Satellite – still the technology of last resort?

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Enterprise

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Enterprise – at a glance

Our Brands

BT EE plusnet

Our customers and services we provide

We sell communications and IT services to around **1.2 million businesses & public sector** in UK and Republic of Ireland

We provide network products to more than **1,400 communication providers** operating in great Britain. We also serve MVNOs, and Media & Broadcast companies

Our Specialist Businesses include payphones, Gigabit Wi-Fi enabled Street Hubs, Directories, and Voice Commercial services. We handle **millions of directory enquiries & 999 calls** and deliver the **Phone Book to 21 million homes & businesses**

Financial highlights (FY 2019/20)

£6.1bn	£1.97bn	£1.4bn
Revenue	EBITDA	Normalised Free Cashflow

We are the leading business communications provider in the UK

Our three-pillar strategy is how we'll realise our ambition, growing value for all stakeholders

BT has a long track record in Space, going back as far as Telstar 1 in 1962…

Some BT Firsts in Space…

1960s & 1970s

- The new Post Office Satellite Earth Station takes part in the **first transatlantic television transmission** made via Telstar 1.
- The open parabolic dish design of the UK General Post Office's Goonhilly Down Antenna One (AKA 'Arthur') set the **global standard for satellite ground stations.**
- GPO UK Signatory on **creation of Intelsat**.
- Post Office Satellite Earth Station **relays radio and television transmissions from NASA to the whole of Europe,** including coverage of the first manned landing on the moon.

1980s & 1990s

- Adastral Park's satellite dishes beamed television signals for **Europe's first satellite transmission service.**
- British Telecom's first satellite coast station came into service - **telephone and telex calls could be made or received direct for the first time to almost anywhere in the world,** via Britain.
- **First ever live satellite television programme from a ship at sea** broadcast from the QE2.
- Launched Skyphone **the world's first satellite telephone system** on a British Airways 747.
- Development of satcoms services via **sub 5 degree low elevation paths at C and Ku-Band**

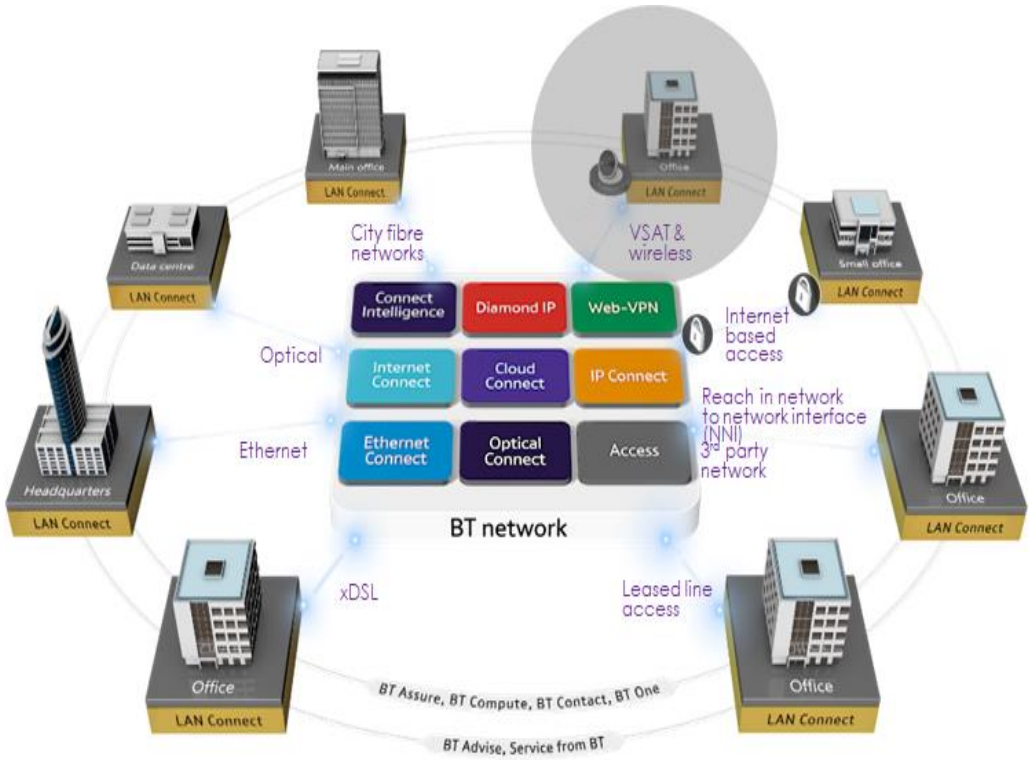
2000s onwards

- **3D modelling satellite beam near field blocking** to ensure antenna placement without interference
- Provision of **bespoke interference countermeasures,** ranging from tuned filters to physical RF screening walls
- Up-Path Power Control Systems Applied to a **C-Band Low Elevation Satellite Link**
- **VSAT connected Ground Based Network (GBN)** used by emergency services **for Public Mobile Radio**
- Design and test **Radio over Fibre long route** over 100km
- **VSAT interference countermeasures** specific to WiMAX proliferation in 3rd world locations

