Department for Digital, Culture Media & Sport

# Next Generation Mobile Technologies: An update to the 5G strategy for the UK

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# 1. Ministerial Foreword

As we set out in the Digital Strategy, we are determined that the UK is a world leader in 5G so that we can take early advantage of the benefits that this new technology offers.

Development of the next generation of digital communications in the UK continues at pace, and the path to 5G is becoming clearer. Since we published our 5G strategy in March, our understanding of the issues and challenges has increased. Now is the right time to update on our progress.

The Government is investing heavily in the UK's digital future and creating the right market conditions. In July, we awarded £16 million to leading UK research institutions. They will develop a unique 5G test network that will be available as a national asset for use by future trials. And at the Budget we announced a further investment of £160 million from the National Productivity Investment Fund for the next phase of funding for our 5G Testbeds and Trials Programme, with specific pots of money for 5G roads and security projects, as well as a large-scale project on the Trans Pennine rail route.

We are also developing a policy framework that will support the necessary commercial investment in 5G technology in the UK, and have set up a barrier busting task force in government to reduce deployment costs. And, to ensure that we have an integrated, long term strategy for investment in our fixed and mobile networks, we are reviewing the telecoms market.

A key component of our strategy is to ensure that we have reliable connectivity across the UK. This will bring short term benefits as well as ensuring that the benefits that 5G promises can be realised. Doing all we can to boost our productivity is a foundation of the Government's Industrial Strategy. That is why we are taking action to extend mobile coverage to 95% of UK geography and ensure that mainline rail routes, major roads and connectivity 'hotspots' are 5G-ready.

The steps set out in this document outline how we will steer the UK towards the next generation of mobile technology. But we know that we cannot do it alone. That is why we will continue to work closely with industry, Ofcom and other stakeholders.

I believe this update to our 5G strategy will cement our position as an international leader in 5G. It confirms the Government's commitment to realising the potential of 5G and will help to create a world-leading digital economy that works for everyone.

# 2. Executive summary

5G has the potential to transform communications. It will support ultra-reliable networks with low latency and fast internet connections, which will allow people and things to interact like never before.

World-class digital infrastructure is a building block of the Government's modern Industrial Strategy[1] - it creates new opportunities for growth by allowing business to be done on the move; unleashing dynamic business models; and opening up new opportunities and markets. It also supports us in our everyday lives - connecting us with friends, family and colleagues; helping us to stay safe; and giving us access to information and services that we increasingly take for granted.

The Government's 5G strategy, published at Spring Budget 2017, set out the framework and steps that we will take to ensure that the UK is a world leader in the development of 5G mobile networks and services. It took on board recommendations from the National Infrastructure Commission (NIC), advice from a range of interested parties and industry players, including the Future Communications Challenge Group, and was published following engagement with a wide range of stakeholders.

The strategy outlined the Government's aims to:

- accelerate the deployment of 5G networks and ensure that the UK can take early advantage of the applications those networks can enable
- maximise the productivity and efficiency benefits to the UK from 5G
- create new opportunities for UK businesses at home and abroad, and encourage inward investment

We are determined that the UK should be a world leader in 5G so that we can take early advantage of its potential and help create a digital economy that works for everyone. Successful rollout of 5G will require significant levels of commercial investment and the Government is taking an active, facilitating role to help create the best conditions for the private sector to invest in developing and deploying 5G in the UK in a timely and efficient manner.

Important to this is the Government's 5G Testbeds and Trials Programme[2], which will encourage trials involving different user-types with different requirements, addressing deployment and technological challenges, and helping to create a 5G ecosystem in the UK. We are also considering the levers available to government to promote long term investment in digital connectivity - including 5G - through our new Future Telecoms Infrastructure Review[3].

Building on the themes and actions outlined in our 5G strategy, the Government is also focussing on the following policy areas to support the development of 5G:

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/662508/industrial-strategy-white-paper.pdf

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/652263/DCMS_5G_Prospectus.pdf

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/663060/Future___Telecoms___Infrastructure___Review-___terms___of___reference.pdf

- developing a **future-focused spectrum policy** to help ensure that spectrum is allocated in a way that supports the Government's mobile ambitions
- considering whether existing **regulatory frameworks** adequately support commercial investment in 5G infrastructure and services
- our **Future Telecoms Infrastructure Review**, which will assess whether any further policy interventions may be needed to create the conditions for long term investment in world-class digital connectivity
- setting up a cross-government **barrier busting task force** to address specific challenges related to the deployment of telecoms infrastructure
- working with **local government** to make sites available for the deployment of infrastructure and to deliver the levels of connectivity which reflect the need of local areas.

In parallel, the Government will continue to work with Ofcom and industry to address mobile connectivity challenges where people live, work and travel, both for current technologies and next generation 5G technologies. The Government is developing plans to:

- ensure **95% geographic mobile coverage** and the availability of essential services where people **live, work and travel**, including development of meaningful **performance metrics** for the quality of service people actually receive
- developing a model to secure fast, reliable mobile connectivity on **main rail routes** and **major roads**

Since publication of the 5G strategy in March of this year, we have been progressing this work to deliver against the Government's goals, and continuing to engage with industry to further our understanding of the expected pathway for the launch of commercial 5G services in the UK. We believe that now is a good time to update on our progress.

Where policies relate to reserved matters they apply to the whole of the UK. Where they relate to devolved matters, we seek to work with, and complement the plans of, the Devolved Administrations.

# 3. Pathway to 5G connectivity

5G is used to describe the fifth generation of mobile communications technologies. It is anticipated that it will deliver a step change of ultrafast, low latency (i.e. quicker reaction times), reliable, mobile connectivity that is able to support ever-larger data requirements, as well as wide-ranging new applications.

