5G 6G INNOVATION CENTRE

UNIVERSITY OF SURREY

Advanced connectivity technologies: a reset Vision to support industry and policy priorities[1]

University of Surrey, 6GIC

[1] 6GIC Strategy Advisory Board's (SAB) current working assumption for a shared 6G Vision that best supports industry and policy priorities for both the UK and other countries facing similar economic challenges.*

** 'Working assumption' is a term used in early standardisation for everyone's best judgement in the light of current knowledge, and is changeable as and when new facts emerge.*

June 2025

Executive summary

This Vision supporting advanced connectivity technologies including 6G, published by the University of Surrey 6G Innovation Centre (6GIC), is unlike any other. It has been shaped in close consultation with UK infrastructure-based mobile network operators (MNOs) and industry, with a clear focus on what must happen next for mobile infrastructure as we enter the artificial intelligence (AI) technology age. While the Vision reflects the commercial needs of UK MNOs as the principal investors in our national public mobile networks, it supports broader mobile infrastructure developments including private networks, which will play a key role in enabling Industry 4.0 applications and secure enterprise systems. It addresses how the UK can become a strong player in the twin opportunities of **AI-on-the-network** and **AI-in-the-network**—while ensuring that MNOs retain and develop sustainable businesses.

The paper is shaped with consideration of both innovation for the market and the economic and commercial realities and requirements of industry. With the paper, we have drawn together the views of MNOs and industry within the UK, plus those of several leading independent consultants.

Our Vision marks a deliberate shift in direction: from incremental leaps in data speeds to **meaningful improvements in the quality and reliability of mobile service coverage**. Use cases such as immersive presence in Industry 4.0 will rely on high-capacity, low-latency communications—often supported by private networks operating alongside public cellular infrastructure. The goal is simple but critical—**mobile networks must work better, everywhere, and in the *moments that matter* for users**.

> **Mobile networks must not only be improved to deliver AI-powered services more reliably—they must themselves become AI-native.**

At present, the UK's mobile networks only partially serve the areas where people need connectivity—both indoors and on the move, and reliability is variable. This is despite growing dependence on mobile services across all levels of society. Even where there is service coverage, it often falls short of delivering the speed, responsiveness, or consistency needed. However, with ongoing commercial pressures for operators, simply building out more infrastructure—whether 4G, 5G, or even 6G—is no longer economically viable. At the same time, **mobile networks must be made more resilient and secure, as our economy and way of life come under increasing pressure from global geopolitical instability**. Instead of simply building more networks, a new and smart design approach is needed.

In this paper, we support an innovative architectural baseline: a 3-dimensional **network of networks (NON)**. This 3D NON unifies terrestrial, WiFi, and satellite networks into a single, intelligent architecture—bridging space and ground-based systems for seamless user experience. With this, mobile networks interoperate with domestic and public WiFi, fixed-line cable networks, and non-terrestrial networks (NTNs)—including satellite systems. We also support use of the **600 MHz band as new clear spectrum for 6G**, which supports the Vision of **pervasive and reliable coverage**: an 'AI instant access coverage layer'.

Mobile networks must not only be improved to deliver **AI-enabled services** more reliably—they must themselves **become AI-native**. That means dynamic, intelligent control of resources, intent-based service delivery, and predictive optimisation. **These capabilities will allow networks to operate more efficiently, reduce**

We also support use of the 600 MHz band as new clear spectrum for 6G, which supports the Vision of pervasive and reliable coverage: an 'AI instant access coverage layer'.

energy use, and better meet user needs in real time. Enhanced by sensing and digital twins, they enable self-optimisation, dynamic resource allocation, and delivery of personalised services. This supports the transition from intent-based networking to autonomic, zero-touch networks that adapt intelligently and autonomously. AI can also help operators to develop new go-to-market services, thereby increasing monetisation opportunities, and decreasing dependencies on third parties. However, **there should be no obligation on MNOs to adopt AI technology, just as there should be none to adopt open radio access network (ORAN) and open networking principles**.

The UK's domestic market is too small to operate in isolation. MNOs must be able to source network equipment and user devices at **global scale**, which requires **alignment with international standardisation bodies such as 3GPP, ITU, and IEEE**. Yet, geopolitical tensions are threatening the coherence of global standards. The UK should not settle for being a passive user of unsuitable global technologies driven by the needs of quite different markets and geopolitical rivalry. The University of Surrey recognises this fragility of global 6G standards-making and supports a twin-track and selective approach of **both evolutionary and revolutionary elements in 6G standardisation**. With focused research, strategic international engagement, and leadership in standards development, the UK has an opportunity to **shape and access the next era of wireless infrastructure in line with national priorities and sovereign capabilities**.

Direct-to-device (D2D) communication—especially satellite-to-handheld—is expected to be a game-changing feature of advanced connectivity, enabling high-reach mobile services and resilient connectivity.

Spectrum remains as a key enabler. In addition to the 5G bands, the 600 MHz and upper 6 GHz bands are especially important as new clear spectrum. The 2 GHz S-band is also critical—supporting satellite-based D2D services with handheld devices. Global harmonisation in the 7–15 GHz bands may turn out to be relevant.[2] **Early planning and access to spectrum will ensure that research outcomes are effectively leveraged**.

The reset Vision also calls for an end to disruptive and capital-intensive generational 'big bang' transitions. Instead, we advocate a **modular, evolutionary upgrade path, anchored in backward compatibility** and building on 5G Advanced (3GPP Release 18+). New features should be commercially justified, not speculative. This approach will reduce capex burdens, enhance sustainability, and accelerate adoption. The Vision remains open on whether evolutionary or revolutionary approaches will prevail—this will depend on whether new proposals deliver performance improvements significantly beyond 5G Advanced by the 2029–30 timeframe.

Shared infrastructure ('*sharing by default*') will be crucial to national rollout in areas with weak investment cases, creating opportunities for **neutral host models** and **public-private partnerships (PPPs)**.

Further, there is much that could be done with **reforms to planning and procurement frameworks** to enable more rapid deployment of new small mobile base stations at a lower cost.

All of this needs to be underpinned by **national collaborative R&D** in areas such as **software-defined networks (SDNs), cybersecurity, systems integration, and energy-efficient architectures**.

The paper outlines several key principles linked to **6G-relevant academic research**. The Vision ensures industrial relevance of our research by tightly coupling it to real-world MNO-defined long-term problems to be solved, that could be facilitated by agile, collaborative funding mechanisms.

