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POSTnote 734

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6G mobile technology

Overview

- 6G is the next generation of wireless communication technology after 5G. Compared to the current generation, 6G is expected to be more responsive, reliable, faster, and have a higher rate of data transferable at any one time.
- 6G is expected to be accessible anywhere, secure, energy efficient, and compatible with various networks such as 5G, Wi-Fi and satellite.
- Technologies such as sensing, artificial intelligence, the Internet of Things, and cloud computing will be important technologies for 6G.
- 6G may increase adoption of autonomous vehicles, smart city technology, manufacturing, virtual and augmented reality, remote surgery, and more.
- In 2023 the UK Government released the 6G Strategy that committed an initial £100 million for 6G research.
- The UK is a global research leader, but stakeholders see a need to better commercialise technology from research.
- Policy commentators warn that limited technology development reduces influence over international standards, which can produce a negative feedback loop, possibly weakening domestic industries.
- Significant resources are needed to engage in 6G standards creation. Some commentators say that coordination between small to medium enterprises, researchers, and related stakeholders is needed to maximise UK influence.

Background

Telecommunications (telecoms) is one of five critical technologies identified in the UK Government's Science and Technology Framework.[1]

Alongside fixed-line networks (POSTbrief 24), mobile networks are an important component of global communication. For instance, in 2023 there were 111.8 million mobile phone subscriptions in the UK.[2]

The UK mobile network has changed over the last four decades, from first generation (1G) in the 1980s to fifth generation (5G) in the 2020s:[3–6]

- **1G**: (1980s) established the first analogue mobile network
- **2G**: (1990s) introduced the digital phone wireless network and text (SMS)
- **3G**: (2000s) enabled improved data transfer speeds
- **4G**: (2010s) brought faster speeds and data capacity for 'mobile broadband'
- **5G**: (2020s) currently provides even faster speeds, along with higher capacity and fast response times (see POSTbrief 32 and 5G in the UK).

However, much of the current 5G network relies on older, 4G technology.

In April 2023 the UK Government released a UK Wireless Infrastructure Strategy, in which it stated an ambition to upgrade the current network to full 5G technology.[7] The strategy stated that "5G Standalone"[a] networks will cover all UK populated areas by 2030 (see figure 1).[7]

Attention has also turned to preparations for sixth-generation wireless technology (6G), expected to be ready for deployment from around 2030.[7]

From 2022 to 2023, annual UK mobile data usage increased by around 15%.[b] [8] Mobile telecoms stakeholders[c] predict that 6G will exhibit increased capacity and faster speeds over 5G to meet this growing demand, although precisely how this will be realised is currently undefined.[9]

Some stakeholders believe that 6G will be more than an incremental improvement over 5G, and instead help to address various challenges including the 'digital divide',[d] increasing broadcast and entertainment requirements, and emergency services

[a] Also known as 5G SA, or standalone 5G, this does not rely on 4G technology.

[b] A 15% increase is 324 petabytes of data (to 2472 petabytes in total). 1 petabyte is approximately 1 million gigabytes, or the entire digital collection of the British Library.

[c] Stakeholders include industry and researchers, vendors (such as Ericsson and Samsung), Mobile Network Operators (such as EE or Virgin Media O2), regulators (such as Ofcom), standards organisations, service providers (for apps or content), and end users.

[d] A digital divide is unequal access between people "who have access to information and communications technology and those who do not."[10] A 2023 report considering the effects of digital exclusion was released by the Communications and Digital Committee.[11]

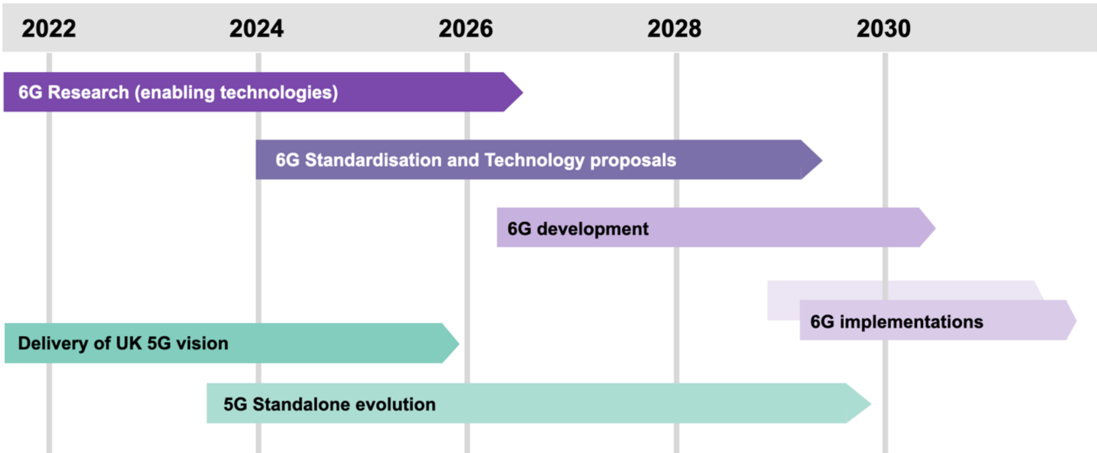
provision.[12–15] Benefits of 6G may include enabling smart cities, better transport networks, environmental management, climate change monitoring, and better access to health and social care.[7]

Some commentators say the future 6G network will be more intelligent, secure, sustainable, and accessible.[13,15,16]

However, stakeholders think the development of 6G is at a critical juncture because international discussions of standards have begun.[17]

This POSTnote provides an overview of the potential applications, capabilities and technologies of 6G networks and the likely future requirements for deploying 6G in the UK.

Figure 1: timeline for 6G development in the UK.



Source: adapted from IET.[e] [20] 6G implementation is expected to be a multistep process.

The need for 6G

What is motivating the move to 6G?

There are several factors motivating research into 6G technologies and an upgrade of the UK mobile network, such as:

- an increasing demand for a network that can handle larger data sets with greater reliability and efficiency[21]

[e] The 6G rollout is linked to the rollout of 5G Standalone in the UK.[18] As of September 2023, Ofcom estimated 18,500 5G deployments across 81,000 sites, compared with 12,000 in 2022.[19]

- mobile networks may need to change to support improving mobile technology, such as faster processors, and possible new industries[f]
- 6G could advance technologies that may be important to the future of the UK, such as robotics and extended reality (POSTbrief 61)[16]
- mobile network operators (MNOs) would like returns on investment after lower-than-expected returns from 5G,[g] [24] although in some cases this may limit the 6G rollout due to less funding being available for upgrades[9]
- reducing the digital divide, for example between populations in cities and those in more remote areas[25]

How is 6G used?

