
BT
Our Space Strategy
Seamless terrestrial to non-terrestrial convergence
to support the growth of the UK space economy

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Introduction

BT has 60 years' experience in the space industry, having played a major part in many space-based communication innovations. We're a significant contributor to the £16.4bn UK space economy, both as a provider and user of space-based services.

We have a key role to play in supporting both the growth and innovation of the UK's space industry, helping the government achieve its ambition of putting the nation "firmly in the front rank of the global space industry", as outlined in its recently announced National Space Strategy.

We've developed a six-pillar space strategy, built around the belief that terrestrial and non-terrestrial convergence will be a key factor in unlocking the value of the UK space industry. It focuses on providing ubiquitous connectivity, flexible and ultra-resilient services, and enabling the creation of new applications, services and business models.

Our mission

We're one of the world's leading communications companies, delivering services to customers in the UK and 180 countries worldwide.

Our main activities involve providing fixed-line services, broadband, mobile and TV products and services, as well as managed network and IT solutions.

Our purpose is to connect for good, and our ambition is to become the world's most trusted connector of people, devices, and machines. To do this, we'll continue to invest in fibre, 5G, edge computing and core and extended access, to build the best-converged smart network. We'll integrate new space and air technologies with these ground technologies as they're created.

Three principles help us shape our network:

1. We'll create Application Programming Interfaces (APIs) for our services and partner ecosystems.
2. We'll use data to optimise and automate our network.
3. We'll create a single, flexible IT infrastructure.

5G by default

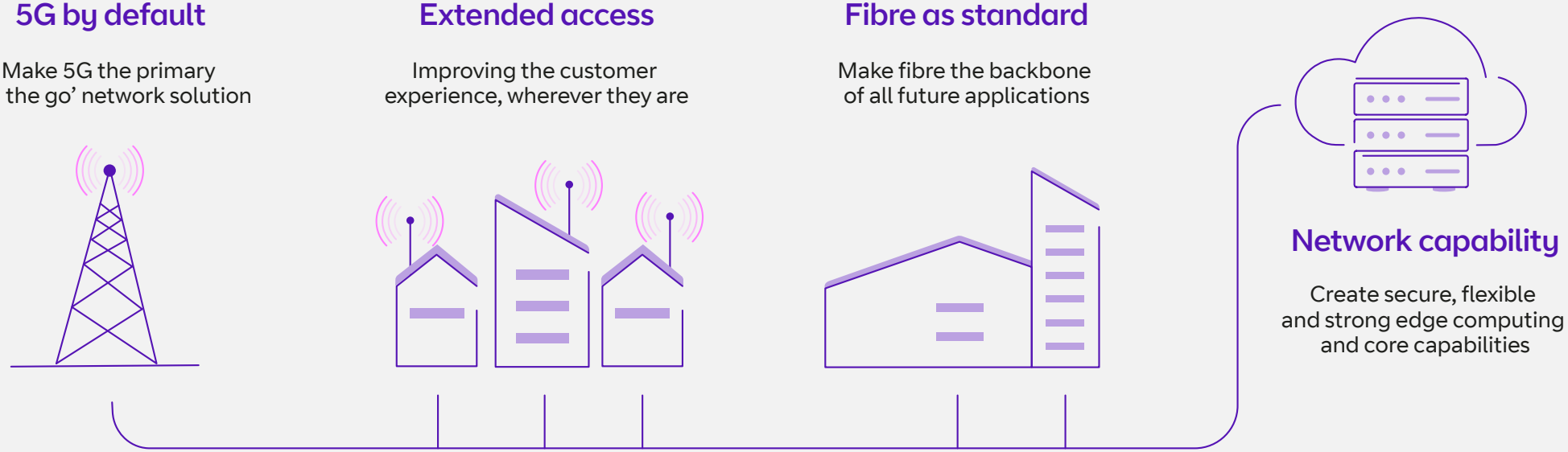
Make 5G the primary 'on the go' network solution

Extended access

Improving the customer experience, wherever they are

Fibre as standard

Make fibre the backbone of all future applications



Network capability

Create secure, flexible and strong edge computing and core capabilities

Our history and heritage in the space industry

Our experience in the space industry goes back to 1962, to the first communications satellite, Telstar 1, and the Post Office Satellite Communications Station at Goonhilly Downs in Cornwall.

The station was designed to track communication satellites, and through them to transmit and receive telephone, telegraph and television signals, and it took part in the first ever transatlantic television transmission. The station used a British-designed dish-type aerial (referred to as Arthur) which was the first of its type, later adopted throughout the world as the standard for satellite communications.

The Post Office was a founder member of the International Telecommunications Satellite Organisation (INTELSAT), created to develop a global commercial satellite communications system.

Its original membership of eleven nations grew to over 100 member countries by 1999 – the UK being the second largest shareholder, with BT as its representative.

On the technical side, we've continued to contribute substantially to space-based communication innovations. We provided the 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; and demonstrated the Very Small Aperture Terminal (VSAT)-connected Ground Based Network (GBN), used by emergency services for their Public Mobile Radio.

The UK National Space Strategy

According to the 2020 'Size and Health of the UK Space Industry' survey, the total UK space industry income grew to £16.4 billion in 2018-19, estimated to be 5.1% of the global space economy.

Most of the income – some £12.2bn – is generated by the downstream segment of the industry through space applications such as communications, broadcasting, and Earth Observation (EO). Upstream activities, including space manufacturing (such as launch vehicles, satellites, payloads, scientific instruments) and space operations (ground station networks and satellite operation), generated £4.3bn.

These downstream space services underpin the UK's digital and critical national infrastructure, from enabling communications, and providing the Positioning, Navigation and Timing (PNT) services that keep global banking transactions operating, to monitoring climate activity from space.

The impact of the space industry is considerable – the report estimated that wider industrial activities representing over £360bn of the UK's non-financial business economy GDP (16.9%) are supported by satellite services such as PNT (£314bn), telecommunications (£101bn) and EO (£100bn) – and it should be noted that these aren't mutually exclusive.

