

5G Further, Faster

*A 5G spectrum initiative at
3.6-3.8 GHz in support of
the Government's proposed
"market expansion" model*



5G Further, Faster is published by the Institution of Engineering and Technology.



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Foreword

Mobile access is increasingly vital for all of us all of the time, wherever we are. This is no longer a matter of convenience but an essential service, for everything from speech recognition (vital for many emergency services) to navigation and health monitoring. We believe that Ofcom's decision about 5G spectrum will determine whether 5G is for the favoured few in busy towns and cities or available to everyone and in as many places as possible.



Mobile operators are no longer significantly improving the coverage they offer as there are few incentives for them to do so. The situation will get worse with 5G as the investment needed to cover areas that barely have 4G will be even greater for 5G.

Ofcom has plans to improve rural coverage at very low data rates (2 Mb/s) but this is just getting rural communities to where they should have been 10 years ago. Ofcom has no spectrum plans to ensure that 5G serves rural Britain with Gb/s data speeds for small towns, villages and farms...even through self-help. Nor has it recognised the 5G needs of enterprises and future manufacturing.

A group of companies and academics working with the IET have set up a new initiative called 5G Further, Faster (5GFF). Our mission is to get UK 5G further out from the profitable high footfall urban areas and to get faster 5G in those places more quickly. We believe that delivering ubiquitous connectivity will require others also to deploy 5G base stations. Many would be willing to do so, including rural communities, building owners and independent network providers. However, they are unable to if they cannot access 5G radio spectrum which normal smartphones can utilise. And they need certainty of access to spectrum to be able to finance their proposed networks.

Recently, technical mechanisms have become available that can allow dynamic automated sharing such that others could use the 5G spectrum where the operators choose not to, potentially creating a diversity of services that can maximise the value of mobile for all of us. The government is keen to promote this and have said so in their Future Telecommunications Infrastructure Report. But the power to do something rests with Ofcom, though it is still unclear whether they will use it. The responsibility for taking this forward is therefore a matter for Ofcom.

Prof Will Stewart
Chair, IET Communications Policy Panel

5G Further, Faster

'5G Further, Faster' (5GFF) is an initiative by a group of companies and academics working with the IET. The group believe strongly that a new approach to the way mobile radio spectrum is allocated in the UK is urgently needed, to allow for the UK to be a world leader in 5G and to benefit everyone all over the country. 5G will power the connected devices which will be crucial to the digital economy of the future. Perpetuating the old method of allocating mobile spectrum only on a national basis will significantly hamper the UK's ability to achieve this. So, the 5G Further, Faster Group supports the vision of the market expansion model outlined in the Government's Future Telecoms Infrastructure Review. Most urgently, this affects specific aspects of the imminent release by Ofcom of radio spectrum at 3.6-3.8 GHz for 5G.

The 5G opportunity

The coming of 5G is discussed and described in every popular newspaper and widely anticipated as an important change that will bring economic benefits that the country cannot afford to pass up. At the same time though, it represents a major challenge for the Mobile Network Operators. They have barely completed the rollout of 4G, large parts of the UK population only have access to 4G from only one operator and now they are being expected to set out their capital investment plans for 5G. What is the real situation with 5G?

Discussion of 5G use cases sometimes focuses on higher download speeds, especially to all the mobiles in a particular area, but equally important are 5G's capability to dramatically reduce latency, greatly increase reliability and to offer marginal cost connections of large numbers of Internet-of-Things devices. The benefits of 5G will to a large extent come from the new business models and new use cases that businesses and the public sector will be able to adopt, consequent on 5G's unique performance characteristics.

In particular 5G networks will be required to enable widespread adoption of new approaches to connected and autonomous vehicles, health & social care services, in-building enhanced mobile broadband, future hands-free farming and industrial automation, also known as Industry 4.0. Many of these innovations in the way UK people live their lives will not be available to those who live, work or travel outside the coverage area of future 5G networks. In some countries with large manufacturing industries, notably Germany and the USA, have already made separate allocations at 3.4-3.8 GHz for regional operators (Fixed and Mobile) and Industry 4.0 use cases.