5G has the potential to transform communications and is likely to lead to new business models and innovation in service provision. Given the potential size of the global 5G prize - *a recent report estimated 5G will enable USD$12.3 trillion of global economic output in 2035*[4] - we need to ensure that the UK is at the forefront of 5G developments, so that we can maximise the potential benefits to our economy and citizens.

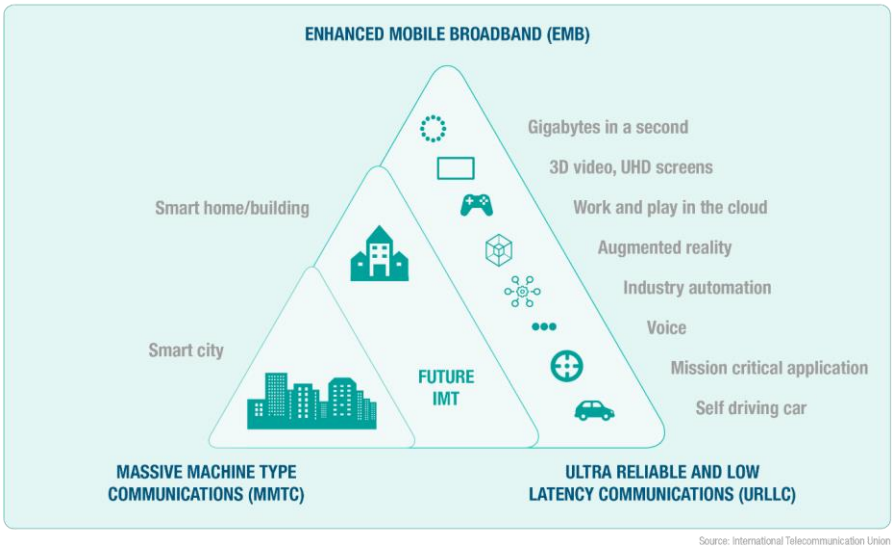
The 5G strategy identified the actions that the Government will take to realise our aim for the UK to be a world leader in 5G. It was well received and will ensure that the UK is well placed to take early advantage of its potential. It took on board the recommendations of the NIC, whose 5G report stated that government must now play an active role to ensure that basic services are available wherever we live, work and travel, and our roads, railways and city centres must be made 5G-ready as quickly as possible.

We outlined that the 5G strategy would be a living document and updated regularly as our understanding of the issues and challenges increases. The Government is committed to the approach set out in the 5G strategy, and this document builds on its success, whilst providing detail on our progress.

The path to a 5G future is likely to integrate existing and new technologies and require wireless networks to align ever more closely with fixed line networks. It will take place in the context of a maturing 4G market, with many of the technological innovations that may be classified as 5G being introduced early on through evolution of the current 4G standards.

[4] IHS Economics / IHS Technology "The 5G economy: How 5G technology will contribute to the global economy" 2017

Figure 1 – 5G expected capabilities




There are many 5G related projects happening around the UK that are focused on a wide range of issues - from technical trials for network capabilities, to the development of new use cases. Successful deployment of 5G in the UK will require significant investment - the vast majority of which will need to come from the private sector - but will also require a suite of supportive policy interventions from government.

There is broad consensus that commercial rollout of 5G in the UK should begin by 2020, with competition likely to drive the mobile market to initially provide enhanced mobile broadband services. The path to the commercialisation of 5G use cases which rely on its other capabilities - particularly those which could be more disruptive - is less clear. The Government's **5G Testbeds and Trials Programme**, working in partnership with industry and others, will help demonstrate the market for 5G services and improve the commercial case for investment.

The Government understands that operators are continuing to focus on **densifying their existing 4G networks** to satisfy increasing demand for data from their customers. As 4G evolves into 5G, we expect that it will be accompanied by a proliferation of small cells in 'connectivity hotspots'. These small cells will require access to power and to **fibre** networks for data transport, which is likely to raise a number of challenges, both practical and economic. Deploying such infrastructure at scale will require an appetite to invest on the part of the market - which we are investigating through our new **infrastructure review** - and will rely on the timely availability of sufficient **radio spectrum** at the right frequencies to provide both widespread coverage and sufficient data capacity. It is also possible that a greater degree of **infrastructure sharing** will be required in order to improve the economic case for investment, in both rural and urban areas.

**Local areas** have a big role to play to facilitate the deployment of infrastructure - both directly through active engagement with the telecoms sector or by allowing access to **public sector assets**, and indirectly through **local planning policies**. That is why DCMS has set up a ***Local Area Connectivity Group*** to bring local areas, industry and landowners together to understand the local area requirements for the deployment of digital infrastructure. We are also working on a **pilot** with a small number of urban and rural areas, and industry, to streamline the process of hosting mobile infrastructure on publicly owned assets. These

initiatives will complement the new cross-government **barrier busting task force,** which will be working with industry, Local Authorities and Ofcom to address barriers to the deployment of digital infrastructure.

Further details on the Government's policies to support these trends are set out below.

**Strategic Policy Statement for Ofcom**

The Digital Economy Act 2017 introduced a new power for the Secretary of State for Digital, Culture, Media and Sport to designate a statement setting out the Government's strategic priorities relating to telecommunications and the management of the radio spectrum, including particular outcomes identified with a view to achieving the strategic priorities.

The Strategic Policy Statement will include the Government's priorities and desired outcomes for 5G. The Government will designate the first Strategic Policy Statement for Ofcom in 2018.

Ofcom must have regard to the statement when carrying out its related functions.

## International 5G activities

The Government is aware of the many 5G initiatives ongoing around the globe, and as outlined in the 5G strategy, we have begun engaging with national governments and international organisations leading on 5G to ensure that we can learn lessons and help to shape the global development of 5G in a way that maximises the benefits to the UK.