Recognising this strategic and economic contribution, the UK Government announced their National Space Strategy on 27 September 2021 with the following vision statement:

"We will build one of the most innovative and attractive space economies in the world, and the UK will grow as a space nation. We will protect and defend the UK's interests in space, shape the space environment and use space to help solve challenges at home and overseas. Through cutting edge research, we will inspire the next generation and sustain the UK's competitive edge in space science and technology."

The UK National Space Strategy emphasises the importance of leadership from the private sector in helping achieve its goals – and as both the UK's national telco and a key player in the UK space sector, we'll have a major role to play.

"Achieving the UK's goals in space will require coordinated action from government. However, public investment alone will not be sufficient. The UK will require a significant increase in private sector investment in space activities, and the full combined efforts of every participant in the UK space economy, from businesses to innovators, entrepreneurs, and space scientists."

The government's investment in OneWeb is specifically highlighted as a demonstration of its ambition in the space sector:

"In 2020, the UK took a $500 million equity share in OneWeb, an innovative, low-earth orbit (LEO) satellite communications company. By 2022 OneWeb will have over 600 satellites in orbit providing global reach and global broadband connectivity. Investing in OneWeb contributes to the government's commitment to making the UK a world leader in space and in science, research and development and supports the government's aspirations for UK leadership in space-enabled capabilities and services."

Our space capabilities today

We're a significant contributor to the UK space economy, both as a service provider to the space industry, and as a user of space capabilities in the delivery of services to customers.

We provide terrestrial connectivity services to the space industry to connect ground stations across the globe, as well as both satellite professional and hosting services, from our Earth Station Madley in Herefordshire.

Madley, one of the largest satellite stations in Europe with more than 60 antennas, can provide rack co-location and antenna hosting, as well as having access to partner teleports – ground stations that communicate with satellites – across the globe. In terms of professional services, we provide a one-stop shop from gateway design and delivery through to end-to-end service management.

We're a downstream user of space capabilities in four main areas:

- Corporate and broadcast networks using satellite access
- Satellite backhaul
- PNT
- IoT and 5G solutions using EO data.

Satellite access

We have a strong track record of delivering satellite networks as part of our converged approach for companies, governments and broadcasters, in remote and challenging locations across more than 100 countries. We also provide business broadband using satellite access. The main operational contexts here can broadly be summarised into three categories:

- Supplementing terrestrial coverage where no terrestrial solution is available, such as in rural areas or in offshore locations like oil rigs.
- Resilience and disaster recovery, as a back-up to terrestrial.
- Temporary access, such as for rapid site set-up in advance of terrestrial deployment, or in response to an emergency.

Customers aren't generally concerned about the underlying technology that serves them; they just want connectivity to work wherever and whenever it's needed. Consequently, we have a key role in developing a converged approach, using and integrating both terrestrial and non-terrestrial technologies to deliver seamless, ubiquitous connectivity. Software-defined virtualisation and orchestration techniques to manage network and infrastructure resources are critical in enabling this converged approach.

Case study 1:
BT Media & Broadcast

BT Media & Broadcast, our centre of excellence for broadcast and media services, provides a useful case study of convergence. It supports end-to-end managed services to broadcasters, such as the BBC, Sky, and CNBC. It incorporates over 40 international points-of-presence including many satellite teleports, and supports over 3,500 international live broadcast events a year.

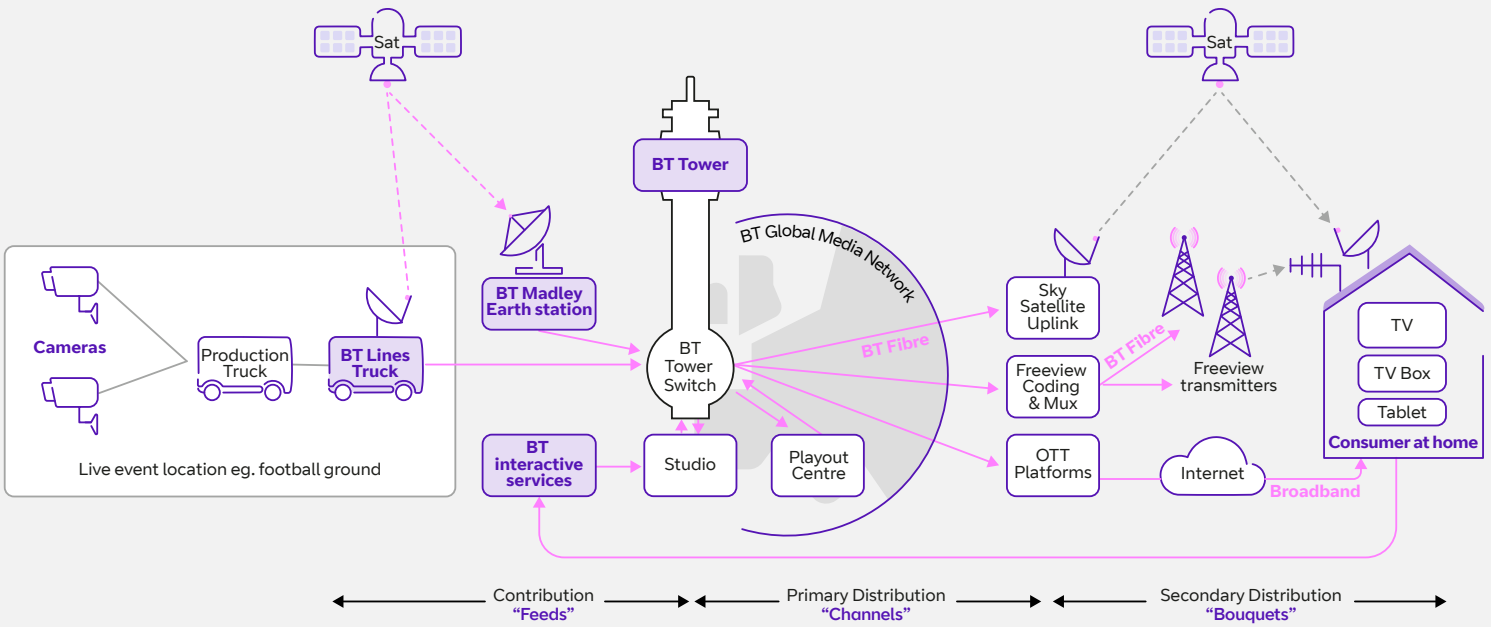
The Media & Broadcast network is based on high-capacity fibre links, with a mix of fixed sites in relatively easy-to-reach locations like TV studios and production facilities, and more remote sites such as regional TV transmitters. On a global scale, there are a range of overseas hand-off points to broadcasters or satellite operators. Many sports venues, such as Premier League football stadiums, have pre-installed fibre connectivity that allows us to visit regularly with minimal set-up effort. A fleet of outside broadcast trucks provide connectivity at remote sites, and satellite is often used as an access connection back onto our Media & Broadcast network.