5G spectrum

There is wide agreement that 5G will need three types of radio spectrum. It will need “low band” spectrum that is suitable for coverage, particularly if rural areas are to have any 5G at all, even at low data rates e.g. 2 Mb/s. The band selected by the UK (and Europe) is 700 MHz. Secondly it will need a band that can deliver much higher bandwidths, to support enhanced mobile broadband in high footfall areas, in buildings and in industrial applications, but these cells will have a significantly smaller footprint than today’s 4G macro cells, which means that additional investment is needed for densification. The band selected by the UK (and Europe) for this purpose is 3.4-3.8 GHz. Thirdly it will need much more spectrum at higher frequencies to enable very high speed downloads, such as will be needed when many people are in close proximity eg in football stadiums. The UK and European band for this is 26 GHz.

Ofcom is presently considering the release by auction of the 700 MHz band and has already auctioned licences in the 3.4-3.6 GHz sub-band. **The urgent matter now is to consider how the remaining spectrum in the 3.6-3.8 GHz band should best be released.**

Ofcom’s traditional approach is to auction national licences for sole use by the purchaser for an extended period. Often they associate the licence with a coverage condition. However, an onerous coverage obligation is not feasible in bands as high as 3.6 GHz. The cost of building the infrastructure would be too high. Instead the locations of 5G cells are expected to largely be driven by capacity and other location-specific demands. This will naturally leave large geographic areas where the spectrum is unused. This can already be seen with the 2.6 GHz 4G band where only 2% of the UK landmass had all of the 2.6 GHz spectrum deployed 5-years after the 4G spectrum auction and the 2.6 GHz TDD band has not been commercially deployed by either licensee.

CARRYING ON FOR 5G AS WE HAVE DONE BEFORE

Ofcom’s most recent consultation on improving coverage of very basic mobile connectivity proposed coverage obligations attached to the release of the new 700 MHz spectrum to achieve the following geographic coverage a) 92% in England, b) 92% in Northern Ireland, c) 83% in Wales and d) 76% in Scotland. It was proposed that the coverage obligations would be achieved within 3 years. This would leave 8- 24% of the geographic area of the nations with no mobile coverage. The 700 MHz band has quite limited capacity though and cannot alone deliver all the benefits of 5G to those within its coverage.

Ofcom has no plans to attach any coverage obligations to the release of the 5G spectrum at 3.6-3.8 GHz. The expectation is that some parts of urban Britain will eventually be covered but the hardest to reach places, including rural areas

and inside many enterprise buildings (including hospitals, factories, warehouses and offices), will not be. As 5G cannot benefit what it does not cover – securing any extent of 5G coverage outside of urban Britain will be one of the great policy challenges for government, regulator and the industry.

A NEW MODEL FOR A NEW SET OF CHALLENGES

The government has recognised this limitation of the current model. In their Future Telecoms Infrastructure Review (FTIR) they propose a new "market expansion model". This is described in the technical annex to this paper.

DCMS have proposed a spectrum sharing model to enable the market expansion model. The need for this lightly licensed spectrum is to provide an anchor band so that those providing coverage in the expansion zone are not entirely dependent on opportunistic use of local spectrum. This is a pre-condition for investor confidence. Also, it is critically important that these innovative, smaller-scale and potentially disruptive market interventions may make use of technology designed for the mass market because otherwise the costs and poor availability of user and network equipment will prevent them from gaining the investment necessary. This means they need to be able to work in the same 3.6- 3.8 GHz band that the MNOs will use, to keep costs under control.

THE 5G FURTHER, FASTER PROPOSALS

- The UK should positively embrace the FTIR "market expansion" model to create an environment that is friendly to those who wish to innovate and extend 5G mobile coverage to the areas MNOs find uneconomic to cover.
- Ofcom should enable opportunistic spectrum sharing across the entire 3.6-3.8 GHz band so that spectrum being wasted in areas where one or more MNOs have not chosen to go can be put to good use to significantly boost performance of local 5G cells, however they are provided. This offers benefit to MNOs as well, especially in the circumstances where neutral host networks are deployed.
- Thirdly a small portion of spectrum, it is suggested 20 MHz, should be available to new entrants, neutral host in-building operators, self-help groups, manufacturing industry or enterprises like farmers. There are options as to how this might be managed and Ofcom should no doubt consult interested parties on how best to do this.