The Government understands that, unlike with previous mobile standards, 5G could be deployed on multiple continents in different scenarios as countries focus on their respective areas of strength and needs. For example, in the US, early deployment of 5G is centred around fixed wireless access uses, whereas other countries are exploring the industrial applications that millimetre-wave technologies could unlock. Whilst other countries may have an inbuilt advantage in the development of some aspects of 5G (for example, the development of 5G hardware), the Government believes that the UK could be a global leader if we focus on enhancing our existing strengths - such as in systems integration and cyber security - and on providing a supportive environment for a 5G ecosystem to flourish.

The timelines associated with the release of international **5G standards** will also impact the pathway to 5G deployment in the UK. The International Telecommunications Union (ITU), the UN agency for electronic communications, has suggested a timescale for 5G standards that support deployment of commercial 5G services by 2020. This corresponds with the outline proposed by the 3GPP - the main industry-led project responsible for setting global standards for 5G. The 3GPP is aiming to finalise its first set of 5G specifications by mid-2018 - so-called Release 15 - which will largely be focused on enhancements to mobile broadband, before issuing the full 5G specifications - Release 16 - by the end of 2019.

There are a number of other standards organisations across the globe that have 5G initiatives that work alongside the 3GPP. As per our commitment in the 5G strategy, we are continuing

to engage with appropriate Standards Developing Organisations (SDOs) to support the take up of UK needs and ideas and monitor developments.

The Government understands that standards' setting is an industry-led process, however we can add value by:

- better coordinating work across government departments that relates to 5G standards
- coordinating activities between industry and academics based in the UK
- facilitating links between academics and standards organisations
- seeking opportunities to sponsor 5G standards meetings in the UK

**The Government will investigate how best to take forward this work in partnership with the new UK 5G Innovation Network.**

## 5G Innovation Network

At Spring Budget 2017, the Government committed to create a UK 5G Innovation Network to operate alongside the 5G Testbeds and Trials Programme. The 5G Innovation Network aims to provide a significant boost to the development of the UK's 5G ecosystem, to help encourage increased inward investment and UK leadership in the 5G arena.

This 'network of networks' will facilitate the engagement and coordination of organisations working on 5G activities across the UK. It will enhance links between ongoing research and development and other activities being undertaken by organisations across telecoms and other sectors, as well as the testbeds and trials that will be funded through the Government's 5G Testbeds and Trials Programme. It will facilitate the joining up of start-ups and Small and Medium sized Enterprises (SMEs) as well as large businesses, academic institutions and the public sector throughout the UK.

The 5G Innovation Network will also be a strong marketing brand, linking in to activities led by the Department for International Trade. This will encourage domestic and global inward investment and participation in 5G activities in the UK, including facilitating access for potential investors to advocates of UK success stories. Furthermore, the 5G Innovation Network will advise the Government's 5G Testbeds and Trials Programme, providing expert feedback from industry, identifying their priorities and advising on future areas of focus.

The setup of the 5G Innovation Network will be facilitated by the 5G Testbeds and Trials Programme but it will be industry-led and represent the different components of the 5G ecosystem.

**A competition to select the organisations to facilitate the 5G Innovation Network was launched in October 2017, and today we can announce that CW, in partnership with the Knowledge Transfer Network and TM Forum, have been successful in their bid to run the Network. This will be up and running during early 2018.**

# Mobile coverage where we live, work and travel

Without reliable connectivity across the country, the benefits of some of the new and innovative use cases arising from 5G will not be fully realised. We need to put the foundations in place now and have set out here the actions that the Government is taking to improve mobile network coverage now and in the near future, and to ensure that key rail routes, major roads and key hotspots are 5G-ready.

Providing reliable digital connectivity across the UK is also a foundation of the Government's Industrial Strategy, and will boost the nation's productivity.

## Improving coverage

The Government's ambition is to extend mobile coverage to 95% geographic coverage of the UK by 2022. By the same date, our aim is to deliver full and uninterrupted mobile phone signal on all major roads.

In the 5G strategy, we agreed with the NIC recommendation that essential mobile services should be available wherever people live, work and travel. We said that we would "set out by the end of 2017 what the essential elements of high quality coverage where people live, work and travel are, and how we will achieve this as soon as is practical, and no later than 2025".

Connectivity should meet consumer expectations, and the growth of 4G networks over the past five years has driven an expectation of faster and more reliable mobile coverage. We consider that essential elements of high quality coverage should deliver a high call success rate and enable a range of services that are most commonly used. We expect that these will evolve over time and would currently include: text, email, e-Gov services, banking and payment apps, health apps, online shopping, audio streaming, reading online news, mapping services and other basic apps.

In the 5G strategy, we asked Ofcom to develop and report on coverage metrics that reflect actual consumer experience. In its Connected Nations 2017 report, Ofcom defined mobile coverage to deliver a decent experience for smartphone users. This equates to nearly all 90 second calls could be made without interruption, and the availability of a data service delivering speeds of at least 2Mbps, to allow users to browse the internet and watch glitch-free mobile videos.

There has been a gradual improvement in mobile coverage and, by the end of the year, all operators will be required to cover 90% of the UK's geography. However, mobile coverage still falls short of consumer expectations and so we are working to make better coverage and quality a reality across the UK. The 700 MHz auction is an opportunity to improve coverage further and contribute to the Government's goals. Ofcom has identified the band as suitable for coverage obligations. The Government will work with Ofcom to determine the best options.

To support industry to improve connectivity we have, through the Digital Economy Act 2017, introduced reforms to the Electronic Communications Code to make it easier and cheaper to rollout digital infrastructure. The reforms will come into force on the 28th December 2017. The Act also strengthened Ofcom's ability to enforce licence obligations more effectively as it gave Ofcom new powers to issue significant fines for operators that did not meet spectrum licence

conditions, such as coverage obligations. These measures reflect our ongoing commitment to drive connectivity improvements across the UK, and will support the rollout of 5G.

