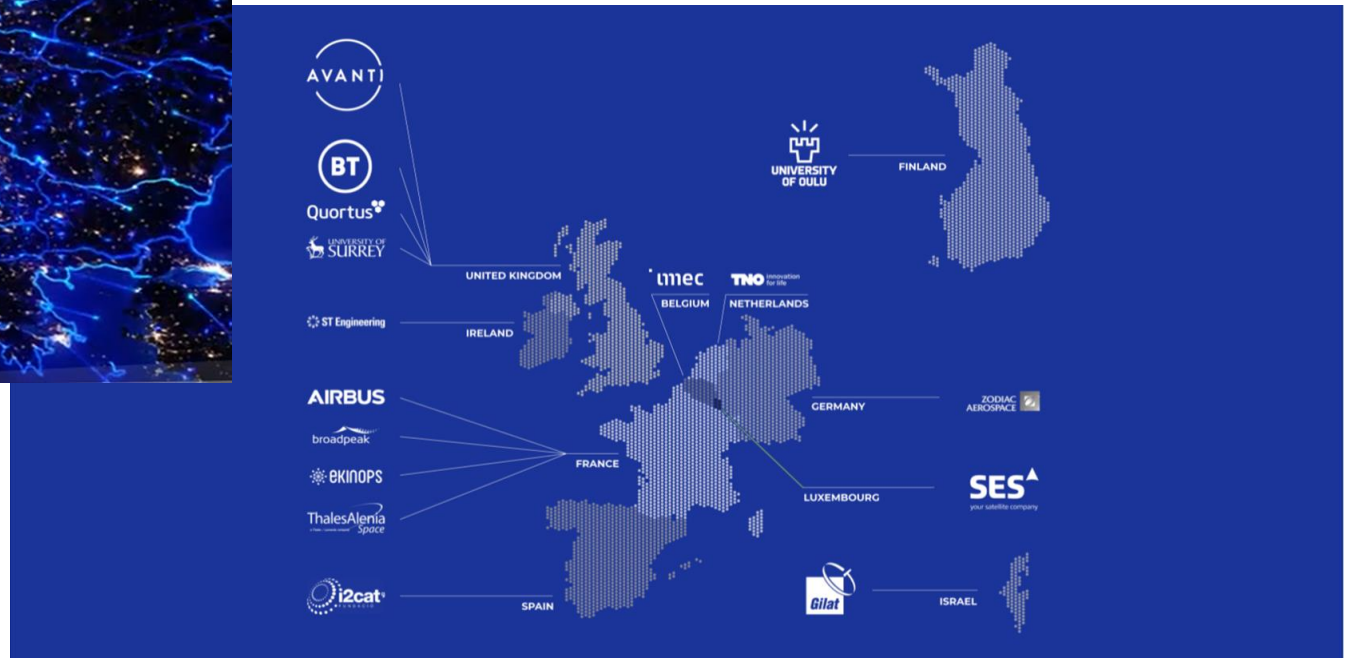
- **Ubiquity:** Satellite provides high speed capacity across the globe using the following enablers: capacity in-fill inside geographic gaps, overspill to satellite when terrestrial links are over capacity, general global wide coverage, backup / resilience for network fall-back and especially communication 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 aerials 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

Active engagements across the evolving eco-system…



Summary

- Non-terrestrial based communications is receiving significant investment at the moment
- The integration of terrestrial and space based communications enables truly heterogeneous and resilient networks
- A multi-orbital space strategy provides complimentary connectivity to support an integrated terrestrial & space based communications network, offering enhanced coverage, increased reliability & new ways of building networks & services
- LEO is an exciting new addition to the space based portfolio, enabling global coverage, lower latency, higher system capacity and higher data rates
- 3GPP Direct to Device (handset) comms is a useful compliment to terrestrial infrastructure however it isn't a replacement

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Thank for you attention
Any questions?