NETWORKS

The 5GFF Group also notes that many of the emerging proposals to provide for the availability of full 5G outside urban areas, and along rail and road corridors, will rely on new forms of infrastructure sharing, including especially neutral host wholesale networks, that will need to be interconnected to the main UK

networks. The UK's regulation of 5G telecoms networks will need to be adapted to enable this to happen. Other innovations will undoubtedly emerge and the UK Government should ensure that the UK is open to these so that the maximum benefits of 5G may be provided to substantially all of the UK as quickly as possible. The Group considers that the proposals that it is making are complementary to the announced and roll-out plans of the UK MNOs and the intention is that they should remain so.

Other information

There is a great deal more information available on this topic. What follows is a technical annex giving more information about how the spectrum issue affects the future of 5G in the UK, while there are a number of proposals from companies and organisations which support the 5G Further, Faster Group available on the IET website (www.theiet.org/5GFF). Readers are invited to contact these 5GFF Supporting Partners listed at the end of this paper if they would like further information.

Technical Annex

5G FURTHER, FASTER REQUIRES A HIGH "BAND" AND "GEOGRAPHIC" SPECTRUM EFFICIENCY

The UK's long-term infrastructure will be the result of a fusion of fibre and 5G. A high performing fibre-5G infrastructure requires both bandwidths to be matched. The most challenged is the 5G bandwidth. Ensuring the full 5G bandwidth is usable at every cell will provide a national infrastructure with the headroom to be hit by multiple demands and for there for *an instantaneous response* at the data speed demanded. Therefore, leadership in the use of 5G requires a new regulatory framework that maximises the "band" and "geographic" *spectrum efficiency* of the 5G pioneer band 3.4-3.8 GHz. This band is of critical importance as its designation as a "5G pioneer band" has ensured its use in every 5G smartphone and other low cost 5G devices. There are already proven approaches to spectrum sharing (eg TV White Space and CBRS) and their adaptation should be straight forward for Ofcom to find an agreed approach with the industry.

5G NEW RADIO (NR) IS, AT ITS MOST BASIC, A REVOLUTION IN CHANNEL BANDWIDTH

Mobile data technology revolution since 1G has been a revolution in channel bandwidth. The first-generation analogue standards operated in a 25 kHz channel width, GSM was able to use a 200 kHz bandwidth, for 3G it was 5 MHz and 4G raised the limit to 20 MHz. 5G extends the channel bandwidth to at least 100 MHz. After the first Ofcom spectrum auction for the sub-band 3.4-3.6 GHz, no UK mobile operator emerged with the possibility of full bandwidth 5G.

Radio channel width MHz	Peak Data Speed Gb/s
40	1.2
100	3.0
200	6.0

Source: 5G PPP input to CEPT

Table 1 – What is full-bandwidth 5G?

Maximising the "band" and "geographic" *spectrum efficiency* for 5G

The UK Government's Future Telecommunications Infrastructure Report (FTIR) has identified the best way for a country to maximise the "band" and "geographic" *spectrum efficiency* of the band 3.6-3.8 GHz. It is termed the "market expansion model" and illustrated in Figure 1. The government has not specified how much spectrum is set aside for lightly licenses use but many in the industry have suggested a figure of 20 MHz. That would be 5% of the 5G

pioneer band and it seems a proportionate amount for a country to invest in “innovation”.