## Improved connectivity along our rail routes

The Government also committed in the 5G strategy to engage with industry to assess the potential for commercial delivery models to improve connectivity on our rail networks, to help pave the way for 5G connectivity.

The Government believes that relying on existing mobile operator coverage, even if supplemented by additional sites to infill poor coverage areas, is unlikely to deliver a sufficient level of connectivity to passengers on trains to meet future needs. This is partly because cuttings and the topography of the rail corridor mean that passengers are usually below the line of sight of masts, which are often primarily placed to provide coverage in populated areas, rather than to rail passengers.

We agree with the NIC, as highlighted in the Government's Industrial Strategy, that significant improvements in connectivity on our railways are needed. Informed by discussions with industry, it is likely that trackside infrastructure will be required to deliver high quality, reliable coverage in areas of high passenger demand. The aim is to test the extent to which trackside infrastructure can be delivered across the UK's mainline routes. The benefit of this approach is that it will provide high capacity, reliable and uninterrupted wireless connectivity to trains. This level of connectivity will be necessary to meet growing passenger demand and enhance passengers' productivity during journeys.

Delivering a trackside model is likely to involve:

- laying trackside fibre to provide high speed backhaul for mobile data, with potential for suitable access points for wider connectivity usage[5]
- mounting wireless devices on masts and other infrastructure along the rail corridor to transmit the signal to the train
- determining the radio access needs for delivering uninterrupted mobile connectivity, and ensuring the spectrum is made available
- relaying signal into train carriages via on-board equipment

This drive to deliver high speed connectivity[6] would supplement the Government's current policies which are to have wifi equipment fitted on virtually all trains by 2020 and further improve mobile connectivity on rail routes[7].

**Delivering trackside connectivity**

There are three important elements that are needed to deliver a future-proof trackside solution: spectrum, an effective commercial model and a robust technical solution. These three elements are interdependent.

[5] Mobile data traffic is forecast to grow at 25%-42% year on year, UK Digital Strategy 2017.

[6] Track to train solutions may be able to deliver up to 1Gbps to the train.

[7] The requirement is for 100 Mbps to the train. This increases 25% year on year after 3 years.

In delivering the technical solutions, fibre is the critical common denominator for any track to train solution because it provides reliable ultrafast backhaul to the core networks. This fibre could also be used to complement existing backhaul to get fibre closer to end users, including in rural communities. In addition, masts and other infrastructure will be required to deploy connectivity solutions.

The choice of technical solution and spectrum requirements are closely linked. Solutions using radio frequencies under 6 GHz are likely to be based on sharing spectrum, either on a licensed or licence-exempt basis; dedicated spectrum is more likely to be available in the millimetre-wave bands (~30 GHz and above). The radio frequency will, in turn, likely affect the cost of infrastructure (e.g. through the spacing and height of the access point infrastructure), and may, therefore, be relevant to the commercial model. The Government will work with Ofcom to identify how spectrum could be made available for this purpose.

**Trans Pennine Initiative**

There are a range of technical, commercial and practical deployment challenges that need to be assessed in the rollout of high-speed connectivity to trains. To test potential solutions in a real world environment, we are initiating a series of trials on the Trans Pennine route. The trial will be undertaken in partnership with Network Rail.

The initiative will deploy trackside infrastructure between Manchester and York, to enable the testing of multiple options for track to train solutions for passenger connectivity. They will begin by the end of 2018 and should help to inform a scalable model to deploy digital trackside infrastructure across other parts of the rail network. The trial will also help us to better understand whether there are synergies between commercial track to train connectivity solutions. These trials will build on Project SWIFT (Superfast wifi In-carriage-for Future Travel), a technical trial delivered by CISCO, Network Rail and Innovate UK, which will provide wifi on the route between Glasgow and Edinburgh.[8]

The Trans Pennine route has been selected for the trials for a number of reasons, including the following:

- the topography of the route presents a variety of challenges to deployment and therefore provides a good test case
- the route has a mix of passengers including commuters, day trippers, and long and short distance travellers which provides a good mix of users to test demand
- this route will be one of the last to receive upgrades to wifi connectivity through franchise agreements, with upgrades not due to take place until 2024.

### Commercial models

The Government's aim is to maximise the level of commercial investment to support the rollout of a trackside model. Initial discussions with industry suggest there is private sector interest in supporting the delivery of mobile connectivity on rail routes as a commercial venture. We will

[8] SWIFT delivers up to 500Mbps to the train.

consider how potential arrangements with mobile operators and infrastructure providers could maximise the commercial investment required to deliver reliable coverage across mainline routes by the mid-2020s, as well as how we can make best use of the planned digital railways upgrades to build the commercial case.

Consideration will need to be given to the optimal commercial and delivery models. We must ensure that the most efficient use is made of the existing infrastructure, such as masts, poles, ducts, power supplies and the fibre network alongside our railways, in the provision of a new trackside model. We will work closely with Network Rail on this. We will also engage Ofcom on how a regulatory regime might support different operating models.

**We will shortly launch a Call for Evidence on commercial options to improve mobile communications for rail passengers.** This explores potential revenue streams and commercial funding models, and invites input into our policy development from industry.

**And, as announced at 2017 Autumn Budget, the Government will also invest up to £35 million to enable trials. This investment will be used to: upgrade the Network Rail test track in Melton Mowbray; install trackside infrastructure along the Trans Pennine route between Manchester, Leeds and York; and support the rollout of full fibre and 5G networks.**

## A 5G-ready roadside network

In the 5G strategy, the Government committed to work with industry to explore the potential for commercial delivery models to improve connectivity on all our transport networks. Our market engagement has also focused on the viability of a 5G-ready roadside network alongside the UK's motorways, given the NIC's recommendation that it *will be vital that our motorways have mobile networks fit for the future* and that *infrastructure should be in place by 2025*[9].