The Government Office for Science published a foresight analysis in 2023 that predicted virtual reality, environmental urban monitoring, and autonomous vehicles to be the main use cases for wireless networks from 2030.[26] While 5G will support some of these uses, 6G technology is expected to provide further benefits with increased responsiveness, security and data transfer:[16,27–29]

- **Smart Cities**. 6G could integrate sensing into communication. For instance, this could help determine the positions of items in the environment around a mobile device with better than 10 cm precision (POSTnote 656). This could support the "Internet of Things,"[h] autonomous driving (POSTbrief 62) or robotics for medical care or manufacturing (POSTnote 692).
- **Digital Twins**. Virtual representations of real-world objects that could allow, for instance, energy supply or transport to be optimised digitally with physical-world results (see POSTbrief 61).[i]
- **Robotics**. A more responsive connection could enable robotic surgery, or fine-control of machinery.[14]
- **Augmented/Virtual Reality**. 6G could offer the speed and responsiveness needed to operate augmented or virtual reality devices in several sectors including communication, education or healthcare (POSTbrief 61)

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[f] There is an estimated $3 trillion growth worldwide by 2030 driven by 5G and 6G.[22] The State of Connectivity Europe 2024 report, by Ericsson owned Cradlepoint, found that 47% of senior UK technology decision makers saw 5G as the most vital factor to the UK being a "leading tech powerhouse".[23]

[g] Mobile network operators spent $162 billion for 5G acquisition auctions globally, equivalent to a decade's worth of expenditure for 4G. Similar capital expenditure is expected again for 6G, and is predicted to outpace revenue growth.[12]

[h] The Internet of Things (IoT) is the collection of physical objects that can connect to a network.[30] IoT devices include smart home devices, such as smart thermostats, or wearable technology, such as smart watches.

[i] Digital twins may also allow more accurate weather and climate modelling and predictions.

Defining 6G

A definition in progress

6G is currently undefined. It is used as a term to encompass next-generation mobile communication technologies. Vendors, such as Samsung and Ericsson,[31,32] and research groups, have put forward differing visions for what 6G might become.[1]

6G will eventually be defined by international standards. The process will commence in 2025, but not conclude until 2028 at the earliest.[33–35] 6G will likely undergo various phases of refinement after commercialisation, as seen with 5G.[j]

A guiding global framework

In 2023, the International Telecommunications Union (ITU), an agency of the United Nations specialising in information and telecommunication technologies, published an international framework for a future 6G standard.[k] [37] The framework aligns with UK expectations, for example with the 2023 UK Wireless Infrastructure Strategy, and with those of the University of Surrey 5G/6G Innovation Centre and wider UK research community.[7,38]

Mobile network capability is defined by Key Performance Indicators (KPIs), such as speed, capacity (maximum data transferrable at any one time), and latency (response time).[14] The ITU framework indicates 6G will bring improvements across all KPIs, but the extent of improvement is not yet agreed (Table 1).

Table 1. Capabilities of 6G

Performance Indicator	5G Standard	Expected 6G Capability
User data speed	100 Mbps	Up to 10x increase
Peak data speed	10 Gbps (theoretical)	Reports of 206.25 Gbps[l]
Network data volume	10 Tb/s/km^2	Up to 1000x increase
User time delay (latency)	1 ms	Up to 10x shorter[m]

Source: On the Road to 6G.[13]

[j] Presently, 5G is scheduled to comprise 5 "release of standards" (Release-15-19), each an update to the 5G standard that provide a stable, known platform on which developers can work.[36]

[k] Recommendation ITU-R M.2160-0 in the International Mobile Telecommunications 2030 Framework.[16]

[l] Reported in a lab environment in China.[24] In May 2023, the first 6G connection with speeds over 100 Gbps was reported in the UK.[39]

[m] One researcher noted this may not be achievable in practice, however.[9]

Current state of 6G in the UK

Wireless Infrastructure Strategy 2023

The UK Government's 2023 Wireless Infrastructure Strategy included a roadmap for research, standards, the spectrum (see below), and international collaboration.[7]

The strategy outlined new indicators to measure 6G performance, which some researchers think better relate to society's needs than KPIs. These include 6G being:[40]

- **Interoperable**: by incorporating multiple technologies that are easily interchangeable (for instance with WiFi,[41] light, or infrared with radio communication).
- **Open, secure and resilient**: by using "security by design" to create a trusted network.[42] This is necessary with the increased importance and quantity of data likely used with 6G (e.g. personal information from sensing and health uses).[42]
- **Sustainable**: by balancing performance with energy efficiency.[n] [43,44]
- **Accessible**: 6G should be accessible anywhere in the UK to help close the digital divide. 6G aims to connect terrestrial (land) and non-terrestrial (e.g. satellite) networks.[o]

By the end of the 2024-5 financial year, the UK Government will have invested an initial £100 million to develop UK 6G technologies.

The 2023 Wireless Infrastructure Strategy included the aim of the UK being a "global leader" in shaping and implementing 6G technology.[7] In 2023, the UK joined the Global Coalition on Telecommunications, which includes the US, Australia, Japan, and Canada.[45] The Department for Science, Innovation and Technology (DSIT) stated that it would chair the first year Steering Group and lead a workstream on 6G.[46] The UK may also be involved with 6G development through the Horizon Europe programme.[47]

Research

DSIT states the UK has a strong global position in telecommunications research, including security, satellite, AI and optical networks.[7] In 2020–21, the UK had the third most research publications related to future telecoms after China and the US.[7] Ericsson, Samsung and Nokia have physical research capacity in the UK.[48–50]

Some researchers see coordination of UK 6G research as important to maximise impact.[14,20] The Joint Open Infrastructure for Networks Research (JOINER) is the 6G

[n] Vendors report most expenditure is on power. Energy efficient networks, while environmentally sustainable, are therefore also efficient from a cost and economic perspective.

[o] Connections to non-terrestrial networks such as satellites will likely not deliver the 6G metrics from Table 1.[9]

national research network for the UK (Box 1). In 2024 the UK Telecoms Innovation Network (UKTIN) included almost 3,000 organisations.[p] [52]

Three future Telecoms Hubs have been created and joined in a coordinating structure following DSIT and Engineering and Physical Sciences Research Council (EPSRC) funding.[q] [53] While funding extends into March 2025, researchers note a gap in funding up to 2030.[54]

In March 2024 EPSRC announced a new £8 million Centre for Doctoral Training in Future Open Secure Networks (FORT) to train over 50 post-graduate researchers.[r] [56]

Box 1: National 6G testbed

Testbeds provide infrastructure for experiments and simulations of new mobile technologies. Results from experiments are used to refine new technology.

