RECOMMENDED ACTIONS FOR A SUCCESSFUL DEPLOYMENT OF 5G IN THE UK

A paper prepared by Analysys Mason on behalf of the UK Spectrum Policy Forum
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Summary of key points

The UK wireless industry participating in the Spectrum Policy Forum (SPF) has been discussing during 2016 the landscape into which 5G services will be launched in the UK and the implications of 5G from a spectrum policy perspective. This paper, prepared by Analysys Mason on behalf of the SPF, describes the industry’s views on the spectrum implications of 5G introduction in the UK in more detail.

In summary, the key messages that have emerged from these discussions are that:

- Commercial launches of 5G networks will require substantial investments in new infrastructure, initially for priority use cases of enhanced mobile broadband services, supplementing LTE, and subsequently to expand the capabilities of networks to enable provision of the full range of ultra-reliable, low-latency and machine-type connections that is envisaged by the 5G vision.
- 5G is not solely about new radio technologies, but is also about overall system architecture. Whilst spectrum availability is a key input, the deployment of 5G itself is an evolution of the whole network system for mobile broadband services, as opposed to a revolution bought about by the availability of a particular spectrum band.
- 5G networks will need to operate over a range of spectrum bands, combining both low and high frequencies, in order to accommodate the demands of next-generation wireless connectivity in terms of coverage, throughput and quality of service (QoS). Millimetre-wave bands1 will partly address the spectrum need for 5G as this portion of radio spectrum can be used to deliver high-speed wireless broadband communications, but there will be requirements for other, lower-frequency bands to be available.
- In the UK, Ofcom is already planning to award spectrum in the 700MHz and 3.4–3.8GHz bands, and these bands could potentially be used for initial deployments of 5G. Key to the success of 5G in the UK will be the timely award of spectrum licences in these bands, with suitable conditions for 5G deployment.
- Use of millimetre-wave bands will be particularly focussed on the highest-capacity outdoor and indoor hotspots (requiring very high data rates and volumes of traffic). Recent studies suggest that the required bandwidth for 5G in such hotspots could be high (e.g. in the range from 3GHz to 6GHz, using channel widths of between 100 and 500MHz, or greater). Considering that 5G networks are unlikely to be commercially available before 2020 in many markets, innovative new applications and services are likely to emerge that will place increasing demands for access to suitable spectrum.
- The SPF is supportive of the global studies on the use of the millimetre-wave frequency bands for 5G that will take place in preparation for the World Radiocommunication Conference in 2019 (WRC-19). The SPF supports these studies based on the list of bands under study for 5G, as specified in ITU-R Resolution 238. The goal of WRC-19 will be to reach global consensus on the identification of the most suitable of these band(s) for 5G. Key characteristics of the bands under study that will influence the eventual choice of band(s) includes the available bandwidth, prospects for global technology harmonisation, prospects for the band becoming available for 5G use, potential for sharing with existing services and the global support for identification of the band for IMT-2020.
- The initial views stated by Ofcom in the context of European and international preparatory work for WRC-19 are generally welcomed by the SPF. Similarly, the initiatives that have been put forward by the European Commission and the Radio Spectrum Policy Group (RSPG) to identify pioneer bands for early deployment of 5G in Europe have been broadly supported in the SPF discussions. However, identification of pioneer band(s) during the remainder of 2016 should not foreclose debate on other potentially suitable candidate frequencies from within the bands under study, and preclude support for the necessary studies as part of the preparatory work leading up to the discussions at WRC-19.
- Of the three bands that the RSPG has identified as having European support for 5G (i.e. 24.25–27.5GHz, 31.8–33.4GHz and 40.5–43.5GHz), the SPF would like to understand further from Ofcom what the prospects are for each of these bands to be made available or utilised for 5G (e.g. in terms of sharing and/or re-purposing of existing uses, licensing, technical conditions for use).
- Of these three bands, internationally the 24.25-27.5GHz band currently seems to have the most support from mobile equipment vendors. There is some interest in 2GHz, although some concerns relating to the potentially available bandwidth, and requirements to protect passive services in the immediately adjacent 31.3–31.8GHz band. Other participants consider these points require further assessment and note that other bands also have certain limitations, such as propagation characteristics and existing use. There is growing interest in 37-43.5GHz. The remaining bands on the WRC-15 list are currently not being as widely supported by the initial 5G technology development and standardisation efforts.
- In parallel to making new bands available to deliver the full 5G vision, sub-6GHz bands already licensed for 2G, 3G and 4G use in the UK will continue to be needed, and the networks deployed in those bands are expected to evolve towards 5G based on market demand. New forms of spectrum access (such as licence-assisted access, or LAA) will also emerge, resulting in different ways of deploying LTE-based technology, and regulatory support will be required to enable implementation of these new approaches.