We have been told that there is increased demand for digital connectivity along our roads to enable a range of existing and emerging applications including: in-car infotainment; congestion alerts and 'incident ahead' safety messages; as well as improved operational services for those managing our roads. However, the incentives of operators, infrastructure providers and the automotive sector to invest in a 5G-ready roadside network that provides improved connectivity and which will be 5G-ready are not yet sufficiently aligned. This is due to the significant uncertainties around the levels of demand for connectivity and how this will evolve over time, and the technological and deployment challenges associated with what is a broad range of nascent use cases.

Our engagement has suggested that whilst existing mobile networks are, in theory, capable of delivering many of the connected vehicle use cases currently conceived, for reliability reasons they would struggle to provide the required connectivity for provision of 'mission critical' and safety related connected vehicle use cases. Our engagement also suggested that whilst 'automated vehicles' will likely benefit from reliable connectivity – for example, to provide

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/577906/CONNECTED_FUTURE_ACCESSIBLE.pdf

a digital mapping feed and in order to interact with other vehicles and the wider environment - they will aim to be as operationally self-sufficient as possible.

The NIC highlighted that making the best use of existing infrastructure would help to make the business case for investing in a roadside solution more attractive. Indeed, given the economics associated with dedicated roadside infrastructure, some stakeholders have suggested that a model which makes best use of shared infrastructure (e.g. fibre, power, cell sites) could be the most feasibly commercially attractive.

Highways England manages, maintains and improves England's motorways and major A roads, and has an existing digital network running adjacent to the majority of motorways in England. They are in the process of renewing this network through the second National Roads Telecommunications Service (NRTS) contract. Their renewed network is to be future proofed, and it will be required to be scalable to meet future requirements as and when they occur. Attempts have been made in the past to consider how greater use could be made of Highways England's assets to improve mobile connectivity, for example through the cross-government 'Telecoms and Digital infrastructure Portfolio board' - although commercial success has been limited, due in large part to insufficient incentives for mobile operators to enhance their roadside coverage.

The Government will ramp up its work with Highways England and operators to better understand some of the deployment challenges associated with installing, maintaining and operating digital infrastructure - to help further our understanding of whether there is a commercial case for investing in such infrastructure and the role that government might play. We will also delve deeper into the likely demand growth for connectivity alongside our motorways, in order to understand how demand will develop and what this suggests about infrastructure requirements.

**In Autumn Budget 2017, it was announced that, as part of the Government's 5G Testbeds and Trial Programme, we will provide initial funding of £5 million for an initial trial, starting in 2018, to test 5G applications and deployment on roads, including helping to test how we can maximise future productivity benefits from self-driving cars.**

**This will build on the work already progressing on connected and autonomous vehicle trials in the West Midlands. The trial will test technical, deployment and commercial aspects of providing roadside 5G infrastructure. Related work will be commissioned to better understand demand and connectivity needs across the UK's major roads.** These activities will inform the business case for investment in the deployment of 5G-ready roadside infrastructure for the UK's motorways.

# 4. Building the economic case for investment

This section outlines a number of steps that the Government is taking to create the right conditions for commercial investment in 5G infrastructure and services.

## The Government's 5G Testbeds and Trials Programme

In the 2016 Autumn Statement, the Government announced its intention to invest in a nationally coordinated programme of 5G Testbeds and Trials, as part of over £1 billion of new funding from the National Productivity Investment Fund to support the next generation of digital infrastructure in the UK.

Through the 5G Testbeds and Trials Programme[10] we will:

- help to establish the conditions under which 5G can be deployed in a timely way to drive efficiency and productivity, and maximise the chances of the UK being amongst the leading 5G countries
- foster the development of the UK's 5G ecosystem to ensure that the UK and UK businesses are well placed to maximise the efficiency and productivity benefits of 5G

The Programme is a fundamental part of the Government's 5G strategy. The Programme will stimulate trials involving many different potential 5G use cases that will help address some of society's biggest challenges, such as those faced in health and social care, and will also fund deployment and technical projects that will help to address some of the practical and economic challenges surrounding 5G network deployment.

**At Autumn Budget 2017 we announced the allocation of £160 million from the National Productivity Investment Fund for the 5G Testbeds and Trials Programme. This includes £10 million that will be used to create facilities where the security of networks can be tested and proven, working with the National Cyber Security Service. The funding for transport infrastructure trial projects is set out above.**

### University Test Networks - laying the foundations

As announced in this year's Spring Budget, the 5G Testbeds and Trials Programme is investing £16 million in the 5GUK project during 2017/18**.** This is a collaborative project between the 5G Innovation Centre at the University of Surrey, King's College London and the University of Bristol.

The project will develop a unique national asset to be used as a testbed for testing technical issues and trialling new applications, which will ensure that the UK is at the cutting-edge of 5G

[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/652263/DCMS_5G_Prospectus.pdf

developments internationally, and will be available for use by other projects including future trials supported by the Programme.

To realise this vision, the project will collectively develop a 5G UK Exchange capability to facilitate interoperation and collaboration between these initial test networks, and to support future 5G projects in the UK helping to support the development of the 5G ecosystem

Each university brings specialist knowledge and capability. In particular:

- the University of Surrey's 5G Innovation Centre (5GIC) is leading the project and is developing 5G radio technologies and a fully virtualised mobile core network with network slicing
- Bristol University is deploying 5G capability in the extensive Smart City and Smart Campus test beds in the city of Bristol, with an emphasis on fixed-mobile convergence and Software Defined Network technologies
- King's College London is focusing on ultra-low latency 5G developments and is also pioneering several important 5G co-design approaches with various industries, including smart cities, smart transport, performing arts and health

5GUK exchange will be delivered by early 2018 and is laying the foundation for the next stages of the Programme.

