



Department for  
Digital, Culture,  
Media & Sport

# UK TELECOMS SUPPLY CHAIN REVIEW REPORT



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Media & Sport

# UK TELECOMS SUPPLY CHAIN REVIEW REPORT

Presented to Parliament  
by the Secretary of State for Digital, Culture, Media and Sport  
by Command of Her Majesty

July 2019



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# Ministerial Foreword

The security of the UK's telecoms networks is of paramount importance. The Government has ambitions to have the majority of the population covered by a 5G signal by 2027, with 15 million more premises connected to full fibre by 2025, and nationwide full fibre coverage by 2033. The potential economic and social benefits of 5G and full fibre digital connectivity can only be realised if we have confidence in the security and resilience of the underpinning infrastructure.

As technologies grow and evolve, we must have a security framework that is fit for purpose and ensures the UK's critical national infrastructure remains safe and secure both now and in the future. That is why I announced the Telecoms Supply Chain Review in November last year, to provide a comprehensive assessment of the supply arrangements for the UK's telecoms networks. The Government worked closely with industry, international partners, and the National Cyber Security Centre to ensure the findings of the Review are supported by expert technical advice, combined with a complete view of the UK market position.

The findings of the Review show that there is much work to be done. It is clear we need to strengthen policy and regulation to better ensure telecoms cyber security. That is why this Review recommends the establishment of a new, robust security framework for the UK telecoms sector, with a set of new Telecoms Security Requirements at its heart, that will provide clarity to telecoms operators, and will ensure that they operate secure and resilient networks, and manage their supply chains appropriately. We will also legislate to put the telecoms security requirements on a statutory footing, strengthen the powers of the regulator, Ofcom, to enforce the security requirements, and provide new national security powers for government to respond to supply chain risks in the future.

It is also important that we have a competitive, sustainable and diverse supply chain to help both drive innovation in the market and reduce the risk of dependency on individual vendors. We will, therefore, pursue a targeted diversification strategy to support the growth of new players in the parts of the network that pose security and resilience risks.

We already have world class arrangements in place to mitigate national security risks to UK telecoms, but there is more to do as we move to the next generation of networks. Before taking decisions on how we respond to vendors that pose the highest risks it is important that we take account of the potential implications of the US entity listing on the market as a whole. These decisions will be taken as soon as we have further clarity.

I believe this Review sets out a clear way to ensure the security framework for telecoms is robust, high quality, and meets the needs of future technologies. Delivering the outcomes of this Review can only be achieved through continued collaboration from Government, the Regulator, the intelligence agencies and industry.



A handwritten signature in black ink that reads "Jeremy Wright".

RT HON JEREMY WRIGHT MP  
SECRETARY OF STATE FOR DIGITAL, CULTURE, MEDIA & SPORT

# EXECUTIVE SUMMARY

# Executive summary

The UK takes the security of our telecoms networks extremely seriously. Next generation networks like 5G raise security risks as well as economic opportunities. This is why the Government has undertaken a comprehensive Review of the supply arrangements for the UK telecoms Critical National Infrastructure (CNI). The Review has addressed three key questions:

- a. How should we incentivise telecoms operators to improve security standards and practices in 5G and full fibre networks?
- b. How should we address the security challenges posed by vendors?
- c. How can we create sustainable diversity in the telecoms supply chain?

In response to the Review's findings, we will establish a new, robust security framework for the UK telecoms sector, marking a significant shift from the current model. The new framework is necessary to safeguard the UK's national security interests and will build on our existing capabilities. It will provide clarity to industry, whilst providing the necessary flexibility and powers for the Government to respond appropriately as risks, threats and technology change.

In light of recent US actions in relation to the telecoms supply chain, we are not yet in a position to make final decisions on the controls that will be applied to individual high risk vendors.<sup>1</sup>

## 5G and full fibre are critical technologies for UK prosperity

As outlined in the Future Telecoms Infrastructure Review (FTIR), the widespread deployment of 5G and full fibre networks is a primary objective of Government policy.<sup>2</sup> These networks will be the enabling infrastructure that drives future economic growth. The next few years will see increased investment in these networks, with the first 5G consumer services launched in May 2019 and over half the country expected to get full fibre connections by 2025.

The security of these networks is in the UK's economic interest. We define security as safeguarding the availability, integrity and confidentiality of the UK's telecoms networks. If these networks are judged to be insecure, their usage and economic value will be significantly reduced.

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<sup>1</sup> On 16 May the US Department of Commerce put Huawei and 68 affiliated entities on the Entity List – a move that means US companies will now have to apply for a licence to sell technology to them. This may have implications for the market as a whole.

<sup>2</sup> The Government is committed to 15 million premises connected to full fibre by 2025 and nationwide coverage by 2033. The UK also wants to be a world-leader in 5G, with a target to have the majority of the population covered by 5G networks by 2027.

## 5G and full fibre networks pose security challenges

While 5G and full fibre networks do not undermine our current cyber security principles and techniques, they do create new challenges for security and resilience, including:

*5G's technical characteristics create a greater surface for potential attacks.* The technical characteristics of 5G increase the risk profile of these networks compared to previous generations of networks. 5G networks will run at much faster data speeds and will be based on software running on commodity hardware, rather than proprietary hardware. Over time, to achieve the full potential of 5G, some of the 'core' functions will move closer to the 'edge' of the network. Critically, as core services move closer to the edge of the network, it will also be necessary to push out the security services that support and protect them.

*The speed, scale and processing power of these new technologies will enable a wide range of new services.* While previous mobile generations connected people to people, 5G has the potential to connect a vast network of people, objects and communication systems (e.g. internet of things), including in critical sectors. This brings a new dimension to security risks, given the greater dependence that UK CNI is likely to have on 5G infrastructure compared to 3G/4G.

*These new technologies could face an increasingly hostile threat environment.* Over the past two years, the UK has, based on National Cyber Security Centre (NCSC) assessments, attributed a range of malicious cyber activity to Russia and China, as well as North Korea and Iranian actors. Certain state actors have the intent and capability to carry out espionage, sabotage and destructive or disruptive cyber attacks, including through access to the telecoms supply chain. These actors may seek to exploit weaknesses in telecoms service equipment, and/or in how operators build and run their networks, in order to compromise security.

### Scope of the Review

The Review examined the supply arrangements for UK telecoms CNI. The Review has been informed by expert technical advice from the NCSC on cyber security considerations, economic analysis from KPMG, and discussions with industry and the UK's international partners.

The Review's starting-point was a set of concerns about the security and resilience of the UK's telecoms networks, largely related to: (a) inadequate industry practices overall, driven by a lack of incentives to manage security risks to an appropriate level; and (b) the risk of national dependency on a small number of viable suppliers.

#### *a) Inadequate industry practices driven by a lack of incentives to manage risk*

The responsibility for the management of security and resilience risks for UK telecoms is currently shared between the Government, Ofcom and industry. Telecoms operators are responsible for assessing risks and taking appropriate measures to ensure the security and resilience of their

networks. However, there can be tensions between commercial priorities and security concerns, particularly when these impact on costs and investment decisions.

Equally, the business models of vendors do not always prioritise cyber security sufficiently. An extreme example of this can be seen in the conclusions of the 2019 Huawei Cyber Security Evaluation Centre (HCSEC) Oversight Board report.<sup>3</sup> The flaws identified in the report are the result of practices that may have achieved good commercial outcomes but have resulted in poor cyber security.

It is also the case that the role of policy and regulation in defining and enforcing telecoms cyber security needs to be significantly strengthened.

#### *b) National dependency on a small number of viable suppliers*

The lack of diversity across the telecoms supply chain creates the possibility of national dependence on single suppliers, which itself poses a range of risks to the security and resilience of UK telecoms networks. The dependency risk is most pronounced in the mobile and fixed access networks where supply is dominated by three global players – Huawei (the UK market leader), Ericsson and Nokia. There is a greater diversity of supply in core network functionality.

This concern is compounded by the presence of systemic security vulnerabilities, as identified in the HCSEC Oversight Board report.

### **The international picture – no universal solutions**

We observe that countries are taking a range of different approaches to 5G security, based on their own circumstances, network architectures, capabilities and risk assessments, while sharing common security objectives.

The UK is able to pursue the approach outlined in this Report because we already have in place a number of pre-conditions for telecoms security that the new regime, described below, will build on, namely:

- an established regulatory framework that can be enhanced;
- a world-class cyber security agency (NCSC) that works closely with telecoms operators and vendors to mitigate risks;
- telecoms operators with the expertise and resources to meet new security requirements; and
- telecoms networks that are of sufficient scale to enable technical risk mitigations.

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<sup>3</sup> <https://www.gov.uk/government/publications/huawei-cyber-security-evaluation-centre-oversight-board-annual-report-2019>. The findings of the 2018 and 2019 HCSEC Oversight Board reports are a key input to the Review.

