Telecoms Supply Chain Diversification Advisory Council

Independent report and recommendations to government

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Chair's Foreword

Dear Minister Bryant,

Congratulations on your appointment as Minister of State at the Department for Science, Innovation and Technology and the Department for Culture, Media and Sport. The Department for Science, Innovation and Technology (DSIT) has an important role to play in cohering government policy across digital technologies and I welcome the fact the new government is committed to DSIT's role as an important economic department.

In January, your predecessor, Julia Lopez, asked the Telecoms Supply Chain Diversification Council to review updated evidence on market concentration risks in telecoms supply chains and produce new recommendations for government. While the Council's report was commissioned by the previous government, our findings and recommendations are non-partisan and relevant to any administration, regardless of political composition.

Over the three years since the 5G Supply Chain Diversification Strategy and Telecoms Diversification Taskforce report were published, the geopolitical and commercial context has changed, and new technologies are rapidly developing. The connectivity delivered by telecoms networks underpins nearly all aspects of the economy and is vital in delivering each of the new government's five missions, making it more important than ever that our networks are resilient and secure. At the same time, the cyber threat to the UK telecoms sector remains severe. Reliance on a small number of equipment vendors makes UK networks more vulnerable to supply chain disruption and cyber-attack, and increases the impact should they occur. It is essential that the government and industry manage these risks, while remaining flexible to changing circumstances.

We have not revisited the previous Taskforce Report, but instead look to the future. This report focuses on what needs to be done to address risks arising from both market concentration and operators making similar deployment choices. In formulating recommendations, we have considered the cumulative impact of government policy and legislation, including the Telecommunications (Security) Act 2021, which creates a high regulatory burden for operators but is important to improving the security of the UK's telecoms networks.

We have also been pragmatic about the commercial factors that will affect the timescales, feasibility, and cost of interventions, such as lengthy and complex procurement cycles for network equipment – decisions about which are often made internationally at a group level. Operators have a duty to provide best value to their shareholders and best service to their customers. They need to be able to take the most appropriate commercial decisions for their businesses and government should generally not mandate what equipment firms use in their networks unless there are pressing security concerns. We must also recognise that while introducing new vendors can improve security and resilience of the UK's networks overall, and promote innovation and price competition, it can add complexity and cost for firms and pose its own security and operational challenges. The government can help operators in the UK navigate this landscape – providing 'commercial diplomacy' to support the entrance of new

vendors to the UK market. This will require working closely with operators and vendors to understand their requirements and any possible barriers to new entrants, and leveraging the diplomatic and regulatory tools uniquely available to government.

There has been substantial progress since the publication of the Taskforce Report. Open RAN is moving to the mainstream, with Nokia and Ericsson committing to deliver O-RAN Alliance compatible products. The government, through measures such as its £250 million investment in Open RAN innovation, its Open RAN principles, and its agreement to sunset 2G and 3G networks by 2033, has delivered clear signals to the market about the importance of supply diversification. However, it is essential that diversification is not treated as an isolated issue - equipment diversity should be considered in all government telecoms objectives, including roll-out and adoption, to ensure the continued security and resilience of UK networks.

By supporting the development of UK capability in telecoms, the government can build the UK's role in the global market and its influence in shaping new technologies. However, the small size of the UK market means it is essential that the government also works with international partners and promotes standardisation. This will create the stable and common conditions needed to encourage more vendors to enter the UK market and achieve lasting change in the global telecoms market. We welcome the leadership role the UK is playing internationally on telecoms diversification including through groupings such as the Global Coalition on Telecoms (GCOT).

Beyond the Radio Access Network (RAN), the Council has reviewed new and emerging concentration risks in other areas of the network, such as the mobile core, operational and business support systems, and telecoms use of cloud services. We make several recommendations that the government should consider to manage the risks identified and get ahead of new threats before they take hold. We have particular concerns about the prominent role of only one vendor, Ericsson, in the mobile core given the criticality of this part of the network. However, it is essential the government takes a proportionate approach to managing any risk.

Addressing risks posed by dependence on a small number of equipment vendors in UK networks is a long-term task and not easy. It requires a careful balance between encouraging new market entrants, valuing Nokia and Ericsson (the incumbent 5G RAN vendors) – which will continue to play an important role in the market – and ensuring openness and interoperability to support diversity in the long term. There is no perfect answer, but – if implemented – the range of recommendations set out in the report should go a long way to improving the security and resilience of UK networks.

I am grateful to all members of the Council for their hard work and expertise in producing this report. I would also like to extend my thanks to representatives from the National Cyber Security Centre and Ofcom for their advice, and officials at DSIT for their support to the Council in delivering this report to short timescales.

Ros Singleton, Chair

Drafting note

The Council produced this report prior to the 2024 general election and the report provides recommendations that apply irrespective of the political composition of the government. References to government activity in the past tense relate to actions taken by the previous administration unless otherwise stated. The report was presented to the Department for Science, Innovation and Technology Minister of State office on 12 September 2024.

Executive Summary

Telecoms networks enable the connectivity that underpins the UK economy and drives new and emerging technologies such as Artificial Intelligence (AI). Telecoms underpins fundamental services in our society, including the Emergency Services Network, and has the potential to transform our public services. It is therefore more important than ever that the UK's networks are built on secure and resilient supply chains.

As set out in the Telecoms Supply Chain Review (2019), dependence on a small number of equipment vendors creates security and resilience risks – leaving our networks more vulnerable to disruption and amplifying the impact, should it occur. The previous government – guided by advice from the Telecoms Supply Chain Diversification Advisory Council – had been taking steps to support a more diverse telecoms equipment market and increase the range of vendors deployed in UK networks. Progress has been made, especially in promoting the development of Open RAN – with the added benefit of stimulating the UK's telecoms ecosystem – and building consensus on the need for action among international partners.

However, rising geopolitical tensions, combined with difficult commercial conditions, rapid technological change, and an evolving policy and standards environment, mean it is important to take stock of the current market concentration picture and the attendant security and resilience risks. This is necessary to ensure that government and industry can effectively mitigate the threats that exist and prevent new dependencies emerging in future. The global standards for the next generation of communications technologies are being set now. This means it is imperative that government and industry increase their influence in standards bodies to ensure these technologies develop in a way that delivers interoperability, security and resilience.

Despite action to date, UK networks are still overly dependent on equipment from a small number of suppliers, especially in the Radio Access Network (RAN) and mobile core. The market will not address or mitigate the risks stemming from this reliance on its own, so further government action is needed across different parts of the network:

- **In the Radio Access Network:** The government should take short-term action to mitigate worsening dependency risks caused by market concentration and operator

deployment decisions – including security testing through the UK Telecoms Lab. It should also continue to promote greater diversity in the medium to long term through using commercial diplomacy to create the conditions to support entry of one or more additional scale vendors and promoting development and use of (standardised) open and interoperable systems, including helping operators overcome the commercial barriers to deployment of Open RAN. It is essential the government considers whether any future interventions to support telecoms roll-out and adoption can also support the introduction of new vendors to the RAN. (Paragraphs 42-49).

- **In other parts of the network:** In the immediate term, the government should deepen its understanding of current and emerging dependency risks beyond the RAN – especially in the mobile core – and consider what mitigations may be required to address the security and resilience consequences of the concentration that exists. In the medium to long term, the government should work with operators to encourage greater diversity of supply in future procurement rounds; promote openness and interoperability in future generations of technology; and forecast the likely impact of technological and market changes – including the growing role of big tech firms in telecoms – on market diversity and deployment choices. (Paragraph 56).

- **In subcomponent supply chains:** The government should ensure telecoms-specific risks are fed into cross-government activity to strengthen supply chains – including in the supply of semiconductors. It should also work with operators to stress test plans to manage disruption to supply of subcomponents and how firms can have the visibility of disruptive events needed to activate contingency plans. The government should also consider how building UK capability in future communications technologies could help address dependency risks in the long term. (Paragraph 64).

Increasing the diversity of vendors in UK networks relies on getting the enabling conditions right. To do this, the government must:

- **Continue to work with international partners – including through the Global Coalition on Telecoms – to promote diversification and send a clear signal to the market.** This should include identifying opportunities to build on existing agreements to support joint R&D projects and join up between labs. (Paragraph 71).

- **Strengthen the UK's ability to participate in and influence the standards development process, so it can play a greater role in shaping the development of future generations of technologies in a way that will support a more diverse supply chain.** This should include better coordinating activity on standards within government and with industry; horizon scanning for emerging risks in how standards are developing; acting early to influence standards setting; supporting industry to play a greater role in the standards process; and building greater in-house capability in government. (Paragraph 80).

- **Take action to address the skills gap and recruitment challenges in the telecoms sector**, especially in areas needed to promote diversification like systems integration, software, and systems engineering. (Paragraph 86).

Introduction

1. The Telecoms Supply Chain Diversification Advisory Council ('the Council') was established nearly three years ago to advise government on telecoms diversification policy, building on the recommendations of the Telecoms Diversification Taskforce ('the Taskforce') and the 5G Supply Chain Diversification Strategy ('the Strategy').

2. As set out in the Telecoms Supply Chain Review ('the Review') and the Strategy, concentrated supply of telecoms equipment makes UK networks less resilient. The Review identified that concentration in the UK's 5G Radio Access Network (RAN) posed an 'intolerable resilience risk'.[1] Concentrated supply can create 'single points of failure' across the supply chain that leave networks vulnerable to disruption from multiple causes, including interruption to supply chains. Improving diversity of supply is one way to improve resilience, as set out in the Department for Business and Trade's Supply Chain Resilience Framework.[2]

3. Lack of diversity in supply can also pose security risks, by creating national dependence on a small number of firms. This can make it easier for adversaries to target UK networks by providing a narrower attack surface and increase the impacts of cyber-attacks, if they occur. The recent CrowdStrike incident highlights the disruption that can be caused by over-reliance on a single vendor. On 19 July, 8.5 million systems crashed globally following a faulty update to CrowdStrike security software,[3] costing the UK economy around £2 billion according to one estimate.[4]

4. It is important to look at these risks at a whole UK network level. This is because individual operators will design and procure their networks to take account of their specific commercial needs (as well as to comply with their legal obligations). However, the aggregate impact of individually sensible decisions by operators could be a national dependency on one or a small number of vendors. Vendor 'lock-in', whereby commercial factors or vendor behaviour can tie operators to a specific vendor and make it difficult to change, can worsen risks posed by reliance on a small number of vendors.

5. It is important to distinguish between *market concentration* – whereby there are few viable vendors in the market for operators to choose from, as was identified to be the case in the UK 5G RAN market in the Review – and *deployment concentration* –

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[1] 5G Supply Chain Diversification Strategy, 2021, https://www.gov.uk/government/publications/5g-supply-chain-diversification-strategy/5g-supply-chain-diversification-strategy

[2] Department for Business and Trade Supply Chain Resilience Framework, 2022, https://www.gov.uk/government/publications/supply-chain-resilience/dit-supply-chains-resilience-framework

[3] Helping our customers through the CrowdStrike outag, Microsoft, 20 July 2024, https://blogs.microsoft.com/blog/2024/07/20/helping-our-customers-through-the-crowdstrike-outage/

[4] The UK cost of the CrowdStrike incident, Korvv, August 2024, https://www.kovrr.com/reports/the-uk-cost-of-the-crowdstrike-incident

whereby operators are deploying the same vendors, despite there being a range of other choices.[5] Both forms of concentration can have security and resilience implications, but different mitigations may be required. Vendor market shares also often differ between global regions, meaning there can be a difference in concentration in the UK market and other markets.[6] International standards play a key role in shaping the global telecoms market. A common set of requirements can make it easier for new firms to enter the market, but the strong influence of a small number of companies in standards development and ownership of standard essential patents can also risk cementing market consolidation.

6. The Council welcomes the steps the government, working closely with industry, has taken since the original Taskforce report to promote greater supply diversity of equipment in UK networks. Progress has been made against all four pillars of the Taskforce report, in strengthening the UK's influence in telecoms standards, creating the right regulatory and policy environment to encourage diversification, accelerating the development of multi-vendor Open RAN and supporting the development of UK capability in telecoms. The UK has played an important role in building a global coalition of countries to promote telecoms diversification. The government has also continued to work closely with Nokia and Ericsson – the incumbent 5G RAN vendors – which play an important role in supplying UK networks, developing new technologies and contributing to the UK telecoms ecosystem.

7. However, the risks that drove the Strategy are still present in our networks. The supply of 5G RAN equipment remains concentrated and changes in the market, technology and geopolitics also mean that new threats are emerging or may do so in future. Addressing the resilience and security risks posed by market concentration was always going to be a long-term task, and the Council sees potential for the UK 5G RAN market and vendor deployments in UK networks to become more diverse towards the end of the decade. In the interim, it is important that government – working with industry – takes action to mitigate the immediate security and resilience consequences of concentration in the RAN and continues to encourage more vendors to sustainably enter the market, including through support for the acceleration of Open RAN.