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1 millimetre-wave refers to frequencies in bands above 20GHz; in the context of 5G, selected millimetre-wave bands have been proposed for further study in accordance with a list of bands agreed at WRC-15.
Introduction

There is already significant interest from a wide range of stakeholders in relation to the development of 5G. The use cases being foreseen within 5G are extremely broad and include several industry segments that have traditionally operated dedicated networks outside the cellular network domain.

The mobile industry is embracing these developments and the goal is to work towards specifying 5G solutions for three distinct use cases that have been widely promoted both in Europe and internationally: enhanced mobile broadband, massive machine-type communication (Internet of Things, or IoT) and ultra-reliable, low-latency communication. Hence, 5G is poised not just to bring new mobile experiences to consumers, but also to provide wireless connectivity solutions that meet the requirements of a range of vertical industries, including automotive, healthcare, energy, smart cities, media and entertainment, as summarised below.

The relevant industry standards body (primarily the 3GPP) has already put in place the necessary steps to standardise the capabilities of the core and radio access networks (RAN) needed to deliver these use cases. The agreed priority within 3GPP is now to define 5G new radio (5G-NR) specifications for enhanced mobile broadband (MBB) services, supplementing the MBB services already being provided by LTE. Subsequent additions to the specifications will enable the full range of 5G functionality, including the ultra-low latency and additional connectivity options required to support the machine-type and ultra-reliable use cases.

Implementation of 5G in the UK is broadly expected to follow this sequence of service launch, with enhanced MBB services being launched initially followed by a richer set of services exploiting fully featured 5G capability. LTE networks will continue to supplement 5G technology and will themselves evolve to address selected 5G use cases, such as the machine-type connections.

- Virtual reality
- Streaming mobile video
- Live TV/entertainment
- In-car infotainment

- Automated industrial processes
- Vertical-specific applications in smart cities, transport, V2X, energy and healthcare
- Mobile cloud
- Safety-related automotive/autonomous cars
- Remote surgery/robotics

**FIGURE 1: 5G APPLICATIONS AND CONNECTIVITY** (SOURCE: ANALYSYS MASON, 2016)
The UK mobile market

When considering the market context into which 5G will be launched, it is relevant to consider the characteristics of the current UK mobile market.

The UK mobile market is highly competitive, with four mobile network operators [MNOS] and numerous mobile virtual network operators [MVNOs], providing services. The market is mature, in the sense that mobile penetration has reached saturation. Experience from 4G deployment in the UK demonstrates that take-up has been rapid, and the penetration rate of smartphones as a proportion of handsets is now very high (driving further take-up of 4G, and increasing mobile data consumption). Mobile data usage has also increased significantly driven by rapid growth in LTE penetration, resulting in a rapid increase in the volume of mobile data traffic being carried by mobile networks in the UK – ahead of many other European nations.

These trends are illustrated in the figures below.

The success of 4G network deployment in the UK, and the subscribers and traffic that 4G networks now support, highlights the importance, from the network operators’ perspective, for 5G to be backwards-compatible with current LTE networks, in order for investments to be viable. Hence, the industry’s view is that 5G will complement, not replace, 4G. In its initial deployment, what 5G is expected to bring is new mobile broadband experiences for consumers and businesses, such as near-instant access to high-quality video, virtual reality services and high-capacity broadband connectivity well suited to supporting mobile cloud-based services. Connectivity tailored to specific vertical markets – such as the automotive industry – is also widely envisaged. With the appropriate investment and regulatory support, 5G networks will also support a wide range of essential UK services well into the next decade – including smart cities, healthcare and other essential public services. Achieving all of this will require substantial investment in new infrastructure and a transformation in network architecture. This is further discussed below.

**FIGURE 2: EVOLUTION OF 4G PENETRATION AND SMARTPHONE ADOPTION IN THE UK** [SOURCE: ANALYSIS MASON, 2016]
The success of 4G network deployment in the UK, and the subscribers and traffic that 4G networks now support, highlights the importance, from the network operators’ perspective, for 5G to be backwards-compatible with current LTE networks, in order for investments to be viable. Hence, the industry’s view is that 5G will complement, not replace, 4G. In its initial deployment, what 5G is expected to bring is new mobile broadband experiences for consumers and businesses, such as near-instant access to high-quality video, virtual reality services and high-capacity broadband connectivity well suited to supporting mobile cloud-based services. Connectivity tailored to specific vertical markets – such as the automotive industry – is also widely envisaged. With the appropriate investment and regulatory support, 5G networks will also support a wide range of essential UK services well into the next decade – including smart cities, healthcare and other essential public services. Achieving all of this will require substantial investment in new infrastructure and a transformation in network architecture. This is further discussed below.
A key component of the industry’s views on 5G is that networks must complement, not replace, 4G. LTE technology will continue to evolve as 5G-NR is introduced and indeed it is likely that LTE-based technology might be optimised to deliver certain use cases envisaged within 5G – for example, lower-bit rate and low-cost IoT connections. 5G will result in interworking between terrestrial RAN technologies, including LTE-Advanced (LTE-A), LAA, Wi-Fi and 5G-NR. This interworking is also expected to encompass satellite systems as an additional component of next-generation connectivity.