## **The Review's proposals**

The range and nature of the security risks identified in this Review requires a strong policy response.

In response to the Review's findings, we will establish a new, robust security framework for 5G and full fibre networks, building on the current model. The new framework will:

- Ensure operators build and operate secure and resilient networks, and manage their supply chains accordingly, and
- Assess the risks posed by vendors to network security and resilience, and apply proportionate and targeted controls to mitigate the risks.

The new security framework will have three key components:

### ***New Telecoms Security Requirements (TSR)***

The foundation for the framework is a new set of security requirements, which will be finalised in conjunction with industry. The TSR will raise the height of the security bar and require telecoms operators, overseen by Ofcom and Government, to design and manage their networks to meet new requirements. The TSR will provide clarity to industry on what is expected in terms of network security.

### ***Establishing an enhanced legislative framework for security in telecoms***

The new requirements will be underpinned by a robust legislative framework. We will pursue legislation at the earliest opportunity to provide Ofcom with stronger powers to allow for the effective enforcement of the TSR and to establish stronger national security backstop powers for Government. Until the new legislation is put in place, Government and Ofcom will work closely and cooperatively with all UK telecoms operators to ensure adherence to the new TSR on a co-operative basis, but with the understanding that they will be legally enforceable when legislation is in place.

### ***Managing the security risks posed by vendors***

The Review concluded that there should be a 'three lines of defence' approach in relation to managing the risks posed by vendors:

- Require operators to subject vendors to rigorous oversight through procurement and contract management. This involves operators requiring all their vendors to adhere to the new TSR;
- Require operators to work closely with vendors, supported by Government, to ensure effective assurance testing for equipment, systems and software, and support ongoing verification arrangements; and

- Impose additional controls on the presence of certain types of vendors which pose significantly greater security and resilience risks to UK telecoms. In considering what those controls should be, it is necessary to address the identified security risks, whilst seeking to minimise the costs to industry and the wider economy.

When taken together, these measures will create a robust new security regime for UK telecoms. Most importantly, this new framework will allow us to respond as threats, risks and technology changes, including strengthening the controls if needed in the future.

The Government is not yet in a position to make a final decision on individual high risk vendors and the additional controls that will be applied to them. We must take reasonable account of the recent measure from the US Government to add Huawei to the US Entity List and subsequently issue a Temporary General Licence (see below). These measures could have a potential impact on the future availability and reliability of Huawei's products together with wider market impacts, and so are relevant considerations, alongside other factors.

## Ensuring a competitive, sustainable and diverse supply chain

The Government's view is that there is a strong requirement for policy interventions to create a more diverse and competitive supply chain over the longer-term. This will be critical to drive higher quality, innovation and reduce the risk of dependency on individual vendors.

The Government will pursue a targeted diversification strategy, supporting the development and growth of new players in those parts of the network that pose security and resilience risks. As part of the UK's modern industrial strategy, we will promote policies that support new entrants and the growth of smaller players, including R&D support, promoting interoperability and demand stimulation, for example through the Government's 5G Trials and Testbeds (5GTT) Programme. The Government will also seek to attract established scale players to the UK market. Given the globalised nature of the telecoms supply chain, we are willing to work with international partners to support market diversification.

## US Entity List

On 16 May 2019, the US Government added Huawei Technologies Ltd and 68 affiliates to the Entity List on national security grounds. US companies now have to apply for a licence to export, re-export or transfer a specified range of goods, software and technology to Huawei and named affiliates, with a presumption of denial. On 20 May, the US government issued a 90-day Temporary General Licence that authorises transactions in relation to specified areas.

In light of the Entity Listing and Temporary General Licence and their potential impact, the Government advises UK network providers who are users of affected products and services to ensure they take appropriate measures to manage any business continuity, resilience and security risks to their networks.

## Next steps

The Government will establish a new, robust security framework for the UK telecoms sector. This new policy framework will be supported by the NCSC's existing risk mitigation model, adapted as necessary for 5G and full fibre technologies.

The Government will take forward the conclusions of the Review, focusing on the following next steps:

- With Ofcom, we will shortly consult with industry on the draft TSR;
- We will identify the most appropriate legislative vehicle/s to pursue the policy and regulatory changes required to enforce the TSR;
- We will continue to work with international partners to improve the standards of cyber security across global telecoms markets; and
- Continue to monitor and better understand the impacts of the entity listing so we can take a final decision in due course.

We will develop and pursue a new diversification strategy – including by working with our international partners – to ensure a competitive, sustainable and diverse supply chain.

The Government will keep the new security framework under regular review, making changes as necessary as threats, risks, and technology evolve.



# 1 INTRODUCTION

# Introduction

1.1 The Telecoms Supply Chain Review (the 'Review') launched in October 2018 with the aim of establishing an evidence-based policy framework for the telecoms supply chain, taking account of security, quality of service, economic and strategic factors.

1.2 The security and resilience of 5G and full fibre networks cannot be reduced to simple, binary choices. The context for the Review is a complex global threat environment, and a complex global market. The Review has not focused on a specific company or country of origin, rather it has undertaken a holistic assessment of the supply arrangements for UK telecoms.

1.3 The Review's starting-point was a set of concerns about the provision of equipment for both 5G and full fibre networks – these were largely related to the overall quality of software engineering, under-investment in cyber security, and a growing dependence on a small number of viable vendors, including high risk vendors.<sup>4</sup> If 5G and full fibre networks are going to deliver significant economic benefits, their deployment must be secure and resilient.

1.4 The terms of reference for the Review focused on supply chain arrangements. However, the analysis conducted has identified unbreakable links between supply issues and the wider security, resilience and operation of telecoms networks. This is reflected in the Review's conclusion that we need to establish a new, overarching security framework for the telecoms sector, covering operators and vendors.

## Scope of the Review

1.5 The Review focused on telecoms Critical National Infrastructure (CNI) supporting public telecommunications networks and services, as defined in the Communications Act 2003. It covered terrestrial infrastructure and those parts of the network most critical to the operation of 5G and full fibre, including: access network functions,<sup>5</sup> core network functions, transport and transmission functions, and management systems.<sup>6</sup> For each network component, consideration was also given to the in-life support arrangements. The terms of reference for the Review were published on gov.uk.<sup>7</sup>

## Governance of the Review

1.6 The Review engaged with the UK telecoms industry, including telecommunications providers and equipment suppliers. This included, amongst other things, structured interviews.

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<sup>4</sup> Consideration of high risk vendors is covered at paragraph 5.22.

<sup>5</sup> Excluding end-user devices like home broadband routers or mobile handsets.

<sup>6</sup> Specifically operational support systems (OSS) and business support systems (BSS).

<sup>7</sup> <https://www.gov.uk/government/publications/telecoms-supply-chain-review-terms-of-reference>

1.7 The National Cyber Security Centre (NCSC) provided expert technical advice to the Review on the cyber security risks facing 5G and full fibre networks. The Review appointed KPMG as independent consultants to undertake economic analysis of the telecoms supply chain.

### **International approach – no universal solutions**

1.8 The Review has taken account of the approaches to telecoms security being considered by the UK's international partners. We observe that countries are taking a range of different approaches to 5G security, based on their own circumstances, capabilities and risk assessments, while sharing common security objectives.

1.9 In May this year, the Prague 5G Security Conference brought around 30 countries together to discuss the security of 5G networks. The UK Government's approach in this Report is consistent with the perspectives and principles set out at Prague.<sup>8</sup>

1.10 Improving cyber standards across the telecoms sector should be a global effort, reflecting the international reach of major operators and vendors. The UK will continue to work with international partners to take forward international discussions on principles to underpin network security.

### **The rationale for policy intervention to address network security risks**

1.11 The responsibility for the management of security and resilience risks to UK telecoms is shared between the Government, Ofcom and industry. Telecoms operators are responsible for assessing risks and taking appropriate measures to ensure the security and resilience of their networks. However, there can be tensions between commercial priorities and security concerns, particularly when these impact on costs and investment decisions. Equally, the business models of vendors have not always prioritised cyber security sufficiently. An extreme example of this can be seen in the conclusions of the 2019 Huawei Cyber Security Evaluation Centre (HCSEC) Oversight Board report. The flaws identified in the report are the result of practices that may have achieved good commercial outcomes but have resulted in poor cyber security.

1.12 The Review has concluded that the current level of protections put in place by industry are unlikely to be adequate to address the identified security risks and deliver the desired security outcomes. This represents a 'market failure' from a policy perspective.

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<sup>8</sup> The Chairman's statement sets out recommendations for consideration by national governments. <https://www.vlada.cz/en/media-centrum/aktualne/prague-5g-security-conference-announced-series-of-recommendations-the-prague-proposals-173422/>

**1.13** The fact that the telecoms market is not working in a way that incentivises good cyber security is due to a combination of factors:

- Insufficient clarity on the cyber standards and practices that are expected of industry,
- Insufficient incentives to internalise the costs and benefits of security. Commercial players are not exposed to the full costs and consequences of security failures; security risks are borne by Government, and not industry alone,
- A lack of commercial drivers because consumers of telecoms services do not tend to place a high value on security compared to other factors such as cost and quality, and
- The complexity of delivering, monitoring and enforcing contractual arrangements in relation to security.