We have a proven track record of delivering corporate satellite networks for corporations, governments and broadcasters in remote and challenging locations

We have experience providing satellite services in more than 100 countries for major multinational companies, using them to send signals overseas, connect remote building and Internet Of Things, and distribute TV

Satellite within the BT Global Connect Portfolio



Key benefits include:

- **Delivers to all site locations** - Satellite Access complements terrestrial and can reach the site locations terrestrial can't.
- **Provides mobility and flexibility** - if a customer changes location and needs on the move connectivity, Satellite Access can provide this.
- **Connection across remote areas** - Satellite Access can provide a wide geographical reach, it can connect sites across remote areas.
- **Backup access**– Satellite Access can be a backup access option to primary terrestrial access providing resilience
- **Fast deployment** - it provides faster deployment than terrestrial access.
- **Off shore access** – Oil rigs, for example, are normally far off-shore where fixed connectivity is not available, Satellite Access is a good solution for these.

To complement our connectivity services, we offer satellite professional and hosting services

Professional Services

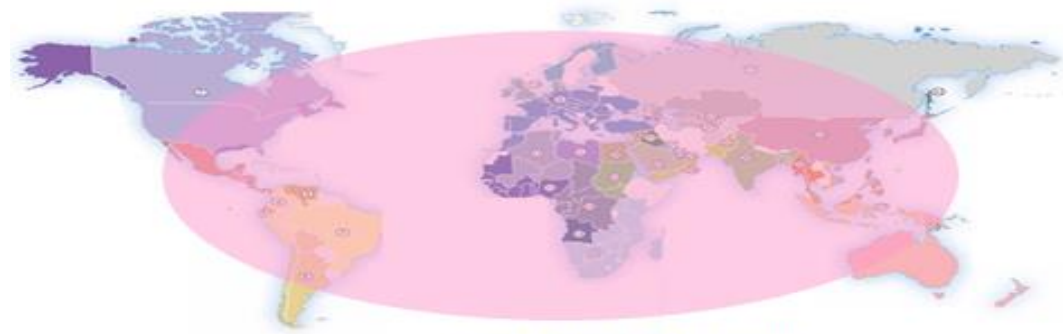
We offer a complete ‘one-stop-shop’ for satellite services including:

- Satellite connectivity & gateway design and delivery
- End to end service management
- Supply change management
- Quality control

Satellite Hosting

Our BT Madley Communications Centre is one of the one of largest satellite receiving stations in Europe
A Carrier and Broadcast grade facility with over 60 antennas providing:

- Rack collocation
- Antenna Hosting
- Service Support
- Tier 1 internet access



Coverage from BT Madley, UK
Additional coverage through partner teleports around the globe

We also use satellite for the delivery of our own services to customers, including a strong case study for terrestrial and non-terrestrial integration within the UK ESN

Terrestrial / Non-Terrestrial Integration Within UK ESN

- The application of satellite communications to mobile backhaul has been relatively niche until recently.
- EE has Satellite Cellular Backhaul to fixed and portable mobile base stations across the UK.
- Terrestrial and satellite backhaul integration provides satellite based network resilience to enable high-availability mobile networking.
- Our main use cases:
  - Network availability uplift
  - Extreme rural coverage - no terrestrial solution available
  - Rapid deployment - while awaiting terrestrial delivery
  - Disaster recovery
  - Tactical coverage
  - Special events

Satellite within BT's ERT & "Helikite" for temporary coverage

- BT's Emergency Response Team (ERT) provides a proactive and reactive capability to deal with threats to our fixed and mobile networks in the UK.
- All vehicles have satellite communications and can operate independently of the BT network.

- EE use "Helikite", mini mobile sites attached to helium-powered balloons to provide wide area 4G coverage when:
  - Permanent sites have been damaged
  - There's no 4G coverage,
  - There is a need for temporary data coverage for remote but densely populated events like music festivals.
- The small cells are connected back into the EE network over satellite or 4G spectrum.