8. While government efforts have rightly focused on diversification in the RAN market, the Council is also concerned about concentration risks in other parts of the network, especially the mobile core. The UK continues to have comparatively weak influence in telecoms standards relative to leading players such as the US, China and the EU, and needs to continue to strengthen its position at both policy and technical levels.

9. Since the Council was formed, the geopolitical, commercial and technological context has changed too. Growing geopolitical tensions have been a catalyst for greater focus

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[5] Telecoms Supply Chain Review, 2018, https://www.gov.uk/government/publications/telecoms-supply-chain-review-terms-of-reference

[6] Market forces create technology ecosystem diversity in network markets, 1H24 Update, Omdia, 2024, https://omdia.tech.informa.com/-/media/tech/omdia/marketing/commissioned-research/pdfs/market-forces-create-technology-ecosystem-diversity-in-network-markets-1h24-updatev3.pdf?rev=0a065dfe0c9149b498df90aca89ddd99

in government and industry on supply chain resilience and security. At the same time, operators face difficult operating conditions. These are driven by a mix of challenging economic factors, difficulty in monetising 5G and competing pressures on their resources – including the costs associated with meeting their legal obligations to remove Huawei equipment and broader obligations under the new telecoms security framework. Challenging economic factors are impacting the wider telecoms sector, including the financial performance of Nokia and Ericsson. Rapid advancements in technology are also affecting the telecoms equipment market, potentially risking new forms of market concentration and dependence, while also offering alternative ways to promote diversity of supply and make networks more resilient and secure.

10. Taken together, the Council recognises why now is an appropriate time to review the latest evidence and provide a revised set of recommendations to government to guide its next phase of work on telecoms diversification.

11. To produce these recommendations, the Council has reviewed updated evidence on the telecoms equipment market, produced by DSIT and the National Cyber Security Centre (NCSC) and informed by industry engagement. The Council ran a series of workshops to discuss the progress made since the Taskforce report and to identify new recommendations. The Council was supported in producing these recommendations by a secretariat from DSIT. This report and the recommendations made reflect the collective views of all members.

Report structure

Chapter One sets out key market, technological, policy and standards trends that could impact efforts to promote a more diverse telecoms equipment market.

Chapter Two considers market concentration risks in three different parts of the telecoms equipment supply chain:

- **The Radio Access Network (RAN)**, where the need for intervention was greatest given the risks identified in the Telecoms Supply Chain Review (2019) and where most government activity to date has been focused.

- **Other parts of the telecoms network**, where the supply market appears concentrated and may require a policy response.

- **Subcomponent supply chains**, where risks of concentration may arise despite diversity at the level of finished equipment, but may be more difficult to uncover and mitigate.

For all three areas, the current market concentration picture is described, followed by recommendations.

Chapter Three considers cross-cutting themes important to diversifying the supply chain: international engagement, standards and skills. For all three areas, progress to date is described, followed by recommendations.

The Conclusion summarises the recommendations and outlines the need for ongoing independent advice to government on telecoms diversification policy.

Chapter One: Commercial, technology, policy and standards context

12. Telecoms diversification policy does not exist in a vacuum. In the years since the original Taskforce report, the global and domestic telecoms sectors have changed and face challenging commercial conditions. In promoting more diverse supply chains, government and industry will need to take account of evolutions in technology that could risk new dependencies or provide new solutions. As noted in the introduction, UK equipment deployments may not follow wider trends in the global market and exhibit greater or less diversity than other markets or networks.

13. Achieving greater diversity relies on UK operators making the significant commercial and financial decision to introduce new vendors. These procurement decisions are driven by a range of factors, including equipment performance, commercial considerations, and compliance with regulatory obligations, including those established by the telecoms security framework and the designated vendor direction that requires removal of Huawei 5G equipment.[7] These factors can create a 'technical debt' whereby operators may adopt network solutions that are easier to deploy in the short-term, at the expense of solutions that could take more time or have higher upfront costs but offer additional longer-term security, resilience or innovation benefits.

14. Technological changes in the network may provide new solutions to security and resilience risks associated with market concentration but could also introduce new dependencies into the network. Telecoms diversification policy sits alongside – and should complement – other areas of government policy, including the 5G coverage ambition set out in the government's Wireless Infrastructure Strategy, growing UK capability in telecoms and wider activity to ensure the security and resilience of UK networks.[8] This chapter explains the commercial, technological and policy contexts affecting the telecoms sector today and which have shaped the recommendations made in Chapters Two and Three.

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[7] The Telecommunications (Security) Act 2021 amended the Communications Act 2003 and placed new duties on public communications providers to manage security risks, including in their supply chains. It established a cyber security framework for telecoms, through the Electronic Communications (Security Measures) Regulations 2022 and accompanying Telecoms Security Code of Practice, which set out the steps needed for providers to meet these regulations. In October 2022, the government issued a designation notice to Huawei and designated vendor direction to 35 telecoms providers under the Act. This direction gives twelve specific conditions on telecom providers' use of Huawei, and UK communications providers are now working towards the complete removal of Huawei from the UK's 5G networks by the end of 2027.

[8] Wireless Infrastructure Strategy, 2023, https://www.gov.uk/government/publications/uk-wireless-infrastructure-strategy/uk-wireless-infrastructure-strategy

Commercial conditions

15. All four UK mobile operators support the need to promote a more diverse telecoms supply chain and recognise that greater vendor diversity can help improve the security and resilience of their networks while promoting competition and innovation. However, integrating new vendors – including through Open RAN – can be difficult, especially in a challenging commercial environment. Operators may face more complex procurement, account management and systems integration, which could add cost and act as an upfront barrier to diversification. They also rightly set a high bar for the performance and reliability of equipment deployed in their networks and must be confident that their equipment allows them to comply with their security obligations under the Telecommunications (Security) Act 2021.

16. Mobile revenues have declined in real terms since 2018 and, before that, had been flat since 2010.[9] Ofcom analysis shows that UK mobile operators make low returns on investment with only two of the four UK MNOs making a (declining) return above Ofcom's estimated cost of capital. These lower returns are driven by several factors, including:

    a. **Continually increasing demand for data** (requiring ongoing investment to maintain and upgrade networks). Ofcom reports that between 2015 and 2020, the amount of mobile data people used increased by 369%.[10]

    b. **Operators struggling to charge a premium for 5G services**. Ofcom analysis shows that average monthly prices for standalone mobile services have fallen in real and nominal terms for nearly all groups of phone plans. There is limited understanding among consumers and enterprises of the benefits 5G services can provide and data from 2021-22 suggests 30% of consumers were not willing to pay extra for 5G.[11] Many of the promised 5G use cases have not yet materialised or been commercialised. This is despite 5G rollout costing operators an estimated £1 billion over 2019-2022.[12] Deployment of standalone 5G (including the use of a 5G core, required to unlock 5G's full potential) will require significant capital investment into operators' infrastructure.

    c. **Rising costs due to inflationary pressures**. In particular, energy and commodity prices have increased substantially in the period since the original

[9] Future of the UK Mobile and Wider Communications Value Chain, Deloitte, 2022, https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/financial-advisory/deloitte-uk-future-of-the-uk-mobile-value-chain-feb-2022.pdf

[10] Ofcom's future approach to mobile markets: A discussion paper, Ofcom, 2022, https://www.ofcom.org.uk/__data/assets/pdf_file/0027/231876/mobile-strategy-discussion.pdf

[11] Participation Survey 2021-22 annual report, 2022, https://www.gov.uk/government/statistics/participation-survey-2021-22-annual-report Participation Survey 2021-22 annual report, Department for Digital, Culture, Media & Sport, 2022, https://www.gov.uk/government/statistics/participation-survey-2021-22-annual-report

[12] Connected nations: UK Report 2023, Ofcom, 2023, http://www.ofcom.org.uk/__data/assets/pdf_file/0022/273721/connected-nations-2023-uk.pdf

Telecoms Supply Chain Review, which has increased the cost of deploying new infrastructure.

17. It is worth noting that these challenges are not unique to the UK and operators globally face competitive pressures and mature consumer markets. Despite difficulties, there are also strengths in the UK telecoms ecosystem. The Government Office for Science's Future Communications Science Power Index ranks the UK 3rd globally for volume and 15th for impact of Future Telecoms Research. The UK also has the second highest number of telecoms start-ups globally that could help provide intellectual property rights (IPR) needed to influence future standards.[13] At the same time, many of the technological changes discussed in the following section play into existing areas of UK strength in R&D, including AI and satellite communications.

Technology trends

18. This section sets out some of the technological trends that the Council assesses will have the biggest impact on future concentration within the telecoms equipment market. Not discussed in this section are the developments in Open RAN since the last Taskforce report, considered in detail in Chapter Two below.

   a. **The development of network of networks solutions:** For economic, efficiency and resilience reasons, future connectivity is likely to be provided by a 'network of networks' comprising fixed (fibre and Wi-Fi), mobile and satellite communications, offering ubiquitous connectivity. The integration of non-terrestrial networks (NTN) is likely to be a native feature of 6G. This trend could increase overall network resilience and increase the number of companies involved in enabling connectivity. However, making networks of networks function effectively will depend on network management and orchestration functions, the market for which could become concentrated, and concentration within a particular market could still present resilience/security risks depending on the exact network deployment. Convergence onto single protocols (e.g. Internet Protocol, 'IP') – as is occurring through the switch off of the Public Switched Telephone Network (PSTN) – can also introduce resilience risks through formation of a single point of failure and the creation of new interdependencies, for example, as seen in outages relating to the Border Gateway Protocol (BGP).

   b. **The role of the hyperscalers (or 'big tech') in telecoms:** Hyperscalers (typically defined as AWS, Google and Microsoft) are playing an increasing role in telecoms networks, primarily through the provision of cloud and platform services. These firms are moving to provide functionality in every part of the network, including the core network, Operations Support Systems (OSS) and Business Support Systems (BSS), and already have a dominant position in the provision of enterprise (day-to-day business use) functions. They could also

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[13] Top 100 Telecom Startups to Watch, Dealroom, 2022, https://app.dealroom.co/lists/33345

move into providing consumer-facing services currently provided by operators. The entrance of these firms could promote competition among vendors and increase choice for operators. Increased cloudification could also reduce operational costs for operators. However, there is a risk that the growing role of hyperscalers could drive new concentrations in parts of the market as well as raise cross-sector questions about the role of these firms throughout the economy. Likewise, the exact role of these companies in the future network is still uncertain, as highlighted by Microsoft's recent step back from development of direct telecoms applications.[14]

c. **The use of AI in telecoms:** Network-wide use of AI as a tool for the design, automation and optimisation of network infrastructure will be a key trend over the next 5-10 years. Use of fast-moving AI technology is likely to become critical to keeping infrastructure and services competitive and secure. It will play an important role in network management and resource orchestration in the RAN and core, and support the introduction of new services. However, greater use of AI could lead to market concentration. Operators may depend on vendors – including the hyperscalers – to provide AI services due to a lack of computational/financial resource, in-house skills and training. There are currently only a few telecoms vendors developing credible AI networking solutions and hardware platform providers. Telecoms data can be difficult to access for new entrants, inhibiting the development of a diverse and competitive market for AI solutions in telecoms.

d. **The use of quantum technologies in networks:** The sector is currently focused on planning for deployment of 'quantum-safe' cryptographic algorithms to protect networks from emerging security risks posed by quantum computing. In the longer term, quantum technologies could play a wider role in future mobile networks, including for security, computing and sensing. This is a new market, and it is too early to make a firm assessment of the possible market concentration risks associated with the technology or the actors who might be involved, which may include hyperscalers, large IT firms, major telecoms equipment vendors and start-ups.

e. **New uses for optical networks:** There is considerable interest in exploring ways to take advantage of the widespread availability of optical fibre infrastructure, including to provide services beyond traditional communications, such as for time distribution and power transfers. Optical networks will also play a significant role in enabling computing power for AI applications and telecoms vendors are beginning to take steps to prepare for this.[15] However, the more uses an optical network has, the more severe the impact could be in the event of

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[14] Microsoft to quit Affirmed and Metaswitch in telecom retreat, Light Reading, 2024, https://www.lightreading.com/cloud/microsoft-to-quit-affirmed-and-metaswitch-in-telecom-retreat
[15] Inside Information: Nokia to acquire Infinera to increase scale in Optical Networks and accelerate product roadmap, Nokia Corporation, 2024, https://www.nokia.com/about-us/news/releases/2024/06/27/inside-information-nokia-to-acquire-infinera-to-increase-scale-in-optical-networks-and-accelerate-product-roadmap/

disruption, especially if the market is concentrated. This risk is likely to be tempered by the fact future networks may comprise of a mix of technologies (as noted in paragraph 18 (a) above).

f. **Accelerated adoption of open-source and software-led solutions** could also provide opportunities to increase the number of firms involved in providing network solutions as well as wider benefits to network performance and resilience. However, these might also precipitate new risks relating to concentration and security. For example, the use of open-source derived code and material changes the risk landscape (including possible attack vectors) and may introduce unknown dependencies, common across different parts of the telecoms supply chain. Past cybersecurity incidents – like discovery of the Heartbleed bug – highlight the challenges around the introduction of open-source into digital infrastructure, including a lack of scrutiny and support to open-source maintainers from the companies using open-source material.[16]

Policy context

19. A competitive and diverse telecoms equipment market increases the security and resilience of UK networks, while promoting innovation. But telecoms diversification sits alongside other policy ambitions set by government for the sector, which also require action from industry and support from government departments and agencies including the NCSC and Ofcom. In contributing to these policy objectives, operators must prioritise, starting with their legal obligations.