If MNOs, Government, and Ofcom get 6G to market right, the impact could be transformative. An uplift in gross value added (GVA) of around £23 billion per year—or over £200 billion over ten years—is within reach.

More than a technical vision, the paper provides a framework supportive to the UK's future in the AI services and wider digital economies.

[2] *The 7 – 15 GHz band includes bands used by the defence and security sectors.*

1. Why a reset Vision for 6G is needed

In 2020, we published our initial 6G white paper, based on early views from industry showing what 6G could offer. In that paper, we noted that much potential remains with 5G technology – a view that we continue to hold.

However, five years on, the world has changed, and the views on the economics of wireless innovation and disruption, including 6G, have changed considerably. Further, artificial intelligence (AI) technology has entered mainstream commercial usage.

More than ever, **telecommunications is now a foundational technology for nation states – critical in enabling economic growth and prosperity, national security and defence, and competitive positioning in the global economy**.

Therefore, it is time to introduce a reset Vision for 6G; one that is grounded in what is likely to be economically viable. It must address the **commercial imperatives of those whose investments will be needed to drive 6G deployment, the real needs of consumers, and crucially, provide a mobile infrastructure able to support economic growth for the country**.

2. 6G supporting economic growth

2.1 Seeing 6G pragmatically and selectively: key features

Based on industry consultation, **we see some—but not all—of the elements in the ITU's IMT-2030 vision as relevant to UK MNO commercial needs** (see Figure 2-1). Our 6G Vision specifically aligns with operator needs and supports credible and useful services.

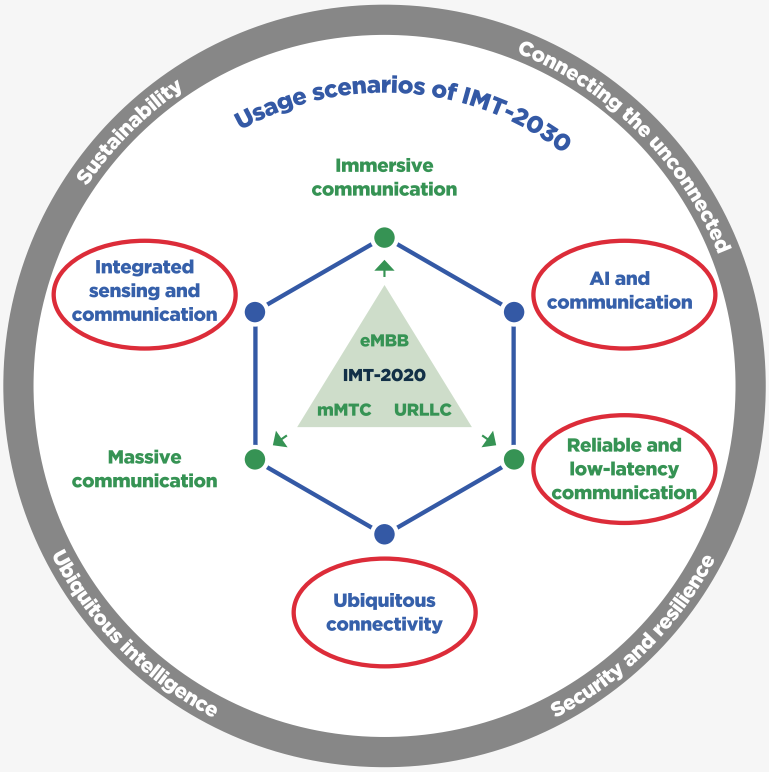


Figure 2-1 – IMT-2030 6G global framework: a nationally selective approach.

We propose a clear distinction between:

- **Essential elements:** AI, reliable and low latency communication, ubiquitous connectivity, spectrum harmonisation, global standards, international cooperation, and public-private partnerships—vital for ubiquity.
- **Optional elements:** integrated sensing, full core replacements and new air interfaces, which, when defined, would need careful review for cost-benefit.
- **Low-priority / not required elements:** immersive and massive communication, mandatory open network architectures, and disruptive generational resets.

This **selective approach couples 6G to UK MNO and policy priorities** and creates the possibility of a shared 6G approach across MNOs.

We support the NGMN Alliance principle: no 6G feature should compromise current 5G performance.[3]

[3] See: ngmn.org/wp-content/uploads/NGMN_6G_Position_Statement.pdf

> **We expect key 6G elements to begin appearing in some markets around 2030.**

2.2 6G as an engine for economic growth – enabled by research

The UK's digital economy accounts for around 10% of national GVA[4], a figure comparable to data for the US[5], and below China's reported figure of 30%.[6] As a services-led economy, the UK will become increasingly reliant on digital trade. As reliance grows, so must resilience.

To influence global technology development and ensure that solutions matched to national requirements are made available in global supply chains, the UK needs visible leadership in R&D in digital systems. Specifically, development of R&D excellence in key areas relevant to national interests will drive inward investment and skills growth.

Use cases such as THz communications, 3D headsets, holography, and immersive presence currently lack business cases for supportive MNO-driven infrastructure investments, but may be important for specific applications such as with private and local networks, 3D virtual reality modelling in healthcare and engineering, and inter-satellite links.

2.3 6G without duplicative effort, and with clear improvements

3GPP's Release 18 adds AI-driven optimisation, better energy efficiency, and expanded NTN support. It is widely seen as a solid foundation for evaluating future 6G features.

New 6G proposals—radio, architecture, or services—need to offer clear advantages over Release 18 to justify development and deployment.

Other advanced connectivity features may develop in parallel, leveraging ongoing advancements in 5G technology.

2.4 Resilience and security

Resilience means the ability to recover from failure or damage quickly and cost-effectively. 6G must include redundancy and failover by design.

Cybersecurity must be built-in and be future-proof. As quantum computing advances, networks must be quantum-safe. Trusted device identity (eg hardware-based security) will also be critical. Security by design is now widely embraced and that will need to be carried through into 6G.

2.5 Radio spectrum: a critical enabler for 6G

Limited spectrum is available for 6G. The best prospects in the UK are at **600 MHz** and with the **upper 6 GHz band (6.425–7.125 GHz), together with refarming of bands as legacy technologies are retired**.

The 600 MHz band offers new clear spectrum for 6G and can support the Vision for pervasive and reliable mobile coverage. In the AI services era, the 600 MHz band can provide an 'AI instant access coverage layer'.