Resilience is a critical success factor for television; potentially huge penalties can be incurred for a break in transmission resulting in the loss of coverage. Because of that, we've created multiple paths across our highly resilient network to ensure 99.999% availability.

Media & Broadcast have recently launched a new end-to-end network, 'Vena', which supports contribution, production and distribution needs. The operating system of this cloud-based network lets services scale up and down, supported by intelligent routing and resilience capabilities, to make sure content reaches its destination and faults are dealt with quickly.

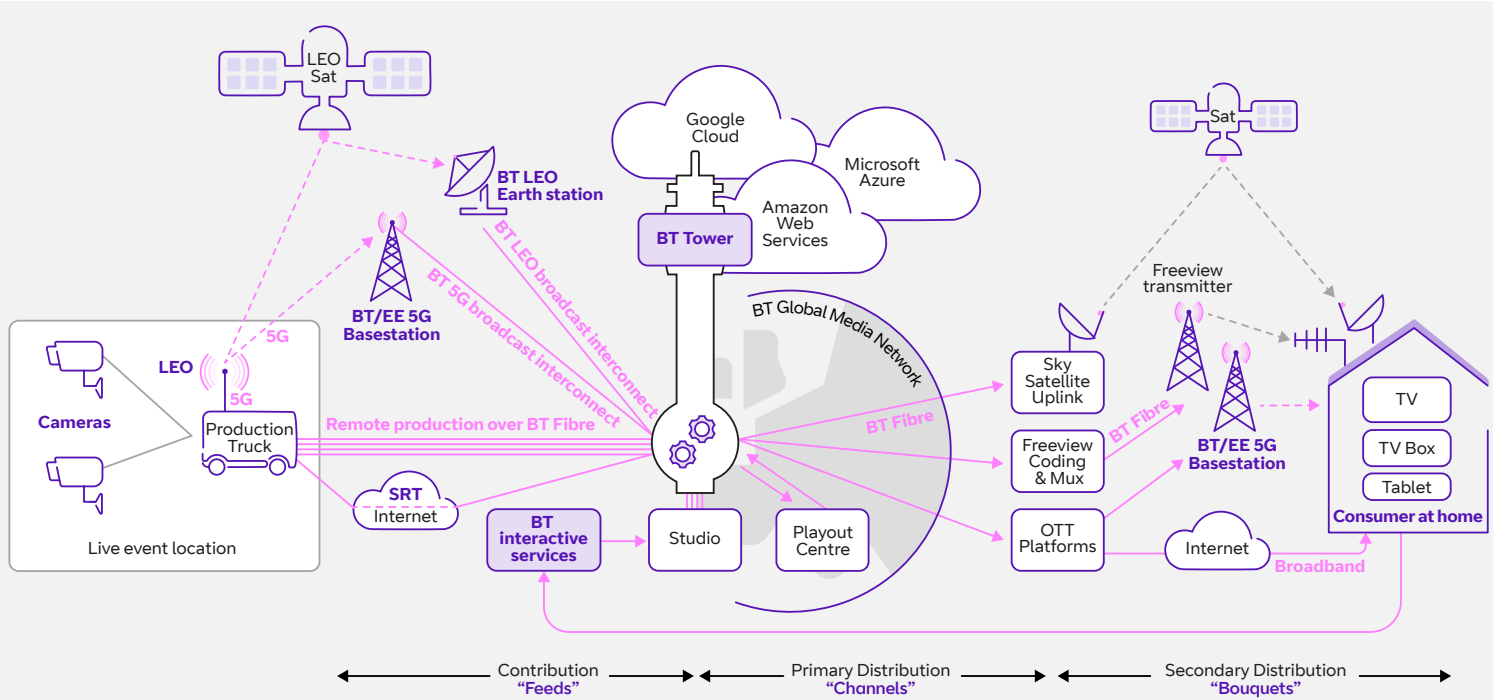
Classic Media & Broadcast

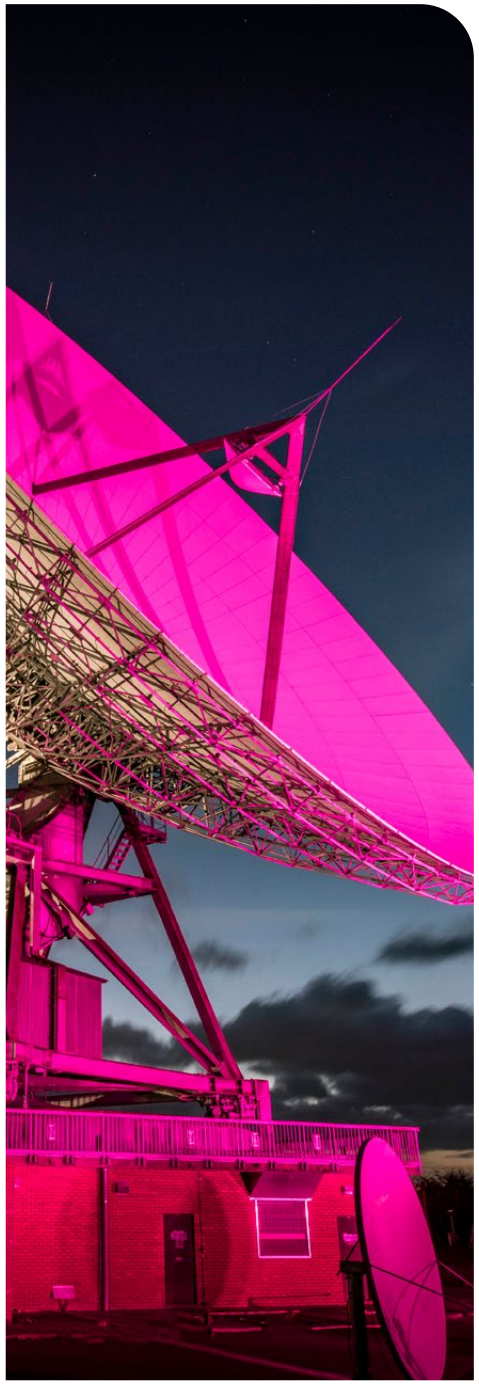
"Glass to glass"