**1.14** It is the case that the role of policy and regulation in defining and enforcing telecoms cyber security needs to be significantly strengthened to address these issues.

The background features a large, abstract composition of geometric shapes. A bright pink triangle occupies the top right corner, extending towards the center. A lighter pink shape is visible in the top left corner. The remaining area is white. The text is centered in the white area.

# **2 THE EVOLUTION OF 5G AND FULL FIBRE NETWORKS**

# The Evolution of 5G and Full Fibre Networks

2.1 The deployment of 5G and full fibre networks across the UK is a primary objective of Government policy. The Government's *Future Telecoms Infrastructure Review* (FTIR)<sup>9</sup> set out ambitious targets to deliver 15 million premises connected to full fibre by 2025 and nationwide coverage by 2033. The UK also wants to be a world-leader in 5G, with a target for the majority of the population to be covered by 5G networks by 2027.

2.2 These new technologies are expected to transform how we work, live and travel – providing opportunities for new and wide-ranging applications, business models, and increased productivity.

2.3 The next few years will see increased investment in these networks. The first 5G consumer services were launched in May 2019. Full fibre deployment is also gaining pace with c.2 million premises now able to be connected.

2.4 Increased reliance on these new networks will increase the potential impact of any disruption and means there is a need to reassess the security framework.

2.5 This section provides an overview of 5G and full fibre networks, how they are likely to evolve, and what this means for the security and resilience of UK telecoms.

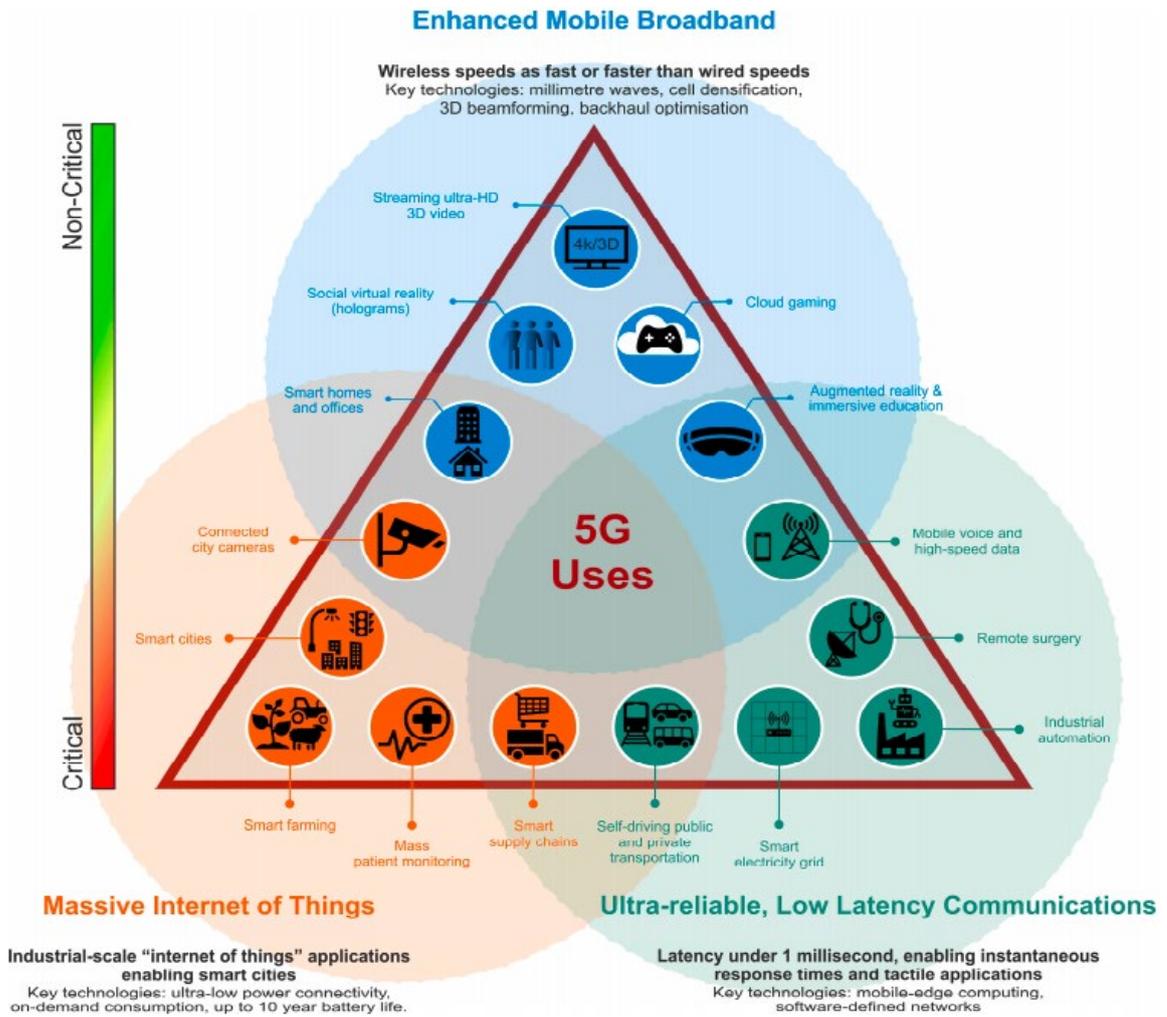
## 5G landscape

2.6 *5G is the next generation of mobile technology and is the successor to 4G LTE.* It will provide new technical capabilities, including higher data rates, ultra-reliable and low latency (minimal time lag) communications, and massive machine-to-machine communications. Figure 1 sets out the range of potential 5G use cases.

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<sup>9</sup> <https://www.gov.uk/government/publications/future-telecoms-infrastructure-review>

**Figure 1: Capabilities of 5G**



2.7 5G has the potential to generate significant economic benefits across industries. The technical capabilities of 5G have the potential to enable innovative new services in manufacturing (e.g. industrial Internet of Things and factory robotics), connected and autonomous vehicles (CAVs), smart cities and smart agriculture.

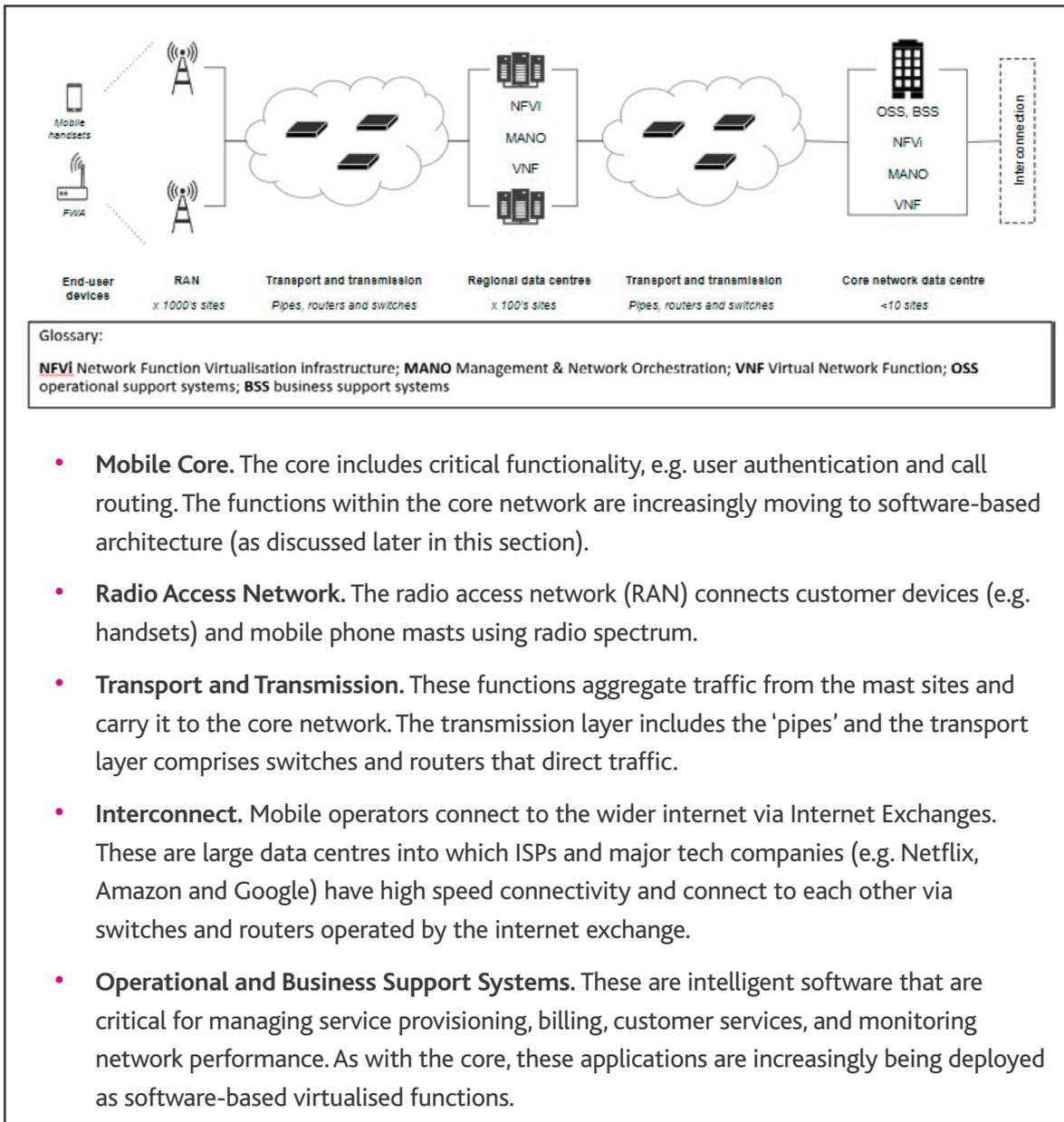
2.8 The first wave of 5G will focus on delivering enhanced mobile and fixed wireless access broadband services. The first 5G deployments will be used to provide additional network capacity in highly populated areas. 5G will mainly be deployed on existing macro-cell sites and, where necessary, on additional sites using small cells. There remains greater uncertainty about the business models for new 5G services for industrial and critical sectors, as described in para 2.7.