The JOINER research network is a 6G national-scale experimental platform connecting 11 university sites across the UK.[57] Once 6G is defined, the network will enable collaboration and experiments between universities looking at communication technology challenges, such as energy consumption and security. The first full-scale 6G demonstrations are planned for March 2025.[57]

JOINER is connected to relevant US testbeds through transatlantic fibreoptic cables.[54] Transpacific fibreoptic cables also link the US to Japan and Korea and provide a fully global 6G testbed.[54] UK researchers are currently working with the EU on how to establish collaborative 6G experimentation with European partners.[54]

International comparisons

Many countries have 6G strategies (Table 2), often emphasising the importance of international collaboration.[58] Common themes that differentiate international plans from the UK strategy include the formation of 6G representation bodies and longer-term research and development funding.

[p] By the end of June 2024, UKTIN had registered 6,540 individuals and 2,911 organisations.[51]

[q] The federated hub structure was supported by the EPSRC and DSIT Federated Telecoms Hub 6G Research Partnership Funds (THRPF); funds supported three separate telecoms research hubs (TITAN, HASC and CHEDDAR) and their joining into a federated structure.

[r] Alongside a £1.1 billion package announced in March 2024 to train 4000 students in future technologies that could 'transform areas like 6G' such as AI and quantum.[55]

Table 2: 6G strategies in other countries			
Area	**Strategy**	**Key features**	**Organisation**
EU	European Vision for the 6G Network Ecosystem	Led by Smart Networks and Services Joint Undertaking, with funds of £1.5 billion in 2021-2027, and an industry contribution of at least £760 million.[58]	6G-IA[59]
US	Next 6G Alliance 6G Roadmap[60]	Next G Alliance, a private sector partnership, is tasked with preparing a roadmap for 6G.[61] £3.5 billion is to be invested in 6G development with Japan.[58]	Next G Alliance
South Korea	K-Network 2030 Strategy[62]	Aims to secure the "best technology in the world". Around £362 million invested in projects to enable commercial 6G in 2028.[63] It will host Pre-6G Vision Fest in 2026 to demonstrate research outcomes.[64] In 2023, an R&D Execution Plan was released with an additional £255 million.[65]	6G Global
China	Various[s]	Focus on a standard-setting role with the formation of China's IMT-2030 Promotion Group. 6G has been selected as a top priority and included in various technology development plans, including the Chinese metaverse.[66]	
Japan[t]	Beyond 5G Strategy[68]	Funding of £437 million and the creation of the XG Mobile Promotion Forum[u] to coordinate research initiatives and advocacy.[69]	
India	Bharat 6G Vision[70]	£930 million has been invested over 10 years for projects on the 6G ecosystem. Aims for ubiquitous, intelligent, and secure connectivity.	Bharat 6G Alliance

Developing and setting 6G standards

Setting global telecoms standards

Standards allow devices to function across borders and network suppliers. Setting standards is a multiyear, multistep process.[34]

Global requirements for 6G are set by the International Telecommunication Union (ITU),[71] an agency of the United Nations with a membership comprising Member States, universities, over 1000 private sector telecommunication companies, and international and regional organisations.[72]

The ITU stated that standards setting is a process of reaching consensus.[71]

Participants say that specialised commercial, legal and/or business training is also needed alongside technical experts to engage in the process.[73]

From 2024 to 2026, the ITU will define performance requirements for 6G, such as coverage, reliability, and data rates.[33] Technologies can then be submitted for consideration in 2027 until early 2029.[74] ITU expert groups will review proposals and essential 6G technologies.

The third-generation partnership project (3GPP) and the European Telecommunications Standards Institute (ETSI) will concurrently develop technical standards for communication between devices that meet ITU requirements.[35]

The current role of the UK

DSIT is engaged in coordinating UK contributions to the ITU,[7] with Ofcom leading the UK's delegation to the ITU-R.[v] [75] For the 2022 ITU 2030 framework discussions, UK contributions included two papers involving 18 research institutes.[17,76]

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[s] See China's 14th five-year plan, along with China's IMT-2030 Promotion Group report.

[t] The Japanese Nippon Telegraph & Telephone (NTT) company will pilot 6G networks at the Osaka World Expo in 2025.[67]

[u] Known as the Beyond 5G Promotion Consortium before 1st April 2024.

[v] The ITU-R is the International Telecommunication Union Radiocommunication Sector, which aids in managing the radio-frequency spectrum internationally.

While the UK contributes members[w] and financial investment[x] to the ITU, it lacks an influential vendor such as Huawei, Ericsson, or Nokia.

Expanding UK influence

The DSIT 6G strategy aims to "ensure the [6G] global vision supports UK ambitions". At the ITU June 2022 meeting, the UK signalled an intent to participate and contribute more actively in the future.[7,85]

Given the significant resources needed to engage in standards creation, some commentators have suggested that coordination between small to medium enterprises (SME), researchers, and related stakeholders is needed to maximise UK influence.[14,20]

Standards and UK telecoms development

Despite strong research efforts, the UK has developed a relatively small number of 6G patents and has no top global 30 network vendors.[y] Policy commentators warn that limited development reduces influence over international standards, which can produce a negative feedback loop, weakening local industries.[14,20]

Any patents determined to be essential for telecommunications standards are required to be available for fair, reasonable, and non-discriminatory use.[z] [88,90,91] The DSIT 6G strategy identifies these as opportunities for spin outs and licensing deals along with broader UK economic growth.[7]

Some researchers and telecommunication strategists agree. They say involvement in standardisation could support UK-created technologies.[54,92] This includes fibre, optical wireless (see LiFi in Box 2), and semiconductors (POSTnote 721).

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[w] As of 2024, the UK has the sixth highest number of research members (6) of the ITU (after China (43), United States (10), India (9), Japan (9) and Korea (7)),[77] and the third highest number of other members (such as network operators and technology industries)[78] after the US and China (considering EU nations as separate member states).[77,79,80] Since 2022, the UK is one of 48 members states on the ITU governing Council.[81,82]

[x] The UK is a 'top contributor' to ITU funding. While member states contribute around 69% of ITU's total revenue, the top 10 nations contribute over half of this value. In 2022 the UK contributed around 2.8%.[83,84]

[y] In 2021 and 2022, China and the US held a majority of 6G related patents (around 40% (4,604) and 35% (2,229) respectively as of August 2021).[86] Data from 2022 suggest South Korea has rapidly progressed to the third largest patent holder, followed by India, Japan and Europe. The UK was estimated to hold 115 patents as of 2023.[87]

[z] Patents of this type are called 'Standard Essential Patents' (SEPs).[88] The UK Intellectual Property office sees SEPs of growing importance to the UK economy and released a forward look at SEPs in 2024.[89]