Future Media & Broadcast

"Glass to glass"





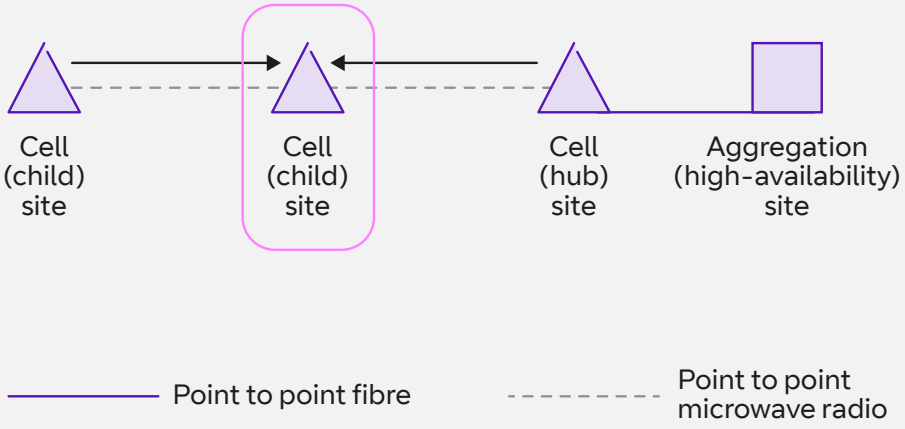
Satellite backhaul

As well as satellite access, we use satellite backhaul within our connectivity portfolio to support delivery of our own services to customers.

Our delivery of the GB Emergency Services Network through the EE mobile network provides an excellent case study for terrestrial to non-terrestrial integration and convergence. We use satellite backhaul to both fixed and mobile base stations, which provide similar use cases as our connectivity portfolio, namely:

- extreme rural coverage, where no terrestrial coverage is available
- increased network availability
- resilience and disaster recovery to provide high-availability mobile networking
- temporary coverage.

Here's an example of satellite-based network resilience:



A fibre aggregation site supports three cell sites. The first is connected on point-to-point fibre, the second sub-tended from the first by point-to-point microwave radio, the third sub-tended from the second in the same way. The VSAT is deployed on the second site (highlighted in red) terminating the first microwave radio link. If the point-to-point fibre is lost, traffic from the first and third sites will use microwave hops to take traffic to the second site, maximising the chances of maintaining service. Because satellite capacity is lower and much more costly than fibre or microwave radio links, QoS is used to prioritise mission-critical traffic.

In addition, we use satellite backhaul to deal with threats to fixed and mobile networks in the UK, such as extreme weather conditions where rapid, on-demand coverage is required. We can deploy rapid response vehicles containing 800 MHz and 1800 MHz mobile network base station capabilities, satellite modem, VSAT backhaul, and a satellite alignment system, and have them operational within 30 minutes.

5G offers the promise of going beyond deploying a base station in this way, to an entire 5G private network solution – the radio access network, a virtualised core network and service platform available in a vehicle.

Positioning, Navigation and Timing

We're a leading contributor to standards, research and innovation in synchronisation and timing in the PNT area. For example, we're a key member of the National Timing Programme, which aims to improve security and resilience in national time and frequency distribution, while supporting UK innovation and skills. Our R&D HQ at Adastral Park has several labs which can validate timing technology and be used as proof-of-concept test beds for wider solutions that have a timing component.

IoT and 5G solutions using EO data

We recently set up a new Data and Artificial Intelligence Solutions team, focussing on developing new ways of using our data assets, such as location and geospatial data, for our customers' benefit. We've developed a Data Exchange to converge both IoT and EO data into a single platform for storage, processing, and analytics.

One example is our partnership with Stirling University, where we're developing a demonstrator that builds and exploits a 5G-enabled IoT digital fabric. This captures data from sensor networks, coupled with satellite data and AI-powered analytics, to deliver nowcasts and forecasts of environmental risks for diverse stakeholders.

This demonstrates how the platform can be used to provide additional ways to monitor water quality in drinking water reservoirs, deliver near-real time forecasts of bathing water quality, generate early warnings and monitoring of floods, and make available real time data on water temperature to inform the brewing and distilling sector.

In the long term, the platform could be applied in a wide range of settings and across multiple sectors. These include agriculture, fisheries, shipping and navigation, food and drink, biodiversity and conservation, oil and gas, renewables and low carbon, green tourism and heritage, local and national governance, and public health. The insight generated could inform decisions that bring major economic regeneration and sustainability benefits to a region.

Our space strategy

Given our strong historic credentials and current capabilities in the space ecosystem, and the need for the private sector to help achieve the government's National Space Strategy ambitions, we'll have a key role to play.

There are six pillars to our strategy:

1. Provide a strong downstream voice into the UK Government and space industry as the nation's leading telco

We've recently re-joined the UK trade association for the space industry, UK Space, where we'll be an active participant in several areas, including telecommunications, PNT and defence. Given nearly 75% of the UK's space industry revenues are from downstream services, it's important for downstream players like ourselves to contribute to and influence relevant discussions and decisions. We'll look at current and future developments in the industry through the lens of how best they benefit our consumer and business customers. And as a strong downstream voice at the table, we'll make sure the views of these customers are represented in UK space sector discussions, as well as in discussions with relevant government departments.

For example, we were a key contributor to UK Space's input to the UK National Space Strategy; we're currently in active discussions with various parts of government, including the DCMS and Cabinet Office, about our space strategy.