**5G network architecture and key risks**

**Key components of a 5G network**

2.9 A typical 5G network comprises different layers which perform discrete but interrelated functions, as described in figure 2 below.

**Figure 2: Parts of a 5G network**



**5G will involve some network architecture changes that may alter its risk profile compared to legacy networks**

2.10 Whilst broadly comprising the same components as 3G/4G, 5G involves some key differences which may change the risk profile of these networks. These are described below.

2.11 *5G networks will behave differently.* In the short term, upgrades to the core will ensure that there is smooth handover and aggregation of capacity between 4G and 5G networks. In the longer term, new 5G use cases will require dedicated bandwidth and guaranteed service quality (using 'network slicing'). Much of this new functionality will be delivered by new software functions hosted in the core.

**2.12** *The functions within the core are becoming 'virtualised'*. This is allowing them to be deployed as software applications on shared hardware, rather than each function running on its own dedicated hardware. This process is called 'Network Function Virtualisation' (NFV) and the computer platforms that are used are called 'Network Function Virtualisation Infrastructure' (NFVi). To ensure the different NFV applications run smoothly and independently, NFVi have special management software. The 'Management and Orchestration' (MANO) software can play a critical role in ensuring the security and resilience of the virtualised applications. Given NFVi and MANO will underpin the critical functions of the core, they must comply with the highest levels of security.

**2.13** *Sensitive functions will move towards the 'edge'*. Mobile core functions may move from centralised locations to local aggregations sites (i.e. to data nodes in metropolitan areas but not to each individual base station), which are closer to end-users, in order to meet the requirements of 5G applications for high bandwidth and low latency. Critically, as you push core functions closer to the edge of the network, it will also be necessary to push out the security services that support and protect them.

**2.14** *Different deployment models*. 5G networks can be deployed in two ways: standalone (SA) and non-standalone (NSA). SA deployments are separate 'greenfield' networks that may share transport, routing and switching with the existing 4G networks. SA deployments are required to deliver the full functionality of 5G, such as ultra-reliable, low latency enterprise services.

**2.15** Critically, NSA deployments will be the first phase of 5G in the UK over the next few years and will rely on existing 4G infrastructure. For NSA deployments, 5G network equipment will need to be compatible with legacy network (i.e. 3G/4G) equipment. For this reason, UK operators will tend to use their current 4G vendors for 5G rollout.

## **Full fibre landscape**

### ***Full fibre will lead to a step-change in the quality and reliability of fixed broadband services***

**2.16** Full fibre or 'fibre to the premise' (FTTP) is the future for fixed line broadband. The capabilities of FTTP go far beyond what can be provided over existing copper-based services, with higher speeds, reliability and resilience. Full fibre networks also require much lower maintenance compared to copper lines. Dense fibre networks will also be vital for 5G, to deliver high speed and high capacity backhaul capabilities.

**2.17** FTTP coverage in the UK is currently low (c.8% of premises), but we expect to see significant deployment over the next few years, with a majority of the UK covered by 2025 in line with industry announcements and the Government's targets. In addition to Openreach and Virgin Media, new entrants are deploying fibre networks. Over time, we expect legacy broadband networks using copper wires to be retired.

## Full fibre network architecture and key risks

### Key network components

2.18 The architecture of a fixed network is similar to that of a mobile network. Fibre connections between premises and local exchanges (or cabinets) in the FTTP access network are equivalent to the wireless connection between handsets and mobile masts in the radio access network. All other elements of the fixed network are similar to mobile networks.

### Figure 3: Fixed network components

**Access networks.** The deployment of FTTP access networks requires fibre optic cables to be installed between telephone exchanges (or cabinets) and each premises to be served. This can require the installation of new underground ducts or telegraph poles, or the re-use of Openreach's ducts and poles. Data is transmitted over the fibre using electronic equipment in the end-users home and in the telephone exchange. Traffic from exchanges is aggregated into the core network and then onto the internet.

**Other.** The other elements of the FTTP network (Transport and Transmission, Core, Interconnect, OSS/BSS etc.) provide similar functions as they do in mobile networks.

### Increasing reliance on FTTP will make the security and resilience of these networks important

2.19 The increased speed and reliability of FTTP networks is likely to result in consumers and businesses becoming reliant on these networks for new services. There are a number of factors which have implications for the risk profile of these networks. These are set out below:

2.20 *Greater dependency by consumers and businesses.* For example, in addition to internet access and voice calls (including emergency calls), services such as TV, home security and other smart homes services will depend on broadband. As well as residential users, many businesses will migrate to full fibre. Symmetrical speeds and lower latency will enable more corporate systems and services to be hosted in the 'cloud' – this increases operational efficiency but also makes network availability and reliability imperative.

2.21 *Role of the incumbent.* Unlike mobile networks where there are four national networks, fixed networks have just two incumbent providers in Openreach and KCOM (in Hull) that together provide national coverage.<sup>10</sup> These incumbents serve several essential functions like alarm systems, telemetry and control systems which will migrate to fibre. As smaller, sub-national, operators build their own market share in the business connectivity market, particularly for critical services, they will need to ensure they are providing the necessary levels of security and resilience.

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<sup>10</sup> Virgin Media also operates a broadband network available to c. 50% of premises

**2.22 Multiple networks and switching between networks.** In the long run, we expect the majority of UK premises to have a choice of FTTP network. This will reduce the dependency on the incumbent networks. However, unlike mobile networks where end-users can relatively easily switch between operators in the event of a significant and sustained network disruption, switching between FTTP networks will require engineer visits and new customer premise equipment.



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# **3 SECURITY RISKS TO UK TELECOMS SUPPLY ARRANGEMENTS**

# Security risks to UK telecoms supply arrangements

3.1 The NCSC provided the expert technical cyber security analysis to inform the Review. This considered the threats and risks to the UK telecoms sector and assessed the criticality of the different elements of the technology stack that make up network infrastructure.

## Telecoms sector threat assessment

3.2 The most significant cyber threat to the UK telecoms sector comes from states. The UK Government has publicly attributed malicious cyber activity against the UK to Russia and China as well as North Korea and Iranian actors – and each have intentionally inflicted damage on the UK through cyber means.

3.3 For example, in December 2018 the UK along with its Allies announced that a group known as APT10 acted on behalf of the Chinese Ministry of State Security to carry out a malicious cyber campaign targeting intellectual property and sensitive commercial data in Europe, Asia and the US.

3.4 Additionally, in November 2017 the NCSC publicly stated that they had seen evidence of Russian attacks against UK telecoms networks. The targeted networks did not contain Russian equipment, but were affected by architectural weaknesses that the attackers were able to exploit.

3.5 Actors may seek to exploit weaknesses in telecoms service equipment, network architecture and/ or operator operational practices, in order to compromise security. The weaknesses could result from design defects, whether voluntary or not, configuration errors in the deployment of equipment by operators, or illegitimate actions by individuals working for vendors or operators in the maintenance and administration of such equipment.

3.6 Some states have significant access to the telecoms sector supply chain, principally through a domestic business supplying equipment and other services, and through foreign direct investment. These activities might negate the need to mount operations (cyber or otherwise) to deliver limited compromise of telecoms networks. As well as espionage, states may seek to conduct disruptive or destructive operations under certain circumstances.