Spectrum for satellites has always sat in a globally driven framework. A promising development is with MNOs having the freedom to allow satellite partners to use their mobile spectrum. S-band (2 GHz) spectrum appears promising for new satellite-based direct-to-mobile-device (D2D) services, given its established global allocation, physical properties, and work within the 3GPP standards body.

There will be pros and cons with use of global mobile satellite service (MSS) bands or access to regional terrestrial mobile bands for NTN systems.[7]

[4] *See: ons.gov.uk/economy/economicoutputandproductivity/output/articles/ukdigitaleconomicresearch/2020*

[5] *See: bea.gov/sites/default/files/2023-12/digital-economy-infographic-2022.pdf*

[6] *See: china-briefing.com/news/understanding-chinas-digital-economy-policies-opportunities-and-challenges/*

[7] *See: https://www.ofcom.org.uk/spectrum/space-and-satellites/consultation-enabling-satellite-direct-to-device-services-in-mobile-spectrum-bands*

2.6 Demand-driven design: scheduling, evolution, modular compatibility

Cellular networks have traditionally undergone major upgrades on a ten-year cycle. In some countries, operators still have the investment capacity to sustain this revolutionary approach. In other countries, including the UK, this is no longer economically sustainable.

A more evolutionary approach to improvements has become essential, thus breaking the link with generational cycles (see Figure 2-2). Globally, it makes perfect economic sense for 6G to embrace both revolutionary and evolutionary versions – each matched to respective national market conditions.

There is limited time available for 6G standards development (around 4 years) – similar to the time taken to develop the 5G standards. This is unlikely to shift given the complexity of ensuring global agreements on 6G standards timelines and contents.

We expect key 6G elements to begin appearing in some markets around 2030, with others following more gradually thereafter.[8]

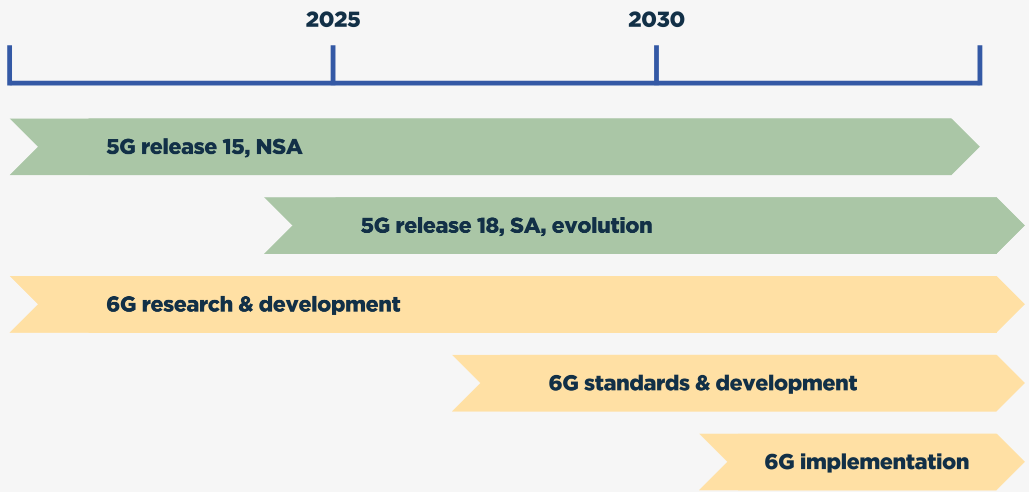


Figure 2-2 – Evolutionary 6G in selected markets.

2.7 Innovation in net neutrality

Operators control the network, its quality, and—critically—programmable APIs[9] that can expose value to developers and customers. Yet, content and service-X over IP (XoIP) players like YouTube captured value early—offering global, app-driven services that bypass operator billing.

Operators, meanwhile, have shouldered infrastructure costs with limited revenue upside. Subsequently, 5G has not brought enough top line value to cover its significant capex levels.[10] By combining programmable APIs and AI-in-the-network, operators may be able to develop important new post-XoIP services.

Regulations may need to be reviewed, to enable operators to capture a greater share of service value including that from post-XoIP and new AI-on-the-network services that require high availability (eg with value pricing in network services).

[8] Based on the assumption that 3GPP work on 6G standards will begin in 2027, with around 18 months required for the development of first chipsets. Some caution is required; R&D cycles in the industry are by no means short – 5G NSA took around 4 years to develop, from initial 3GPP standards work to first commercial launch. 4G development to launch took around 6 years (with major architectural revisions from 3G).

[9] Network APIs (application programming interfaces) are interface points in a network or software system that allow external control. Commercially, network APIs could be offered by operators to external parties on a fee-paying basis.

[10] Whilst capex does not hit operator's profits directly, it does indirectly, as debt and equity loans must be serviced, and investor confidence can be impacted, raising cost of capital charges; too much capex and not enough revenue spells trouble for operators.

2.8 Pervasive coverage and high reliability

Higher data rates have pushed mobile networks into higher frequency bands, reducing coverage area per site and weakening network economics. Consistent, reliable coverage is essential for digital services and future AI applications. In the AI era, users will expect to be connected pervasively and 'in the moment.'[11,12]

Ubiquitous wireless service is essential—not just for users, but for national productivity and resilience.

The release of 600 MHz spectrum, as a 'clean' new layer with national reach, would be a powerful enabler. Upgrading the 470–698 MHz band to primary mobile status under WRC-31 would support both digital inclusion and emergency connectivity.

2.9 A 3D network of networks

As outlined in previous work, a **network of networks (NON) architecture** supports wider coverage and cost efficiency by enabling interworking across multiple network technologies (see Figure 2-3). The NON concept itself is not new; it was considered with the development of 5G networks, and remains a core design objective for 6G.

The goal with 3D NON is seamless user connectivity across indoor, urban, rural, and remote environments by routing user services via cellular, WiFi, satellite, and potentially fixed-line infrastructure. It is poor engineering practice to design outdoor wireless networks to serve indoor users due to building attenuation; network economics suffer as a result. Rather than relying on a single system to do everything, **3D NON links fit-for-purpose technologies into one coherent system architecture**.

Operators support this approach, recognising that **MNOs cannot economically cover all areas—especially indoors, where WiFi can already provide service**. Seamless roaming and handover across different technology domains remain challenges, but are increasingly solvable with smarter architectures and software-based networks.