Box 2: LiFi

The visible light and infrared spectrum has a 2600 times larger capacity than the radio spectrum and is beyond Ofcom's regulatory scope.[93] LiFi, a UK founded technology, uses the visible spectrum to securely transmit data.[aa] [96]

As light is blocked by most objects, the system offers local, highly secure, shortrange data transmission.[96]

In time, LiFi could be integrated into existing infrastructure such as streetlamps or car headlights to provide access points between user devices and radio mobile networks.[bb] [92] A UK company has commercialised the technology through a range of products[101] in areas such as defence and education.[102,103,13,104]

Coordination of 6G development

Experts say investment is required to secure new technology from research.[24,54,92]

A lack of major telecoms vendors in the UK is seen as one cause for limited telecoms development in, for instance, products and standards.[73]

Organisations such as Innovate UK and Digital Catapult aim to accelerate research into telecoms products. A researcher suggested that this work could be supported by technology tests and measurements for which the UK has known strengths, such as those by the National Physical Laboratory.[9] Some stakeholders call for policy that provides a method of coordinated product development and investment.[54,92]

In February 2024, the UK Government's Science Framework Update stated guidance to better coordinate 6G research output will be released in the year following publication.[105] It is expected to set out priorities to translate research into standards, patents, and exports.[105] The UK Government is considering the formation of a Future Telecoms Institute to focus on open standards and capitalising on research and development work.[106]

Some research institutes work with vendors and mobile network operators earlier in research, rather than introducing operators only when the technology is deployed.[cc]

[aa] Outdoors, LiFi has been shown to transmit up to 5 Gbit per second over 500 m using white light-emitting sources without impacting the operational lifetime of the light source.[94] LiFi is thought to be more secure: receivers know if interception has occurred by recognising changes in light properties, for instance if light reflects from a mirror.[95]

[bb] Given 80% of mobile network usage occurs indoors, LiFi could help optimise indoor connections also. See research into reconfigurable Intelligent Surfaces (e.g. at the 5G/6G Innovation Centre).[97–100]

[cc] Project REASON will "pursue breakthroughs on elevating bottlenecks of current systems,"[107] and works with major centres, including the National 6G Research Facility, and the University of Surrey 5G/6G Innovation Centre.

Implementing 6G in the UK

Governance

The DSIT 6G strategy does not include deployment. It instead recommends a "governance framework of relevant authorities and stakeholders across the public and private spheres."[7] Some experts call for a coordinating 6G governance taskforce.[14]

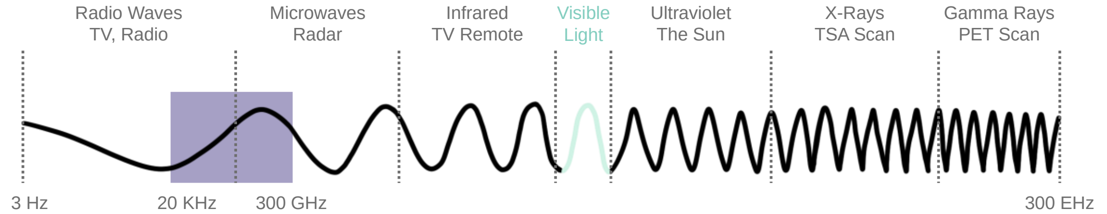
As competition intensifies for the minerals and components needed for wireless hardware (POSTnote 721), the 2023 Government Office for Science Wireless 2030 report noted that governing supply and demand for 6G components in the UK could "mitigate risk and maximise benefit".[26] The report also identified that stakeholders must consider future uses of 6G before infrastructure projects begin.

The electromagnetic spectrum

Radio waves transfer data

Mobile communications networks use radio waves, a type of electromagnetic wave like visible light (Figure 2).[108] Radio waves have various frequencies. Higher frequencies carry more information than lower frequency radio waves but travel less far in air.

Figure 2: electromagnetic spectrum, with mobile spectrum in purple.



Source. Adapted from *6G World. The 6G Spectrum Explained.*[109]

The 6G signal is expected to be mainly a combination of radio waves and the higher-frequency microwaves (Box 3, Figure 3).[110,111] 6G may also use other electromagnetic spectrum ranges, such as visible light (Box 2 and Figure 2).[112–114]

Box 3: 5G and possible 6G spectra

Low bands (400 MHz to 1 GHz): Only 700 MHz is used in the UK. It is currently used to reach remote areas.[dd]

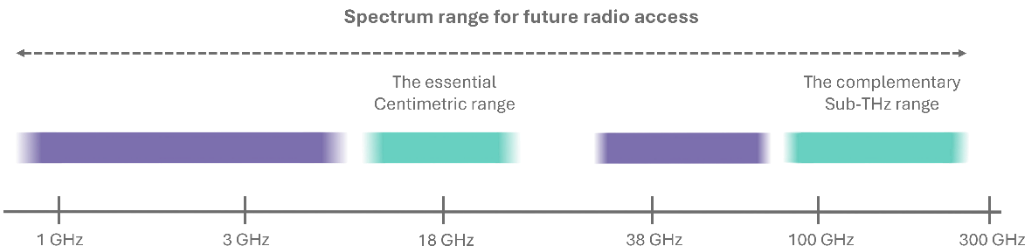
5G midband (2.3 GHz to 7 GHz): used for 5G, especially in urban areas.

Centimetric (7 GHz to 24 GHz): A likely major contributor to future 6G networks.[115,116] This band offers a balance of capacity and coverage. Being adjacent to the 5G midband, existing infrastructure may be reused.[ee]

Millimetre (mm) wave bands (24.25 GHz to 71 GHz): A wide band that could increase data rates and capacity. The disadvantages are increased power usage, shorter range and signal being more easily blocked by obstacles, such as walls. The UK does not deploy mm wave technology currently. While Ofcom plans to make this band available,[117] it is unclear if it will contribute to 6G.

High frequency sub-terahertz (THz) (90 GHz to 300 GHz):[28] An experimental range that includes visible light and is unlikely to be implemented until later phases of the 6G rollout.[118] This range is useful for small, high-density environments, such as data centres, and may provide connections between servers (eliminating cabling), extended reality headsets, or robotics.[ff] [119]

Figure 3: spectrum range for 5G (purple) and possible range for 6G (green).



Source: Adapted from Ericsson.[120]

Regulating the electromagnetic spectrum

The spectrum is a finite resource.[121,122] Transmitters, such as mobile phone masts, and receivers, such as mobile phones, must tune to the same frequency to communicate.

[dd] Low bands are less affected by obstacles such as walls and buildings and can travel further distances. However, they offer less capacity and can reduce network speeds.