2. Proactively engage with those in the space ecosystem to collaborate on relevant research and commercial opportunities

We'll continue to work with start-ups, scale-ups, established companies and research and innovation bodies, and be an active participant in UK Space Agency (UKSA) and European Space Agency (ESA) projects. We've established relationships for space-related projects with academic institutions including the Universities of Surrey and Stirling, which we'll build on. We take an agnostic approach to our partnering, and while we may be competitors in some markets, we understand the need to bring the best knowledge and solutions to bear in meeting our customers' needs. As an example, we recently collaborated with consulting firm CGI on the ESA 5G Carnot Sat project.

3. Explore the role emerging space technologies could have in the delivery of services to our customers

To help us achieve our ambition to become the world's most trusted connector of people, devices and machines, we'll continue to explore the role new and emerging space and air technologies could play in service delivery. To date, our main use of satellite communications has been to provide an alternative to terrestrial coverage where it was unavailable, to add resilience to terrestrial networks, or for rapid deployment or service restoration – essentially, using satellite as the technology of last resort. We're now actively exploring market and technology developments to understand which new use cases could help us achieve our aims. New technologies such as Low Earth Orbit (LEO) satellites and High-Altitude Pseudo Satellites (HAPS) offer the promise of higher speeds and lower latency, opening up exciting new opportunities.

The issue of long latency of geostationary orbit satellites (500-600 ms) is being overcome by LEO satellites that give significantly improved latency of 30-60 ms.

Deploying constellations of LEO satellites to deliver connectivity services is becoming viable financially, as a result of the growing demand for broadband connectivity in remote and rural locations, an improvement in satellite performance resulting from new technology, and a reduction in launch and manufacturing costs. We've recently signed an industry-first global partnership with OneWeb to explore how their LEO capability could be converged with our terrestrial capabilities, to serve remote and rural locations in the UK and overseas.

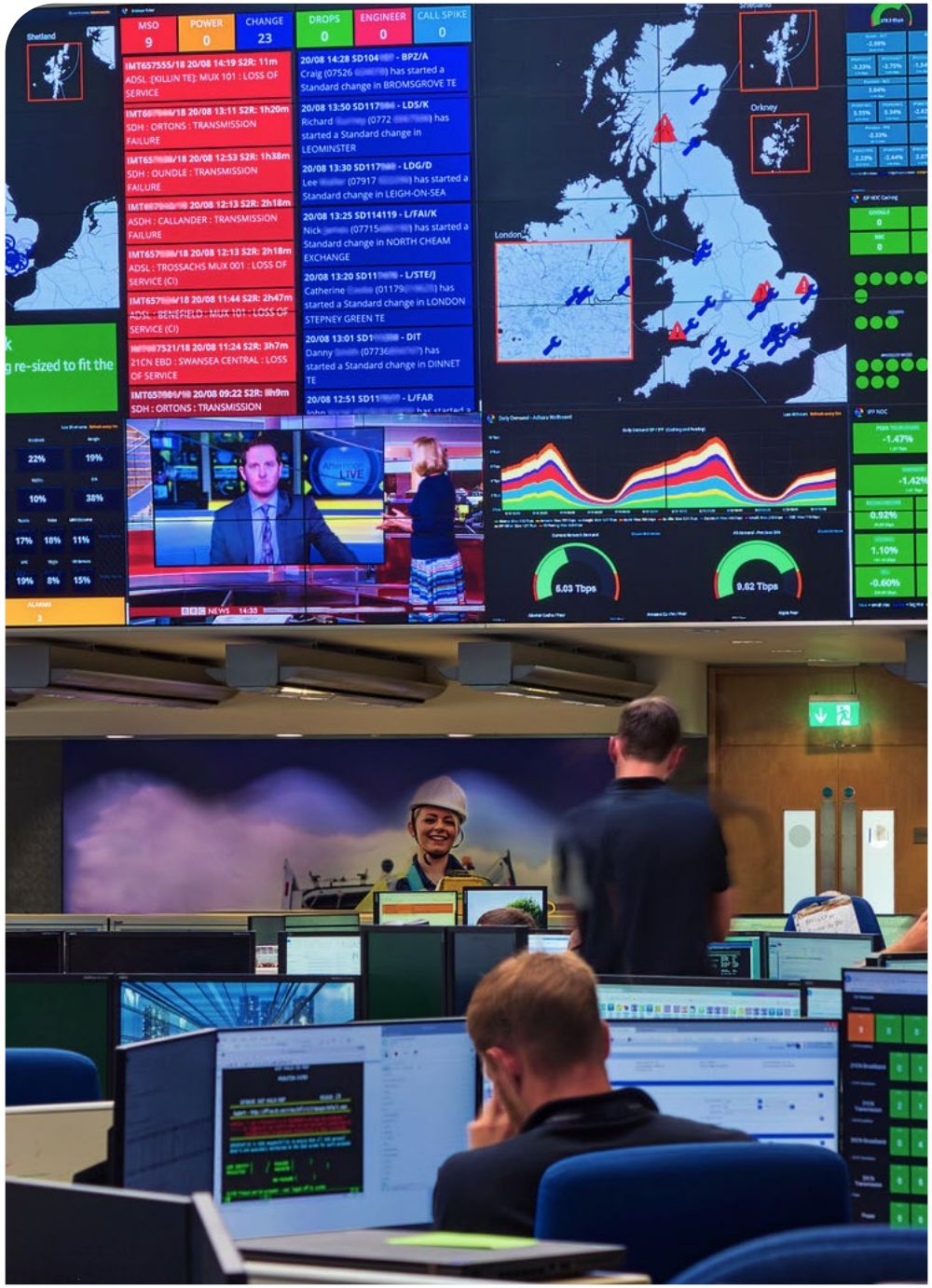
Initially we'll carry out a series of trials with OneWeb in our EE labs in Bristol, to show their capabilities can integrate with our existing services. Once these are completed, we'll carry out early adopter trials with end customers.