5G will bring new, virtualised architectures supporting many small cells, and further development of existing cell sites incorporating multiple new antennas. Access to appropriate new sites (including small-cell types) will be required and there will be a need for existing sites to be upgraded with the addition of multiple new antennas. Regulatory support is also encouraged to promote the measures needed to allow these sites to be accessed and rights to use the sites for 5G agreed. In particular, reform of the Electronic Communications Code (ECC) must be followed through and implemented in a timely manner.

A wider availability of higher capacity backhaul connections will also be needed, and ensuring that suitable backhaul options are available – both wired and wirelessly – will be key to operators in order to deploy 5G.

In terms of the spectrum that will be used to deploy 5G access networks, it is now widely recognised that a combination of low- and high-frequency spectrum will be needed. In parallel with licensed spectrum bands, new spectrum regimes are expected to evolve (such as LAA). Millimetre-wave bands are one aspect of the 5G spectrum need, but there will also be requirements for other, lower-frequency bands (with the timely availability of both the 700MHz and 3.4-3.8GHz bands relevant in this regard). On the need for millimetre-wave bands, these are required to enable significantly higher data rates to be achieved compared to the capabilities currently supported by LTE-A, potentially using wider channels of 100–500MHz bandwidth per channel, or more. Use of millimetre-wave bands will be particularly focussed on the highest-capacity outdoor and indoor hotspots (requiring very high data rates and volumes of traffic). The required bandwidth for 5G in such hotspots could be very high, based on the channel widths envisaged (e.g. the total bandwidth needed could be in the range from 3GHz to 6GHz, as suggested by current studies). The bandwidth requirement will have an influence on which of the candidate bands from the WRC-15 list might be the most promising for 5G, which is further discussed in the next section.

The SPF supports the emerging view in Europe that the 3.4-3.8GHz band might be a promising band for early 5G deployment, which in the UK is subject to the planned Ofcom spectrum award in the 3.4–3.6GHz range (and the expected consultation on future use of the 3.6–3.8GHz band).

Finally, the sub-6GHz bands already licensed for 2G, 3G, and 4G use in the UK will continue to be needed, and the networks deployed in those bands are expected to evolve towards 5G based on market demand.
WRC 19-related considerations

The SPF is supportive of the results that have emerged from the global studies on the use of millimetre-wave frequency bands for 5G and would like to see a global consensus being reached on the identification of the most suitable band(s) for 5G. Key characteristics of the bands under study that will influence the eventual choice of band(s) includes the available bandwidth, prospects for global technology harmonisation, prospects for the band becoming available for 5G use, potential for sharing with existing services and the global support for identification of the band for IMT-2020.

Some SPF members are of the view that the most important characteristics to consider when considering the most promising bands for 5G in the context of the WRC-19 studies are the current use of the band (and sharing prospects) combined with the prospect of the band being internationally harmonised for use by IMT-2020 networks. Other members consider a wider range of characteristics as being important, in particular technology harmonisation and standardisation (which underpin the commercial feasibility of deploying 5G in different millimetre-wave bands).

The SPF is supportive of the UK’s current position that has emerged from the various European Conference of Postal and Telecommunications Administrations (CEPT) and ITU-R working groups (i.e. that the CEPT should focus on frequency bands that have the greatest potential to be globally harmonised, while also taking account of the need to consider the early harmonisation of a pioneer band in Europe). In terms of identifying the most promising bands for early 5G deployment in Europe, the SPF would like to understand further from Ofcom what the prospects are for each of the three proposed bands (i.e. 24.25–27.5GHz, 31.8–33.4GHz and 40–43.5GHz to be made available or utilised for 5G in the UK (e.g. in terms of sharing and/or re-purposing of existing uses, licensing and technical conditions for use).

Although SPF members broadly welcome in principle the RSPG’s idea of identifying a pioneering band during the remainder of 2016, this should not foreclose debate on other potentially suitable frequencies from those under study, nor preclude support for the necessary studies as part of the preparatory work leading up to the discussions at WRC-19.

