5G

TECHNICAL CONSIDERATIONS

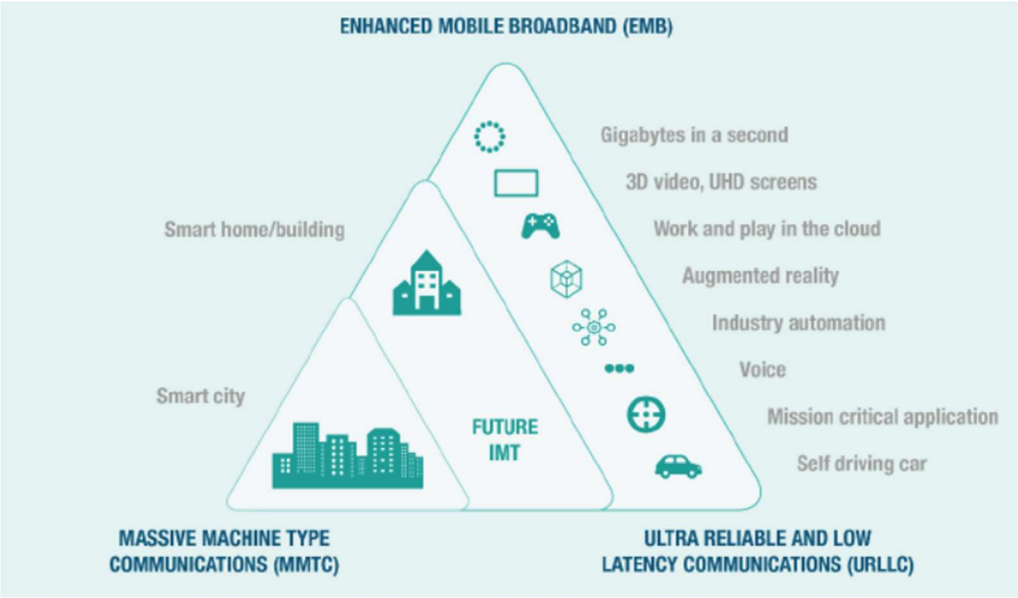
1.0 Implementing the UK Digital Strategy

1.1 Mobile and other forms of digital connectivity were once handy to have, perhaps even a luxury. However, as clearly recognised by UK Government in its Digital Strategy, they are now an essential part of everyday life.

1.2 Advanced digital connectivity provides new business opportunities, allows the UK to be competitive in changing global markets and supports people in their everyday lives. From the first generation of analogue phones to modern 4G enabled smart phones, the UK public has embraced the benefits provided by better mobile connectivity. The UK Government's Digital Strategy ambition is for the UK to be the global leader in the next generation of mobile technologies and digital communications like 5G and for the UK population to have access to world leading technology and lifestyles associated with those benefits.

1.3 Next generation smart devices utilising 5G, will benefit from enhanced mobile connectivity and facilitate the expanding range of services available to communities. From the first generation which provided voice calls, second generation that allowed basic data such as texting and the third and fourth generation networks which have offered progressively better internet and video access and the development of a myriad of "apps", the development of mobile connectivity continues at pace.

1.4 5G brings a revolutionary approach to managing the spectrum and greatly increasing data speeds and will deliver ultra-fast wireless broadband connections. The public advantages and opportunities this presents will be revolutionary - near-instant downloads of HD films, smart medical devices and smart cities, connected autonomous vehicles and traffic management, smart manufacturing with heterogenous autonomous machines, direct machine to machine communication, automated agriculture, far greater security provision, more stable and reliable connectivity and advances in further application development and many uses not yet identified.



1.5 It is estimated that 5G will directly contribute to an additional £7 Billion a year to the UK economy in just six years from roll-out and the significance of 5G is reflected in a range of Government policy:

> *"This Government has a clear ambition for the UK to be a global leader in the next generation of mobile technology – 5G. Good digital infrastructure is a building block of the Government's modern Industrial Strategy - 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. 5G promises a step-change in mobile connectivity with enormous potential to boost productivity and grow the economy, and we want the whole country to benefit. So, we will take a leading role in its development and roll-out, putting the UK at the forefront of the 5G revolution".*
>
> Department for Culture, Media & Sports - Next Generation Mobile Technologies: A 5G Strategy for the UK

1.6 The Mobile Network Operators (MNOs) deployment of 5G will start with our major centres and transport networks. The next phases will see coverage

extend across the whole of the UK, in line with coverage obligations and public demand for the services and benefits.