[ee] However, at least four times as many antennae may be required, increasing infrastructure and costs.[115]

[ff] Challenges under research include balancing power requirements and signal strength.

The mobile communications regulator in the UK is Ofcom.[123] It manages the mobile spectrum to avoid interference between devices and network operators.[gg] [125] The mobile spectrum has historically been divided and assigned to network operators by auction, with the next auction being for millimetre-wave bands.[126]

In 2023, Ofcom released a discussion paper on the next generation of spectrum management.[127] Ofcom states it takes a "technology-agnostic" approach with a focus on making efficient use of the spectrum with widespread availability.[128]

Regulation of the UK 6G spectrum will align with international assignments. The international assignments will be decided at the ITU 2027 World Radiocommunication Conference.[129,130]

As 6G may rely on higher frequencies, there will be more data capacity available for network operators. However, there are large numbers of current users of higher frequencies, particularly in defence.[127,131] Rather than removing these users for 6G, Ofcom is exploring "spectrum sharing".[132–134]

Ofcom is also responsible for providing research access to ensure the required spectrum is available to develop 6G technology.[135]

Infrastructure

The UK mobile network comprises 'access networks' that connect directly to mobile phones via the radio spectrum, and 'core networks' that carry communication data around the country, generally by fibreoptics, cables, or point to point radio links.[136]

Some European companies, such as Vodafone, have highlighted their preference for software upgrades over hardware replacement, and for the current 5G standalone network to incorporate 6G.[24,42,137] If 6G eventually uses the same spectrum bands as 5G, 6G may initially be built onto older infrastructure.[138,139] Network operators call for a "smooth transition" from 5G to 6G, compared with the more uneven rollout of 5G.[24]

The UK National 6G Radio Systems Facility opened in July 2024 to investigate the physical infrastructure needed for using the 6G spectrum.[hh] The facility will provide an experimental platform to test future 6G radio technologies.[141]

Physical infrastructure

Radio access networks require computing and radio hardware,[ii] and complex antennae to receive and create wireless signals. The most visible part of the radio access network is called the base station. They are antennae and hardware that come in various sizes and radio ranges. Smaller base stations typically use less

[gg] Ofcom has a range of powers to enforce spectrum usage, including fines, licence revocation and criminal proceedings.[124]

[hh] The facility is funded by the Engineering and Physical Sciences Research Council (EPSRC). The proposal was supported by over 40 companies and research institutions interested in 6G.[140]

[ii] Computing and radio hardware includes a baseband, which controls what information should be sent through the hardware cables, and a radio unit, which converts and amplifies data signals into radio signals.

radiating power, have shorter ranges than large base stations, and can be built into city infrastructure such as bus shelters or billboards.[142] 6G may use all of the following:[143,144]

- **Macrocells**: the largest base stations with masts typically 10 to 40 metres high and radio ranges of up to a few miles.
- **Microcells**: used to fill gaps in the larger radio network and often mounted at street level. They are typically the size of burglar alarms and have a range of a few hundred metres.
- **Picocells**: usually found inside buildings such as offices or airports and have a range of around a hundred metres.
- **Femtocells**: for use within the home or small businesses and have a range of around 10 metres. They are around the size of a home broadband router.
- **Attocells**: for indoor use with cells sizes of tens of centimetres, and possibly to be used by future optical wireless systems.

Policy commentators say coordinating council building permissions and planning is important to deploy the smaller base stations, such as microcells, which are more likely to be used for 6G.[14]

Virtual infrastructure

Parts of the current mobile network are moving from hardware to software in a process called virtualisation.[7] Virtualisation can reduce cost, increase adaptability, and make it easier to upgrade the network.[7]

AI (POSTbrief 57 and POSTnote 633) is expected to be fully integrated into the 6G network.[145,146] Experts think this could allow the network to learn and manage itself,[146,147] possibly reducing costs and improving operations and security.[146,148,149]

There is currently no clear view on how AI integration will be achieved, and research is ongoing into issues of energy consumption and managing security risks.[148,150] One researcher thinks testing at a large scale may help overcome these issues (Box 1).[54]

AI powered mobile networks may bring broader AI policy and ethical considerations (POSTnote 708) such as ensuring compliance with data protection law.[jj]

Non-terrestrial networks

6G will move beyond land-based, or terrestrial, networks by integrating space networks (satellites) or air networks (unmanned aerial vehicles).[kk] [13,16,104] This could improve connectivity in remote areas. However, as satellite connections typically have

[jj] See the Data Protection Act 2018.

[kk] Towards Ubiquitous 3D Open Resilient Network (TUDOR), led by the UK's 5G/6G Innovation Centre, is researching terrestrial, airborne and satellite networks.[151,152] Regulation of the spectrum used by satellites remains an open question. The World Radiocommunication Conference (WRC) commenced allocation discussions in 2023, with outcomes to be decided in 2027. [153,154]

higher latency, poor signal reception and higher cost, it will likely remain a complementary system to terrestrial networks.[ll] [159–161]

Diversification for a secure network

Some suppliers to mobile networks may pose security risks (POSTnote 584).[162,163] Huawei equipment, for example, will be completely removed from 5G networks by the end of 2027 due to it being a "high risk vendor". This followed from advice by the National Cyber Security Centre.[164,165]

In February 2024 the UK and US, along with 8 other nations (not including China), endorsed a joint statement on 6G security principles including using only "trusted" technology to maintain national security.[162,163]

The UK strategy for 6G equipment acquisition is currently undefined.

However, in 2020 the UK Government's 5G supply chain diversification strategy policy paper suggested the following to reduce the risk of being overly reliant on too few suppliers:[166–168]

- supporting current suppliers
- attracting new suppliers to the UK market
- accelerating open-interface solutions and deployment

Diversification could also create employment opportunities and support the UK telecommunications market.[166,169]

Open-RAN (O-RAN) is the sharing of mobile infrastructure between operators. The UK Wireless Strategy targets network operators to carry 35% of UK network traffic over O-RAN by 2030.[170] O-RAN is expected to be a component of 6G.[mm] [175–178]

The UK Telecoms Lab (UKTL)[nn] was established in 2022 with an investment of £80 million by the Government to develop secure and trustworthy mobile networks.[179,180]

[ll] Satellite launch costs are now estimated to be 40 times lower than in the 1980s, and costs are expected to continue to fall by 95% by 2040.[155] Two UK satellite firms are Surrey Satellite Technology Ltd, which specialises in small satellites, and BT.[156–158]

[mm] Realising Enabling Architectures and Solutions for Open Networks (REASON),[mm] is a UK project working on O-RAN for 6G.[49,107,171] SmartRAN Open Network Interoperability Centre (SONIC) provides an independent laboratory for testing O-RAN systems.[172–174]

[nn] Operated by the National Physical Laboratory.