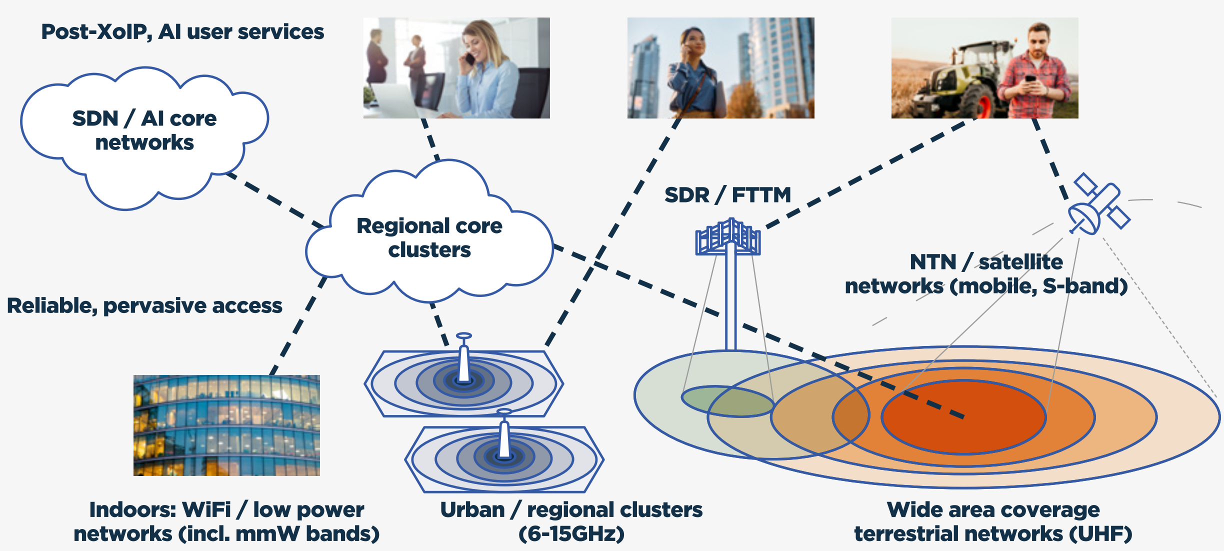


Figure 2-3 – The 3D network of networks (3D NON) concept.

> **The goal with NON is seamless user connectivity across indoor, urban, rural, and remote environments by coordinating cellular, WiFi, satellite, and potentially fixed-line infrastructure.**

Designing 3D NON will require careful coordination of access technologies and core networks. Direct connection of all access types into the cellular core may not be optimal. Separation of data and control planes would improve resilience and efficiency.[13]

Strong collaboration across industry and standards bodies will be essential. This could be accommodated with an outward-looking 3GPP. Given industry politics, there is no guarantee that this approach will prevail; success will require leadership, influence, and collaboration.

We do not see the development of new standards bodies as likely or useful. **A key risk with standards bodies (eg 3GPP, IEEE, ITU, NTN bodies) is that they can drift apart. A preferred outcome is that they develop increased levels of interworking and technology integration – supporting NON**.

[11] 5 Mbps is considered by some to be a high enough data rate to support media clips including video at high definition (HD) levels.

[12] See: https://spectrum.ieee.org/6g-bandwidth

[13] For example, with Control and User Plane Separation (CUPS) architectures.

2.10 Non-terrestrial networks and satellite-based systems

Interest in non-terrestrial networks (NTNs) has grown due to advances in satellite technologies—including heavy-lift launch vehicles, large-area satellites, and inter-satellite links (ISLs).

NTN is a key part of the 3D network of networks vision.[14] It can extend coverage in rural and remote areas where terrestrial networks are uneconomic, improving cost efficiency and service reach.

Seamless integration of NTN and terrestrial networks depends on further development of harmonised technical standards. We support ongoing NTN efforts in 3GPP, which began with Release 17.

A likely commercial model involves satellite providers wholesaling **direct-to-device (D2D)** services to terrestrial operators as add-on offerings, with network integration and interoperability as key design features of the 3D NON approach.

However, radio power link budget constraints remain a challenge for NTN. **Early NTN D2D services will support low bandwidth applications such as messaging, voice, and IoT**.[15]

2.11 AI-on-the-network

AI-based services are expected to become central to the digital economy, demanding reliable, always-on mobile access. We use the terms **AI-on-the-network** and **post-XoIP** services to distinguish these more demanding services from earlier Over-The-Top (OTT) services, which operated adequately over basic VoIP 'best-effort' networks. AI technologies are expected to support greater personalisation of digital services to users than is currently possible.

The economic value of AI services will not be reachable at full efficiency without pervasive and reliable mobile coverage.

> **"NTN is a key part of the 3D Network of Networks vision."**

2.12 Asset sharing

Future availability of clear mobile spectrum is much diminished which would lead to the need for radio cell densification to meet rising demand. However, densification cannot support pervasive coverage or sufficient capacity as capex levels would be unaffordable.

Therefore, **operators are likely to have to pivot towards shared infrastructure models in commercially unviable areas**.

Whilst we recognise the importance of radio spectrum sharing in the future of the wireless industry, we have not addressed this in any detail in this paper as it is not currently topical within the MNO industry.

Reliable indoor public mobile coverage inside non-domestic buildings poses significant challenges (where building owners may need to be asked to take on more responsibility). Joint venture models are likely to be appropriate in these cases.

[14] Inclusive of NTN-based data and voice communications, and positioning, navigation, and timing (PNT) services.

[15] IoT: Internet of Things: data communications for sensors and machine – machine links.

2.13 A common asset base serving public and private sector needs

Defence and security agencies are seeking to adapt commercial platforms for cost-effective, mission-critical use.

Features such as **reliable coverage and quantum-safe security could position 6G-enabled networks as a potential backbone for critical public systems –** such as a new civil defence or emergency services system. Security and resilience will be critical factors in these cases.

> **6G should allow real-time configuration, improving cost, performance, and flexibility.**

2.14 AI-in-the-network and intent-based networking

SDNs allow dynamic resource allocation.[16] AI can manage this better than fixed or deterministic methods. Network sensing technologies combined with AI-in-the-network will enable network intelligence and adaptation, supporting efficient operation.

Intent-based networking provides just enough bandwidth and quality for each service— eg low for a car parking application, and higher for a video call. Even more automated methods: autonomic and zero-touch networking (AN, ZTN) aim to make networks self-managing – with embedded intelligence so that nodes can automatically configure, secure, and optimise without human input. AN technology will be relevant at all levels of the networking system: with 3D NON, access, core, and service delivery platforms.

AI, sensing, and communications, combined with digital twins, will enable predictive optimisation and automatic configuration of radio networks.