## Phase 1 Projects

The 5G Testbeds and Trials Programme will deliver projects in phases, **starting with an initial Phase 1 competition for funding of up to £25 million**, announced on October 16th 2017[11]. These projects comprising testbeds with trials will be funded for delivery between April 2018 and April 2019 and will focus on new and innovative aspects of 5G in order to stimulate the development of 5G use cases and business models.

The Government has published briefing and guidance documents to support potential applicants to this competition, which set out the funding available for individual projects along with eligibility criteria and timings.

As with the investment in the University Test Networks, the aim of this competition is to support the development of a 5G ecosystem in the UK and contribute towards the delivery of the objectives in our 5G strategy.

## Next Activities in the 5G Testbeds and Trials Programmes

The Government intends that further activities in the 5G Testbeds and Trials Programme will include funding for projects that support the development of new 5G applications and services, as well as larger, multi-year projects that seek to develop strategic partnerships between the Programme, industry and local areas.

These could be focused in areas that align with the Government's strategic priorities or where we believe that there could be significant benefits to the UK. They could also be focused on

[11] https://www.gov.uk/government/news/nationwide-competition-brings-5g-one-step-closer

addressing deployment and technical challenges associated with rolling out 5G at scale in urban and rural areas.

**To inform the next stage of the Programme, the Government has today published a Call For Views which seeks input from interested parties on how, through a number of large deployment pilots, the Government can help establish conditions under which 5G-ready networks can be deployed in a timely way. These deployment pilots could explore challenges such as the use of neutral hosts for dense small cell networks in urban areas, or could help identify new revenue streams to support investment in mobile and fixed wireless connectivity in less populated areas.**

**We are seeking views on the appropriate scale and scope of deployment pilots, the timescales over which they should be delivered, the amount of funding contribution which would be appropriate, and the method by which funding should be allocated.**

The 5G Testbeds and Trials Programme is also working in tandem with the Government's Local Full Fibre Networks Programme to support investment in fibre infrastructure and further the understanding of the interaction between fixed and mobile technologies.

## 5G spectrum

The Government continues to support the use of the 700 MHz, 3.4-3.8 GHz and 26 GHz bands for mobile and as candidate bands for early 5G use in Europe. In addition to considerations of emerging technologies and their requirements, how new bands should be licensed, and under what conditions; decision makers should also take into account 5G's requirement to use wider spectrum bands than previous generations of mobile technology in order to achieve the expected performance of 5G in terms of speed, capacity and latency.

In the 5G Strategy, published at Spring Budget 2017, the Government asked Ofcom to review and report back by the end of 2017 on the scope for the spectrum licensing regime to facilitate better 4G and 5G deployment at national, regional and local scales, including in-building usage. Our aim is to find new ways to stimulate access to connectivity for under-served areas, communities and locations, particularly in business premises.

Ofcom has published its response to these asks[12]. The Wireless Telegraphy Act 2006 (WT Act) already gives Ofcom considerable flexibility to authorise the use of spectrum in order to meet stakeholder demand and in accordance with its wider duties and policy objectives. Ofcom's report sets out how it will use its flexibility, alongside its other regulatory powers to support the potential for new services and innovative uses and users, as part of its work to promote high quality connectivity where people live, work and travel.

In particular, Ofcom will consider further sharing in already assigned bands and the potential for an innovative licensing regime for millimetre wave spectrum that takes into account the particular challenges and opportunities offered by such high-capacity, short-range

[12] https://www.ofcom.org.uk/__data/assets/pdf_file/0019/108604/Review-of-the-authorisation-regime-for-spectrum-access.pdf

connectivity. Ofcom recognise that small, standalone networks may need to be deployed to support new 5G services.

The Government will give full consideration to the inputs of the report. We also welcome the action Ofcom has already taken since publishing our 5G Strategy in March 2017 to set out:

- its decision on rules for the **auction[13] of 2.3 GHz and 3.4 GHz spectrum** (July 2017)
- its decision[14] to **expand spectrum access for mobile services in the 3.6-3.8 GHz band** (October 2017) and plan to award it in 2019
- its plan to consult on enabling further sharing in the 3.8-4.2 GHz band in 2018, with a view to enabling innovative uses[15]
- the input from stakeholders[16] it needs to inform its work to **make spectrum in the 26 GHz band available** for 5G wireless networks
- its intention to start work to make the 66-71 GHz band available
- its current thinking on other 5G bands

The Government's ambition is to see additional spectrum for 4G and 5G assigned as soon as possible, to provide certainty for future investment. The continuing delays to the 2.3 GHz and 3.4 GHz auction, as a result of litigation, are therefore a source of some concern. In the interests of the earliest possible 5G deployment in the UK, **the Government wants Ofcom to complete the licensing of the 700 MHz and 3.6-3.8 GHz bands as soon as possible, and before the end of 2019 at the latest**, including the resolution of any legal challenges.

As set out above, because the 3.4-3.8 GHz band is a crucial 'first 5G' band for the UK (one of the EU "pioneer bands"), the Government is particularly keen to ensure that it is used efficiently. Both investment in 5G networks and effective competition between mobile network operators is likely to be harmed if the band is excessively fragmented; all things being equal, a few large contiguous blocks of spectrum are more likely to meet Ofcom's objectives to ensure optimal use of spectrum than many smaller ones.

In particular, we note the German plan to divide the spectrum into four blocks of c.100 MHz. We are therefore suggesting that in future **Ofcom, when issuing or amending licences to use spectrum for mobile networks, should have regard to the benefits of allowing the assembly of large contiguous blocks of spectrum**. For the same reason, both ourselves and Ofcom are sceptical about proposals to dedicate parts of the 3.4-3.8 GHz band to specific use cases such as intelligent transport systems, on the grounds that many or all of these functions could be achieved more flexibly and efficiently by network slicing.