Our relationship with OneWeb is part of a multi-orbit space strategy supporting global coverage of LEO and GEO satellite systems, as well as the use of MEO satellites where appropriate. Over time, we anticipate increased usage of inter-satellite links, particularly between satellites in LEO constellations, although links between satellites in different orbits will also become available. Adopting LEO inter-satellite links will allow 'networking in space', mitigating many of the issues of limited coverage through the need for so many LEO ground segments. This will mean traffic can enter a constellation anywhere in the world, and be directed to a strategic ground segment. It's vital that the UK hosts a ground segment for all LEO constellations, to ensure strategic flexibility.

In IoT, the main use case for satellite was backhaul connectivity from terrestrial low-power wide area networks, such as LoRa. But emerging satellite start-ups, such as Lacuna, potentially offer direct satellite communication to IoT devices, based on IoT open standards. We expect the availability of lower cost antennas, combined with the launch of much smaller LEO cube and nano satellite constellations and cost-effective monthly service pricing, to help deliver cheaper, ubiquitous connectivity for IoT and machine-to-machine. This will allow their use in asset tracking, livestock management, farms, substations, reservoirs, and many other sensor applications.

5G and software-defined networking will have a strong impact on the satellite industry. Support for satellite components in 5G is expected to be available with Release 17 3GPP, allowing them to extend 5G coverage, and further enabling 5G though multi-casting content to edge caches. Greater adoption of technologies like software-defined networking and 5G network management into future satellite networks will help us to standardise service delivery; an example of this is our end-to-end network Vena (see Case study 1 above).

Software-defined networking is expected to facilitate multi-orbit convergence – such as automatic failover between medium Earth orbit and LEO systems - ultimately, converging with terrestrial networks, with the aid of multi-band and multi-network ground infrastructure. The ESN example mentioned above demonstrates what's possible in terrestrial and non-terrestrial network convergence. That convergence, supported by integrated service management, will be key in unlocking the value of the space industry. It'll support the delivery of ubiquitous connectivity and flexibility, enabling the creation of new applications, services and business models.



4. Become thought leaders in terrestrial and non-terrestrial convergence

Convergence of space and terrestrial capabilities has been an ambition of industry for many years, though there's often been a disconnect between terrestrial and space communities over exactly what this means. From a telco perspective, convergence means the seamless combination of space and terrestrial capabilities in the delivery of a service. This isn't necessarily the same as integration, although that may be needed in some cases.

Our objectives in any converged service are the ability to maintain control over the end user's quality of experience, and the end-to-end service costs. Many R&D projects aimed at integrating satellite and terrestrial capabilities have typically resulted in either breaking the end-to-end management link, more complex solutions that increase costs, or both – thus failing to attract the interest of telcos.

Our recently launched Smart Mining solution, created in conjunction with Société Européenne des Satellites (SES), is a great example of a vertically-focused solution built on converged terrestrial and non-terrestrial capabilities.

You can read more about it by going to Reimagining mining operations with satellite connectivity – BT for global business.

5. Foster disruptive thinking and solutions to promote the UK as global thought leader in space

The UK already accounts for 6% of total global space investment, second only to the US. Space clusters are developing in Harwell, Oxfordshire, the Leicester Space Park, and Westcott, Buckinghamshire, while Scotland produces more small satellites than any other country in Europe. Our collaborative work with UK start-up Arqit provides an example of seamless satellite-terrestrial convergence; it also demonstrates what's possible, in terms of fostering disruptive thinking and solutions, in promoting the UK as global thought leader in space (see Case study 2).

Case study 2: BT and Arqit

We've been collaborating with Arqit, a quantum technology start-up, for several years. Arqit have pioneered a unique quantum encryption technology, QuantumCloudTM, to protect communications links between any two locations on Earth against current and future forms of hacking, including from quantum computers.

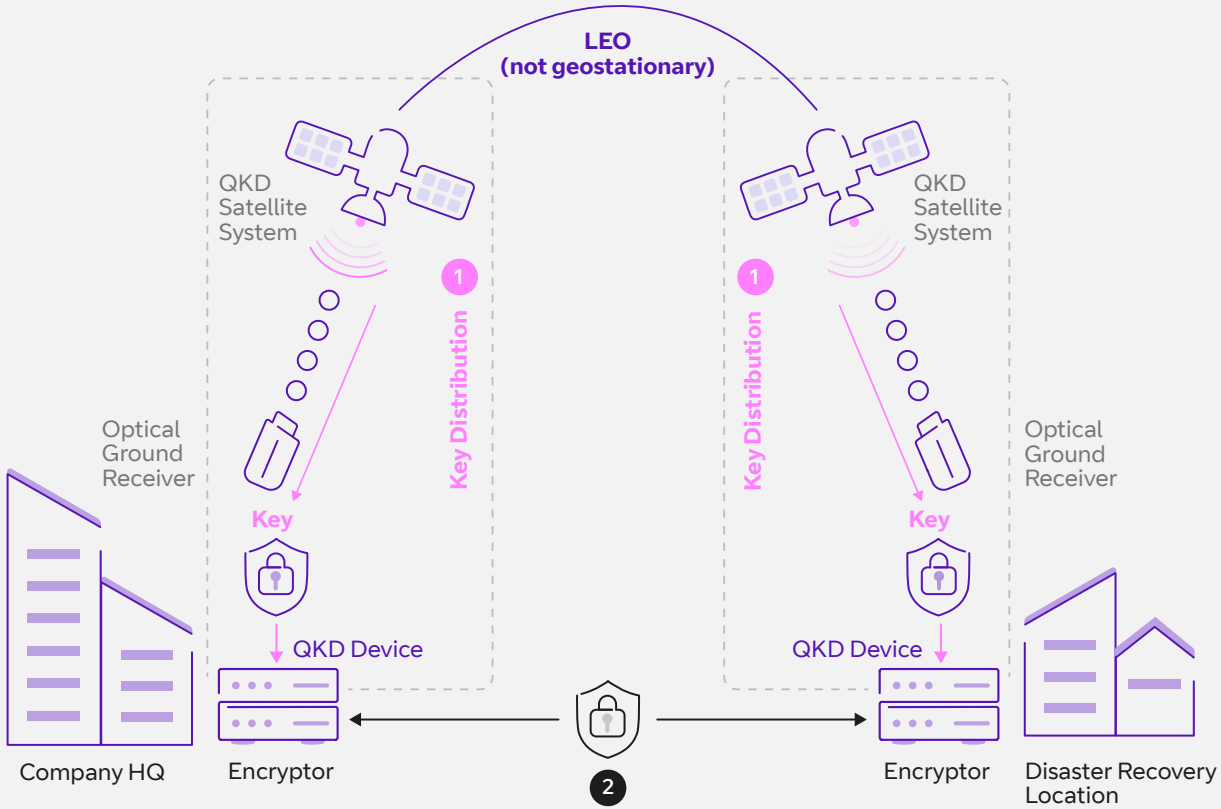
Arqit has recently raised $400 million in the space industry's latest special purpose acquisition company (SPAC) deal and intends to create 2,000 hi-tech jobs in the UK. That makes them the first space company 'unicorn' – a privately held start-up valued at over $1Bn – to emerge from the UK, demonstrating our ability to produce world-leading companies in cutting edge areas.