AI-enhanced compression adjusts to content, user, and network conditions— outperforming traditional data compression methods. **6G should allow real-time network configuration, improving cost, performance, and flexibility**.

As AI-native networks mature, operators will need intelligent orchestration beyond simple traffic shaping. Embedding AI into the control plane enables real-time, intent-driven service delivery—ensuring that the right quality is provisioned only when needed. AI can be implemented via co-pilot and agentic AI architectures that interact with AI-in-the-network - to ensure conflict resolutions and coordinated decision making.

AI-in-the-network can support commercial innovation and cost efficiency. However, it should not become a cost burden for mobile operators, or a 'gate' on innovation.

2.15 Backwards compatibility and software-defined networking

Our 6G Vision embracing software-defined networks and radios (SDN/SDR), virtualisation, and cloud RAN will help manage radio spectrum fragmentation especially in mixed-technology environments.

SDN will further advance network slicing to support vertical-specific applications in sectors such as transport, health, and media.

SDN will enable backwards compatibility – a key feature required by operators.

[16] This dynamic allocation is often referred to as 'network slicing,' where common network resources can be used for different user services – according to adaptive configurations.

2.16 Efficient energy use to reduce operational costs

Energy costs are rising and must be factored into network design. Switching off non-essential functions during quiet periods is already well-advanced.

Intent-based and autonomic networking can further drive energy savings by allocating just enough resources for each service, cutting consumption without affecting quality.[17]

2.17 Global scale remains essential for supply chain efficiencies

Global scale involving the entire supply chain is vital for the mobile industry. It underpins affordable equipment and international roaming. Scale efficiencies can be improved through shared technology standards, aligned and tunable spectrum bands, plus collaborative R&D, unified certification, and regulation.

> **Key issues for the broadcast industry include pervasive wireless coverage and low jitter.**

2.18 Open networking and ORAN still developing

Open RAN was introduced to broaden supply chains after restrictions on high-risk vendors. However, open network standards are produced by the ORAN Alliance, not 3GPP. New technologies need scale to become viable.

Ofcom's Connected Nations UK Report (2024) finds mobile traffic carried over such architectures in the UK remaining limited at around 24,600 GB, a decrease from 78,600 GB reported in 2023.[18] Open networking remains under development and in its early days.

2.19 Supporting convergence in broadcast and media production

The media sector depends on wireless connectivity supporting content production and distribution (eg with bonded 5G channels – for efficiency and convenience). Low jitter, accurate timing and synchronisation, coverage, and reliability are key requirements in the broadcasting and media sectors.

6G must support low-latency and accurate timing, with use cases such as wireless cameras for programme making and special events (PMSE) (eg outside broadcasts), overcoming practical limitations encountered with previous technologies.

2.20 Advanced network timing and synchronisation

As networks converge and services evolve, precise timing becomes essential— for orchestration, security, and sensing. It is also critical for quantum-safe encryption and efficient real-time energy management.

R&D leadership supporting national solutions in advanced network timing and synchronisation will be important for 6G, and the national interest.

[17] *From a network design perspective, 'enough' means providing sufficient quality of service (QoS) (no more, no less), in the moment or session, to service customers' application needs.*

[18] *See: ofcom.org.uk/siteassets/resources/documents/research-and-data/multi- sector/infrastructure-research/connected-nations-2024/connected-nations-uk-report-2024.pdf*

3. Economic benefits

The defining characteristics of 6G will be pervasive coverage and reliable service availability.

Around 20% of UK mobile users experience unreliable connectivity during parts of the day—particularly when in transit (eg road, rail, rural areas, not spots, outdoors).[19] The absence of consistent device connectivity reduces users' ability to engage in the digital economy, and to undertake basic tasks such as emails and web/file access – which impacts working time and productivity levels.

By 2030, UK mobile operator revenue is projected to reach £15bn annually. If pervasive coverage from bringing together mobile- and satellite-based networks eliminates current service gaps, it could unlock an extra £3.5bn in revenue and around £2bn in direct GVA uplift.[20]

The UK digital economy could reach £200bn in GVA by 2030, with mobile access contributing around £90bn. If full mobile access is achieved across all users, this could rise by a further £10bn, creating a total uplift of around £23bn per year, or over £200bn over a decade (see Figure 3-1).

As a service-led economy, the UK will depend increasingly on pervasive mobile connectivity for digital trade, productivity, and competitiveness.

The path to this value is clear: users need reliable mobile access 'in the moment'— whether travelling, working remotely, or simply when 'out and about.'

By closing the persistent gaps in mobile coverage, especially in rural areas and travel corridors, mobile infrastructure can unlock higher productivity, economic activity, better digital service delivery, and broader user inclusion.

Pervasive connectivity is not only a user need; it is a national requirement – providing the means to unlock value and increase economic growth.

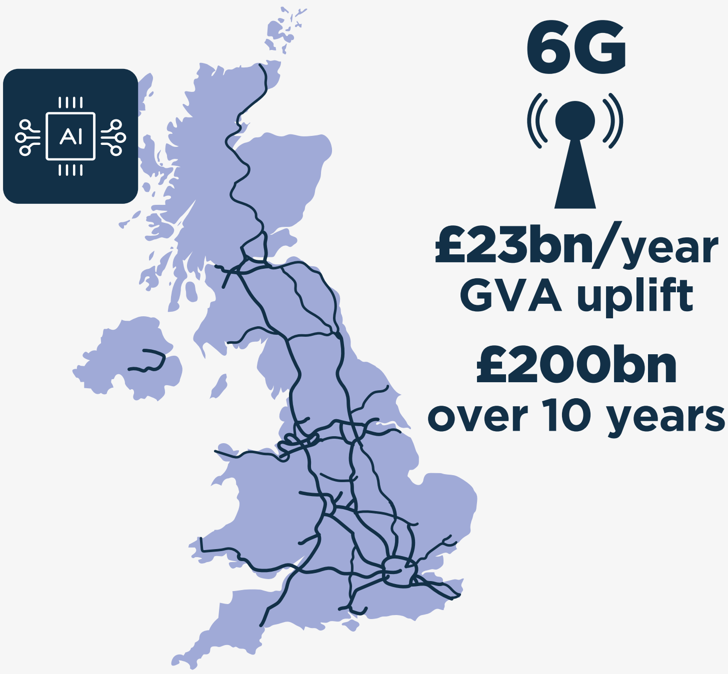


Figure 3-1 – Potential GVA uplifts with pervasive, reliable networks enabled by 6G.