20. Operators are working to meet the Huawei designated vendor direction (which includes removing Huawei from their 5G networks by 2027), which government figures estimate will cost industry £2 billion (across all parts of the network and generations of technology).[17] Unlike the US, where the US government provided funding to operators to support Huawei removal, the UK government has not provided an equivalent scheme to UK operators, which have borne the cost.[18] These costs come in addition to those faced by operators to meet non-regulatory security pressures, such as to meet new security threats posed to cryptography by quantum computing. Operators must also pay spectrum license fees.

21. Operators are also delivering the Shared Rural Network, to reach the ambition for 95% coverage, which involves investment of over £500 million by operators and £500

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[16] Heartbleed bug: What you need to know, BBC News, 2014, https://www.bbc.co.uk/news/technology-26969629; GOV.UK and the Heartbleed OpenSSL bug, Inside GOV.UK, 2014, https://insidegovuk.blog.gov.uk/2014/04/11/govuk-and-the-heartbleed-openssl-bug/
[17] Digital, Culture, Media and Sport Secretary's statement on telecoms, GOV.UK, 2020, https://www.gov.uk/government/speeches/digital-culture-media-and-sport-secretarys-statement-on-telecoms
[18] Secure and Trusted Communications Networks Reimbursement Program, Federal Communications Commission, 2022, https://www.fcc.gov/supplychain/reimbursement

million by government to fill 'partial not-spots' (spots with coverage from at least one but not all mobile operators).[19]

22. The previous government offered the sector some support in meeting these ambitions. The Wireless Infrastructure Strategy (WIS) included a series of measures to support investment in the sector, including provision of up to £40 million for regions and local authorities to explore innovative applications of 5G and advanced wireless under the 5G Innovation Regions programme. Wider government work on encouraging investment has also benefitted the sector. For example, BT has said that the decision to make the 'full expensing' tax policy permanent as part of the 2023 Autumn Statement package will enable them to increase investment in its fibre rollout by £300 million a year.[20]

23. At the same time, the Science and Technology Framework identified 'Future Telecoms' as one of five critical technologies (alongside AI, engineering biology, quantum, and semiconductors).[21] The Framework set the foundations of a strategic approach to growing the future telecoms sector.

Standards landscape

24. Global standards determine the technical specifications of key telecoms technologies and play a critical role in ensuring a fair market and common requirements for new entrants. Standards can affect the ease with which operators can switch between equipment from different vendors and how readily new players can enter the market. The telecoms standards landscape is complex, comprising a mix of industry and government-led standards development organisations (SDOs), including:

    a. The International Telecommunication Union (ITU) – the UN body that sets frameworks for standardised telecoms technologies, which establish the high-level aims and capabilities. Contributions are led by national governments and territorial administrations.

    b. The 3rd Generation Partnership Project (3GPP) – the industry-led global SDO which develops detailed technical specifications to meet ITU requirements.

    c. European Telecommunications Standards Institute (ETSI) – the primary European telecoms SDO, and one of the "regional SDOs" that comprises 3GPP.

    d. The International Organisation for Standards (ISO) – a global network comprised of representatives from national standards bodies (such as the British Standards Institution – BSI).

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[19] Shared Rural Network, 2020, https://www.gov.uk/government/news/shared-rural-network
[20] What did the Autumn Statement mean for UK telecoms?, UKTIN, 2023, https://uktin.net/whats-happening/news/what-did-autumn-statement-mean-uk-telecoms
[21] UK Science and Technology Framework, GOV.UK, 2023, https://www.gov.uk/government/publications/uk-science-and-technology-framework

25. These organisations have shaped the telecoms infrastructure used today, but can be cumbersome, slow and opaque. As telecoms technologies evolve in line with the technical trends outlined in paragraph 19 above, the standards context will change too. For example, the internet and IP protocols underpinning Voice over IP (VoIP), which is replacing traditional PSTN connections, are not standardised in the same way as traditional telecoms technologies. Instead, they are developed through less formalised not-for-profit organisations such as the Internet Engineering Task Force (IETF), Internet Corporation for Assigned Names and Numbers (ICANN) and the World Wide Web Consortium (W3C). Some bodies, like the O-RAN Alliance – which plays a critical role in developing specifications for Open RAN – demonstrate elements of both traditional SDOs and new informal groups. It is important that government and industry give thought to how to influence these newer bodies, including how best to address issues that have created barriers to entry in existing SDOs, such as the treatment of intellectual property.

26. To be effective in influencing the development of telecoms standards in a way that promotes diversity of supply, government and industry must be able to navigate this complex and evolving landscape.

Chapter Two: Recommendations in different parts of the network

The Radio Access Network

The problem

27. In line with the Strategy and Taskforce report, most government interventions to date have focused on increasing diversity in the RAN equipment market, where the need to diversify was most pressing. Several reasons motivated the focus on RAN diversification, including: the high concentration in the market (exacerbated by the ongoing restriction and removal of Huawei equipment on security grounds); sensitivity of the RAN owing to its importance to the network and vulnerability to unauthorised access; that the RAN constitutes the largest expense in the network by far; and that the RAN relies on the most specialist skills to develop, integrate, and operate.

28. Despite government action to date, the UK 5G RAN market remains highly concentrated and, as anticipated, has become more concentrated considering ongoing work to remove Huawei equipment from the network. It is important that government – working with industry – takes action to mitigate the security and resilience risks stemming from this, while continuing to encourage more vendors to sustainably enter the market. Government support to further accelerate the development and adoption of open and interoperable solutions like Open RAN will also support the entrance of new vendors over time.

Government activity to date

29. Addressing lack of diversity among 5G RAN equipment vendors in UK networks was always going to be a long-term task. The previous government has taken a range of measures to promote greater diversity, including:

    a. Accelerating the development of Open RAN (see paragraphs 30-34 below).

    b. Adopting complementary policy and regulatory measures to remove barriers to entry to the UK market, such as agreeing a timeline with industry and Ofcom to sunset 2G/3G networks.

    c. Supporting the incumbent vendors to ensure their ability to supply the market in the near term, recognising the important role they will continue to play in UK networks.

    d. Strengthening the wider telecoms regulatory regime and environment – including through the Telecommunications (Security) Act 2021 and establishing the UK Telecoms Lab (UKTL) – to improve overall network resilience and security.

30. Most of the government's interventions to date have focused on supporting the development of Open RAN – in line with the Taskforce report and guided by advice from the Council. There are several reasons for this. First, significant uptake of Open RAN – when developed and deployed in line with the Open RAN principles (see Figure 1 below) – should result in greater diversity of supply as the technology and market matures towards the end of the decade. Second, Open RAN should also deliver other benefits, including allowing operators to introduce new services and better tailor their networks to their needs, while also providing opportunities to support UK companies and strengthen the UK telecoms ecosystem. Third, there is a clear market trend towards greater adoption of Open RAN which targeted government intervention has accelerated.

31. In the UK, government interventions – such as the £250m Open Networks R&D programme – have encouraged Open RAN activity by crowding-in private investment, helping to address technical barriers to performance parity between Open RAN and traditional RAN solutions, and supporting growth of SMEs and specialist companies. Testing facilities, such as SONIC Labs, have supported SMEs in driving their products towards maturity and forging technical and commercial relationships across the Open RAN ecosystem. As Open RAN reaches technical maturity, it is beginning to be adopted in public networks. In the UK, Vodafone has reported that Open RAN is attaining performance parity with 'traditional RAN' solutions, including in technically challenging high demand density environments.[22] Some trials suggest Open RAN may already be delivering greater energy efficiency than traditional RAN solutions.[23] Widespread rollout of 5G Standalone – in line with the government's ambitions set out in Chapter One – will also help reduce complexity in Open RAN deployment, by reducing the need for interoperability between 5G and 4G required in 5G non-standalone.

32. The global Open RAN market is also maturing. New greenfield networks internationally – such as Dish in the United States – have been built using Open RAN. Brownfield operators – including all four UK operators – are trialling Open RAN to varying degrees. Vodafone launched a Europe-wide invitation to tender for Open RAN in early February 2024.[24] The growth of private networks and densification of public networks using small cells are also creating new opportunities to deploy Open RAN and prove the solutions in real-world conditions.

33. Both Nokia and Ericsson – which previously expressed scepticism about the performance and feasibility of Open RAN – are now providing O-RAN Alliance compliant products.[25] Both firms are participating in DSIT's Open Networks

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[22] Evidence presented at the Vodafone stand at Mobile World Congress, 2024

[23] Vodafone, WindRiver, Intel, Keysight Technologies and Radisys test 'green' Open RAN network, 2022, https://www.vodafone.com/news/technology/vodafone-wind-river-intel-keysight-technologies-radisys-test-green-open-ran

[24] Huawei has most to lose as Vodafone kicks off 170,000-site tender, Light Reading, 2024, https://www.lightreading.com/open-ran/huawei-has-most-to-lose-as-vodafone-kicks-off-170-000-site-tender

[25] Ericsson takes leadership in industrialisaing Open RAN, Ericsson, 2023, https://www.ericsson.com/en/press-releases/2023/9/ericsson-takes-leadership-in-industrializing-open-ran; Open RAN, Nokia Corporation, 2024, https://www.nokia.com/networks/radio-access-networks/open-ran/

Programme and are active members of the O-RAN Alliance, making significant technical contributions to Open RAN specifications and co-chairing working groups. The Council sees this as a positive development for the market, so long as these Open RAN products advance in line with the spirit of UK's Open RAN principles, especially demonstrated interoperability.

Figure 1: UK government Open RAN principles

Open disaggregation, allowing elements of the RAN to be sourced from different suppliers and implemented in new ways.

Standards-based compliance, allowing all suppliers to test solutions against standards in an open, neutral environment.

Demonstrated interoperability, ensuring disaggregated elements work together as a fully functional system – at a minimum matching the performance and security of current solutions.

Implementation neutrality, allowing suppliers to innovate and differentiate on the features and performance of their products.

Source: www.gov.uk/government/publications/uk-open-ran-principles/open-ran-principles

The current market position

34. While the Open RAN market is maturing, Open RAN is not an end in itself. Government support for Open RAN has ultimately been driven by its potential to address the security and resilience concerns posed by the lack of diversity of vendors in the UK 5G RAN.

35. Despite government action so far, the UK 5G RAN equipment market remains highly concentrated. Nokia, Ericsson and Huawei continue to provide nearly all 5G RAN equipment deployed in UK networks. UK operators now primarily use Ericsson and/or Nokia 5G RAN equipment, due to the ongoing removal of Huawei 5G equipment in line with legal obligations, the lack of a new market entrant (at scale), and the limited live deployment of Open RAN to date. Globally, the market remains concentrated, and declining revenues signal challenging commercial conditions for existing vendors.[26] Recent press, which Nokia has denied, suggest that Samsung and Nokia are in early

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[26] Global RAN market declined by 11% in 2023, Telecoms.com, 2024, https://www.telecoms.com/wireless-networking/global-ran-market-declined-by-11-in-2023

discussions about Samsung acquiring Nokia's mobile networks business.[27] This situation underscores the potential risk of further consolidation within the market.

36. Since the Telecoms Supply Chain Review, Ericsson has taken Huawei's place as the largest supplier of 5G RAN equipment in the UK. Huawei's remaining market share is set to diminish to zero by 2027, in line with the government's direction to operators.[28] Nokia and Ericsson's market share has increased as operators have procured their equipment to replace Huawei. Challenging financial results in the global equipment vendor market – driven by factors including a slowdown in operator spend – could increase the risks of long-term dependence on a small number of vendors.

37. The UK 5G RAN market is likely to remain concentrated in the medium term (five years) without further intervention. Most operators have made major financial investments in new 5G RAN equipment in recent years – to meet their roll out plans and to replace Huawei equipment. This, coupled with the commercial pressures outlined in Chapter One, mean that most operators are unlikely to undertake large-scale procurement in the short term. The possible Three/Vodafone merger may also affect the range of vendors deployed in the UK 5G RAN. The merger is currently being reviewed by the Competition and Markets Authority (CMA) to assess its impact on consumers and competition in the market. The Council recognises that the government has no role in this decision-making process.

38. In the long term (5-10 years), greater uptake of Open RAN has the potential to increase market diversity (see below), and deliver other benefits, including driving innovation and building UK capability.

Open RAN trajectory

39. Despite progress, it will take time to see large-scale Open RAN deployments in UK networks. The previous government had an ambition for 35% of aggregate network traffic to be carried over open and interoperable solutions by 2030, which all four UK MNOs reiterated their endorsement for in September 2023.[29] This indicates support in principle from industry, although there are significant differences in ambition and deployment timelines between operators due to commercial constraints (see Chapter One).