Preparing users

Users will require new hardware to connect to 6G networks. Integrating 6G into business and industry may require skilled experts in this new technology (see POSTnote 697 and POSTnote 659).[oo]

Public awareness

The Government Office for Science Wireless 2030 report identified public support and operator engagement as important to drive demand for 6G.[26] However, it warned a more digitally connected, "always-on" population may have impacts on wellbeing.[26] Some commentators emphasise the need for outreach work that explains the benefits of 6G by working with health authorities, psychologists and marketers to develop non-contentious 6G messages. This follows the delayed rollout of 5G due to public health concerns.[pp] [6]

Future challenges

It is unclear how current challenges for mobile networks will impact 6G:

- **User standards**. Unlike broadband, no legislated standard currently exists for 5G or 6G wireless mobile networks. Ofcom assesses coverage and speeds and reports on this annually in the Connected Nations report.[19]

- **Threats to the electromagnetic spectrum**. A report on the UK electromagnetic environment noted threats including space weather that could disrupt access to mobile networks.[182] Non-naturally occurring risks include electronic warfare and jamming.

- **Quantum technologies**. Quantum computing creates opportunities to improve network encryption and security, but there are risks it could breach current security systems that have not been updated for this technology (POSTnote 552).[183–185]

[oo] A UK report cited a lack of digital skills as a reason businesses are not deploying their own cellular networks.[23] However, there is a growing interest in fully private networks.[181]

[pp] Words and phrases like 'microwave', 'beamforming' and 'massive MIMO (multiple in multiple out)' have been explicitly omitted from 5G public messages as they were found to cause anxiety in the wider population.[14]

References

1. Department for Science, Innovation and Technology (2023). Science & Technology Framework - taking a systems approach to UK science & technology.
2. Ofcom (2023). The Communications Market 2023.
3. Solyman, A. A. A. *et al.* (2022). Evolution of wireless communication networks: from 1G to 6G and future perspective. *Int. J. Electr. Comput. Eng. IJECE*, Vol 12, 3943–3950.
4. Sound, S. S. (2017). 1G, 2G,…& 5G: The evolution of the G's. *Stanford University*.
5. Ofcom (2016). Cellular Networks and Technology.
6. Clark, A. (2024). 5G in the UK. House of Commons Library.
7. Department for Science, Innovation and Technology (2023). UK Wireless Infrastructure Strategy.
8. Ofcom (2024). Telecommunications Market Data Update - Q4 2023.
9. Paul, G. (2024). Personal communication.
10. Office For National Statistics (2019). Exploring the UK's digital divide.
11. Communications and Digital Committee (2023). The Government has "no credible strategy" to tackle digital exclusion.
12. Cole, Z. *et al.* (2024). Shaping the future of 6G. Mckinsey & Company.
13. Wang, C.-X. *et al.* (2023). On the road to 6G: Visions, requirements, key technologies and testbeds. *IEEE Commun. Surv. Tutor.*, Vol 25, 905–974. IEEE.
14. Dohler, M. *et al.* (2021). From 5G to 6G governance. University of Bristol.
15. 5G/6G Innovation Centre (2024). 6G Wireless: a new strategic vision. University of Surrey.
16. International Telecommunication Union (2023). Recommendation ITU-R M.2160-0.
17. Weissberger, A. (2022). Summary of ITU-R Workshop on "IMT for 2030 and beyond" (aka "6G"). *IEEE Communications Society*.
18. Hogan, M. (2024). 6G straight from the Ericsson labs: Is it too early? Ericsson.
19. Ofcom (2024). Connected Nations 2023.
20. The Institution of Engineering and Technology (2021). 6G for policy makers.
21. Ofcom (2022). Mobile networks and spectrum.
22. Grijpink, F. *et al.* (2020). Connected world: An evolution in connectivity beyond the 5G revolution. McKinsey & Company.
23. Wooden, A. (2024). Techies expect improved connectivity to create a 19% hike in revenues. *Telecoms*.
24. KPMG (2024). 6G: A Quantum Leap or a Quagmire for Global Connectivity?
25. Chaoub, A. *et al.* (2022). 6G for Bridging the Digital Divide: Wireless Connectivity to Remote Areas. *IEEE Wirel. Commun.*, Vol 29, 160–168.
26. Government Office for Science (2023). Wireless 2030.
27. Next G Alliance (2022). 6G Applications and use cases.
28. European Telecommunications Standards Institute (2024). TeraHertz technology (THz): Identification of frequency bands of interest for THz communication systems.
29. Next Generation Mobile Networks Alliance (2022). 6G Use Cases and Analysis.
30. IBM (2023). What is the Internet of Things (IoT)?
31. Ericsson (2024). Follow the journey to 6G.

32. Samsung (2020). 6G: the next hyper connected experience for all.
33. International Telecommunication Union (2022). IMT towards 2030 and beyond.
34. Ericsson (2024). 6G standardization timeline and principles.
35. 3GPP (2023). 3GPP Commits to Develop 6G Specifications.
36. 3GPP (2024). The 3GPP's System of Parallel Releases.
37. International Telecommunications Union (2023). ITU advances the development of IMT-2030 for 6G mobile technologies.
38. 5G/6G Innovation Centre (2024). Our 5G/6G vision.
39. National Physical Laboratory (2023). NPL and partners make UKs first 6G connection.
40. InterDigital (2023). Experience The Future of 6G: A New Direction for Telecom.
41. Ericsson (2020). 5G and Wi-Fi: Charting a path toward superior indoor connectivity.
42. Next Generation Mobile Networks Alliance (2023). 6G Trustworthiness considerations.
43. Next Generation Mobile Networks Alliance (2023). Network Energy Efficiency Phase 3A.
44. Next Generation Mobile Networks Alliance (2024). Reducing Environmental Impact.
45. Department for Science, Innovation and Technology (2023). UK joins leading nations to form new telecoms coalition and invests £70 million in new future telecoms technologies.
46. Department for Science, Innovation and Technology (2023). Global Coalition on Telecommunications: joint statement of intent.
47. Daly, A.-M. Europe launches first large-scale 6G Research and Innovation Programme. *Horizon Europe*.
48. Ericsson (2022). Ericsson in multi-million GBP 6G research program.
49. Samsung Research (2022). Samsung R&D Institute UK announces participation in REASON project, funded by DCMS.
50. Nokia Bell Labs (2023). Nokia Bell Labs Cambridge.
51. Short, M. (2024). Personal communication.
52. UK Telecoms Innovation Network (2024). About UKTIN.
53. UK Telecoms Innovation Network (2024). Federated Telecoms Hub Launches 6G Research Partnership Funds.
54. Simeonidou, D. (2024). Personal communication (POST research interview).
55. Department for Science, Innovation and Technology (2024). Thousands more to train in future tech like AI as government unveils over £1.1 billion package to skill-up UK.
56. University of Surrey (2024). University of Surrey leads £8 million initiative for training in secure AI-era networks.
57. University of Bristol (2023). JOINER.
58. European Parliament (2024). The path to 6G.
59. 6G Smart Networks and Services Industry Association (2022). About the 6G IA.
60. Next G Alliance (2022). National 6G Roadmap.
61. Next G Alliance (2024). Next G Alliance FAQs.
62. Government of Korea (2023). MSIT Launches the K-Network 2030 Strategy.
63. Nam-soo, P. (2023). 6G R&D. *Korea Information and Communication Technology Association*.
64. UK Telecoms Innovation Network (2023). South Korea aims to launch first commercial 6G networks in 2028.
65. Government of Korea (2023). Securing global leadership in 6G with '6G Global 2023'.