3.7 As set out in the previous section, the move to 5G brings a new dimension to the security risks, given the greater dependence that wider UK CNI is likely to have on UK telecoms than is the case

with 3G/4G. The NCSC concludes that if new 5G use-cases emerge at scale, a successful cyber attack could be highly disruptive across UK CNI and the wider economy.

**3.8** Based on experience from security testing<sup>11</sup> and security incidents, the NCSC assesses that existing vendor agnostic security mitigations, as applied across the telecoms sector, are at best only moderately effective. While this evidence is by no means comprehensive, it points to a telecoms sector that needs to improve cyber security practices. In addition, 90% of the significant security incidents reported to Ofcom in 2018 are attributed to system failure (including hardware or software failures, and systems, processes and procedures failures).<sup>12</sup>

## Telecoms sector risk assessment

**3.9** The NCSC have identified a number of key security risks associated with the telecoms supply chain:

- National dependence on any one vendor, especially ones deemed high risk;
- Faults or vulnerabilities in network equipment;
- The 'backdoor' threat – the embedding of malign functionality in vendor equipment; and
- Vendor administrative access to provide equipment support or as part of a managed services contract.

**3.10** *National dependence*: The decision by an operator to use a vendor for a major supply contract is significant, resulting in a long-term partnership and creating a degree of dependence by the operator on the vendor for the long-term success and sustainability of the network. Certain scenarios, including commercial failure or the imposition of certain types of sanctions affecting the ability of that vendor to continue to provide the required level of service, will have an impact on operators, with that impact increasing in line with the level of dependence. This risk is highlighted by US action taken against ZTE and more recently Huawei.

**3.11** The dominance of a vendor across networks would create a national dependency which exposes two vulnerabilities: (i) a lack of resilience as low vendor diversity increases the risk of the impact of any systemic failures or hostile exploitations, and (ii) due to the criticality of telecoms CNI to national security, a national dependency automatically gives rise to a national security risk. National dependence also risks giving inappropriate strategic economic leverage to a company, or a nation state.

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<sup>11</sup> The National Cyber Security Programme funded intelligence-led penetration testing pilots (TBEST) highlighted a number of cyber security vulnerabilities. The companies have remediation plans to address and mitigate those vulnerabilities. Responsibility for the rollout of TBEST has now passed to Ofcom.

<sup>12</sup> Connected Nations 2018, Ofcom, December 2018 <https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2018/main-report>

**3.12 *Fault or vulnerability in network equipment:*** As explained above, there is a need to increase product quality and security across the telecoms sector. Low product quality – as a result of legacy equipment, poor software development processes or poor vulnerability management – could result in two types of cyber event: systemic failure due to a fault, or equipment vulnerability being exploited by an attacker. The impact from the widespread exploitation of operator equipment due to poor product quality varies from 'moderate' to 'very high' for different vendors.

**3.13** The 2018 and 2019 Huawei Cyber Security Evaluation Centre (HCSEC) Oversight Board reports have highlighted major quality and security issues with Huawei's engineering, leading to the Board only being able to provide 'limited assurance' that risks to UK national security from Huawei's involvement in the UK critical networks have been sufficiently mitigated.<sup>13</sup> Both reports raised concerns around source code, security critical third party software and consistent binaries. The 2019 Report noted that no material progress has been made against the issues raised in the 2018 report. The NCSC assess that it is more likely that the flaws in Huawei's engineering processes compared to that of other vendors will cause systemic failures.

**3.14 *The 'backdoor' threat:*** This threat covers malicious functionality added to equipment either intentionally by the vendor or covertly by a hostile actor who has access to the vendor's hardware or software. Given the range of alternative attack routes available, an adversary would not find implementing 'backdoors' either the lowest risk, easiest to perform or the most effective means of performing a major cyber attack on UK telecoms networks today.

**3.15** The NCSC's assessment of the risk to the UK of embedding covert, malicious functionality or 'backdoors' in equipment from any vendor is 'moderate'. For Huawei, the risk is reduced from high to moderate due to the extensive mitigations and oversight already in place (e.g. the HCSEC). The assessment of this risk may change over time, however, if UK telecoms networks were to become dependent on individual high risk vendors.

**3.16** A subset of the 'backdoor' risk is the link between the supplier and a hostile state actor, and the intent of that state with respect to the UK. The 2017 Chinese National Intelligence Law<sup>14</sup> is the most obvious focus for this risk, but it is not the only law of its kind.<sup>15</sup>

**3.17 *Vendor administrative access to provide equipment support or as part of a managed services contract:*** Administrative access – especially remote access – to telecoms networks presents a significant cyber risk to these networks. These permissions can be given to vendors to provide

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<sup>13</sup> <https://www.gov.uk/government/publications/huawei-cyber-security-evaluation-centre-oversight-board-annual-report-2019>

<sup>14</sup> The largest vendor in the UK supply chain, Huawei, is a Chinese organisation and as such could be subject to the direction of the Chinese state under the Law. Furthermore, an employee of any Chinese organisation, without the knowledge of the organisation, could also be subject to the direction of the Chinese state under the Law and may have no option but to comply.

<sup>15</sup> Most states have laws that allow for direction for the purposes of national security. Where these arrangements differ across countries is in respect to the rule of law, and the oversight and assurance arrangements for those laws.

equipment support or as part of a managed service contract. Administrative access gives control to parts of UK critical telecoms infrastructure, potentially allowing disruption or extraction of data at scale. The NCSC assesses the risk of disruption to, or compromise of data from, UK networks via a vendor's administrative access as 'high'.

**3.18** Third party administrative access to telecoms networks needs to be tightly controlled and monitored, regardless of the vendor or managed service provider. Operators must have sufficient in-house capability to oversee any third party access. Where these functions are performed by high risk vendors, the protections need to be increased to a commensurate level. Not all operators will be able to achieve this. The Government will be taking forward separate work to consider the risks surrounding managed services. In the meantime, a clearer articulation of the minimum protection requirements in the TSR will help address these issues.

### Sensitivity of network functions

**3.19** The NCSC have assessed the security significance of different network components. For the purposes of security, it is most helpful to think about the network in three parts: functions that are critical in terms of security; functions that are significant but not absolutely critical in terms of security; and functions that are moderate in security terms. Figure 4 sets out a simplified summary. While 5G and FTTP change some of the dynamics of the critical/high/moderate functions, they do not change the fact they can be segmented in this way.

**Figure 4: Summary security sensitivity of telecoms functions**

	Critical	High	Moderate
All networks	Central control functions	Audit and logging systems Lawful intercept	Transport equipment
Fixed networks	Central control functions	Broadband connections management functions Access network	User independent access functions
4G	Central control functions (Hardware)	Signalling functions Radio access network	
5G	Central control functions (most software including networks function virtualisation infrastructure)	Signalling functions Radio access network	User independent access functions

**3.20** The critical functions to safeguard network availability and integrity, and data confidentiality at scale, are part of the core network. As described in section 2, the most critically important part of a 5G network is known as the network function virtualisation infrastructure (NFVI), and its security is paramount because it is the most significant control function in the network.

**3.21** The radio access network or RAN poses less critical security risks in these areas. Diversity of supply is also an important risk mitigation. Interoperability means Supplier A has to be able to work closely with Supplier B, which reduces the risk of some deliberate or accidental vulnerabilities

in either remaining unidentified. It also reduces the risk of vendor lock-in, systemic security vulnerabilities and other related issues.

**3.22** Even in 5G, certain parts of the physical infrastructure are not significant in security terms. For example, the transport equipment that carries data down fibre is not aware of the content of the data it is carrying and it is relatively simple to segregate to assure availability.

**3.23** When taken together, the NCSC advise that the range of security threats and risks to UK telecoms networks cannot be managed through technical remediation alone. A combined approach – encompassing a full range of available technical and policy levers – will be necessary to manage the security threats and risks – see Section 5.



# **4 ECONOMIC RISKS TO UK TELECOMS SUPPLY ARRANGEMENTS**

# Economic risks to UK telecoms supply arrangements

4.1 the Review considered the telecoms equipment markets for key network components (as set out in Section 2). It looked at the market dynamics underlying the supply chain arrangements for telecoms equipment, and found high concentration and dependency risks in certain key market segments.

4.2 Based on these findings, we have concluded that there is a high risk of increasing dependence on a single vendor in the fixed and mobile access network segments. Dependency levels on any single vendor are lower for other parts of the network; there is a greater diversity of suppliers for core network functions.

4.3 National dependency on specific vendors may mean that the UK telecoms market is more susceptible to risks relating to products and to suppliers. Taken in conjunction with the findings of the security assessment in section 3, national dependency on individual high risk vendors in particular could pose significant security concerns. Additionally, the growth of large firms with high market shares and weaker rivals can drive down competition, potentially increasing prices, reducing quality and stifling innovation in the longer term.

4.4 The remainder of this section sets out the current vendor landscape, the drivers of market concentration, and future trends.