40. The 35% ambition has a role to play in setting direction and signalling to new entrants that there is an opportunity for them to enter the market. If delivered in line with the Open RAN principles, achieving the ambition should mean greater diversity of vendors in UK networks. However, it is not a panacea. The target is stretching; it is more ambitious than analyst forecasts for the global market, which indicate that Open RAN

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[27] Nokia Mobile Networks Assets Said to Draw Samsung Interest, Bloomberg, 2024, https://finance.yahoo.com/news/nokia-mobile-networks-assets-said-122943031.html

[28] Huawei legal notices issued, Department for Digital, Culture, Media and Sport, 2022, www.gov.uk/government/news/huawei-legal-notices-issued

[29] Open RAN principles: memorandum of undersanding between government and industry. Department for Science, Innovation and Technology, 2023, https://www.gov.uk/government/publications/open-ran-principles-memorandum-of-understanding-between-government-and-industry

is set to account for 20-30% of worldwide RAN revenues by 2028, up from 7-10% in 2024.

41. There are also concerning trends that may limit Open RAN's ability to act as an effective tool to promote greater diversity of vendors. These include:

   a. **Single vendor deployments:** There are indications that most new Open RAN deployments are being led by a single existing scale vendor. For example, AT&T's recent $14 billion RAN procurement, which includes plans for 70% of its network traffic to flow over Open RAN capable platforms by 2026, is led by Ericsson.[30] Ericsson's AT&T deal involves manufacturing telecoms equipment in the USA, in line with US Government 'Build America, Buy America' rules.[31] Open RAN solutions delivered by a single vendor can be compatible with O-RAN Alliance specifications and do promote greater network resilience, as the use of open interfaces should make equipment more interchangeable in the event of disruption to supply. However, single vendor Open RAN solutions – especially when delivered by existing incumbent vendors, Nokia and Ericsson – will not automatically increase the diversity of vendors in the UK 5G RAN. For example, MasOrange plans to remove ZTE equipment and reduce its use of Huawei - in part for security reasons - and deploy Ericsson Open RAN, increasing its reliance on a single vendor.[32] Single vendor Open RAN solutions could undermine the ability of Open RAN to deliver greater flexibility and performance benefits for operators, as single vendor solutions do not allow operators to procure solutions that leverage the respective strengths of different vendors.

   b. **Specifications and standards developments:** Specifications and standards for Open RAN could develop in a way that risks market fragmentation and adds costs – potentially inhibiting new market entrants. There are already indications that the development of multiple open fronthaul specifications have added complexity in the radio.[33] There is also a risk that specifications for the RAN Intelligent Controller (RIC) could develop in a way that encourages 'lock in' to RIC solutions and apps offered by large vendors, to the detriment of new market entrants.

   c. **Operator reluctance to take on complexity:** While offering benefits, Open RAN adds complexity to operator deployments. Against a backdrop of increased commercial pressures (Chapter One) and a skills shortage (Chapter Three), operators – especially smaller players with limited in-house capacity and

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[30] AT&T to Accelerate Open and Interoperable Radio Access Networks (RAN) in the United States through new collaboration with Ericsson, Ericsson, 2023, https://www.ericsson.com/en/press-releases/2023/12/att-to-accelerate-open-and-interoperable-radio-access-networks-ran-in-the-united-states-through-new-collaboration-with-ericsson

[31] AT&T's Purchase of Ericssin Equipment Further Solidifies Ericsson's Global Leadership, US International Trade Commission, 2024, https://www.usitc.gov/publications/332/executive_briefings/ebot_att_ericsson_deal.pdf

[32] MasOrange to scrap Huawei and ZTE in Ericsson 'open RAN' shift – report, Light Reading, 2024, https://www.lightreading.com/5g/masorange-to-scrap-huawei-and-zte-in-ericsson-open-ran-shift-report

[33] Ericsson and pals split open RAN community with massive MIMO plan, Light Reading, 2023, https://www.lightreading.com/open-ran/ericsson-and-pals-split-open-ran-community-with-massive-mimo-plan

expertise – may be reluctant to adopt multi-vendor Open RAN over established single vendor solutions. Operators may also find it more difficult to demonstrate compliance with their obligations under the Telecommunications (Security) Act 2021 when deploying more complex Open RAN solutions than simpler single vendor alternatives. From a commercial perspective, operators may also prefer to have a single vendor to hold responsible for the performance of their RAN.

d. **Possible new concentration risks:** Open RAN solutions rely on a systems integrator function to orchestrate technologies from different vendors. At present, this function is performed by a mix of operators, vendors and specialist systems integrators, depending on the specifics of the Open RAN deployment. However, it is possible that systems integration could coalesce around a few players, potentially creating a new market concentration risk.

Recommendations

42. Diversifying the 5G RAN equipment market was always going to be a long-term task. It is important that the government continues to treat the security and resilience risks posed by market concentration seriously and takes targeted and proportionate action to mitigate and address them. The Council recommends further government action is focused on:

    a. **Mitigating the immediate security and resilience risks stemming from a lack of diversity of vendors in the 5G RAN in the short term**.

    b. **Further support and investment to promote greater diversity in the UK RAN market in the medium to long term,** by encouraging one or more additional scale vendors to enter the UK market and continuing to promote the development of Open RAN such that it is an effective mechanism to increase vendor diversity.

Mitigate short term resilience and security risks

43. In the short to medium term, the UK RAN market is expected to remain highly concentrated – with attendant security and resilience risks.

44. The duties placed on public telecoms providers to identify, reduce and mitigate security compromises, and government's high risk vendor powers, introduced by the Telecommunications (Security) Act 2021, already go a long way to increasing the security of UK networks.

45. However, the government should consider if further mitigations or contingency plans are needed in the short to medium term to manage the distinct security and resilience risks posed by dependency on a small number of vendors.

46. This should include:

    a. Working with operators and the incumbent 5G RAN vendors – Nokia and Ericsson – to test the security of 5G RAN equipment, including through UKTL, to mitigate dependency-related security risks in the short term.

    b. Working with operators to test their contingency plans and model the possible impact on networks if one of their existing supplier's operations were significantly disrupted.

    c. Government and industry considering ways to prioritise early deployment of proven vendor partnerships in Open RAN and use of systems integrators that have shown proficiency in other markets. This is likely to make it easier for operators to be able to switch between vendors in the event of supply disruption.

Promote greater diversity of supply in the medium to long term

47. The long-term solution to security and resilience risks posed by reliance on a small number of vendors is to increase the number of 5G RAN vendors deployed in UK networks and to support a healthy global RAN market to deliver sustainable diversity of supply.

48. To do this, the government should:

    a. **Revisit efforts to create the conditions to attract one or more additional scale vendors to enter the UK 5G RAN market, alongside Ericsson and Nokia**. The Taskforce report recommended that the government should create the conditions that will attract the entry of at least one, and ideally two, additional 'scale' vendors – while recognising the introduction of new suppliers should be done compatibly with a move towards more open and interoperable networks.

    The global 5G RAN market is more diverse than that in the UK – even when excluding vendors that are not permitted in UK networks on security grounds.[34] This means there is scope for established vendors – such as Samsung, NEC and Fujitsu – to enter the UK market. The sunsetting of the UK's 2G and 3G networks has helped remove a barrier to entry. However, the market conditions required to support entry of a new scale vendor to the UK market have not yet materialised (outside of small-scale Open RAN deployments – as set out in paragraphs 30-34 above).

    Since the Taskforce report, the RAN market has evolved. Agreement of O-RAN Alliance specifications and trends towards increased virtualisation mean that the distinction between 'traditional RAN' and 'Open RAN' is being eroded. Most new RAN products – including those provided by established scale vendors – are likely to be compliant with O-RAN Alliance specifications. This means that any new scale RAN vendor entering the UK market is likely to offer an O-RAN Alliance compliant solution.

    The government should perform 'commercial diplomacy' and work with UK operators and new vendors to identify remaining barriers to entry to the UK market and routes to deployment. This should include consideration of the remaining regulatory barriers to market entry, wider regulatory impediments to

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[34] Market forces create technology ecosystem diversity in network markets, 1H24 Update, ibid.

deployment (including planning conditions) and financial impediments. It should assess whether existing tax and other financial incentives available to vendors and operators – including Foreign Direct Investment support from the Department for Business and Trade – are sufficient or could be better utilised to strengthen the commercial case for operators to procure from a more diverse range of vendors. The government should also work with international partners that are home to major vendors to understand how they could support their firms to enter the UK market. It is essential that diversification is considered across all of government's work to shape and support UK networks. The government should consider how any future interventions to support rollout and adoption can also accelerate the introduction of new equipment vendors to the UK network.

The relatively small size of the UK market can be a barrier to new market entrants. To ameliorate this, it is important that, where feasible, the UK works closely to align standards and operating requirements for telecoms equipment with international partners – especially those geographically close to the UK. This will help reduce logistical, workforce and service delivery costs for equipment vendors, helping to increase margins and make sustainable operations in the UK a more viable commercial proposition.

While it is likely to take time for one or more additional large-scale vendors to enter the UK market to a significant degree, the government should consider how the actions to promote an additional scale vendor(s) set out in the preceding two paragraphs and on Open RAN in paragraph 47(c) above could be expedited to promote greater diversity in supply as quickly as is feasible. This could include prioritisation of early deployment of proven vendor partnerships in Open RAN and use of systems integrators that have shown proficiency in other markets, as noted above, or incentivising adoption of solutions that support more diverse deployments.

b. **Take decisive steps to drive the development and deployment of Open RAN solutions in line with the Open RAN principles.**

Given the progress being made in the development of Open RAN, the government should continue to support the development and deployment of Open RAN solutions. However, the shape of this support needs to adapt to meet changes in the market and ensure intervention is aimed at the current barriers to widespread deployment. The government should:

  i. **Work with operators to address the commercial barriers inhibiting deployment.** Commercial factors are now the most pressing obstacles to widespread adoption of Open RAN. The government should work with operators to identify what support would help move the dial in operators' procurement decisions. The Wireless Infrastructure Strategy set out a suite of supply and demand side policy measures to drive investment in

5G.[35] Prompt and full implementation of these will support widespread investment in 5G networks, including Open RAN networks. Government should consider what further measures could support the commercial adoption of Open RAN, including funding and other financial incentives, if appropriate.

ii. **Continue to work with Nokia and Ericsson as they develop O-RAN Alliance compliant technologies to promote multi-vendor deployments**. Both firms will continue to play an important role in the market – including in developing and deploying Open RAN. Government and operators should work constructively with both firms to ensure Open RAN is developed and deployed in a way that allows it to support greater diversity of vendors and true interchangeability.

iii. **Continue investment in testing and integration infrastructure – such as through SONIC Labs and the UK Telecoms Lab**. Operators have been clear that they will only adopt Open RAN at scale when they are satisfied it is as performant and secure as alternative RAN solutions. Government-funded neutral testing infrastructure can help accelerate the deployment of Open RAN by signalling the readiness of Open RAN solutions to the market and providing evidence to support government's telecoms diversification and security policy. At present, there are two government-established labs. SONIC Labs has focused on lower technology readiness level products and is designed to help support vendors – including small and emerging vendors – to develop new Open RAN products.[36] The UKTL will focus on higher technology readiness levels, providing security and interoperability testing for market and near-market ready RAN products.[37] As the Open RAN market develops and UKTL becomes established, the government should be clear about how these labs work together and ensure there is an established pipeline of testing available to support industry through all phases of product development. SONIC Labs and UKTL should also work more closely with operator labs to ensure they complement activity already undertaken by industry. Further, as noted in paragraph 72(a)(iii) below, SONIC Labs and UKTL should work more closely with labs established by other governments to ensure testing activity is complementary and to maximise value. Potential areas for collaboration could include carrier-grade performance testing and standards certification to reduce the systems integration burden on MNOs.

iv. **Coordinate priorities for certification of Open RAN systems with industry bodies and labs.** Certification will be important in giving operators confidence to deploy Open RAN and in supporting their own

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[35] Wireless Infrastructure Strategy, ibid.
[36] SONIC Labs, Digital Catapult, https://www.digicatapult.org.uk/expertise/programmes/programme/sonic-labs/
[37] UK Telecoms Lab – UKTL, NPL, https://www.npl.co.uk/uk-telecoms-lab

testing activity. If operators are to trust Open RAN solutions tested outside of their labs, they must be certified robustly and reliably, ideally through a global industry-led certification scheme. Certifications should be specific to deployment scenarios and architectures to be useful to operators. The UK government should work with other governments and industry bodies, specifically the O-RAN Alliance, Telecom Infra Project (TIP) and GSM Association (GSMA), to develop a formal industry-led programme of repeatable tests against operator requirements. The Council also recommends that at least one UK lab becomes an O-RAN Alliance Open Testing & Integration Centre (OTIC), to be formally recognised as a certification house. The Council does not recommend that the UKTL (nor SONIC Labs) issues certificates on security, as operators have responsibility for ensuring the security of their networks in line with their obligations in the Telecommunications (Security) Act 2021.