66. Central People's Government of the People's Republic of China (2023). Chinese Metaverse.
67. Umekuni, T. NTT to pilot 6G network at 2025 Osaka World Expo. *Nikkei Asia*.
68. Yasushi Munemasa (2022). R&D Strategy policy for beyond 5G in Japan. Ministry of Internal Affairs and Communications.
69. XG Mobile Promotion Forum (2024). About us.
70. Government of India (2023). Bharat 6G Vision.
71. International Telecommunication Union (2021). Brokering standards by consensus.
72. International Telecommunication Union (2024). About ITU.
73. Tafazolli, R. (2024). Personal communication (POST research interview).
74. Ericsson (2024). 6G standardization timeline and principles.
75. Ofcom (2020). Ofcom at the International Telecommunication Union (ITU).
76. International Telecommunications Union (2022). Workshop on 'IMT for 2030 and Beyond'.
77. International Telecommunication Union (2024). Our members.
78. International Telecommunication Union (2024). ITU Membership: United Kingdom.
79. International Telecommunication Union (2024). ITU Membership: China.
80. International Telecommunication Union (2024). ITU Membership: United States.
81. International Telecommunication Union (2023). Council Member States - 2024 Session.
82. International Telecommunication Union (2022). UK wins seat on top UN telecoms council.
83. International Telecommunication Union (2024). How is ITU funded?
84. International Telecommunication Union (2024). Top contributors.
85. International Telecommunication Union (2022). ITU's top contributors: United Kingdom.
86. Asghar, M. Z. *et al.* (2022). Evolution of Wireless Communication to 6G: Potential Applications and Research Directions. *Sustainability*, Vol 14, 6356.
87. Ali, R. (2023). The race to 6G. *Uswitch*.
88. Intellectual Property Office (2023). Standard Essential Patents (SEPs) explained.
89. Intellectual Property Office (2024). Standard Essential Patents: 2024 forward look.
90. Intellectual Property Office (2022). Government publishes Standard Essential Patents call for views response.
91. IP Europe (2024). What is a standard-essential patent?
92. Haas, H. (2024). Personal communication (POST research interview).
93. Haas, H. (2018). LiFi is a paradigm-shifting 5G technology. *Rev. Phys.*, Vol 3, 26–31.
94. Cheng, C. *et al.* (2024). 100 Gbps Indoor Access and 4.8 Gbps Outdoor Point-to-Point LiFi Transmission Systems using Laser-based Light Sources. *J Light. Technol*, Vol 42, 4146–4157.
95. pureLiFi (2023). The Next Generation of Security & Connectivity Mobile Technology Experts.
96. Dimitrov, S. *et al.* (2015). Principles of LED light communications: towards networked Li-Fi. Cambridge University Press.
97. Basar, E. *et al.* (2019). Wireless Communications Through Reconfigurable Intelligent Surfaces. *IEEE Access*, Vol 7, 116753–116773.
98. Zeng, S. *et al.* (2021). Reconfigurable Intelligent Surfaces in 6G: Reflective, Transmissive, or

Both? *IEEE Commun. Lett.*, Vol 25, 2063–2067.
99. Sarah *et al.* (2021). Reconfigurable Intelligent Surfaces: Potentials, Applications, and Challenges for 6G Wireless Networks. *IEEE Wirel. Commun.*, Vol 28, 184–191.
100. Pan, C. *et al.* (2021). Reconfigurable Intelligent Surfaces for 6G Systems: Principles, Applications, and Research Directions. *IEEE Commun. Mag.*, Vol 59, 14–20.
101. pureLiFi (2024). PureLiFi Technology: Radio Free Wireless Communications.
102. pureLiFi (2024). Case Studies.
103. LiFi Group (2024). Revolutionary Wireless Communication Technology.
104. You, X. *et al.* (2021). Towards 6G wireless communication networks: vision, enabling technologies, and new paradigm shifts. *Sci. China Inf. Sci.*, Vol 64, 110301.
105. UK Government (2024). The UK Science and Technology Framework: update on progress (9 February 2024).
106. Personal Communication.
107. REASON Open Networks (2023). Realising Enabling Architectures and Solutions for Open Networks.
108. Kao, M.-S. *et al.* (2020). Understanding Electromagnetic Waves.
109. 6GWorld (2024). The 6G Spectrum Explained.
110. Nokia (2023). Spectrum for 6G explained.
111. Wang, C.-X. *et al.* (2020). 6G Wireless Channel Measurements and Models: Trends and Challenges. *IEEE Veh. Technol. Mag.*, Vol 15, 22–32.
112. Haas, H. *et al.* (2023). Why optical wireless communications is ready for 6G. in *49th European Conference on Optical Communications (ECOC 2023)*. Vol 2023, 1594–1597. IET.
113. Ariyanti, S. *et al.* (2020). Visible Light Communication (VLC) for 6G Technology: The Potency and Research Challenges. in *2020 Fourth World Conference on Smart Trends in Systems, Security and Sustainability*. IEEE.
114. 6G Flagship (2022). Visible Light Communication.
115. Ericsson (2023). Why cmWave spectrum is expected to be a powerful enabler of 6G and future networks.
116. Krasova, T. (2023). 6G will be held together with centimetric band. *LightReading*.
117. Ofcom (2023). Rolling out millimetre wave spectrum – what you need to know.
118. Ericsson (2024). Sub-terahertz communication in 6G.
119. Rappaport, T. S. *et al.* (2019). Wireless Communications and Applications Above 100 GHz: Opportunities and Challenges for 6G and Beyond. *IEEE Access*, Vol 7, 78729–78757.
120. Ericsson (2024). 6G Spectrum: Unleashing Extreme Performance.
121. Ofcom (2022). What is spectrum?
122. Department for Science, Innovation and Technology (2023). Spectrum statement.
123. Ofcom (2022). Spectrum Roadmap: Delivering Ofcom's Spectrum Management Strategy.
124. Communications Act 2003. Statute Law Database.
125. Ofcom (2014). Spectrum management strategy.
126. Ofcom (2024). Making mmWave spectrum available – updates on auction design.
127. Ofcom (2023). Spectrum management for Next Generation Wireless Broadband.
128. Department for Science, Innovation and Technology (2023). Spectrum statement.
129. International Telecommunications Union (2024). ITU-R Preliminary Studies for WRC-27.