[19] A 2023 survey of the London to Edinburgh mainline revealed that some passengers experienced no usable mobile internet connection for over 2 hours of the 4-hour 40-minute journey. Connectivity dropped regularly for every network, with coverage gaps up to 31 miles long. See: streetwave.co

[20] Assuming additional customer charges are applied to provide coverage in some areas, as is likely to be the case with mobile plus NTN services.

4. Delivering advanced connectivity technologies – a national perspective

4.1 Develop a national 6G framework

To secure a successful and economically viable wireless systems future, UK Government and Ofcom would need to **include 6G in their national digital connectivity framework – with effective policy and regulation**. This would add economic growth, resilience, enhanced defence and security, infrastructure viability, and international influence – while supporting industry and consumers with the development of innovative and valuable digital services.

An effective national policy for 6G could consist of coordinated and collaborative R&D, influencing key areas of global standards making and technology supply, together with an approach to strengthen implementation and operation of digital systems and infrastructure. This could include a strong focus on development of skills and execution in software development, systems integration, cyber security, operational excellence, and systems resilience.

There is an essential role for Government – to support industry in focusing – with national policy that supports economic and commercial growth, for the benefits of industry, consumers, and the national interests.

4.2 Publish a national 6G spectrum roadmap

If Ofcom could **identify and support suitable 6G pioneer bands by 2026** this would enhance greatly the efficiency of 6G research by avoiding the need to repeat work when deployment bands come to be finalised (see Figure 4-1).

600MHz, UHF, sub-1GHz band	• UHF band: supporting pervasive and reliable national coverage
MSS L & S bands	• NTN & mobile bands, supporting global rural / remote coverage
Legacy mobile bands (refarmed, and co-existing)	• Mobile bands, supporting coverage at the local level
Upper 6GHz (6.425-7.125GHz) band	• Mid-band: supporting capacity needs in local areas and indoors
7-15 GHz bands	• Candidate 6G bands: supporting global roaming / harmonisation

Figure 4-1 – Candidate radio spectrum bands for 6G services.

4.3 Support pervasive mobile coverage via public-private partnerships

UK industry broadly supports **public-private partnership (PPP) models to achieve widespread and inclusive mobile network coverage** (see Figure 4-2).

To this end, **Government and Ofcom will need to play a key role in supporting industry to define and deliver pervasive connectivity.**

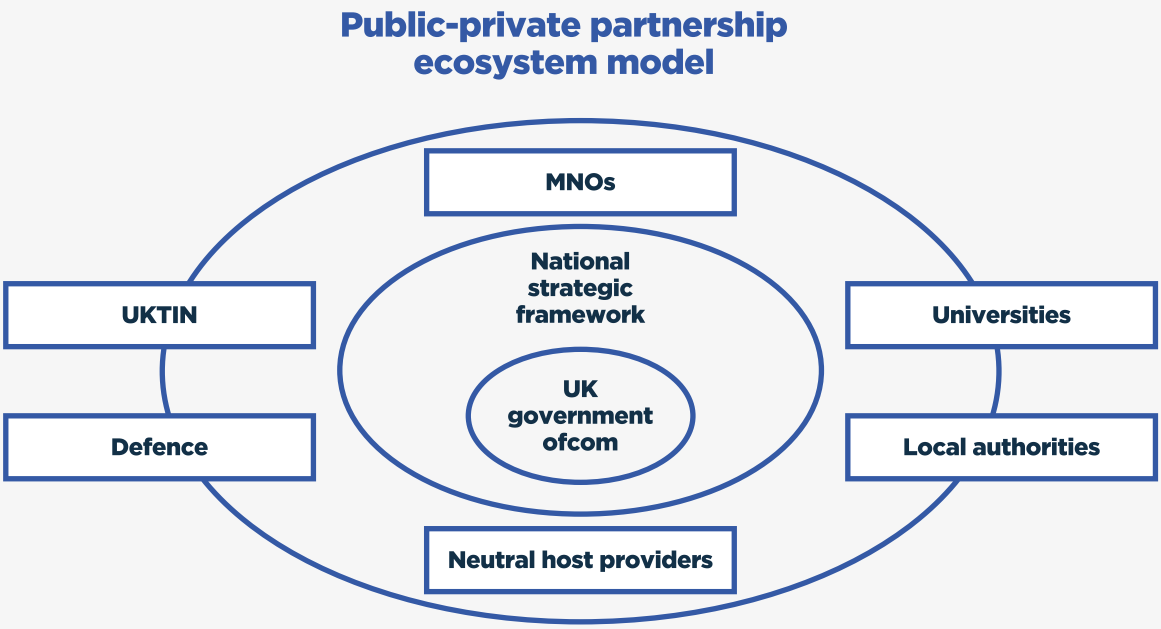


Figure 4-2 – Public-private partnership ecosystem model.

4.4 Modernise regulatory models to reflect service-driven value

With an extractive approach, the current regulatory framework struggles to deliver the levels of investment needed. Government should **embrace development of wireless and fixed telecoms networks as essential infrastructure** underpinning economic growth possible with new AI services and the wider digital economy. Ultimately, service-driven value must catch up with rising costs and new investment demands.

Key regulatory issues will include regulation supporting cost efficiency, asset sharing, and value pricing for operators.

4.5 Incentivise asset sharing

To overcome cost and coverage challenges, UK policy and regulation must increasingly create positive incentives for **industry-wide infrastructure sharing, and neutral host models**.

This activity should be supported by reforms to planning laws and wayleave processes to accelerate deployment—such as granting rights to attach wireless network antennas to public sector buildings—and by public procurement frameworks (eg with public sector procurement at scale).

5. Supporting rationale: key drivers and priorities

5.1 A new geopolitical order

Geopolitical tensions are very evident in the modern world. There is no doubt that digital technology and services are becoming increasingly important in daily life, business, government and public services, and national economies.

It is also clear that many nations, groups, and individuals see digital leadership as an axis for economic growth and geopolitical positioning. **Technology and networks therefore, are, by necessity, critical national infrastructure (CNI).**[21]

5.2 Learning from the past

Success in mobile generations has relied on more than technology—it required **strategic alignment across regulation, policy, and industry**. GSM's 1987 MoU enabled 2G's dominance through standardisation and harmonised spectrum. 3GPP's formation in 1998 boosted global coordination. 4G delivered the mobile internet, powering apps, streaming, and digital payments. In contrast, **5G progress has stalled, with many networks still running on 4G cores and operators hesitant to invest further without clear returns**.