v. **Work closely with industry to invest in targeted R&D at higher technology readiness levels.** Further support for R&D should be focused on addressing the remaining technical barriers that are impeding uptake of Open RAN by operators. The government should consider specific funding to support R&D on the RAN Intelligent Controller (RIC), Service Management and Orchestration (SMO), X/R-Apps, security, power efficiency, radio hardware, and high demand density testbeds. Well targeted investment would also prevent a sudden end to funding following the £250m committed over the past three years. This ongoing support can help to ensure that this public investment maximises its return through promoting greater commercialisation and ecosystem developmejt, something that the Council has previously observed is missing from government funding programmes. Considering how other sectors approach integration challenges between equipment from different vendors could also be beneficial.

vi. **Support companies developing Open RAN technologies in the UK to commercialise and achieve scale**. Existing government R&D interventions, combined with investment from the private sector, have helped generate a strong ecosystem of nascent Open RAN companies and technologies in the UK. However, commercialisation and scale are key to unlocking the potential of UK Open RAN firms in making a significant contribution to the UK economy and ensuring they can benefit from opportunities to export to the global market. The government should consider funding mechanisms that will support companies developing Open RAN to scale and ways to help firms showcase their products and find export opportunities.

vii. **Explore alternative routes to adoption**. The market for 5G is still nascent, with numerous use cases and deployment scenarios still to be commercialised as 5G Standalone is deployed. 5G promises a step

towards a 'network of networks', including private networks, densification layers, neutral hosts and the Internet of Things. The government should consider how these can act as routes to market for Open RAN, especially for small players, and how public sector procurement of these kinds of connectivity solutions could be a significant source of demand.

viii. **Counter adverse trends in the Open RAN market**. As noted in paragraph 42 above, Open RAN could develop in a way that inhibits its ability to drive greater diversity. The government should counter adverse trends in the market. This includes:

1. **Seeking further endorsement of, and compliance with, the UK's Open RAN principles from operators, vendors and international partners**. In particular, this means support for demonstrated interoperability to address the risk of single-vendor dominance. Likewise, the principle of implementation neutrality should be observed to ensure that systems integrators (SIs) do not develop a dominant position in the market. SIs have a significant role to play in giving operators confidence to deploy Open RAN solutions – especially smaller operators that may lack the capability to perform the SI functions. However, it is important that SIs should not reach a point of becoming effective scale suppliers and leaving operators without the flexibility promised by Open RAN. The government should keep its Open RAN principles under review to ensure they continue to be effective as the market evolves.

2. **Monitoring the development of the Open RAN market to identify and mitigate trends that may impede diversification**. This should include continuing to monitor the specification and standards development process, with a focus on Open Fronthaul and RAN Intelligent Controller (RIC).

ix. **Ensure openness and interoperability are sustained in future generations of communications technology**. The Council welcomes the role the previous government played in shaping the IMT-2030 Framework, which includes standardisation and interoperability as a key considerations for 6G, in line with the previous government's 6G Vision, published as part of the Wireless Infrastructure Strategy in 2023.[38] Future generations of technology should continue to support greater vendor diversity. However, 6G could present renewed concentration risks depending on how the architecture develops. The trend towards greater adoption and development of Open RAN by operators and some vendors attenuates this threat somewhat. However, as noted in paragraph 81(c) below, the government should continue act early in the standards development

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[38] see Wireless Infrastructure Strategy, ibid and ITU, M.2160 : Framework and overall objectives of the future development of IMT for 2030 and beyond, 2023, www.itu.int/rec/R-REC-M.2160-0-202311-I/en

process and as technical specifications are developed to ensure openness and interoperability are central to the development of new technologies, to reduce the risk of vendor lock-in.

49. The Council does not currently believe there is a need for regulation to promote Open RAN. Operators already face a range of regulatory responsibilities which add to their costs, often to a greater degree than other technology firms.[39] However, the government should be aware of the risks of reconsolidation in the equipment supply market in future and other negative market trends that could undermine its diversification ambitions. The government should continue to hold regulation in reserve as a policy lever should the market fail to drive sufficient diversity. The Council emphasises that regulation should only be an option of last resort and following robust analysis of the market conditions and considering the totality of regulatory obligations on operators.

Other parts of the telecoms network

The problem

50. The Review identified that the greatest risk of national dependence in UK telecoms networks lay in the RAN. The subsequent Strategy and Taskforce Report looked to address this risk and set out ways to improve the diversity of supply to the UK 5G RAN. However, both documents identified that market concentration could emerge elsewhere in the telecoms equipment market and present security and resilience risks, additional to those in the RAN. Deployment concentration might also emerge – whereby operators are deploying the same vendors despite there being a range of other choices – which can also have security and resilience implications. Addressing security and resilience risks associated with deployment concentration may demand a different policy response than diversification.

51. Changes in the mobile operator market – including consolidation among mobile operators globally or in the UK – may impact market and deployment diversity in telecoms equipment. Geopolitical risk also remains a major consideration in identifying supply chain risk and means that geographic diversity of supply also remains a concern for the sector.

52. Market data indicates that, since the original Taskforce report, concentration has emerged in other parts of the UK telecoms network, particularly in the mobile core. Increasing use of virtualisation/cloudification within the core network and the attendant decoupling of hardware/software has the potential to increase the diversity of supply to the core. Vendors – including the incumbents – have been developing their products in line with these trends. However, since the original Taskforce report, the UK mobile core network is increasingly delivered by a small number of vendors, particularly

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[39] Examples include spectrum license fees and costs associated with obligations under the Telecommunications (Security) Act 2021.

Ericsson, who now supply the bulk of core network functions for three of four UK MNOs.[40] Analysts indicate the global market is moderately concentrated but shows indications of becoming less concentrated over time.[41] While the new telecoms security framework anchored by the Telecommunications (Security) Act 2021 is improving the overall security of the UK telecoms sector, market concentration within the core network could increase security and resilience risk for the UK telecoms network. The current position in the mobile core is unlikely to change in the short term as procurement for 5G standalone core is mostly complete and new procurements are not expected in the next five to seven years.

53. Mergers and acquisitions amongst Operations Support Systems (OSS) and Business Support Systems (BSS) vendors has also impacted overall concentration within this market. At present there are a range of suppliers in the OSS/BSS market, but these systems have high switching costs due to the complexity and interdependencies of legacy systems, which also contribute to high barriers to entry for new suppliers in the market.[42]

54. Recent analysis of the optical fibre cable market by the Trade Remedies Authority suggests that the optical fibre cable market has a wide range of suppliers. However, other parts of the optical communications market, such as for passive optical networks (PON), are marked by limited vendor choice. The optical communications network is also subject to Huawei's vendor designations notice issued under the Telecommunications (Security) Act 2021.[43]

55. At the same time, technological changes within the telecoms network, like those highlighted above in Chapter One, have the potential to introduce new security and resilience vulnerabilities stemming from concentrated supply. One example is the use of cloud services by telecoms operators. There are broadly three ways for operators to deploy cloud services, in enterprise IT (e.g. day-to-day business use), for multi-edge computing, and in providing network functions. At present, cloud services are most commonly used for enterprise IT. Ofcom has recently detailed how telecoms operators' use of cloud services for enterprise IT purposes reflects the overall market picture in public cloud infrastructure services, namely concentration of supply around the three 'hyperscaler' cloud service providers (AWS, Google and Microsoft).[44] As telcos explore new and greater usage of cloud services, including in the provision of network

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[40] See: Vodafone strengthens European partnership with Ercisson through new 5G Core contracts, Ericsson, 2021, https://www.ericsson.com/en/news/2021/6/vodafone-strengthens-european-partnership-with-ericsson; Virgin Media O2 selects Ericsson 5G Core to power Standalone network, Ericsson, 2021, https://www.ericsson.com/en/news/2021/7/ericsson-5g-core-selected-to-power-standalone-network-deployment; BT picks Ericsson to replace Huawei in core, Mobile World Live, 2020, https://www.mobileworldlive.com/home-banner/bt-picks-ericsson-to-replace-huawei-in-core/

[41] Market forces create technology ecosystem diversity in network markets, 1H24 update, ibid.

[42] The evolution of BSS and OSS in the telecoms sector, Telecoms.com, 2023, http://www.telecoms.com/oss-bss-cx/the-evolution-of-bss-and-oss-in-the-telecoms-sector

[43] Designation Notice under section 105Z8 of the Communications Act 2003, designating Huawei for the purpose of a designated vendor direction, Department for Digital, Culture, Media & Sport, 2022, https://assets.publishing.service.gov.uk/media/6345346ed3bf7f586f6fd1e5/Final_Huawei_Designation_Notice.pdf

[44] Statement: Cloud services market study (final report), Ofcom, 2023, https://www.ofcom.org.uk/internet-based-services/cloud-services/cloud-services-market-study

functions and multi-edge computing, underlying concentration in the cloud service market could pose security and resilience challenges to the UK telecoms network. The increased use of AI and quantum (e.g. for security, computing and sensing) will have implications for network security and resilience generally. It may also introduce new concentration risks that pose security and resilience risks.

Recommendations

56. To mitigate these new and emerging risks, the government should:

    a. **Deepen and maintain understanding of concentration and current market dynamics within the UK mobile core network and the wider telecoms equipment market, and keep any associated security and resilience risks under review.** The Council is particularly concerned at the concentration that appears to have emerged in the UK mobile core network since the Taskforce report. The government should work to understand how the UK core network compares to the global market and understand what factors are affecting UK operators' choices in the deployment of their core networks. However, it is also important that government actively keeps market dynamics in the wider telecoms equipment market under review and any attendant security and resilience risks, working across government and with operators to understand concentration risks. The relationship between concentration and security/resilience risk is widely understood but it is important that the government carefully assesses and characterises the relative risk associated with concentration across the network.

    b. **Consider other interventions – beyond promoting diversity of supply – to address security and resilience risks associated with market concentration, including testing of mobile core equipment by the UKTL.** The Council recognises that diversification may not be the appropriate tool to address security and resilience risks in the mobile core or other non-RAN parts of the network, especially given the timelines of procurement cycles and the existence of diverse supply within the global telecoms equipment market. The government should consider what non-diversification mitigations may be necessary in the short to medium term. This should include consideration of the role of UKTL in providing additional security testing of equipment widely deployed in the UK core, to help mitigate risk associated with short-term concentration. Given the pressures on the telecoms sector over the past few years, the government should carefully target interventions to have the greatest impact on overall network security and resilience.

    c. **Work closely with operators to promote diversity of supply in the next procurement cycles.** As acknowledged above, diversification may not be the appropriate tool to address short and medium term security and resilience risks associated with concentration in the non-RAN telecoms network. In the longer term, government should work closely with operators to better understand and promote diversity of supply in the next procurement cycles for key parts of the network, including the mobile core. As detailed in the Telecoms Supply Chain

Review report and the Taskforce report, diverse supply to UK operators has clear resilience and security benefits to the UK networks. Ultimately, however, this relies on underlying diversity of supply within the telecoms market, which the Government should keep under review (see recommendation in paragraph 57(a), above).

d. **Promote open and interoperable solutions across current and future networks, including 6G and other future communications technologies**. Openness and interoperability can encourage greater diversity of vendors, make it easier for operators to switch between them and prevent the emergence of concentrated markets. The government should generally promote open and interoperable solutions across different parts of the network, to improve the overall resilience of the UK networks. This includes in standards development processes (see paragraphs 73-81 below). It should consider setting out a general set of principles in support of open networking within telecoms, building on the existing Open RAN principles, as part of its work supporting future communications technology. In promoting openness, government should be mindful that in parts of the network there may be a choice of vendors in the market, but there could be other barriers to vendor diversity, such as high switching costs or technical/commercial lock-in risks applicable to specific systems.

e. **Conduct specific forecasting on how technological changes in the network (e.g. increased integration of AI, quantum and cloud) will impact future network diversity.** This should include identifying opportunities to build UK capability in these areas. Government should also consider how the increased presence of the hyperscalers/big tech within the network could impact the concentration of equipment supply. Other changes in the market could also have an impact on the diversity of equipment deployed in networks, including consolidation among operators or potential future separation between firms running the network and those providing the service to end customers, as well as other changes in the wider market structure.

f. **Continue to forecast the skills needed to deliver telecoms networks of the future, discussed in detail in paragraphs 82-87 below.** The availability of a skilled workforce is key to enabling innovation across the whole sector so that firms of all sizes can support the development of UK capability in the network, which can help address telecoms concentration risks.
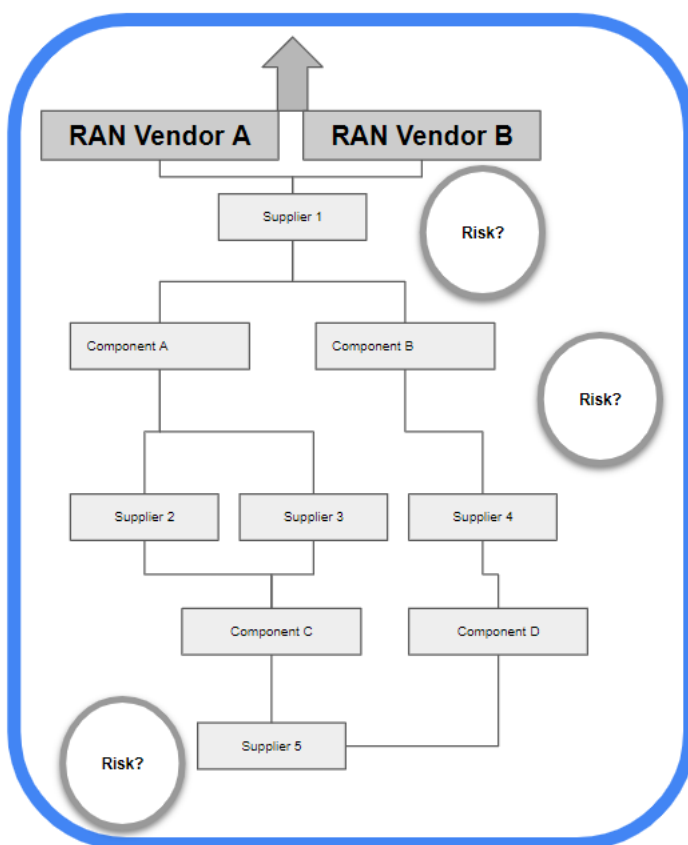
Subcomponent supply chains

The problem

57. Most government work on telecoms diversification has been focused on addressing concentration risks in the supply of 'finished' equipment provided by equipment

vendors to operators, in line with the areas of risk identified in the Telecoms Supply Chain Review (2019).