1.7 The deployment of 5G will begin through utilising the MNOs existing 3G and 4G networks and so for a period of time, sites are likely to carry different services in parallel, with intelligence applied to ensure high data uses operate through the higher capacity networks. Although 5G will undoubtedly bring new opportunities and huge benefits to society, this can only be delivered with additional infrastructure and that will mean new structures, antennas and ancillary equipment.

1.8 The success of 5G will be hugely dependent on its network resilience, especially if it is to be used for many of the planned services mentioned in paragraph 1.4, such as connected autonomous vehicles and smart medical services. Consequently, the network is likely to have a degree of duplication and overlap of sites to ensure full and reliable coverage, network capacity and operational resilience.

1.9 New mobile technologies - or generations - have been introduced roughly every 10 years, each offering improved services compared with previous generations. However, the existing 4G network rollout has been relatively rapid and indeed 5G deployment will mean that the timescales between mobile technologies has now reduced further. Although this has huge benefits as indicated above, it does mean that the UK legislative systems, including planning systems, have to continually adapt to these changing circumstances.

1.10 With each mobile generation, the types, amount and scale of apparatus needed to deliver new mobile connectivity change, and this will be even more evident with 5G. Government policy and permitted development rights will become more focussed on assisting the timely delivery of 5G, allowing the public benefits from the advances of this technology to be achieved.

1.11 In turn all of this will be reflected in operator delivery obligations and timescales. Parity of new mobile services will also become more evident – reflecting concerns about digital divides and that connectivity should be universally available, bringing with it challenges of delivering new or improved services into geographically more peripheral population areas:

> *"Getting 5G deployment right will be critical in a future where connectivity is becoming integral to almost all parts of the economy, and the UK will put its future growth and competitiveness at risk it if falls behind".*
>
> 'Connected Future' National Infrastructure Commission 2016

1.12 However, the one constant in the regulatory and policy framework is the continued emphasis on reusing and sharing existing sites as the best way of avoiding the unnecessary proliferation of new sites and so minimising potential environmental impact.

2.0 National policy support

2.1 Currently all the UK planning systems support advanced modern mobile connectivity, reflecting the UK Government's Digital Strategy and significance of 5G to the UK economy. 5G and associated benefits are described in more detail in the accompanying Cellnex document ***'National Policy – Delivering Ultra Fast Broadband Mobile Connectivity'***. Planning reform across all UK regions is now starting to reflect the specific support for next generation mobile technologies in particular 5G. For example, in England, the National Planning Policy Framework February 2019 states:

> *"Advanced, high quality and reliable communications infrastructure is essential for economic growth and social well-being. Planning policies and decisions should support the expansion of electronic communications networks, including next generation mobile technology (such as 5G) and full fibre broadband connections".*

2.2 In relation to mobile connectivity, there is very clear emphasis on supporting advanced digital communications, but at the same time the importance of striking an appropriate balance with environmental considerations is still recognised, with emphasis on appearance and design as well as sharing existing sites.

2.3 5G installations will in many cases be larger than the latest generations, because of the greater amounts of apparatus to support. This will take us back to ground-based mast heights used more typically with the first generation, i.e.

20 to 45 metres. However, this has to be viewed in the context of other, often much larger forms of essential public infrastructure that currently exist in urban and rural areas such as pylons, wind turbines, railway and road communications, street furniture, CCTV, and heating infrastructure. It is obviously a regrettable feature of a modern society that there will be some inevitable and unavoidable visual impacts associated with the public infrastructure necessary to serve us.

2.4 The delivery of 5G mobile connectivity will therefore bring about the need for new infrastructure but no more and often less than might be expected to deliver other essential public services. The regulatory and policy framework encourages minimising the potential impacts, but as with previous generations this will be tempered by the special technical and operational requirements that appertain. With 5G these will be considerable and more so when compared to previous generations of mobile base station deployment which are explained below.

3.0 Special operational, technical and siting considerations

3.1 The rollout of 5G equipment will initially be concentrated at a “macro” level, that being the upgrade of existing main base station or macro installations, coupled with the development of new macro installations. The potential for Small Cells, being micro base stations often utilising public infrastructure (like lamp posts) to provide dense urban 5G coverage (and capacity) will evolve as the technology is taken up. Initially this will be concentrated towards main cities and towns with greatest mobile phone demands.

3.2 Many existing macro installations are on rooftops and stand-alone towers. These will need to be upgraded and, in some cases, redeveloped to accommodate the new equipment and antennas.