Key 'trigger events' like the GSM MoU or spectrum auctions drove momentum in past generations. These aligned stakeholders, unlocked investment, and accelerated deployment. Without such catalysts, progress slows, and impact weakens.

For 6G, trigger mechanisms remain critical—but must evolve. Success will depend on effective national influence, coordinated strategies, long-term public-private commitments, and flexible delivery programmes matched to demand.

> **"For 6G, trigger mechanisms remain critical—but must evolve."**

5.3 Growth via connected AI technology

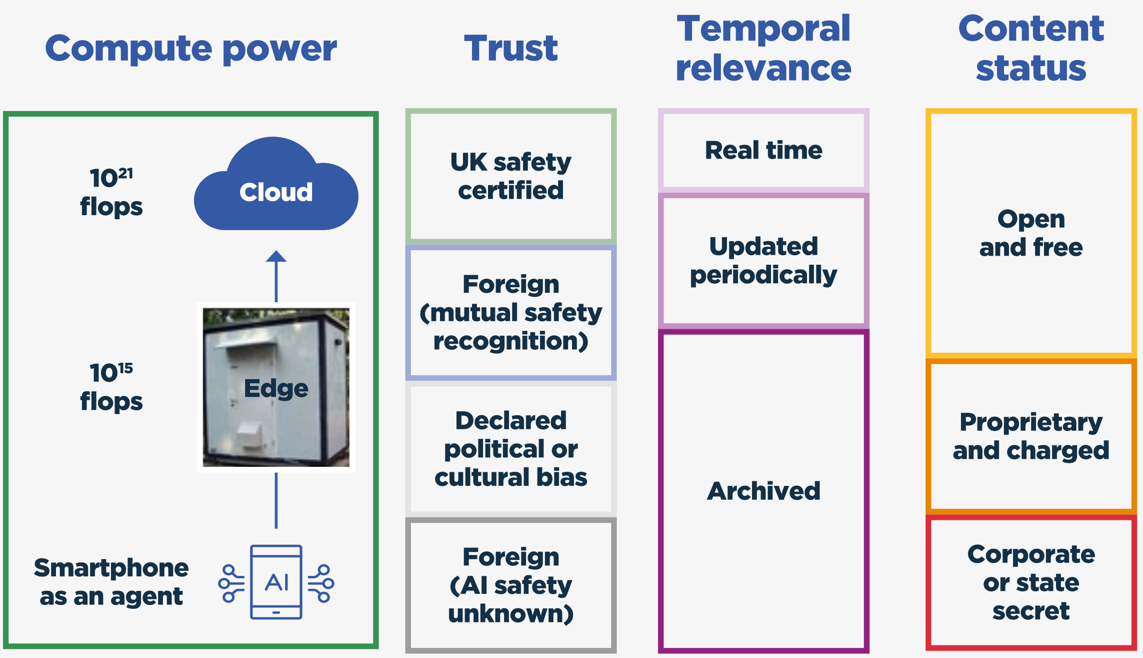
AI technology has risen rapidly to prominence over recent years, driven by advances in computing, massive data, and algorithms, and **AI services (AI-on-the-network) are expected to become a major element of the digital economy**. Figure 5-1 shows an assessment of how market segmentation in AI may develop.

The UK's AI future will only be as strong as its mobile networks – with delivery of pervasive coverage, congestion-free capacity in the instant of use, low latency / jitter, and stable hand-overs. With effective action, the UK can attain leadership in mobile network operations – supporting innovative AI services enabling economic growth, societal wellbeing, and public safety.

Essentially, AI services are expected to develop as a combination of segments, some supported by national computing in the cloud, others at the personal or local level (eg with new AI co-processors in smartphones and laptops).

AI-in-the-network – with AI technology used to control and allocate network resources – is also expected to be a major differentiator with 6G networks. With this in place, supported by software-defined networks, network efficiency and flexibility levels can be transformed. For AI-in-the-network, AI models dedicated for the telecoms industry will need to be developed.

[21] *Defined in the UK under The Telecommunications (Security) Act 2021, supported by the NPSA and NCSC agencies.*



Complexity of market segmentation of AI services and applications will see the smartphone emerge as our AI agent, navigating the transactions needed for the job in hand

Figure 5-1 – Potential segmentation of AI services.

5.4 Too much capex, not enough revenue

Since 2G, mobile operators' capex-to-sales ratios have generally increased, and **5G has proven too costly with limited upside revenue**. Enough is enough and the industry now faces a structural problem: network upgrades tied to each new generation demand heavy investment, but returns are not keeping pace.

Two core issues drive this. First, generational cycles repeat roughly every decade, driven more by industry habit than clear demand. Despite slower traffic growth, operators still feel pressure to invest to meet user expectations and stay competitive. Second, ARPU has declined over the past decade due to market saturation and competition from XoIP services.[22,23] With little room for subscriber growth and low user willingness to pay for higher data rates, revenues stay flat while costs rise.

The result: **the mobile networks business model is under pressure, and the established capex-driven generational playbook no longer works**.

[22] *See: ofcom.org.uk/phones-and-broadband/service-quality/communications-market-2024*

[23] *For example, with voice calling and messaging over apps such as WhatsApp, cellular operators are completely bypassed on revenues, though to add insult to injury, they may support traffic for these services.*

5.5 Pragmatism over routine

The NGMN Alliance's 2021[24], 2023[25], and 2025[26] white papers advocated an incremental 6G built on 5G, avoiding the disruptive 'big bang' model. Our analysis in Section 3 supports this.

The NGMN Alliance vision also calls for backward compatibility, improved coverage and security, open supply chains, AI integration, and a network of networks model. Key spectrum priorities include sub-6 GHz and 6–15 GHz bands, with emphasis on sustained global scale and real operator value.

The Wireless Broadband Alliance (WBA) echoes similar themes: seamless connectivity, cost-efficiency, global standards, and AI to boost network performance.[27]

[24] *See: ngmn.org/wp-content/uploads/NGMN-6G-Drivers-and-Vision-V1.0_final_New.pdf*

[25] *See: ngmn.org/wp-content/uploads/NGMN-6G-Drivers-and-Vision-V1.0_final_New.pdf*

[26] *See: ngmn.org/wp- content/uploads/250218_Network_Architecture_Evolution_towards_6G_V1.0.pdf*

[27] *See: wballiancec.wpenginepowered.com/wp-content/uploads/2025/01/WBA-6G-Vision- Statement_Final5.pdf*

5.6 Mitigating disruption in established standards bodies

Global 6G discussions reveal a split: some countries, backed by stronger MNO investment or state support, aim for revolutionary data speed upgrades.