58. However, the Taskforce was clear that market concentration further down RAN supply chains – in the supply of subcomponents like semiconductors – could also pose a resilience and security risk to telecoms networks. The resilience and security benefits of improving vendor diversity at the finished equipment level could be undermined if these vendors share single points of failure (or 'critical dependencies') on one or a few suppliers of critical subcomponents (illustrated in Figure 2 below). To mitigate this risk, the Taskforce recommended that the government consider the introduction of provenance standards on vendors to allow operators to understand what equipment was going into their networks.[45]

Figure 2: Illustrative diagram showing critical dependencies in subcomponent supply chains

59. Key subcomponents including multilayer capacitors, DC-DC voltage regulators, and multi-layer Printed Circuit Boards (PCBs) have been found to exhibit critical dependencies, such as geographical concentration of manufacturing facilities. Other

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[45] Paragraph 54, Telecoms Diversification Taskforce: Findings and Report, GOV.UK, 2021, https://assets.publishing.service.gov.uk/media/60644773e90e074e57968b72/April_2021_Telecoms_Diversificatio n_Taskforce_Findings_and_Report_v2.pdf

subcomponents such as Radio Frequency (RF) power semiconductors, Transceiver Systems on Chip (SoCs) and accelerators for baseband processing exhibit significant market concentration. These subcomponents will continue to remain critical in delivering the performance of current and future telecoms technology.[46] Risks posed by critical dependencies are in addition to wider supply chain disruption driven by COVID-19 and geopolitical events, which have affected a range of components, including passive components such as resistors. A robust supply of subcomponents for the RAN and other parts of the telecoms network will be necessary for the UK to meet its ambitions on telecoms – including delivering standalone 5G to all populated areas by 2030.

60. Since the Taskforce report was published, DSIT – working with industry – has made good progress in improving visibility of these risks. Evidence assessed by the Council indicates there are instances of critical dependencies in supply chains and that these could exacerbate the impact of supply disruption or pose a cyber security threat. Where supply of a subcomponent is concentrated to a small number of companies, the possible impact of a security event is greater than where there is diversity of supply. For example, an attacker would have greater impact if they maliciously targeted a semiconductor used across all RAN supply-chains than a subcomponent used less commonly. At the subcomponent level, some of these risks become 'cross-sector', for example, the concentration in the supply of advanced semiconductors is not a telecoms-specific issue and is acknowledged in the National Semiconductor Strategy.[47]

61. There is evidence that industry awareness of – and mitigations for – critical dependencies within supply chains is improving. Supply chain disruption in recent years, including that caused by COVID-19 and rising geopolitical tensions, has led many telecoms operators and equipment suppliers to improve their understanding of their supply chains and has led some firms to take measures such as diversifying their suppliers, holding greater stock in the supply chain to mitigate against disruption, and developing and testing contingency plans for supply disruption. Supply chain obligations on communications service providers introduced through the Telecommunications (Security) Act 2021 and associated regulations have also prompted operators to better understand their supply chains. Government publications such as the National Semiconductor Strategy, Critical Imports and Supply Chains Strategy, and Critical Minerals Strategy have set cross-sector guidance on how industry and government can work to improve visibility of supply chains and mitigate

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[46] 6G Technologies, Next G Alliance, https://nextgalliance.org/white_papers/6g-technologies/
[47] National Semiconductor Strategy, Department for Science, Innovation and Technology, 2023, https://www.gov.uk/government/publications/national-semiconductor-strategy/national-semiconductor-strategy

risks.[48] There is also telecoms industry representation on the Government's recently established Critical Imports Council.[49]

62. However, while some firms within the sector may feel they have sufficient visibility of their supply chains and appropriate tools to mitigate risks posed by critical dependencies, this is likely to vary significantly between different operators and equipment vendors. Some firms do not have good visibility of their supply chains at the subcomponent level and are not investing in mitigations (such as holding strategic stock) to the same degree as others. Even well-prepared operators and vendors may feel they will lack sufficient notice of events that could disrupt supply chains to take timely mitigations.

63. The introduction of new finished equipment suppliers, while building overall resilience, may also help promote greater diversity in telecoms' overall supply chains by introducing or creating opportunities for new subcomponent suppliers and driving innovation.

Recommendations

64. Despite increased visibility of supply chains, the risks posed by multiple telecoms equipment vendors sharing reliance on a small number of suppliers for critical subcomponents remain a concern. To mitigate these risks, the government should:

   a. **Continue to ensure that the risks of critical dependencies in telecoms equipment supply chains are considered in existing cross-government work to strengthen supply chains and that these measures are adequately impactful to meet telecoms-specific critical dependency risks**. Given the cross-sector nature of many risks to subcomponent supply chains, it is important that telecoms-specific supply chain risks are explicitly fed into efforts to implement the National Semiconductor Strategy, Critical Minerals Strategy, and Critical Imports and Supply Chains Strategy.

   b. **Consider how evidence of critical dependencies in the supply of critical subcomponents could be used to tailor government efforts to build UK capability in telecoms.** For example, the supply of RF devices is one area where evidence shows there may be a concentration of supply. This is also an area where the UK has strong domestic capability that could be leveraged to help grow the UK's role in the telecoms supply chain while also helping to diversify supply to reduce the likelihood of critical dependencies.

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[48] Critical Imports and Supply Chain Strategy, Department for Business and Trade, 2024, https://www.gov.uk/government/publications/uk-critical-imports-and-supply-chains-strategy; UK Critical Mineral Strategy, Department for Business and Trade, 2022, https://www.gov.uk/government/publications/uk-critical-mineral-strategy

[49] Government ramps up work to secure supplies of medicines and smartphone chips, Department for Business and Trade, 2024, https://www.gov.uk/government/news/government-ramps-up-work-to-secure-supplies-of-medicines-and-smartphone-chips

c. **Support operators to stress test plans to manage critical dependency risks in telecoms supply chains**. This should cover operator business continuity plans and 'stress test' exercises, and should ideally seek to encourage a more consistent approach to supply chain visibility and preparedness across operators. It should also identify how government can best provide early warning to operators of events that could disrupt supply chains – including through existing government-industry structures. DSIT should continue to work with Ofcom, the NCSC and operators to support compliance with existing supply chain obligations under the Telecoms Security Act 2021.

d. **Consider how to build new and existing mechanisms for information sharing to ensure industry has visibility of emerging risks to subcomponent supply.** Government can support industry mitigation of subcomponent risks through improved information-sharing where government has early visibility of possible disruption to supply.

Chapter Three: Creating the right environment for diversification

65. Addressing market concentration risks across all parts of the network explored in Chapter Two will depend on making successful use of international engagement, influencing standards development processes and addressing skills gaps that may impede diversification.

Cross cutting recommendations

66. In the preceding sections, the Council has provided a range of recommendations to government to drive progress towards more diverse, resilient, and secure supply chains. Successfully implementing these recommendations will require the government to:

   a. **Ensure government policy on telecoms is coordinated and coherent. As set out in paragraphs 20-24 above, government has an active policy agenda in telecoms.** This is welcome and reflects the importance of telecoms in underpinning the digital economy and as a key enabler for other sectors. However, it is critical that government policies on telecoms and its expectations of industry are coherent, well explained to the sector and provide clear value for money over the long term. It is essential that departmental divides do not dilute or repeat interventions and investments, and that the total impact of government activity on the sector is considered. The creation of DSIT was a welcome step in improving coordination on technology policy and as lead department for telecoms it has an important coordinating role to play.

   b. **Ensure it has access to the data required to track the market and assess attendant security and resilience risks**. As set out in Chapter One, the telecoms equipment market is affected by frequent and rapid changes in commercial conditions and technological advancement. It is therefore essential that the government tracks these developments so it can adapt policy accordingly. This could include working with Ofcom to make best use of data collected for the Connected Nations report and under powers in the Telecommunications (Security) Act 2021.

International cooperation

Progress

67. Concentration in the supply of telecoms equipment is a global issue. The UK comprises a small part of the global telecoms equipment market and cannot shape it alone. It remains essential that the government works with other countries to provide clear and consistent signals to the market and promote common policy requirements to help lower barriers to entry.

68. The Taskforce emphasised that the government should seek to build support for telecoms diversification with a wide range of international partners, position the UK as a thought leader on the issue and identify tangible opportunities for collaboration with international partners.

69. The Council welcomes government activity in this space, which covers a range of multilateral initiatives, including the Global Coalition on Telecoms (GCOT) – which includes a workstream on telecoms diversification – and driving telecoms diversification through the G7, including the grouping's endorsement of the need for open and interoperable approaches to future networking.[50]

70. Bilaterally, the UK has reached a Memorandum of Understanding (MoU) with Australia, deepened engagement with the United States – including through the Atlantic Declaration – formed the UK-Republic of Korea Digital Partnership and agreed the UK-India Collaboration in Future Telecoms.[51] On research and development, the Council welcomes the UK's associate membership of Horizon Europe, the Flexi-DAS project with the Republic of Korea and a shared testbed within the UK-India Future Networks Initiative.[52] The government also hosted the UK's first 'International Telecoms Conference' in June 2023, bringing to London nearly 200 participants from across international governments, industry and academia to show UK thought leadership in telecoms – including diversification.[53] Widespread endorsement of the UK's Open RAN principles by international partners including the Australian, Canadian and US governments and industry groups like the O-RAN Alliance and the Open RAN Policy Coalition also illustrates the UK's role in driving international debate on diversification policy.

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[50] Global Coalition on Telecomunications: joint statement of intent between UK, Australia, Canada, Japan and US, Department for Science, Innovation and Technology, 2023, https://www.gov.uk/government/publications/global-coalition-on-telecommunications-joint-statement-of-intent-between-uk-australia-canada-japan-and-us
[51] See: The Atlantic Declaration, Prime Ministers' Office, 2023, https://www.gov.uk/government/publications/the-atlantic-declaration; UK-Republic of Korea Digital Partnership, Department for Science, Innovation and Technology, 2023, https://www.gov.uk/government/publications/uk-republic-of-korea-digital-partnership
[52] About the Flexi-DAS Project, 2024, https://www.flexi-das.co.uk/; UK-India Future Networks Initiative (UKI-FNI), 2024, https://www.ukifni.org/
[53] International Telecoms Conference – In partnership with DSIT, TechUK, 2023, https://www.techuk.org/what-we-deliver/flagship-events/dsit-international-telecoms-conference.html

Recommendations

71. The Council welcomes the strong leadership position the UK has built in telecoms diversification. Now, having reached bilateral and multilateral agreements with key international partners, it is important that the government leverages these to drive tangible outcomes, while continuing to ensure support for diverse supply chains underpins wider international engagement on telecoms. To do this, the government should:

a. **Continue to use international engagement to support a wide range of policy levers on telecoms diversification. In doing so, the government should strategically target engagement in line with the strengths and priorities of international partners and UK government.** These levers should include:

i. **R&D collaboration:** The government should leverage new and existing international agreements to identify and fund R&D activities to address specific barriers to diversification. This could include multinational mission-driven initiatives to move the dial in specific areas, such as security and power efficiency.

ii. **Support industry and academia to make best use of international R&D opportunities, such as Horizon Europe:** The government should maximise UK participation in the Smart Networks Systems Joint Undertaking to promote openness and interoperability in future generations of telecoms technologies. Government should raise awareness of and help firms navigate Horizon calls for participation. This should involve working closely with the 6G Smart Networks and Services Industry Association (6G-IA) and actively supporting networking to form consortia, both within the UK and with EU Member States. The government could also consider further building on R&D collaborations, for example with the USA and South Korea.