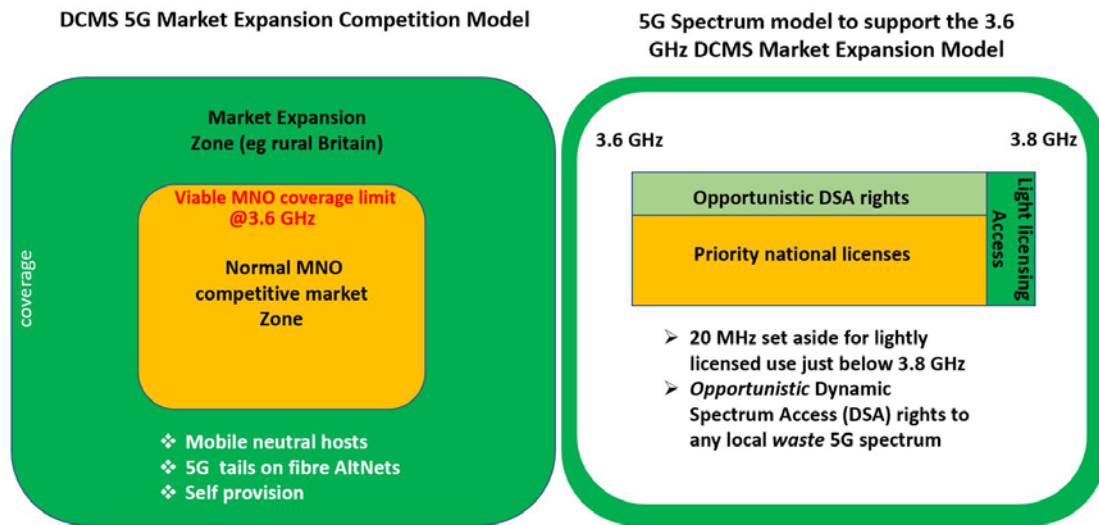


Figure 1 – Illustration of the Market Expansion Model

The opportunistic Dynamic Spectrum Access (DSA) delivers on the “band” *spectrum efficiency* and the lightly licensed spectrum delivers on the “geographic” *spectrum efficiency*. The impact is shown on the next two illustrations:

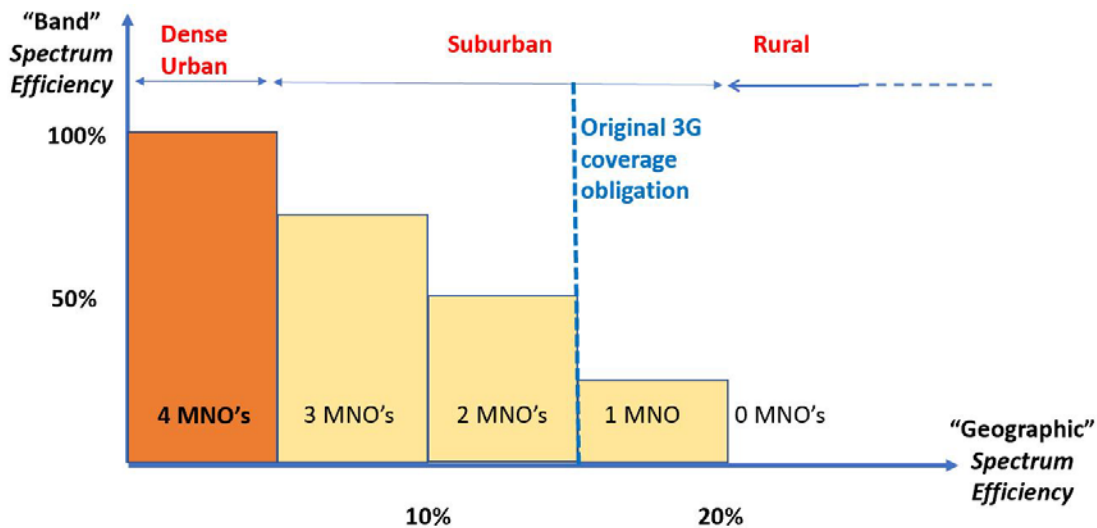


Figure 2 – Illustrative spectrum efficiency for traditional model at 3.6 GHz that has no coverage obligation and roll-out is “capacity” driven

The geographic profile of the number of MNOs is *purely illustrative*. But we know all four MNOs will want to have coverage of railway stations, town centres etc. We also know that, if roll-out is capacity driven (no coverage obligation), then there will be differences between MNOs in their suburban capacity pressures, reflecting different customer demographics, different cell edge locations, ready fibre access and site access. (The cell edges are the

troughs where capacity falls by up to a factor of 100 with single frequency networks). Areas where *not all of the spectrum* is deployed will therefore rise sharply at 3.6 GHz outside of dense urban centres. The blue vertical line shows where the original 3G coverage obligation was set. It is included to give confidence that the scaling is in the right ballpark.