We also want to see further progress on plans for **licensing the 24.25-27.5 GHz band**. The upper 1 GHz of this band is currently used by the Ministry of Defence. The Government will

[13] https://www.ofcom.org.uk/__data/assets/pdf_file/0022/103819/Statement-Award-of-the-2.3-and-3.4-GHz-spectrum-bands-Competition-issues-and-auction-regulations.pdf

[14] https://www.ofcom.org.uk/__data/assets/pdf_file/0019/107371/Consumer-access-3.6-3.8-GHz.pdf

[15] Ofcom's initial view is that in any future framework all existing and new users of the band (including current satellite users) would be authorised on the basis of first-come first-served coordination mechanisms, as is the case in the band now. Existing licences and grants would remain in place

[16] https://www.ofcom.org.uk/__data/assets/pdf_file/0014/104702/5G-spectrum-access-at-26-GHz.pdf

**make the 26.5-27.5 GHz band available for 5G mobile**, subject to the need to protect essential defence functions within the band. The UK is looking for the whole band (24.25-27.5 GHz) to be harmonised for 5G mobile at the ITU World Radio Conference in 2019, and Ofcom is contributing to national and international technical co-existence studies to understand the impact on existing users[17] and any technical and regulatory measures, including the option of progressively clearing 24.25-26.5 GHz, in time, geography and with regards to bandwidth required to facilitate 5G.

In the context of international harmonisation, the UK does not favour use of the 28 GHz band for 5G mobile in Europe, given the need to protect satellite services at those frequencies, but the government is open to coexisting use of 5G technologies (for example for fixed wireless access) where this is feasible. We welcome the efforts of industry and regulators, including Ofcom, to identify and investigate other 5G candidate bands above 30 GHz for future global harmonisation.

There may also be opportunities for 5G outside of its core bands, for applications other than mobile broadband, through sharing with other services. For example, the Government wants to **retain C-band satellite services as users of the 3.8-4.2 GHz band**, and **encourages Ofcom to continue to look at appropriate 5G sharing opportunities in the band on that basis only**. We would ideally have liked to set a timetable for further work on this, but given the uncertainties around when suitable equipment will be available and when innovative 5G use cases will develop we think this is not practical.

## Infrastructure

As outlined earlier in this document, it is possible that greater infrastructure sharing will be required in future to improve the economic case for investment in 5G-ready networks. The Government committed in its 5G strategy to work with Ofcom to identify and tackle unnecessary barriers to **infrastructure sharing** and to explore the potential for a clearer and more robust framework for sharing, while preserving investment incentives.

We believe that infrastructure sharing, in compliance with competition rules, can be an effective and economically efficient way of delivering telecommunications infrastructure, especially in areas where it is uneconomic to deploy competing infrastructure networks. The Government understands that Ofcom's major concern when taking decisions on infrastructure sharing is the potential for collusion between operators and the associated negative impact this would have on consumers. Ofcom have told the Government that they are not aware of any cases in the UK where passive infrastructure sharing has been prevented, and stated in their Digital Communications Review[18] that they are sympathetic to network sharing arrangements that reduce the cost of coverage where there are not adverse impacts on competition.

Mobile networks have consolidated through joint ventures between Vodafone and Telefonica

[17] Fixed Links, Satellite Receiver Earth stations, Programme Making and Special Events (PMSE) applications and Short Range Devices (SRDs). There is also a harmonisation for automotive radars until 1 January 2022.

[18] https://www.ofcom.org.uk/__data/assets/pdf_file/0016/50416/dcr-statement.pdf

(CTIL) and between EE and Three (MBNL), and the Government has also made a number of reforms to the **Electronic Communications Code (ECC)** which will make site sharing easier. These changes will soon come into force, and they will directly address investment barriers, lower the cost of infrastructure rollout, and support further coverage enhancements.

At present, therefore, the Government believes that the current regulatory system is not acting as a barrier to infrastructure sharing. However, given the step change in infrastructure envisaged in a 5G future, additional investment in networks will be critical. It is likely that, in future, further infrastructure sharing and neutral host models could be attractive in order to allow for the cost-effective deployment of networks. Indeed, in its recent Call for Inputs on the 26 GHz band, Ofcom noted that a neutral host model could be envisaged as an alternative model in order to help reduce the cost of deploying networks.

**The Government will keep the regulatory framework governing infrastructure sharing under review to ensure that it is adequately supporting investment in infrastructure, as part of its day to day work, and will consider the scope for alternative market structures as part of its telecoms market review.**

Access to fibre including on an affordable basis for backhaul is a crucial component of 5G networks - to enable higher and more consistent data rates and to support the introduction of small cell networks and centralised Radio Access Network (RAN) architectures. Most fibre investment will be funded commercially, so setting the right market structures and policy environment is vital. The Government's role is to support industry to maximise the deployment of full fibre networks and get fibre closer to end-users, using targeted public funding as a stimulus. This principle informed the package of announcements made at the 2016 Autumn Statement, which included:

- an initial £200m from the National Productivity Investment Fund for the DCMS Local Full Fibre Networks (LFFN) programme, which will support local bodies to stimulate the market for fibre connectivity in their areas
- an investment of £400 million in a new Digital Infrastructure Investment Fund - launched on 3 July - to unlock over £1bn of commercial finance for full fibre broadband connections across the UK
- 100% business rates relief for new fibre infrastructure for five years, helping to ensure the right incentives for investment in fibre are in place

Whilst Openreach has a near monopoly on the final stretch of copper to premises, there is an opportunity to build a more competitive market in full fibre. Competitors to Openreach are making their investment intentions clear, and co-investment is an option to extend fibre networks. CityFibre and Vodafone have recently announced a strategic partnership that will deliver connectivity to one million homes and businesses by 2021, with the possibility of extending this agreement to cover an additional four million premises.