Based on industry efforts and developments in Europe and internationally to date, mobile equipment vendors are of the view that the 24.25–27.5GHz band has the most widespread support, and has the benefit of being adjacent to the 28GHz band, which is seeing support for 5G use in some countries outside Europe. There is some interest in 32GHz, although some concerns relating to the potentially available bandwidth, and requirements to protect passive services in the immediately adjacent 31.3–31.8GHz band. Other participants consider these points require further assessment and note that other bands also have certain limitations, such as propagation characteristics and existing use. There is growing interest in 37–43.5GHz. The remaining bands on the WRC-15 list are currently not being as widely supported by the initial 5G technology development and standardisation efforts. The SPF has further noted the alternative methodologies being considered within ITU-R Working Party 5D (WP5D) to calculate the bandwidth needed for 5G and sees merit in a number of these. The traffic-based approach is not generally favoured as being less relevant to new enhanced mobile broadband services, where distinct quality of experience and reliability requirements might exist for different possible use cases. In this context, the application-based and technical performance-based approaches seem more applicable for services where quality of experience and reliability might vary based on individual user needs. The survey/questionnaire-based approach might also provide a useful top-down comparison to either of the application-based or performance-based methods.

In general, when addressing the WRC-19 studies, SPF is of the view that it is important that realistic assumptions are used on the requirements for 5G applications (e.g. when considering ultra-high-definition video traffic carried by 5G networks, appropriate encoding and compression assumptions should be made). It should also be noted that, in line with current market solutions, a portion of mobile data traffic will be offloaded to licence-exempt spectrum (e.g. by utilising Wi-Fi offload in the 2.4GHz or 5GHz bands), meaning that not all future mobile broadband traffic will be carried using licensed 4G/5G bands.

Considering that 5G networks are unlikely to be commercially available before 2020 in many markets, further innovative new applications and services are likely to emerge before that time, placing increasing demands for access to suitable spectrum.

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1 Some SPF members are of the view that synergies with current ‘WiGig’ developments will make the 66–76GHz band an interesting proposition for identification for use by IMT-2020/5G. However, other members were of the view that the current primary mobile allocation in this band is sufficient for expected uses and further WRC action (i.e. to identify for IMT-2020) is not needed.
In summary, the SPF believes that there are three main factors impacting a timely implementation of 5G in the UK. These are access to appropriate sites, availability of supporting infrastructure (including backhaul) and availability of the spectrum needed to support 5G.

The implied policy-led actions to deliver a timely launch of 5G in the UK can therefore be summarised as follows:

- Timely licensing and availability of new frequency bands suited to 5G deployment is important – both bands that might become harmonised globally for 5G use and within the context of bands already being planned for UK mobile award, such as the 700MHz and the 3.4GHz bands, which the UK government is planning to make available for mobile broadband use.

- As regards millimetre-wave bands, global harmonisation is supported in order to achieve economies of scale. In terms of identifying a pioneer band in the millimetre-wave range in Europe, the SPF would like to understand further from Ofcom what the prospects are for each of the three proposed bands (i.e. 24.25–27.5GHz, 31.8–33.4GHz and 40.5–43.5GHz) to be made available or utilised for 5G in the UK (e.g. in terms of sharing and/or re-purposing of existing uses, licensing, technical conditions for use).

- The SPF is supportive of the UK’s current position that has emerged from the various CEPT and ITU-R working groups (i.e. that the CEPT should focus on frequency bands that have the greatest potential to be globally harmonised, while also taking account of the need to consider the early harmonisation of a pioneer band in Europe. Ofcom is urged to continue to promote these positions in Europe and internationally.

- In parallel with making new licensed spectrum available, regulatory support is also needed for new forms of spectrum access – such as LAA. In this context, the SPF is also broadly supportive of Ofcom’s stated views in relation to improving access for radio local area networks (RLANs), including LTE-based technology, in the 5GHz band. There are some specific issues affecting the 5GHz band, which the SPF has also been discussing during 2016 (and these issues will be the subject of a separate briefing paper).

- Ensuring suitable access and tenancy conditions for radio sites is becoming increasingly important both as LTE-A evolves and as 5G is introduced. New types of sites will be needed (particularly for small cells) and existing sites will need to accommodate additional antennas. Reform of the ECC needs to be followed through and implemented in a timely in order to aid 5G network planning. It will also be relevant to ensure that sufficient wireless backhaul capacity continues to be available, as mobile network throughput increases and as new types of sites are deployed.

Finally, it is noted that the 5G era will result in a complex mix of devices and services being supported by mobile networks. The business models, and the key capabilities needed to deliver specific use cases to different vertical markets, still need to be better understood. In this context, ensuring co-operation between stakeholders, and conducting the necessary 5G technology trials to demonstrate network and device capabilities for different applications will be important. UK-based 5G demos and test-beds that will help to build cross-sector agreement are broadly supported by the SPF. These will require access to appropriate spectrum, infrastructure and funding in order to implement, particularly if large-scale, multi-party trials are to be conducted.
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