iii. **Encourage government-funded labs to collaborate with international counterparts and those in the private sector:** The UKTL is building an advanced telecoms testing platform that will allow its testing programme to evolve in line with market trends and emerging security threats. UKTL has the potential to work with labs or testing facilities run by other governments, which could enhance UKTL's capabilities and avoid duplication. SONIC's existing capability and relationships should also be leveraged through more formal collaboration with international counterparts and deeper involvement in the O-RAN Alliance, such as by becoming an OTIC.

iv. **Thought leadership:** The government should mobilise the UK's current position as a global thought leader on Open RAN to proactively address emerging risks to telecoms diversification, including single vendor Open

RAN deployments and Open RAN security, in line with international partners.

v. **Attracting inward investment while continuing to protect the UK's strategic capabilities:** The government should continue to promote inward investment into the UK telecoms sector while also securing consistency between the government's wider investment priorities and the security and resilience aims of diversification policy. Investment in the sector should be welcomed, but the government should ensure that UK economic assets are protected against evolving national and economic security risks, including via use of its powers within the National Security and Investment Act 2021.

vi. **Promoting the export of UK products and services:** Access to, and success in, international markets can enable UK telecoms companies to achieve the scale necessary to compete with large suppliers. It will also help drive innovative collaborations between UK companies and those in other countries. The government should support UK companies, including SMEs, to expand their businesses overseas. This should include identifying ways to support UK firms in the Open RAN ecosystem finding new markets to help commercialise their products.

vii. **Standardisation**: The government has made some progress in developing the UK's capacity to influence global standards making processes – against a challenging backdrop of operators reducing their footprint in standards development organisations (SDOs). The government should continue to work with like-minded partners to ensure standards, including for 6G and future telecoms, develop in line with the UK's objectives on interoperability, security and resilience. The government should explore ways to ensure other international engagement – such as joint R&D activity – can contribute to standards.

viii. **Consider further targeted engagement with specific countries**. This could include identifying ways to support India or other countries that are likely to play an important role in future telecoms supply chains.

ix. **Support non-government international engagement to promote international collaboration by industry and academia to support telecoms diversification.** To date, most of the government's international activity on telecoms diversification has been at a government-to-government level. However, close international cooperation between regulators, industry and government laboratories, and academia is also important, including to accelerate the adoption of Open RAN. As noted above, this could involve greater join up between government-funded labs.

b. **Capitalise on the creation of GCOT to make rapid progress on the diversification workstream**. This should include using GCOT to support and

accelerate industry-led Open RAN certification to reduce the systems integration burden on operators and demonstrate meaningful non-financial assistance to industry, paving the way for improved market competition. The UK should also advocate for GCOT to encourage discussion about the security threats and opportunities unique to Open RAN to identify solutions to remaining security concerns; promote federation between labs in different GCOT member countries to reduce duplication and encourage information sharing; and support R&D collaboration.

Standards, patents and intellectual property

Progress on standards

72. The Taskforce was clear about the importance of strengthening the UK's influence in the global telecoms standards development process. Having a stronger role in the standards development process is essential to ensuring the UK is better able to shape telecoms technologies in a way that supports a more diverse supply chain. This is a long-term ambition and will take time to achieve.

73. Now is a critical period to influence the standards that will determine future communications technologies, including to ensure they develop in a way that reduces the risk of new market concentration and vendor lock-in emerging in future. Negotiations on technical standards for 6G are beginning, following agreement of the IMT-2030 Framework in 2023. It is important that the government works to ensure the high-level ambitions for openness, interoperability and security achieved in the Framework are carried through into technical specifications. Telecoms standards will also have a significant influence on the development of adjacent technologies such as AI, quantum communications and satellite communications, as the technologies converge.

74. As set out in Chapter One, the landscape for standards setting is complex. It has evolved since the original Taskforce report and will continue to do so, and it is important that the government's approach adapts accordingly. For example, the ISO/IEC "SMART standards" programme is exploring increased digitisation and machine-readability of standards to aid implementation, which may lead to a significant change in the mechanics of the standards development process and, therefore, the required skillset. The increased use of software, especially open-source derived code, may challenge the focus on Standard Essential Patents (SEPs) within SDOs – the licensing of which currently generates significant revenue for many large vendors – altering the business case for engaging in standards development. However, against this increased complexity, cost pressures linked to challenging commercial conditions mean many businesses have reduced the resources allocated to influencing telecoms standards.

75. While industry should lead standards development, the Council welcomes the progress government has made to foster the UK standards ecosystem and support UK contributions to global standards processes in line with diversification objectives. There has been progress across the four areas set out in the Taskforce report, but also clear opportunities for the government to go further:

    a. **Improving capacity to monitor standards activity**: The Council is pleased that DCMS, and now DSIT, created a dedicated team to focus on telecoms standards and that there has been engagement by this team with both the Council and partners in NCSC and the National Quality Infrastructure (NQI) to help shape policy.

    b. **Growing influence and impact within existing structures**: The previous government took steps to increase its influence in key standards bodies. Some positive examples include DSIT and Ofcom's contributions to the International Telecommunications Union's IMT-2030 Framework, government monitoring of 3GPP, and its work on O-RAN Alliance specifications at ETSI. These are evidence of government intent, but more will be needed. Without a long-term commitment to engage more fully in the critical standards bodies and develop broader UK participation, government will be unable to influence communications standards meaningfully and address concentration risks. Interventions like the UK Telecoms Innovation Network (UKTIN) and the linking of R&D and standards activity will help over time to increase UK influence.

    c. **Developing and delivering a strategic approach**: The previous government's more proactive approach to 6G standards is evidence of a developing strategic approach to telecoms standards. Cross-government coordination appears to be improving, particularly in areas like security where initiatives like UKTL show DSIT, Ofcom, NCSC and others working together to align R&D and standardisation activity. The strong focus on standards and regulation in the National Science and Technology Framework and the overall approach to digital standards as articulated by then Minister Bhatti earlier this year shows an awareness of the need for good coordination and long-term thinking to address the influence challenge. Government should also consider the broader approach to driving change through standards bodies, including by developing a more cohesive influencing approach that covers not just participation but also governance, attendance and coordination.

    d. **Promoting new systems and structures**: The previous government has been proactive in engaging its international partners on its approach to diversification, including on standards issues. The formation of GCOT, discussed at paragraph 70 above, may be a useful vehicle for some of these conversations.

76. While the Council welcomes the government's progress on standards since the Taskforce report, more needs to be done to achieve the influence on standards required to support telecoms diversification meaningfully. At present, government coordination on standardisation can feel piecemeal; a more holistic and forward-

looking strategy is needed, one that encompasses not only telecoms policy teams but also those working on cybersecurity, software, AI and other areas. More needs to be done to improve coordination of existing UK expertise and to draw out the interconnections between different groups, making use of the NQI organisations NPL and BSI.

77. Government will need to decide if it is willing to commit the resources required to match the previously stated public ambitions to increase its influence in standardisation. There is a potential danger that standards coordination, monitoring, and training will become a "box ticking" exercise. The UK has a shrinking and ageing pool of expertise in standardisation. If the government wishes to see a sustained increase in the UK's influence, it needs to engage with existing pools of expertise and corporate activity in the UK, particularly the MNOs, on a long-term basis, and to resource properly its own engagement with standards bodies, including by maintaining and building technical expertise on standards within government to avoid reliance on contractors and consultants.

Progress on patents and intellectual property

78. The Telecoms Diversification Taskforce also noted the need for the government to address challenges associated with Intellectual Property (IP) that were compounding the resilience and concentration issues in the UK's telecoms supply chain. The previous government had taken some definite steps to understand this area better, but the scale of the challenge has only grown; ownership of 5G patent families and SEPs remain very highly concentrated among a small number of companies, none of which are UK owned. The intensely competitive atmosphere in which SEP licences are negotiated, and lack of clarity around patents associated with specific standards (which are self-declared by the IPR owner with little information supplied) still creates substantial barriers to entry for small companies. This has tended to make the most attractive way for an SME to exploit their IPR to sell it to one of the large vendors. The UK footprint in terms of SEPs and registered patents has not substantially improved since the Taskforce report.

79. The Council notes that the Intellectual Property Office have undertaken a substantial review of the framework surrounding SEPs, including licensing issues and Fair, Reasonable And Non-Discriminatory (FRAND) terms. The Council welcomes DSIT's close work with the IPO to ensure the needs of the telecoms sector are properly considered. However, it remains to be seen whether the outcomes of the review (including the IPO's new Resource Hub and any regulatory interventions) will improve the picture. The growing use of open-source technology within the network also present new risks and opportunities in patents and standardisation, as briefly touched on in paragraph 17.

Recommendations

80. Ensuring the UK has a strong voice in telecoms standards development remains vital to ensuring UK interests are represented in future generations of technology, including

the promotion of diverse, resilient and secure supply chains. To support this, the government should:

a. **Continue to improve coordination on standards across and outside of government:** It remains essential that DSIT collaborates on standards, across and outside of government. Government should do more to coordinate existing expertise in standardisation in the UK and draw on that in its policy design. Coordination with the UK's NQI like NPL and BSI should go further, engaging to support policy and strategy as well as technical aspects. As communications technologies advance, it is essential that DSIT activity draws on work going on in related spheres like cyber security and AI standards. Similarly, operators have the most substantial UK footprint in telecoms related SDOs and can help identify key areas of consumer demand and deployment challenges.

b. **Horizon scan for emerging trends in standards development that may act against openness, interoperability and security:** Government should work with partners to understand the potential impacts of upcoming developments in standards on its diversification objectives. As well as monitoring current issues, such as standards relating to the RIC and Open Fronthaul, this should include consideration of the impact of technological trends such as greater integration of AI, quantum and satellite communications into telecoms (as detailed in paragraph 18) and the potential contribution of those industries to telecoms standards. That will require government to analyse the work of standards bodies less traditionally centred on telecoms, such as Institute of Electrical and Electronics Engineers' (IEEE) or IETF, whose work on these technologies will have implications for what operators are able to deploy. Government should also properly consider the impacts of longer-term changes to the dynamics of innovation like the greater use of open-source solutions in networks, which may encourage pools of activity and the development of solutions and de facto standards outside of or in parallel to the existing SDO-focused development process.

c. **Continue to act early on areas of priority in support of diversification and security within SDOs:** Government should build on its successes in engaging at the ITU and elsewhere to seek to mitigate risks to supply chain diversity early in the 6G standardisation process, including to ensure interoperability is realised in technical specifications. As adjacent technology areas converge with telecoms (as detailed in paragraph 19), the government must look more widely than traditional SDOs, for example to bodies such as the IETF and the W3C. DSIT should be working with like-minded nations to make progress, while advancing broader imperatives like the need to champion sustainability and strong security requirements for our critical network infrastructure.

d. **Build DSIT technical expertise in standards and patents:** It is important that government is not solely reliant on external technical expertise in achieving its ambitions to influence open, interoperable, and secure telecoms standards. The government should consider means to build, recruit, and retain personnel with

sufficient technical expertise to better engage with standards development (including Standard Essential Patents), over time and within DSIT. Given the significance of upcoming negotiations around 6G standards and the long-term timeframes of standards negotiation, government should be establishing sustainable in-house technical expertise on standards within departments to help ensure the UK can have enduring influence.

e. **Promote academic, industrial and commercial engagement with standardisation:** Ensuring UK academia and industry is actively engaged in standards is vital to building enduring UK influence in standards and ensuring the UK research and innovation community is atuned to discussions in standards bodies. Government should continue work to drive up UK engagement with standardisation, in particular by helping to make the commercial case to businesses. However, government should be realistic about the barriers faced by businesses, particularly SMEs, when trying to engage with standards, and should consider deploying targeted and long-term support to companies with the most promising technologies. This should be fed into the design of future research funding but should also go beyond that. Government should not rely too heavily on UKTIN as a single solution to this challenge. As noted in paragraphs 82-87 below, a key barrier to increasing UK participation in standards processes is the shrinking and ageing pool of UK expertise and experience. Expertise in standards development is not a distinct skillset that can be developed in isolation from technical knowledge of the underlying technology. Addressing skills gaps in standards will therefore need to be achieved through sustained efforts to grow UK expertise and capability in key technology areas.

f. **Continue to address IPR challenges without ignoring commercial concerns:** Government should accelerate steps to address IPR and SEPs-related barriers to diversification in the telecoms market. In particular, to avoid uncertainty for industry, the IPO should make public any regulatory interventions they seek to make. However, government also needs to drive up the overall level of patent filing and see this as a key component of its approach to standardisation too.

Skills

Progress

81. The Taskforce previously identified skills gaps as a key barrier to diversification and the UK's effort to become a leader in the development and adoption of telecoms technologies, in part because deployment of open and interoperable solutions like Open RAN creates a need for new skill profiles. This is against a backdrop of both a long-term skills gap and recruitment challenges in the telecoms workforce, driven by factors such as an ageing talent pool, poor gender diversity and unclear career

pathways. Building and maintaining market diversity and UK capability in telecoms requires a strong education, skills, and talent pipeline.