Ofcom has also set the goal of promoting investment in full fibre networks, and is taking action in support of this. Ofcom are making it cheaper and easier for competitors to access BT's existing network of underground ducts and telegraph poles, as has been done successfully in Spain and Portugal, which should significantly reduce the cost of rolling out networks. The legal separation of Openreach from BT is also designed to make it more responsive to its

industry customers (e.g. Sky and TalkTalk).

In addition to facilitating access to Openreach's infrastructure, the government is working to make public sector assets accessible to make areas more attractive to invest in new fibre networks. As part of the first wave of Local Full Fibre Network (LFFN) projects, Tameside Metropolitan Borough Council is forming a new cooperative organisation that will aggregate ducts owned by the local authority across the borough and along the tramlines, as well as others owned by the private sector, and bring to market common access products, which it hopes will result in more connections to homes, businesses and masts. **We will also explore the potential for jointly funded projects through our LFFN and 5G Testbeds and Trials Programmes.**

As announced in the Industrial Strategy, the Government is undertaking an **in-depth review of the telecoms market** in order to build on positive market developments. This will establish a clear evidence base to determine what, if any, additional policy interventions may be needed to deliver government's objectives.

The Future Telecoms Infrastructure Review will assess[19]:

- the barriers to investment in digital infrastructure and next generation digital connectivity, now and over the coming decades including cost, levels of demand, market structures and regulation
- how investment incentives vary between different areas of the UK and across different parts of the telecoms market
- what, if any, policy changes government should consider to encourage greater investment in new digital infrastructure. These may include encouraging greater competition, other measures that can increase the attractiveness of investment through changes in the relative risks and returns, or direct government intervention

**The Review will seek a wide range of evidence, including from key industry and other stakeholders; and today we are launching a Call for Evidence to inform the review. A report, to be published in Summer 2018, will identify options for incentivising investment in the UK's future digital infrastructure.**

## Barrier Busting

The Government will ensure that it takes a broad view of deployment related matters in order to identify and address the barriers that could stand in the way of the government's 5G aims. That is why we have **set up a new cross-Whitehall task force, led by DCMS, to drive changes to make it easier for digital infrastructure to be rolled out.**

In respect of the **planning system**, the Government has been working with industry to assess whether further changes are needed in order to meet the challenges of 5G deployment. It is important that we assess the impact of the reforms introduced in November 2016 - which were

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/663060/Future___Telecoms___Infrastructure___Review-___terms___of___reference.pdf

warmly welcomed - as well as providing the evidence to show how possible further reforms could support high quality coverage.

The Government housing White Paper *Fixing our Broken Housing Market* published in February 2017 consulted on proposals to amend national policy so that local planning authorities are expected to have planning policies setting out how high quality digital infrastructure will be delivered in their area, and accessible from a range of providers.

**Following this consultation, and the outcome of the further consultation on Local Housing Need published in September 2017, the government will set out how these proposals are to be taken forward as part of the publication of a draft revised National Planning Policy Framework proposed for early 2018.**

Many of the asks received by government focus on the current connectivity landscape, as the requirements that will be necessary to support 5G infrastructure are not fully known. **However, we will be using the 5G Testbeds and Trials Programme to identify whether there are any further changes required.**

## Local area partnerships

The government believes that local authorities could play a proactive role in making mobile deployment easier through coordinated digital connectivity plans. This will be increasingly critical as the UK moves from 4G to 5G, due to the need to deploy infrastructure on a scale not previously seen. The action that Aberdeen City Council have taken to launch a 5G-ready small cell network connected by fibre in the city is an example of best practice which the government is keen to replicate around the country.

In order to highlight examples of best practice we are creating a Local Connectivity Group, made up of local areas, government departments, Ofcom, landowners and industry. The Group will help to provide an accurate picture of local area requirements for the deployment of digital infrastructure, encourage local areas to develop local plans for digital connectivity and could limit inconsistencies in interpreting regulations affecting infrastructure deployment across the country. As part of this work the government also wants to work with city region mayors.

**The government has asked techUK to provide the secretariat for this group on its behalf - given its experience in running similar Groups - with government acting as a full member. The government will also use the LFFN and 5G Programmes to drive changes in local areas, by encouraging them to have policies in place that are supportive of digital infrastructure.**

Opening up government buildings and land for mobile infrastructure development will be important for the rollout of 5G. From our engagement with industry we understand that the public sector is often viewed as a landlord of last resort. While prices charged have been a major factor, the industry have also fed back that other, non-monetary barriers remain. The imminent legislative reforms will change the landscape and introduce new and much needed alterations to support the deployment of infrastructure.

That is why we have been working with local areas and industry to streamline the process by which **Local Area assets are made available for mobile infrastructure**, using a small selection of councils as pilots. In the longer term, if this approach is a success, government would use its Local Connectivity Group to encourage widespread adoption.

DCMS has also been working with the Government Property Unit (GPU) to make central government estate the landlord of choice for the industry. The GPU have developed a Cross-Departmental **Digital Infrastructure Toolkit,** which will be published shortly**.** This toolkit includes a departmental rental guide developed to include market competitive rates, lease guidance and a standard lease, and is an important step towards opening up the government estate.

As well as keeping the Toolkit under review, alongside the GPU, **the barrier busting task force will work closely with the mobile operators to tackle any further barriers in this area, and report back progress by the end of 2018.** We will also look at how we might make data on sites and buildings more readily accessible than it is now, to make it easier for mobile operators to make informed choices on the potential of government sites and buildings to enhance their networks.

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