## The current supplier landscape

4.5 The global telecoms equipment market for network operators is dominated by three global players – Huawei, Ericsson and Nokia. Other players include Samsung, CISCO, Juniper, Ciena and ZTE – however, their participation varies across different parts of the network.

4.6 In the UK, there is a high concentration in certain market segments and the leading players are also Huawei, Ericsson and Nokia. These firms supply the main UK mobile operators and have the ability to provide end-to-end network equipment.

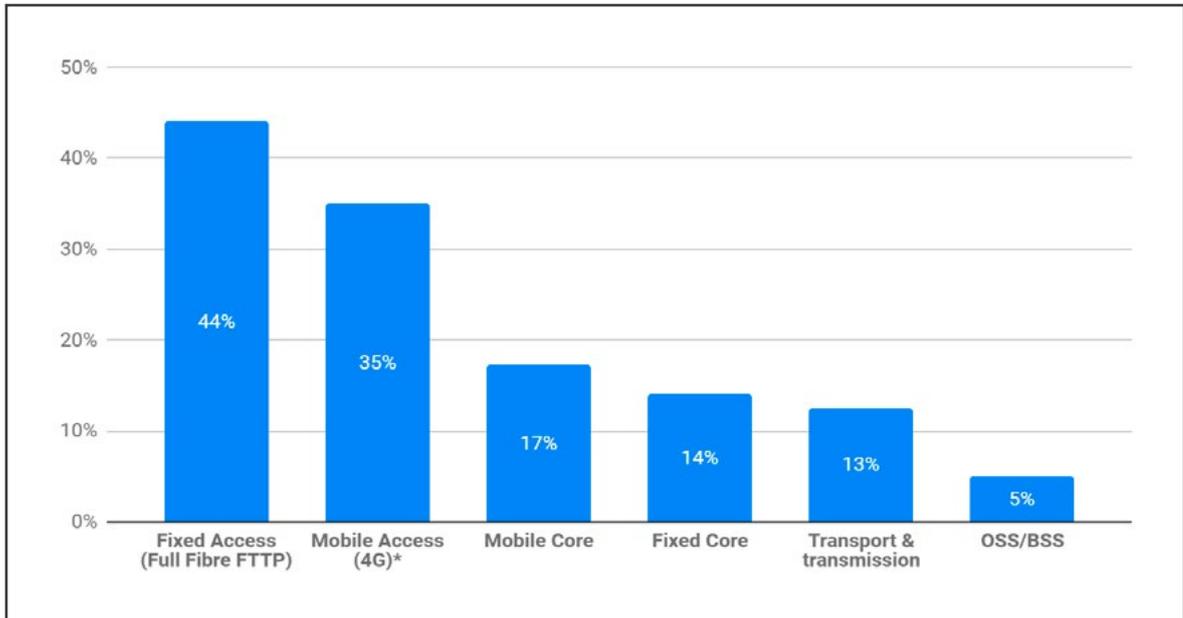
4.7 Huawei is the leader in the 4G mobile access market in the UK. It has the highest market share in this segment at c.35% overall.<sup>16</sup> It is also the leader in fixed access in the UK (see Figure 5 below).

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<sup>16</sup> DCMS estimate based on total number of mobile sites, 2018.

Its market share in full fibre (FTTP) is c.45%, whilst its reported market shares in other fixed network segments are lower.

**Figure 5: Huawei’s market shares<sup>17</sup>**



Source: \*DCMS estimate. The rest is information supplied by Huawei to the Review.

**4.8** Huawei faces competition mainly from Nokia and Ericsson in the UK mobile and fixed access equipment markets, although the latter does not have a strong position in the fixed access market. Ericsson is also active in the mobile core market while Nokia is also active in both the mobile and fixed core markets. Samsung has a limited presence in the provision of mobile and fixed network equipment in the UK.<sup>18</sup>

### Dependence on single suppliers across market segments

**4.9** *5G access network* – Our analysis suggests there will likely be a significant increase in the use of Huawei equipment for 5G access networks overall compared to the use of its equipment in current (3G/4G) networks.

**4.10** *FTTP access network* – Huawei is the leader in the supply of FTTP equipment, both globally and in the UK. Whilst total FTTP connections in the UK are at low levels today (at c.8% of total households<sup>19</sup>), we expect there to be significant deployment of FTTP networks over the next few years, in line with market plans and the Government’s targets.

<sup>17</sup> Measure of market shares vary – Fixed Access (number of homes passed), Mobile and Fixed core (number of subscribers), Transport & Transmission (proportion of traffic), and OSS/BSS (number of subscribers).

<sup>18</sup> Samsung is active in 5G in other countries such as South Korea and the US. However their lack of 2G together with UK operators’ desire to use non-standalone 5G deployments limits Samsung’s potential as a 5G supplier in the short-term.

<sup>19</sup> <https://www.thinkbroadband.com/news/8461-uk-hits-8-full-fibre-coverage>

**4.11 Core network functions** – The core network has a greater diversity of established suppliers, for example, Cisco and Juniper provide core network functions, alongside Huawei, Nokia and Ericsson.

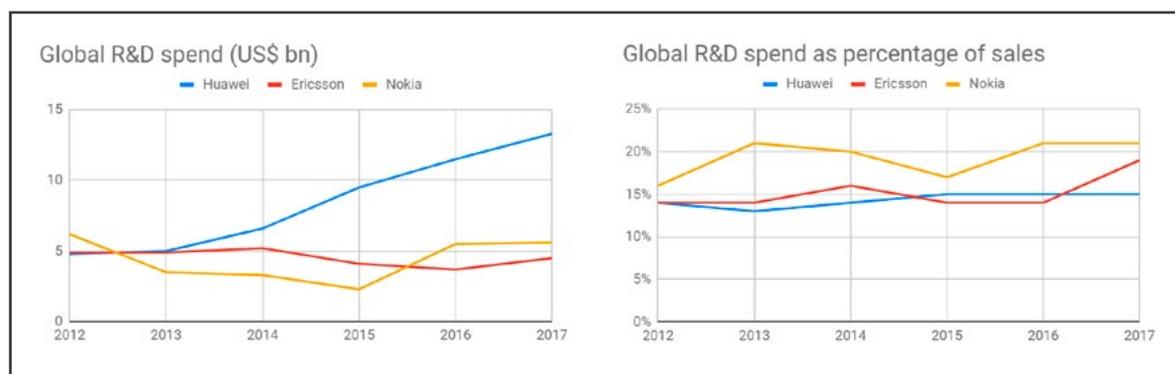
**4.12 Other network functions** – segments including transport, transmission, and management systems (OSS, BSS) have low levels of dependency on any single supplier.

### Drivers of market concentration in the mobile and fixed access segments

**4.13** The Review has assessed the market dynamics in fixed and mobile access to understand the key structural factors that create barriers to entry and drive higher concentration among vendors.

**4.14 R&D investment is a key barrier to entry.** The high levels of R&D and time taken to develop technically capable products act as a barrier to entry and expansion. There is intense competition across vendors and R&D plays a significant role. As set out in Figure 6 below, Huawei spends the most in absolute terms on R&D but has mostly been the lowest spender across the three main vendors as a proportion of sales.

**Figure 6: Total R&D spend**



Source: DCMS analysis based on company financials

**4.15 Economies of scale.** High R&D requirements mean that vendors need to undertake significant investments, some of which involve fixed and irrecoverable costs. In such markets, economies of scale can drive firms to chase volumes in order to reduce average costs and offer lower prices than smaller rivals. The investment risks involved can act as a barrier to the entry and expansion for smaller players. On this aspect, Huawei benefits from access to a large home market in China, which also has in place barriers to foreign suppliers.

**4.16 Intense competition.** UK operators have sophisticated procurement strategies which allow them to leverage vendors against each other, particularly on price elements. Whilst competition on price can be desirable, at its extreme it can lead firms to cut costs, reducing overall quality in the market. This may put at risk investment in certain areas, such as security, that are difficult to observe and where the commercial incentives are currently limited. Reduced scope for high profits in the vendor market may also act as a barrier for new entrants and contribute to maintaining market concentration in the long-run.

**4.17 Switching costs.** In mobile and fixed access, switching costs are high once the equipment of a particular vendor is deployed in the network. This is most notable in the mobile access network, where switching may involve replacing costly legacy equipment, due to the non-standalone nature of 5G deployment in the next few years (as explained in Section 2). In the absence of strong switching incentives, this can prevent the market from working effectively, for example, restricting the ability of operators to respond swiftly to price and quality changes by switching to better products from other providers.

**4.18 Reputation, track record and global relationships.** Track record and the need to demonstrate technical ability could also act as barriers to entry. This is further supported by vendor relationships with international telecoms companies who typically procure globally. Suppliers have a commercial interest in strengthening their position in the UK market. While the UK accounts for about 2% of suppliers' global mobile revenues<sup>20</sup>, suppliers have indicated that they view the UK as an important market for strategic and branding reasons.