130. GSMA (2024). The road to WRC-27: a new cycle begins.
131. Wooden, A. (2024). Decoding spectrum: How frequency bands work in telecoms. *Telecoms*.
132. Ofcom (2023). Supporting increased use of shared spectrum.
133. Ofcom (2015). Spectrum Sharing Framework.
134. Ofcom (2023). Opportunities for dynamic or adaptive approaches to managing spectrum in the UK.
135. Ofcom (2020). Supporting innovation in the 100-200 GHz range.
136. Christie, L. (2019). 5G Technology. Parliamentary Office of Science and Technology.
137. Lawrence, A. (2024). The Hardware Refresh Cycle – No Need For A 6G Rollout? *6G World*.
138. O'Farrell, T. (2024). Personal communication (POST research interview).
139. Persson, P. (2024). Personal communication (POST research interview).
140. University of Sheffield (2023). UK's first national 6G research facility to be opened by University of Sheffield.
141. 6G National Radio Systems Facility (2024). Launch event.
142. Cellnex (2024). 5G Small Cells.
143. Scottish Government (2001). Planning Advice Note: PAN 62 Radio Telecommunications.
144. Haas, H. High-speed wireless networking using visible light. *SPIE*.
145. Nokia Bell Labs (2023). AI-native air interface.
146. Letaief, K. B. *et al.* (2019). The Roadmap to 6G: AI Empowered Wireless Networks. *IEEE Commun. Mag.*, Vol 57, 84–90.
147. Choi, A. J. (2023). AI-Native Open RAN for 6G. O-RAN Alliance.
148. Saimler, M. *et al.* (2023). AI as a service: How AI applications can benefit from the network. *Ericsson*.
149. Yang, H. *et al.* (2020). Artificial-Intelligence-Enabled Intelligent 6G Networks. *IEEE Netw.*, Vol 34, 272–280.
150. Siriwardhana, Y. *et al.* (2021). AI and 6G Security: Opportunities and Challenges. in *2021 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)*. 616–621.
151. Satellite Applications Catapult (2022). TUDOR (Towards Ubiquitous 3D Open Resilient Network).
152. UK Telecoms Innovation Network (2023). TUDOR.
153. GSMA (2024). Spectrum Policy Trends.
154. Martin, A. *et al.* (2024). Spectrum for the Space and Satellite Industry. *Space News*.
155. Wooden, A. (2024). The rise of satellites in telecoms. *Telecoms*.
156. BT (2024). Our Space Strategy.
157. BT (2024). Delivering a multi-orbital and multi-constellation space strategy.
158. Surrey Satellite Technology Ltd (2024). Building world-leading small satellites for 40+ years.
159. 6G-NTN (2024). Vision on Non-Terrestrial Networks in 6G system (or IMT-2030).
160. UK Telecoms Innovation Network (2024). Future Capabiltiy Paper: Non-Terrestrial Networks.
161. 6GNTN (2024). Report on 3D Multi Layered NTN Architecture.
162. Wood, N. (2024). UK and US among 10 governments backing 6G security wish-list. *Telecoms*.
163. Government of the United States (2024). Joint Statement Endorsing Principles for 6G: Secure, Open, and Resilient by Design.
164. UK Government (2022). Designated Vendor Direction under section 105Z1 of the Communications Act 2003.
165. National Cyber Security Centre (2020). NCSC advice on the use of equipment from high risk vendors in UK telecoms networks.

166. Department for Digital, Culture, Media and Sport (2020). 5G Supply Chain Diversification Strategy.
167. Science and Technology Committee (2021). 5G market diversification and wider lessons for critical and emerging technologies: Government Response to the Committee's Second Report of 2019-21.
168. UK Telecoms Innovation Network (2020). UK Government Telecoms Diversification Policy and Initiatives.
169. National Physical Laboratory UK Telecoms Lab (2024). Personal communication (POST research interview).
170. Sweeting, G. (2024). Three deploys UK's first open ran small cell in Glasgow, but says UK Govt Open RAN targets 'not a priority'. *Total Telecom*.
171. UK Government (2022). The Future Open Networks Research Challenge Winners.
172. Digital Catapult (2024). SONIC Labs: The Programme.
173. Department for Science, Innovation and Technology (2022). SmartRAN Open Network Interoperability Centre (SONIC) Labs.
174. Digital Catapult (2023). SONIC Labs 2022/23 Annual Report.
175. Abdalla, A. S. *et al.* (2022). Toward Next Generation Open Radio Access Networks: What O-RAN Can and Cannot Do! *IEEE Netw.*, Vol 36, 206–213.
176. Bonati, L. *et al.* (2021). Intelligence and Learning in O-RAN for Data-Driven NextG Cellular Networks. *IEEE Commun. Mag.*, Vol 59, 21–27.
177. Niknam, S. *et al.* (2022). Intelligent O-RAN for Beyond 5G and 6G Wireless Networks. in *2022 IEEE Globecom Workshops (GC Wkshps)*. 215–220.
178. O-RAN Alliance (2023). O-RAN Towards 6G.
179. Department for Science, Innovation and Technology (2022). Government announces cutting-edge new telecoms lab for Solihull.
180. National Physical Laboratory (2024). UKTL - The telecoms security lab.
181. Dell'Oro Group (2024). Private Wireless.
182. Steinmann, F. (2024). Roundtable Discussion: Building Resilience in the UK's Electromagnetic Environment. Cranfield University.
183. Ali, M. Z. *et al.* (2023). Quantum for 6G communication: A perspective. *IET Quantum Commun.*, Vol 4, 112–124.
184. Nawaz, S. J. *et al.* (2019). Quantum Machine Learning for 6G Communication Networks: State-of-the-Art and Vision for the Future. *IEEE Access*, Vol 7, 46317–46350.
185. Wang, C. *et al.* (2022). Quantum-Enabled 6G Wireless Networks: Opportunities and Challenges. *IEEE Wirel. Commun.*, Vol 29, 58–69.

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