3.3 Where a mobile operator already operates from a rooftop or mast and is therefore already providing mobile services to the local area, the 5G apparatus will be an upgrade of existing services and likely to provide coverage over the same area. As the reuse of existing sites accords with the regulatory and policy framework, there is no need to consider alternative sites, as made clear for

instance in paragraph 115(c) of the NPPF (England). In any event, to do so might also conflict with the existing network architecture and relocation might therefore be difficult, complex and time consuming to achieve.

3.4 In other cases where the operator has no existing base station in the area, the new 5G installation will be located and designed so that it can integrate into the wider 5G network under deployment. This may be for coverage or other reasons such as network resilience as previously explained, but because of the increased density of sites, there may have to be achieved within tight siting parameters.

Operational considerations

3.5 Whether it is the upgrade of an existing mobile base station or provision of a new site, a combination of the following operational considerations will apply:

- The need to provide an acceptable level of coverage over the target coverage area by the sector antennas and to meet expected demands and network resilience (antennas can only handle certain call and data levels)
- The need for a dense and superfast fixed fibre network, necessary for a 5G base station to rapidly process calls and data instructions and connect to the wider network
- Where necessary, point-to-point radio transmission dish antennas with heights required to allow direct line of sight
- Proximity to a suitable and reliable power source
- Positioning to meet public and occupational exclusion zones to meet ICNIRP guidelines (International Commission for Non-Ionising Radiation Protection)
- Demarcation and safety handrailing, protected cable routes, climbing access and some small signage
- An accessible route for construction and future maintenance access – pedestrian or vehicular

- A reasonable degree of security and associated signage
- A sympathetic and willing site provider
- For new ground-based masts, sufficient buffer space to allow for drop and exclusion zones
- Suitable ground and rooftop conditions to accommodate load bearing apparatus

More apparatus requirements

3.6 As 5G will operate across multiple radio spectrums it will require additional antennas and new equipment cabinets. Each generation of mobile base station has introduced slightly different antenna requirements, technical and siting considerations. Generally, each generation of mobile connectivity has seen the number of antennas required being reduced, particularly due to the sharing capability of newer antenna systems and network consolidation agreements between some of the MNOs. 5G is likely to require more antennas due to the need to ensure resilient coverage and in some locations, particularly towns and cities, the operators may need additional antennas simply to meet network capacity requirements.

3.7 Previous mobile generations used sector or omni directional antennas sited high to provide geographical coverage over the cell area in a blanket fashion. In urban areas, the 5G frequencies allocated by Government will not travel as far, which means the network will have to be denser. To ensure efficiency the antennas will be more “intelligent”, more optimised and highly ‘directional’. 5G antennas will therefore be highly advanced, in many cases using multiple-input multiple-output technology (MIMO) which essentially allows new antenna technology to be “smarter” and better track and communicate simultaneously with multiple mobile users.

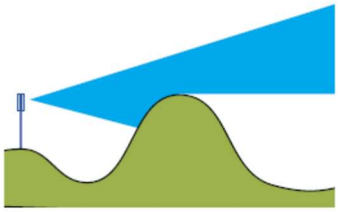
Greater height and siting implications

3.8 This has implications for siting and design. On building rooftops in particular, 5G antennas will need to be much closer to the building edge to avoid

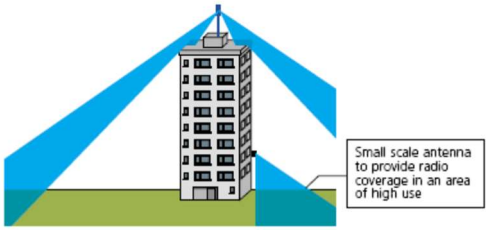
shadowing and antenna ‘clipping’ off the edge of the buildings and to allow the smart “tracking” features of the antennas.

Source: Cellnex Blackheath Telephone Exchange – roof edge 5G antenna configuration

3.9 Clipping of signals is already an important operational factor reflected in planning guidance such as this diagram from Annex C of Planning Advice Note 62 in Scotland, but now more prevalent to 5G:



• Signal loss due to shadowing from terrain.



• Signal loss due to shadowing from buildings.

Source: Annex C of Planning Advice Note 62 in Scotland

3.10 If this is not possible, then the antennas may have to be located higher on structures in the centre of the roof, but raised to a height to avoid the same 'clipping' issues. For antennas on ground-based masts, they will also have to be sufficiently high and clear of obstacles that can degrade signal propagation and be sited close to the target area.

Larger apparatus and redevelopment requirements

3.11 As new 5G antennas will also continue to provide other services like 3G and 4G (the antennas allow shared frequencies and shared services), they will normally be larger and so greater in appearance (although there is an expectation that 5G antenna technology and design will evolve and may reduce over time).