Quantum Key Distribution (QKD) uses physical principles to create shared encryption keys over two remote sites. Keys are delivered using the smallest possible packets of light and are made completely secure using quantum mechanics. This provides a further layer of security for personal and sensitive data, over and above the standard methods used by banks and credit card companies.

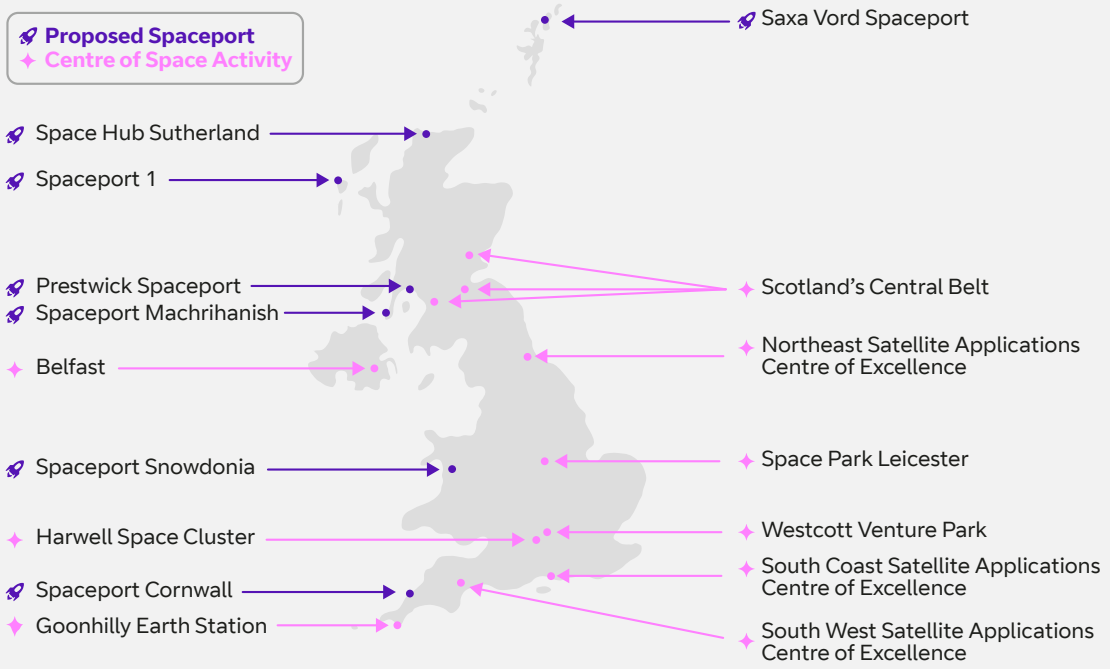
While being transferred in a quantum state, any attempt to intercept the key being transferred will disturb the photons sending the keys, introducing errors to their encoding. This means organisations will know when a key has been intercepted by a cyber-criminal, so the transaction can be terminated, with a new key being sent automatically.

The investment in Arqit will support the construction and launch of two satellites in 2023 that'll enable satellite Quantum Key Distribution (SQKD), the delivery of encryption keys from a satellite to ground stations. Point-to-point fibre-based QKD is currently range-limited to 100 km; SQKD represents the best short-term option for extending this range. Combining fibre QKD and SQKD capabilities will mean clusters of customers in diverse locations can be connected to benefit from end-to-end QKD security, simply by daisy-chaining the two solutions rather than requiring any integration of the two platforms. This is an example of seamless satellite terrestrial convergence.

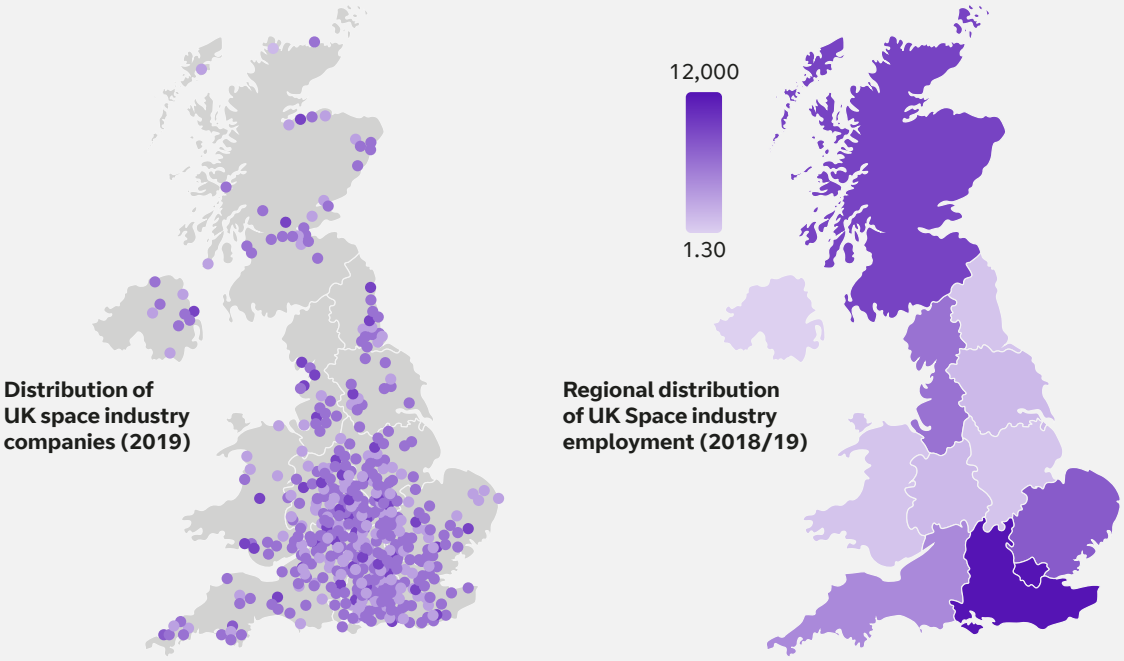
Satellite QKD system



Map of space companies
(from UK National Space Strategy)