Figure 3 then super-imposes the effect of over-laying the traditional regulatory framework with the government’s market expansion model:

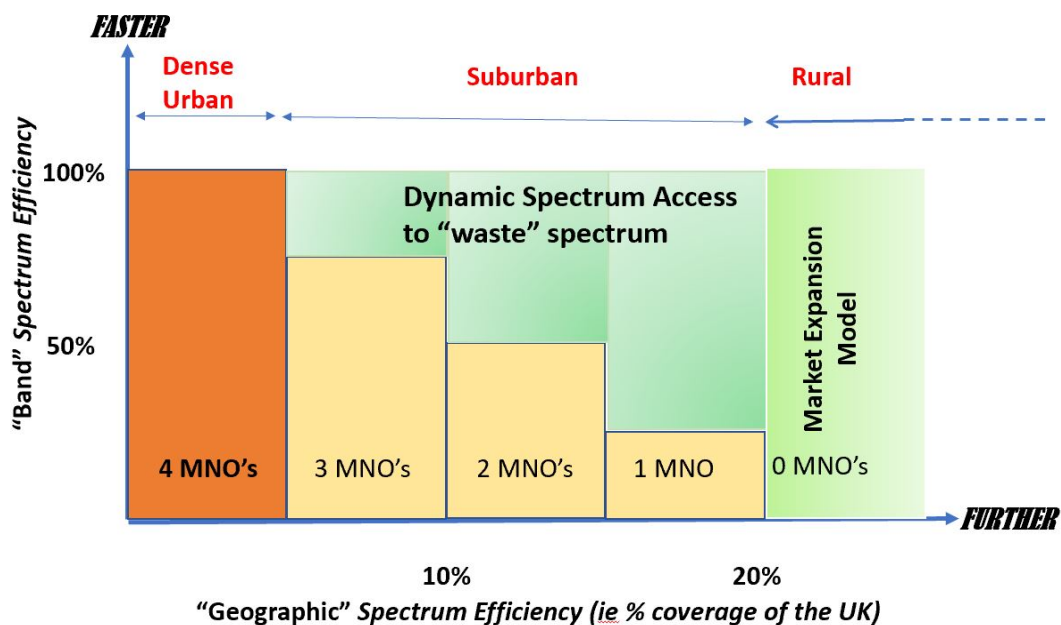


Figure 3 – Illustrative impact on spectrum efficiency of overlaying the traditional model at 3.6 GHz with the government’s proposed market expansion model

The precise profile is not knowable, but we believe the projections are directionally correct and it would be accurate to suggest an up to four-fold improvement in “band” *spectrum efficiency*, increase in “geographic” *spectrum efficiency*, better quality of 5G coverage inside commercial/industrial premises and access to 5G for millions living in rural Britain.

MATURITY OF THE TECHNOLOGY

In the US the FCC has established the new Citizens Broadband Radio Services (CBRS) with a block of 150 MHz (3.550GHz-3.700GHz) allocated for shared use with up to 70MHz allocated to Tier 2 Priority Access Licences (PALs) which may be used to address the Enterprise market. A new ecosystem has formed around CBRS in the 3.5 GHz band and vendors have created a range of new product to address the market. The technology to implement spectrum sharing in this band is therefore well advanced and no doubt can be readily adapted to suit the UK circumstances. The German regulator BNetzA, are considering the release of 100 MHz of 3.4-3.8 GHz for Private and Regional Mobile networks in an initiative being driven primarily by large German manufacturers addressing Industry 4.0.

CONCLUSION

Figure 3 show that an investment in 5% of the 5G pioneer band at 3.6 GHz combined with opportunistic dynamic spectrum access (DSA) can deliver almost the performance equivalent of two national 5G infrastructures for the price of one. It is an open goal ready for Ofcom to score a win for the United Kingdom in enhancing 5G *spectrum efficiency* to the best in the world.

Supporting Partners

5G RuralFirst *
Dense Air *
WHP Telecoms Ltd *
Nominet *
Wireless Infrastructure Group *
OpenCell
Federated Wireless
Rivada Networks *
Google *

** These companies have published their own proposals, available to read at www.theiet.org/5Gff*



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