82. The availability of skills and expertise, and where they are located within the ecosystem, can impact the ability of operators to build and operate their networks. This could be a factor in determining how easy it is for operators to switch vendors or deploy multi-vendor solutions. As the Taskforce identified, telecoms is not a single technical discipline and some of the technological trends identified in Chapter One could worsen the skills gap. For example, greater use of AI in telecoms will result in higher demand for scarce AI skills, which could result in expertise being concentrated in a small number of dominant vendors best able to attract candidates, exacerbating market concentration. The geographic location of relevant interoperability skills is also important. Extensive reliance on firms or skills located overseas could also pose a resilience risk to UK networks.

83. The Council recognises that embedding skills to support diversification will take time, as will action to address long-term structural changes in the telecoms workforce. Skills gaps remain a barrier to diversification. In particular:

   a. A lack of skills in specific areas required to promote diversification:

      i. **Integration and systems engineering.** Integrating separate components from multiple suppliers in Open RAN, the core network or OSS/BSS relies on systems integration and engineering skills, which involve knowledge of hardware, software, wireless communications, and network management. There is also greater need for end-to-end knowledge of the network for open networks compared to traditional RAN. A lack of these skills may impede operators' ability to deploy more complex solutions and result in them leaning towards single-vendor solutions.

      ii. **Software development and management**. The demand for software skills is expected to increase as networks become more cloud-based and less reliant on traditional hardware. Virtualisation of functions is essential to enable the flexibility, innovation and efficiency of Open RAN, and there is an increase in demand for skills to support this shift in architecture. Skills in the co-design of hardware and software components will be particularly important for Open RAN compared to traditional RAN, as the nature of open interfaces requires integration between hardware and software components. Making the most of opportunities presented by the RIC relies on strong software, wireless and AI skills among operators and vendors. Many of these skills are transferrable to other sectors.

      iii. **Standards**. The Taskforce noted a need for the government to take a more holistic view of skills required for engagement with telecoms standards, to ensure the UK could influence the development of new generations of technology. A shortage of standards skills remains a barrier to growing the UK's contributions to standards setting. However, the skills

necessary to be effective in standards processes cannot be developed in isolation from deep knowledge of the technology being standardised and should be seen as an augmentation of existing engineering skillsets. Industry should therefore be encouraged to invest in strengthening engineering skills in areas such as electronics, communications, radio frequency and software engineering, to develop a strong cohort of industry representatives well placed to participate in standards development processes.

iv. **Disconnect between the skills some academic courses provide and those the sector needs**. This can mean that new entrants to the telecoms job market require more training – adding costs for industry and acting as a barrier to attracting talent to the sector.

v. **The telecoms sector can be viewed by new talent as less attractive than other sectors, making recruitment difficult**. A range of factors including relative pay, clarity over career pathways and the demographic composition of the telecoms sector can deter new entrants. The STEM skills required by telecoms and to promote diversification, such as in software, AI and systems integration, are also needed for many other UK sectors, including the UK's other critical technologies: AI, semiconductors, quantum and engineering biology. There is a consensus that the UK already has a shortage of these skills, and demand is likely to grow as many other sectors automate.

84. The Council welcomes government action to date to address telecoms skills gaps, including:

a. Establishing the UKTIN Talent Programme, which facilitates the Talent Advisory Group to support collaboration among industry, academia, and government to address telecoms skills gaps. UKTIN uses marketing, events, and publications to raise awareness of the opportunities a career in telecoms can provide.

b. The UK Telecoms Lab will also support the wider skills agenda, producing skills awareness products.

c. Creating new EPSRC-funded Centres of Doctoral Training (CDTs), which will train thousands of students and support leading research across critical technologies, including telecoms.[54]

d. As part of the Open Networks Programme, DSIT concluded a skills study in March 2024 that outlines the current and future landscape for open networking skills in the UK. It identified many of the challenges set out in paragraph 73 above, including a general shortage of STEM skills across the economy, the impact of demographics on the telecoms workforce and problems in attracting

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[54] £1 billion doctoral training investment announced, UKRI, 2024, https://www.ukri.org/news/1-billion-doctoral-training-investment-announced/

talent. It also considers possible solutions, including improving government and industry's understanding of the skills requirements needed to promote Open RAN, improving awareness of telecoms careers and supporting diversity in the workforce. This provides an evidence base for government and will help support assessment of the feasibility of interventions. Research and development projects to support diversification under the government's Open Networks Programme have also had a positive secondary effect in helping promote the skills needed for open networking.

e. Helping to build domestic skills in technology areas adjacent to (and increasingly convergent with) telecoms. This includes AI, by providing funding for postgraduate conversion courses in AI, and establishing the Flexible AI Upskilling Fund pilot scheme which will support skills training in SMEs.[55] Support to help change careers is also welcome as means to encourage a wider range of perspectives and cross-fertilisation of ideas between sectors, which can promote innovation.[56]

f. The previous government took steps to support the skills needed to strengthen the UK's role in standards development, including establishing the UKTIN Standards Expert Working Group to upskill UK SMEs on engaging with SDOs.

85. The Council also recognises that industry is working to fill skills gaps, by offering training for current staff, and graduate and apprentice programmes for young talent. Industry bodies such as the Institute of Telecoms Professionals (ITP),[57] the Institution of Engineering and Technology (IET)[58] and the Royal Academy of Engineering (RAEng)[59] also run initiatives such as apprenticeships and training, and offer career advice to help promote the careers in telecoms. Ensuring a strong pool of recruits with key foundational skills in maths, physics, electronics, and software engineering are ultimately key to meeting the skills needs of the telecoms sector.

Recommendations

86. Addressing the telecoms skills gap will take time. It is important that the government – working with industry – continues to help ensure the UK telecoms workforce has the skills needed to deliver the open and interoperable solutions that will promote a more diverse supply chain, and to promote UK capability in telecoms more generally. This includes key foundational skills in IP networking, software engineering, radio frequency and electronics. To do this, the Government should:

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[55] Flexible AI Upskilling Fund pilot, Department for Science, Innovation and Technology, 2024, https://www.gov.uk/government/publications/flexible-ai-upskilling-fund; Postgraduate conversion courses in data science and artificial intelligence, Office for Students, 2023, https://www.officeforstudents.org.uk/for-providers/student-choice-and-flexible-learning/postgraduate-conversion-courses-in-data-science-and-artificial-intelligence/
[56] For example, The Skills Toolkit, The National Careers Service, 2024, https://nationalcareers.service.gov.uk/find-a-course/the-skills-toolkit
[57] The Institute of Telecommunications, 2024, https://www.theitp.org/
[58] The Institution of Engineering and Technology, 2024, https://www.theiet.org/
[59] Education and Skills, Royal Academy of Engineering, 2024, https://raeng.org.uk/education-and-skills

a. **Ensure the specific skills associated with diversification are covered in government interventions (including advisory bodies) to improve skills in telecoms technologies.** In doing this, the government should also be mindful of how skills that are adjacent to (and increasingly convergent with) the telecoms sector can be used to support diversification.

b. **Explore how R&D interventions can be used to better promote the sharing and development of skills (e.g. through secondments).** This could be supported through establishing a joint agreement with industry around a long-term plan to build telecoms R&D capability in the UK. Supporting industry and academia to provide international secondments and fellowships would also encourage collaboration, help share best practice and strengthen the UK's global standing in telecoms.

c. **Identify international centres of excellence in telecoms skills that could provide a model for addressing UK skills gaps**. There are concentrations of telecoms skills, often centred around industrial-academic partnerships – such as in Malaga, Spain – that could provide a model for strengthening UK skills in telecoms.[60]

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[60] Malaga TechPark, 2024, https://www.pta.es/en/

Conclusion and summary of recommendations

87. In the years since the original 5G Diversification Strategy and the Taskforce report, government, working with industry, has made progress in addressing the security and resilience risks caused by concentration within the telecoms equipment market. Action has been taken across all four pillars of the original Taskforce report and positive impacts on the market are beginning to emerge.

88. However, in the short to medium term, the UK will still be highly dependent on a few vendors of 5G RAN equipment. It is clear that the government needs to work with domestic network operators, the incumbent vendors – Nokia and Ericsson – as well as other parts of industry to consider if further mitigations are needed to manage the security and resilience risks this poses. This should include work with UKTL to test the security of 5G RAN equipment.

89. It is important that the government continues to encourage more vendors to sustainably enter the market. To promote diversity of supply in the RAN, the government needs to revisit efforts to create the conditions to attract one or more additional scale vendors in the UK 5G RAN market (which is likely to offer O-RAN Alliance compliant products). Ongoing diversification in the global RAN market indicates there is scope for established vendors to enter the UK market. The government should work with UK operators and vendors without a large presence in UK networks to identify remaining barriers to entry to the UK market and routes to deployment.

90. Open RAN is close to attaining performance parity with traditional RAN solutions, in part due to UK government support for its development. As the technology and market matures towards the end of the decade, the adoption of Open RAN should promote greater diversity of supply. The Council recommends the government take decisive steps to continue to drive the development and deployment of Open RAN solutions, in line with the Open RAN principles and in a way that promotes open, interoperable and secure networks.

91. The Council also remains concerned about the security and resilience risk presented by concentration emerging in other parts of the UK network. Since the original Taskforce report, the UK mobile core network is increasingly delivered by a small number of vendors. It is important the government understands the security and resilience implications of this, and, if necessary, considers what mitigations are required to reduce any associated security and resilience risk. The government should continue to keep market concentration under review, as telecoms technology and the market evolve over time. At the same time, government should continue to work to address risks posed by multiple telecoms equipment vendors sharing reliance on a small number of suppliers for critical subcomponents within the RAN.

92. The UK is one part of a global equipment market and an even larger telecoms sector. The previous government had taken steps to build support for telecoms diversification with a wide range of international partners, and the Council recommends this continue – including by capitalising on new opportunities through the UK's associate Horizon membership and the Telecoms Diversification workstream of the Global Coalition on Telecoms.

93. Cross-cutting work on issues like skills, standards, and IP is also required to achieve a more diverse telecoms equipment market. It is key the government commit appropriate resource, including technical skills, to these issues to ensure the right environment is developed to support a competitive and diverse telecoms sector.

Future independent advice to government on telecoms diversification policy

94. Delivering diverse, secure and resilient telecoms supply chains is a long-term policy aim that will require sustained effort from government and industry. In deciding and implementing the next phase of the government's policy response, it is important that the government continues to take independent advice from industry and academia.

95. The Telecoms Supply Chain Diversification Advisory Council has played this role to date, although the tenure of many members is set to expire in autumn 2024. It is sensible that governance structures for policy advice on telecoms are considered in the round and it may be appropriate for future independent advice on diversification policy to be provided by a single body with a broader remit for telecoms policy. This will help ensure coherence across the government's activity and avoid fragmentation.

Glossary

Acronym	Meaning
3GPP	3rd Generation Partnership Project
6G-IA	6G Smart Networks and Services Industry Association
AI	Artificial Intelligence
BGP	Border Gateway Protocol
BSI	British Standards Institution
BSS	Business Support Systems
CDT	Centre for Doctoral Training
CMA	Competition and Markets Authority
DCMS	Department for Culture, Media and Sport (formerly Department for Digital, Culture, Media and Sport)
DSIT	Department for Science, Innovation and Technology
EPSRC	Engineering and Physical Sciences Research Council
ETSI	European Telecommunications Standards Institute
ETSI (PAS)	European Telecommunications Standards Institute (Publicly Available Specifications)
FRAND	Fair, Reasonable And Non-Discriminatory
GCOT	Global Coalition On Telecoms
GSM	Global System for Mobile Communications

GSMA	GSM Association
ICANN	Internet Corporation for Assigned Names and Numbers
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers'
IET	Institute of Engineering and Technology
IETF	Internet Engineering Task Force
IMT	International Mobile Telecommunications
IP	Intellectual Property
IPO	Intellectual Property Office
IPR	Intellectual Property Rights
ISO	International Organisation for Standardisation
IT	Information Technology
ITU	International Telecommunication Union
ITP	Institute of Telecoms Professionals
MNOs	Mobile Network Operators
MOU	Memorandum of Understanding
NCSC	National Cyber Security Centre
NPL	National Physical Laboratory
NQI	National Quality Infrastructure

NTN	Non-Terrestrial Networks
Ofcom	Office of Communications
ONP	Open Networks Programme
OSS	Operations Support Services
OTIC	Open Testing and Integration Centre
PCB	Printed Circuit Board
PON	Passive Optical Networks
PSTN	Public Switched Telephone Network
R&D	Research and Development
RAEng	Royal Academy of Engineering
RAN	Radio Access Network
RF	Radio Frequency
RIC	RAN Intelligent Controller
SDOs	Standards Development Organisations
SEP	Standard Essential Patent
SIs	Systems Integrators
SMEs	Small and Medium-sized Enterprises
SMO	Service Management and Orchestration
SoCs	Systems on Chip

SONIC	SmartRAN Open Network Interoperability Centre
STEM	Science, Technology, Engineering and Mathematics
TIP	Telecom Infra Project
UKTIN	UK Telecoms Innovation Network
UKTL	UK Telecoms Lab
VoIP	Voice Over IP
W3C	World Wide Web Consortium
WIS	Wireless Infrastructure Strategy