Market and technological developments suggest satellite may move away from being considered the technology of last resort…

5G AND SDN AND ITS IMPACT ON THE SATELLITE INDUSTRY

- 5G coverage extension & ability to multi-cast content to edge caches
- SDN , multi orbit convergence, terrestrial / non terrestrial convergence
- Multi-band and multi network ground infrastructure a key enabler
- Standardised satellite service orchestration through SDN and 5G Network Management
- Lower costs, more innovative business models?
- 3GPP Release 17

IOT WILL BENEFIT FROM LOWER COST SATELLITE SERVICES & ANTENNAS

- Lower cost antennas & LEO cube/nano satellite constellations integrated with terrestrial standards
- Ubiquitous IOT connectivity
- Use cases enabled: asset tracking, live stock management, farms, substations, reservoirs, gas pipelines, fleet management…
- Reduced costs of entry to IoT-focused satellite services market
- Cost effective satellite connectivity will drive greater adoption of IOT in remote locations

LEOS & HAPS LOOK TECHNICALLY PROMISING – BUT THE DEVIL WILL BE IN THE DETAIL

- Promise of higher speeds and lower latency
- Expansion in number of use cases addressed
- However, little information to date on pricing and service levels and definitions
- Need for Inter-satellite links for LEOs
- Satellite Quantum Key Distribution (SQKD)
- P2P fibre-based QKD is range limited to 100km so SQKD better option in short term

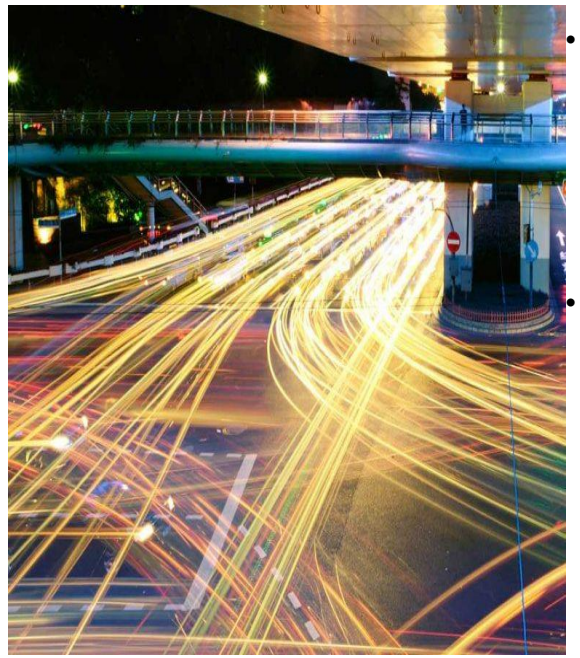
Whilst new technologies such as LEO & HAPS, and future satellite integration with 5G will increase the number of use cases satellite communications support, the scale of the opportunity will ultimately be restricted until the economics change

BT has on-going dialogue with space eco-system players and is investigating new opportunities that could support the evolution of UK space interests, e.g…

Satellite Quantum Key Distribution

- BT is part of one of the ESA-funded consortia working on space-based QKD technology.
- The project, called QKDSat, is led by UK-based start-up ArQit, which aims to launch a constellation of small low Earth orbit satellites equipped with QKD payloads.

Carnot Sat – 5G



- BT is partnering with CGI, Avanti and Surrey University on a study under the ESA Carnot-Sat project led by CGI.
- The output of will enable network operators to quickly and efficiently design and optimise 5G networks with the use of satellites, and identify potential new business models

To recap…

- BT has nearly 60 years experience in UK Space and Satellite
- Satellite is a core part of our portfolio of connectivity and professional services
- It is also integrated into our mobile network as satellite backhaul
- Satellites use cases within BT are similar across our external and internal deployments, namely:
    - Infill where no terrestrial solution available
    - Network resilience and disaster recovery
    - Temporary coverage, e.g. rapid site set up, special events
  - Market and technological developments are creating new use cases that satellite could address
    - 5G standards & SDN will drive greater standardisation into satellite networks
    - New lower cost, dedicated satellite IOT solutions could open up cost effective access and IOT take up to rural locations
    - Both LEOS & HAPS offer the promise of higher speeds and lower latency but little detail on service and pricing to date
    - S-QKD is emerging a solution where Satellite is a better option than Fibre in the short term
  - For satellite in general to move away from being the technology of last resort the economics will need to change
  - BT has on-going dialogue with the Space sector and is investigating new opportunities that could support the evolution of UK space interests