**4.19 National policies.** National policies can offer key strategic advantages and play an important role in supporting the growth of incumbent suppliers. The Chinese government's industrial policies have accelerated the growth of Huawei through subsidies, R&D funding and supportive policies.

### **Future trend towards concentration**

**4.20** The telecoms equipment market has seen significant consolidation over time, with a series of mergers and acquisitions, reducing the number of global players. These include Nokia/Siemens (2006), Nokia/Motorola (2010), Ericsson/Nortel (2011) and Nokia/Alcatel-Lucent (2015).

**4.21** Increased consolidation is consistent with a market which is characterised by high levels of R&D investment, economies of scale, buyer power and intense competition keeping prices (and therefore profits) low. These factors will continue to be relevant for the UK mobile and fixed access markets.

**4.22** These factors suggest that the current market conditions are not particularly favourable to new entrants. New entry entails significant long term commitments in terms of time and R&D investments, and recovery of costs is not immediate. However, technology developments associated with 5G (e.g software-defined networks – see Section 2) may create greater opportunities for market entry and diversification over time. There is also the scope for policy interventions to support this trend (see Section 5).

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<sup>20</sup> DCMS estimate.



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# **5 THE POLICY RESPONSE: A NEW ROBUST SECURITY FRAMEWORK**

# The policy response: a new robust security framework

5.1 The range and nature of the security risks and threats identified in this Review requires a strong policy response. The Government will establish a new, robust security framework for 5G and full fibre networks to:

- Ensure operators build and operate secure and resilient networks, and manage their supply chains accordingly; and
- Assess the risks posed by vendors to network security and resilience, and apply proportionate and targeted controls to mitigate the risks.

5.2 The new security framework will have three key components:

- **New Telecoms Security Requirements (TSR).** The foundation for the framework is a new set of security requirements, which will be finalised in conjunction with industry. The TSR will raise the height of the security bar and require telecoms operators, overseen by Ofcom and Government, to design and manage their networks to meet these new requirements. The TSR will provide clarity to industry on what is expected in terms of network security.
- **Establishing an enhanced legislative framework for security in telecoms.** In addition to putting the TSR on a statutory footing, the new legislation will provide Ofcom with stronger powers to allow for the effective enforcement of the new requirements and will establish stronger national security backstop powers for Government.
- **Managing the security risks posed by suppliers.** The new framework will ensure that telecoms providers are managing the security risks posed by all suppliers. The Government will make a final decision on the additional controls to be applied to individual high risk vendors in due course.

5.3 In addition, the Government will also take forward work to develop a targeted diversification strategy in order to **ensure there is a more competitive, sustainable and diverse supply chain.**

## New Telecoms Security Requirements (TSR)

5.4 Overall, we must have higher standards and practices of cyber security across the entire UK telecoms sector. This is a technical pre-condition for secure 5G and full fibre networks. The first step is to provide a clear statement of what 'good' looks like in relation to network security and resilience.

5.5 The Government and Ofcom, in consultation with industry, will establish a new set of security and resilience requirements for 5G and full fibre networks. These requirements will be clear, targeted and actionable, providing clarity to industry on what is expected. The adoption of the requirements by operators (and through them, suppliers) will mitigate network security and resilience risks, and ensure the protection of the UK's national security interests. By raising the security bar, the TSR should increase the demand for those vendors that place a high value on security and disincentivise the use of those vendors who do not.

5.6 Given the global nature of telecoms, there is also an opportunity for regulatory alignment with like-minded countries to sharpen the security incentives in these markets.

### UK Telecoms Security Requirements (TSR)

The purpose of the Telecoms Security Requirements (TSR) is to ensure providers of public electronic communications networks or public electronic communications services take appropriate and proportionate measures to prevent, remove or manage the risks posed to the security of networks and services, specifically to ensure:

- that networks and services are accessible and available to customers;
- the confidentiality of communications and data;
- the integrity and authenticity of networks, systems, communications, and sent, received or stored data; and
- the protection of networks and services from unauthorised access or interference.

The new requirements will cover four main categories:

- Business and governance processes to enhance security,
- How networks are built to enhance security,
- How networks are securely managed, and
- Vendor procurement and ongoing management to support network security.

The requirements will provide a 'floor' not a 'ceiling'; operators will be encouraged to exceed them and constantly innovate to enhance security. The requirements will take time to finalise and will likely be phased-in, starting with the highest priority areas. Finally, the requirements will be dynamic, being subject to periodic review so that they remain responsive to the changing threat and technology landscape.

The Government and Ofcom will consult with industry on the new requirements before finalising the TSR.

5.7 It will be necessary for Ofcom to lead on the implementation and enforcement of some aspects of the TSR and for the Government to lead on others. Under the Communications Act 2003, Ofcom is responsible for ensuring operators take appropriate measures to safeguard the general security and resilience of their networks and services. It is the responsibility of the Government to take the necessary measures to ensure the protection of the UK's national security interests.

## Establishing an enhanced legislative framework for security in telecoms

5.8 The Government will pursue a phased approach to implementing the TSR:

- **Phase 1: Enforcement under the existing regulatory framework.** Ofcom will continue to pursue a proactive application of the current regulatory regime under the Communications Act 2003, reflecting the new TSR, where appropriate, in its non-binding industry guidance and in enforcement activity.<sup>21</sup> The national security aspects of the TSR (i.e. those aspects related to controls on high risk suppliers) will be implemented by Government, underpinned by the clear intention to legislate.
- **Phase 2: Enhanced regulatory framework.** The intention is to embed the new TSR into legislation, with a new security obligation on operators to comply with the requirements. Ofcom's regulatory powers will be strengthened in a number of specific areas to enable full enforcement of the TSR, alongside the creation of new bespoke national security powers for the Secretary of State to intervene, as a last resort, to enforce aspects of the TSR on grounds of national security.

### Phase 1: Enforcement under the existing regulatory framework

5.9 The new TSR will provide certainty to industry on 'what good looks like', albeit in the first instance the TSR will not create binding legal obligations. Until new legislation is put in place, Government and Ofcom will work with all UK telecoms operators to secure adherence to the TSR.

5.10 Ofcom has agreed to:

- Include the finalised TSR, where appropriate, in its industry guidance, and use that to engage industry to understand supply chain risks and the arrangements adopted by operators to mitigate them;
- Engage industry as part of their Security and Resilience Assurance Scheme to gain regular updates on operators' major supplier arrangements and TSR compliance plans, including how they are being dealt with at Board level;
- Where there is reason to suspect that conduct may also be a breach of a provider's security and resilience obligations, use its current information gathering and audit powers to investigate suspected breaches of the TSR;
- Encourage providers to participate in Ofcom's threat intelligence-led penetration testing scheme (TBEST) and, subject to third party contract arrangements, test operators' vendor specific arrangements. Subject to any applicable restrictions on the disclosure of information, Ofcom would also aim to share thematic findings across the sector to support a culture of continuous improvement; and
- Increase analysis and reporting on network security and resilience.

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<sup>21</sup> Section 105A security of public electronic communications networks and services

5.11 Following a final decision on the specific controls to be applied to individual high risk vendors, the Government will expect operators to take appropriate actions, with a clear intention to legislate for national security backstop powers.

## Phase 2: Enhanced regulatory framework

5.12 The TSR will be underpinned by new legislation, with a statutory obligation on operators to comply with the new requirements. Ofcom will be given stronger powers to allow for the effective and enduring enforcement of the TSR. We are considering strengthening the current regulatory regime in the following specific areas:

- a new duty on Ofcom to promote the security and resilience of public electronic communications networks and services, to sit alongside Ofcom's existing statutory duties;
- a requirement for new statutory guidance linked to the TSR;
- a requirement for continuous monitoring of operators' compliance with the TSR;
- a requirement for operators to provide all the information necessary to assess the security and resilience of their networks;
- Ofcom's periodic infrastructure reports to include reporting of new security and resilience measures included in the TSR;
- investigations into non-compliance with the TSR and the effects on the security of networks;
- an increase in the financial penalties for non-compliance with the TSR, in line with other penalty powers in the Communications Act 2003 or NIS and GDPR<sup>22</sup>; and
- a requirement for operators to take part in Ofcom's TBEST scheme.

5.13 The responsibility for the national security aspects of the TSR will rest with Government. This will likely require:

- A new *national security direction power* for the Secretary of State to require, as a last resort, operators to comply with specific controls in relation to individual high risk vendors and do other specified things that are reasonably necessary to protect networks from national security risks; and
- A new *information obligation* on operators to provide the Government with information about vendor arrangements that could raise national security risks.

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<sup>22</sup> Section 105D Communications Act 2003 provides a maximum penalty of £2m for failure to meet obligations under s105A (security of public electronic communications networks and services), whereas s97 (amount of penalty under s96 (penalties for contravention of conditions) provides a maximum penalty of 10% of turnover for a contravention of conditions. Alternatively, NIS & GDPR penalties for failure to meet obligations are up to £17.5m or 4% annual global turnover, whichever is higher.