Source: Cellnex Trowell Services – 5G antenna and feeders

3.12 In turn, larger and heavier 5G antennas, are likely to require more supporting steelwork on rooftop installations. Necessary antenna supporting apparatus will also require additional supports.

3.13 Where 5G antennas are to replace those on an existing mast, the additional structural and wind loading of the new 5G antennas (and necessary support apparatus) may necessitate redevelopment of the existing structure.

More antenna support apparatus

3.14 As new 5G antennas will provide other services like 3G and 4G and antennas can be shared by more mobile operators (as part of radio network sharing agreements), they will also require a greater range of ancillary apparatus to combine the different radio frequencies and also help regulate signal / power loss between the equipment in the equipment housing and the antennas themselves.

3.15 This ancillary apparatus will be mainly small units normally behind or very close to the antennas. In some cases, they may be grouped on purpose-built support apparatus, but however configured it will necessitate higher and larger structures to support these additional complements.

Source: Blackheath Telephone Exchange – 5G antenna support apparatus

Greater reliance on fibre connectivity

3.16 Unlike earlier networks, 5G will rely more on dense fixed line fibre networks as these are both reliable and very high capacity. As a consequence, fibre routes and the opportunity to extend them will significantly influence siting and design of new installations.

3.17 In some cases, network requirements may also require dish antennas (transmission dishes) that operate on a direct 'line of sight' basis, a bit like a search light beam, to other dishes on corresponding installations on the network. This is likely to be the case where the 5G base station also incorporates planned other mobile services such as 4G. Fibre and dish "backhaul" requirement for 5G are very important as:

- They link the base station to the wider national network, which in turn is linked to other national and international networks
- Link the base station to a master control centre that manages the call handover process that occurs when a mobile user moves from one cell area to another
- Likely to provide telemetric monitoring to ensure the site is working properly, with some faults able to be fixed remotely.

3.18 Base stations also require cabinets to house the electronic communications radio equipment and an electricity meter cabinet for the necessary power connection. For 5G base stations sited on buildings, these cabinets are normally located at roof level to reduce feeder lengths, which if too long can affect radio signals and antenna performance.

Additional rooftop siting constraints

3.19 Additionally, on rooftops, the following considerations will also apply:

- Antennas have to be positioned to avoid radio interference with any existing equipment already installed on the building.
- All apparatus has to be maintainable in accordance with general health and safety requirements including the Construction Design Management regulations.
- All apparatus has to be installed in a structurally feasible manner.

- On a rooftop, all apparatus has to be clear of existing features such as access points, air conditioning units, roof lights, or other electronic communications apparatus.
- Apparatus has to be installed in accordance with the requirements of the building owner.

ICNIRP compliance implications

3.20 As some 5G apparatus will operate at higher power levels than earlier generations, it will need to be elevated higher off building rooftops, to ensure public exclusion zones can be maintained (see "***5G - Health and Safety*** for more information***)***".

3.21 Rooftop installations, whether new or existing will all be subject to this constraint and so require more prominently sited apparatus, which is a factor to bear in mind when considering alternative sites.

Interference considerations

3.22 The mobile network operators are also under a legal obligation to comply with the conditions of their licences granted by Ofcom. These conditions ensure compliance with legal obligations in respect of avoiding interference between themselves, with other radio systems, other electrical equipment, instrumentation and air traffic systems. The conditions of the licence are mandated by Ofcom who are responsible for the regulation of the civilian radio spectrum. Ofcom also has powers to investigate and remedy any reported significant interference.

4.0 Town Planning implications

4.1 All of this presents more complex issues for both the mobile operators, site owners and also additional considerations for Local Planning Authorities, as previously 2G, 3G or 4G systems could generally be accommodated without

the need for the same extent of extra supporting structures, support apparatus and antenna heights.

4.2 All new proposals will still have to operate within the prevailing ICNIRP (International Commission for Non-Ionising Radiation Protection) guidelines and that will influence siting and design to a greater extent than before.

4.3 The special technical and operational factors that apply to 5G will therefore affect siting and design considerations greater than before. This document should help explain these key considerations and how they are material considerations that must be reflected in town planning decisions.

4.4 All that said, it is recognised that any proposal must strike an acceptable balance with environmental considerations and the Government recognises that the best way to achieve this is still through sharing and the reuse of existing infrastructure.

4.5 In weighing the balance, it is also necessary to take into account the now massive and still growing public demand for mobile connectivity and the revolutionary nature of the many and considerable public benefits that 5G will deliver to support a prosperous economy and to make our lives safer and more convenient.

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