Others, constrained by their regulatory framework, limited capital, and mature markets, prioritise broader, evolutionary improvements in coverage and quality.

The fragile state of global standards-making, under intense geopolitical rivalry, makes it essential for the mobile community to accommodate diverse market needs. Figure 5-2 shows potential development paths for 6G.

If the UK is to access 6G supply chains that are relevant to national interests, it needs a clear and forward-looking 6G proposition of its own. This will allow it to align with partners who support an evolutionary approach, while still accommodating those pursuing a more revolutionary path.

Government should support industry participation in technical standards development through UKRI, DSIT, and trade engagement, with strategic funding directed toward key priority areas. Industry has the knowledge and expertise to contribute on technical details in the standards process – which is complex and requires deep expertise. Government has a role to coordinate and support industry contributions to standards in the national interest.

Priority areas are where global standards have significant economic or sovereign impact— alongside AI-native networking, 3D NON interworking, spectrum innovation, and advanced network security and resilience technologies.

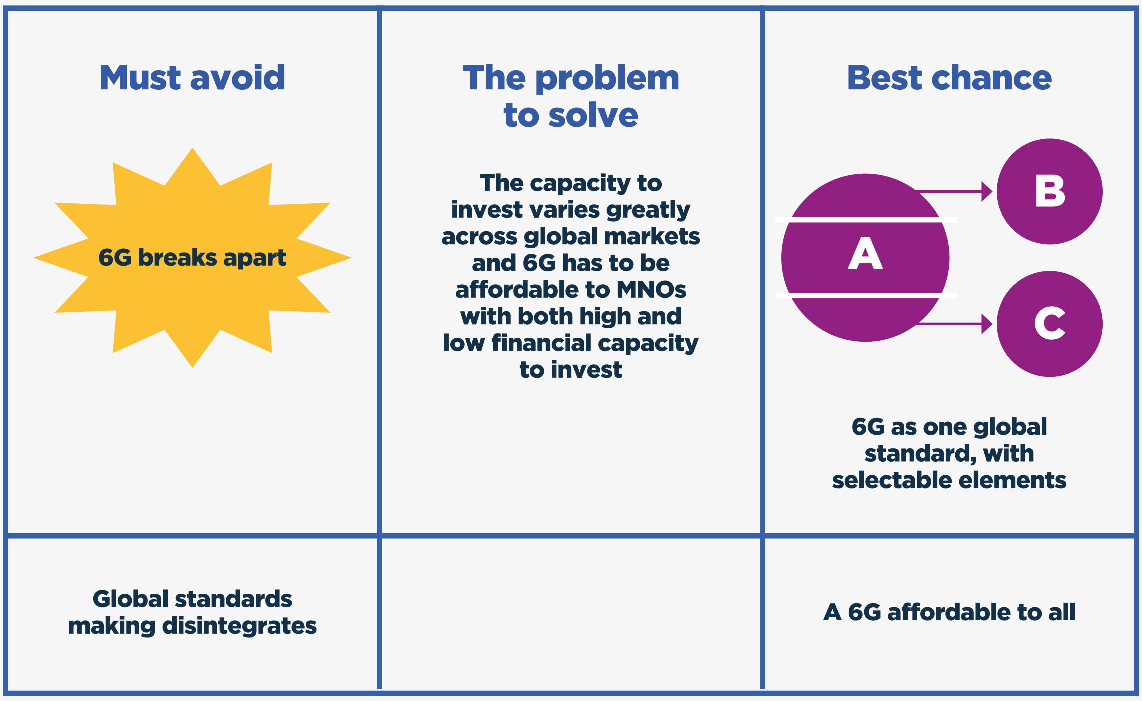


Figure 5-2 – Combined evolutionary and revolutionary approaches for 6G.

6. Collaborative R&D: a catalyst for success

“The UK is in a strong position to leverage expertise to realise economic growth from AI and digital services.”

6.1 A focus on R&D leadership, selective innovation, systems delivery

The UK is in a strong position to leverage expertise to realise economic growth from AI and digital services. **The R&D leadership needed to shape this will generate IP along the way to fuel new UK spin-off enterprises**.

The pillars of **National Resilience, Global Influence, and Economic Growth remain key, along with bridging R&D and commercialisation through access to capital and scale**.[28]

UKTIN was created to drive this mission by uniting industry, government, and academia. Its success depends on staying focused and aligned with these core principles.[29]

6.2 R&D: a key enabler for success

Strategic investment in university-led research, backed by agile funding, national testbeds, and industry-academic secondments, is essential to maintain UK influence and commercial impact.[30]

The resulting R&D excellence drives digital leadership, attracting investment, building skills, and linking research to the market through venture capital and global supply chain influence—advancing the UK’s national interests.

6.3 A collective view for action

This paper sets out to **enable national excellence in next generation mobile networks, via MNO and industry alignment – with a working assumption of a common 6G Vision that is firmly based upon key research priorities and commercial needs**.

That **collective strategic focus** helps the 6GIC and others to better focus research and development. It strengthens the UK’s ability to shape global standards, spectrum policy, and supply chain alignment.

6.4 Seizing the opportunity: a call for strategic UK leadership in advanced connectivity technologies

The paper provides a 6G reset Vision, to inform Government and Ofcom on key enablers and the scale of economic benefits feasible.

It could help UK industry and the public sector to lead in a services-driven, digitally-traded global economy—**unlocking an estimated £23bn in annual GDP uplift**, whilst also attracting sustained investment.

Decisions made now will define future outcomes. Delay by Government and Ofcom risks ceding ground to others and locking in frameworks misaligned with UK sovereign interests.

[28] *See: assets.publishing.service.gov.uk/media/6405955ed3bf7f25f5948f99/uk-science-technology- framework.pdf*

[29] *See: uktin.net/sites/default/files/2023-06/UKTIN%20publication%20Issue%20001-min.pdf*

[30] *One of the key learning points from the UK’s 5G Test Beds and Trials Programme was that industry wanted fewer, bigger technology projects – essential in international showcasing, and impressing global leverage.*

> **"The R&D leadership needed to shape this will generate IP along the way to fuel new UK spin-off enterprises."**

> **This 6G Vision, published by the University of Surrey 6G Innovation Centre (6GIC), is unlike any other.**

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