Map of space clusters
(from UK National Space Strategy)



6. Leverage our world-class research capabilities at Adastral Park

Adastral Park is a cluster of high-tech telecommunication and technology companies, and home to our global research and development HQ. It combines a national operation centre, test facilities such as the 5G VINNI, and a world-class R&D unit with over 2500 scientists, IT experts and engineers. The park is home to our own innovation labs and Innovation Martlesham (an established and growing cluster of circa 150 high-tech ICT companies, as well as educational initiatives such as the Tommy Flowers Network and the DigiTech Centre collaboration with the University of Suffolk.

Looking at the distribution of space companies in the UK against the location of regional space clusters, there is clearly a gap in the East of England.

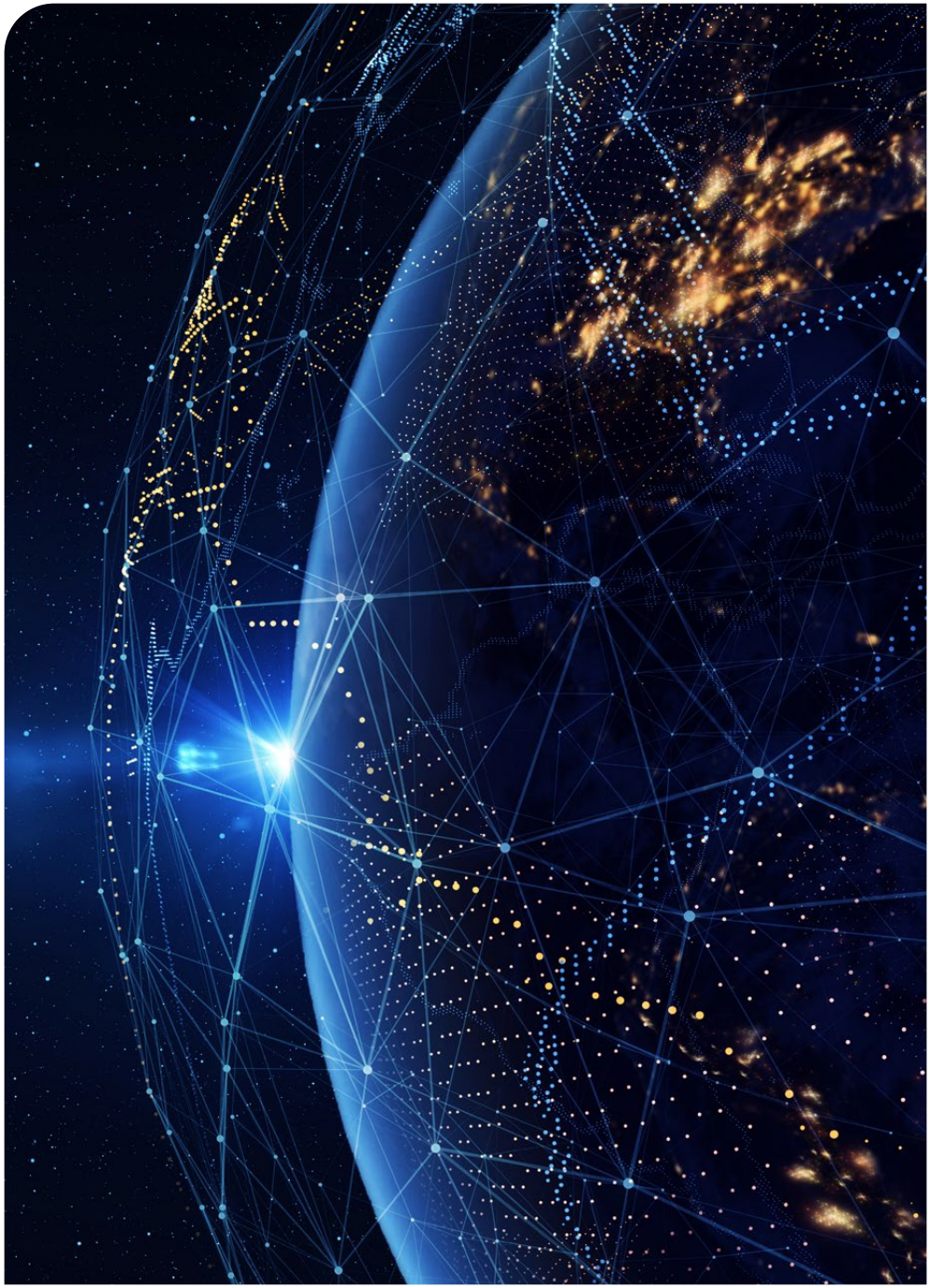
Along with the New Anglia Local Enterprise Partnership, the UK Space Agency and the Satellite Applications Catapult, we're currently exploring the feasibility of establishing an East of England Space Hub at Adastral Park.

Conclusion

These are exciting times for the UK space industry.

As demonstrated by its investment in OneWeb, the government is focusing on the importance of space to the UK's economy and security. We'll use our experience and capabilities to help the government achieve the goals of the UK National Space Strategy – proactively engaging with the UK space ecosystem, focusing on terrestrial and non-terrestrial convergence to deliver ubiquitous connectivity, alongside new services such as SQKD.

Network operators like us will have a key role in leveraging terrestrial and non-terrestrial technologies to deliver the services customers need.



Offices worldwide

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April 2022