**5.14** Whilst the TSR will apply to all operators, the new national security powers will be targeted and proportionate, in that they will only apply to defined network areas and arrangements with high risk suppliers.

## Managing the security risks posed by vendors

**5.15** The Government will pursue a 'three lines of defence' approach in relation to managing the security risks posed by vendors:

- Require operators to subject vendors to rigorous oversight through procurement and contract management. This will involve operators requiring *all* their vendors to adhere to the new TSR;
- Require operators to work closely with vendors, supported by Government, to ensure effective assurance testing for equipment, systems and software, and support ongoing verification arrangements; and
- Impose additional controls on the presence of certain types of vendors which pose significantly greater security and resilience risks to UK telecoms. In considering what those controls should be, it is necessary to address the identified security risks, whilst seeking to minimise the costs to industry and the wider economy.

## Current risk-based mitigation strategy for suppliers

**5.16** One of the NCSC's key objectives is to maintain a deep understanding of the cyber risks to the UK telecoms sector and develop strategies to manage those risks. Part of this requires knowledge of the capabilities and qualities of vendors providing equipment and/or services to the sector, and the associated risks that they pose. The NCSC's assessment of those risks shapes the way in which each vendor's presence is managed – albeit today this is on a voluntary, not mandatory basis. This risk-based strategy leads to a variety of approaches aimed at increasing understanding of areas, including engineering and design processes, ongoing product support and vulnerability remediation. The level of assessment of different vendors is proportionate to the level of risk identified.

**5.17** The UK has a rigorous strategy in place for managing the risks arising from the involvement of Huawei in parts of the UK's critical national telecommunications infrastructure, including through the Huawei Cyber Security Evaluation Centre (HCSEC) and the Oversight Board. The last two Oversight Board annual reports highlighted serious cyber security and engineering flaws in Huawei products currently deployed in the UK.

## New security requirements to be applied across all suppliers

**5.18** Building on these arrangements, it is important that we secure improvements to the security practices of all vendors. The TSR will set out new security requirements that operators will need to apply to the software and hardware supplied by vendors. The effect should be to improve cyber security standards across *all* suppliers and, in doing so, help to level the playing-field *between* suppliers.

**5.19** The TSR will incentivise Huawei to address the systemic engineering failures identified in the Oversight Board reports. Measures to equalise cyber security standards across vendors should make it harder for a vendor to enjoy competitive advantage at the expense of security. Moreover, operators who continue to use individual high risk vendors will be required to demonstrate to Ofcom and Government that they have put in place appropriate architectural controls and other measures to address the identified risks.

**5.20** Another critical way of applying the new TSR will be through effective assurance testing and ongoing management of vendor equipment. Operators should work closely with vendors, supported by NCSC, to ensure: i) a robust security development lifecycle process; ii) effective assurance in the context of that specific operator's deployment of designated equipment, systems and software; and iii) ongoing verification arrangements to make sure that security requirements are met.<sup>23</sup> It is clear that operators should prioritise greater security assurance and whole-of-life costing in their vendor base and the new TSR will help drive that.

**5.21** When taken together, these measures will create a robust and risk-based security regime for telecoms that will improve how the market works. This new framework will allow the Government to respond as threats, risks and technology changes, including strengthening the controls if needed in the future.

### **New controls to be applied to individual high risk vendors**

**5.22** The intention is that the new TSR will set out the additional controls on the presence of individual high risk vendors, in order to protect the security of networks and guard against the risk of national dependency.

**5.23** The Government is not, however, currently in a position to make final decisions on the additional controls that will be applied to individual high risk vendors. For example, further work is needed to understand the implications and impacts of the US government's recent measure to add Huawei to the Entity List on national security grounds. This measure could have a potential impact on the future availability and reliability of Huawei's products and could have implications for the market as a whole. This is a new and relevant factor for the Government to consider in the Review, alongside other factors.

**5.24** Decisions will be taken on this matter in due course.

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<sup>23</sup> NCSC's expert opinion is that vendor controlled commercial certification schemes, such as those based on Common Criteria, would not add value in these circumstances.

## **Ensuring a competitive, sustainable and diverse supply chain**

**5.25** There is a need to create a more diverse and competitive supply base for telecoms networks. This will be critical to drive higher quality, innovation and reduce the risk of national dependency on individual suppliers.

**5.26** The new security framework, set out earlier, should support greater market diversity by incentivising those commercial practices that place a higher priority on cyber security. Given the global nature of telecoms, regulatory alignment across like-minded countries has the potential to sharpen security incentives for operators and vendors.

**5.27** In addition, the Government will develop a **targeted diversification strategy**, supporting the growth of players in those parts of the network that pose security and resilience risks. The strategy will support industrial strategy policies to incentivise entry and growth, including market design and R&D support; promoting interoperability and demand stimulation; and attracting established players to the UK market. It will also be underpinned by wider policies set out in the *Future Telecoms Infrastructure Review (FTIR)*. The Government is willing to discuss opportunities for market diversification with like-minded countries.

**5.28 Market design and R&D support.** The Government's FTIR sets out a package of policy interventions to support market expansion in 5G – including improving access to spectrum, removing barriers to roll-out and promoting new infrastructure models. This should support the development of a more diverse supplier base over time.

**5.29** We want to ensure that any public investment and support is targeted at those areas which can address market failures and yield the strongest security and prosperity benefits to the UK. The Review has identified a number of potential areas including, software-based innovation in core network functions, open architectures in access networks, and cyber security in small cell technologies.

**5.30** The Government's £200 million 5G Testbeds and Trials Programme can play an important role in targeting investment in these areas. There are also a number of existing public funds that could support investment in valuable areas, including Innovate UK, the £2.3 billion Industrial Strategy Challenge Fund and the National Security Strategic Investment Fund.

**5.31** Greater interoperability and more open interfaces will be required to facilitate new entrants. It is not sufficient that interoperability is included in technical standards – industry must work to ensure equipment from different vendors is interoperable in real world deployments. The Government's 5G Testbeds and Trials Programme provides an opportunity to support architectural models that open-up the RAN, allowing operators to use different vendors for different components of the RAN.

**5.32** The Government will also explore the need for a new national telecommunications lab, with the support of industry and academia. In addition to testing interoperability, the lab could also provide a de-risking function for new entrants to the market and a capability for security researchers to work on new telecoms technologies in a safe environment.

**5.33 Stimulate demand for new entrants.** The Government can support new entrants through interventions that help stimulate demand and reduce risk. The Government's 5G Testbeds and Trials Programme is funding a series of projects that bring together operators, vendors, industry 'verticals' (e.g. manufacturing, healthcare and logistics) and universities, to explore new applications and business models for 5G. The Programme is already supporting a number of new suppliers across a range of different projects.

**5.34** Growth in downstream markets can create opportunities for new entrants and diversification, for example, Airspan is providing Fixed Wireless Access services and small cell solutions. Smaller, standalone suppliers have opportunities to enter the market for private, transport and enterprise 5G networks.

**5.35** Finally, the Government can play a role to influence procurement decisions through its collective buying power. The Government will use future public sector telecoms network procurement decisions to promote the use of a diverse and secure supplier base. This approach has been previously used in the public sector to facilitate new entrants in the ICT sector. While the public sector does not currently procure telecoms infrastructure equipment on a large scale, this may increase, to some degree, as 5G technology allows for network slicing and custom networks.

**5.36 Attract established players to the UK market.** In addition to stimulating the growth of new suppliers, the diversification objective could also be achieved by attracting established players to the UK market. This could change market dynamics, driving greater competition and innovation.

**5.37** The UK already has a number of schemes in place to attract large businesses, including attractive tax incentives (e.g. the lowest corporation tax rate in the G7 and R&D tax credits), a stable regulatory regime and access to talent and labour. These opportunities will be explored further, working with international partners where appropriate.



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# **6 CONCLUSIONS AND NEXT STEPS**

# Conclusions and next steps

**6.1** The Government will pursue a new, robust security framework for telecoms. This new policy framework will be supported by the NCSC's existing risk-mitigation model, adapted as necessary for 5G and full fibre technologies.

**6.2** In order to implement the new security framework, we will:

- shortly consult with industry on the draft TSR, in conjunction with Ofcom;
- identify the most appropriate legislative vehicle/s to take forward the proposed regulatory and policy changes;
- work with international partners to improve the standards cyber security across global telecoms markets; and
- continue to monitor and better understand the impacts of the entity listing so we can take a final decision in due course.

**6.3** We will develop and pursue a diversification strategy – including by working with our international partners – to ensure a competitive, sustainable and diverse supply chain.

**6.4** We will keep the new security framework under regular review, making changes as necessary as threats, risks, and technology evolve.



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