Frequency Band Review for Fixed Wireless Service

Final Report

Executive Summary

Prepared for Ofcom

2315/FLBR/ES/1

29th November 2011

0 EXECUTIVE SUMMARY

0.1 Introduction

This report presents the findings of a study commissioned by Ofcom into the potential future demand for spectrum in frequency bands currently used by point to point fixed links. "Fixed links" in the context of this study are point to point radio links used to convey voice or data traffic between two specified geographic locations. Such links provide an alternative to other transmission media such as copper cables or fibre and are used for a variety of applications, including backhaul for mobile networks and broadcast transmitters, direct voice or data connections to end users (leased lines) and connecting nodes within private or corporate communication networks.

Four illustrative scenarios were developed, for each of which demand for various downstream services was projected and the implications for fixed link spectrum assessed. The downstream services included mobile (cellular) networks and broadcasting, which use fixed wireless links for backhaul and distribution, and satellite services which can compete with fixed services for access to certain frequency bands. Account was also taken of the likely needs of other significant users of fixed link spectrum, including local authorities, utility companies and the public safety community. Analysis of the scenarios suggests that there will be sufficient spectrum to meet all anticipated future needs in bands above 20 GHz, but that potential shortages of spectrum may arise in bands below 20 GHz in some geographic regions under some scenarios.

0.2 Current status of fixed link bands

Analysis of Ofcom licensing data has shown that backhaul for public mobile networks is currently the dominant driver of fixed link demand. Mobile network operators account for approximately 55% of total fixed link capacity in the UK, with fixed network operators (some of whom also provide backhaul capacity to mobile networks) accounting for a further 28%. Other major users include local authorities, public safety and the utility sector (electricity, gas and water companies), each of which accounts for 2 – 3 % of total fixed link capacity.

In general, higher frequency bands are used for shorter links and at higher frequencies links are increasingly concentrated in urban areas, with lower frequencies used to provide longer haul links between conurbations and in less populated areas. The 1.4 GHz band differs from other fixed link bands in that the link capacity is limited to below 10 Mbps and compact, relatively low gain antennas can be used. In consequence there is a wider mix of link lengths in this band and the band is less attractive for mobile backhaul applications where wider bandwidths are required.

Over the last two years, demand for fixed links has been stable or declining in most frequency bands, with the exception of the 15 GHz and 6 GHz bands. Both of these bands were formerly self-managed (by Cable and Wireless and BT respectively) and since being returned to Ofcom management have been increasingly used as an alternative to existing bands that had become congested in some geographic areas.

The fixed satellite service (FSS) shares a co-primary allocation in several fixed link bands. According to Ofcom, it estimated that there are currently approximately 500 permanent satellite earth stations across the UK operating in spectrum that is shared with fixed links. A total of 707 satellite links are deployed from these permanent earth stations.

0.3 Development of downstream services scenarios

The study developed a set of four hypothetical future scenarios which were used to estimate future demand for downstream services and the associated impact on fixed link spectrum requirements. A number of parameters likely to have a particular impact on future fixed link demand were identified and applied to the scenarios, namely:

- **The Economy**—the state of the UK and global economy is likely to have a significant impact on future demand for mobile and broadband services, with a consequent impact on demand for backhaul capacity. A weak economy may also lead to higher levels of crime and social disorder and greater pressure to reduce operational costs in the public sector, which could encourage wider deployment of wireless CCTV systems and other high bandwidth applications by local authorities and public safety bodies.
- **Policy and Regulation—**government or regulator mandates relating to issues such as rural mobile or broadband coverage could have a significant impact on demand for wireless backhaul links to support terrestrial networks, or on satellite demand in the absence of adequate terrestrial coverage. Regulatory moves to open up the fibre market could conversely reduce the demand for wireless backhaul in many areas (see below). The impact of policy and regulation is likely to be greater in a weaker economic scenario.
- **Extent of fibre availability—**demand for wireless backhaul links in urban and suburban areas is highly dependent on the cost and availability of fibre connectivity. In urban areas where there is competitive supply, the price of fibre is attractive; however, in more remote locations the cost associated with buried fibre, ploughed or ducted, prevents the medium from being more widely used. Regulatory initiatives to improve access to established ducts and poles required to rollout fibre cost-effectively and the supply of dark fibre in the access network would be likely to lead to extended fibre deployment and less reliance on wireless backhaul.

- **Broadband Service Demand (Mobile and Fixed)**—broadband service demand will largely depend on the state of the economy and regulatory policy, e.g. relating to broadband coverage and speeds, but the analysis also takes into account potential wider market trends in relation to different types of device or application. Traffic management strategies such as data offloading to Wi-Fi or application of monthly data caps are also taken into account.
- **Public Sector Demand**—demand arising from local authority and public safety users will be dependent in part on the state of the economy (in terms of how much is available to invest and pressure to reduce costs e.g. by wider CCTV deployment or automation) and government initiatives such as moves to tackle crime or enhance the capabilities of the emergency services.
- **Utility Demand—**the main factor affecting demand from the utility sector is likely to be the introduction of smart grid technology to improve energy efficiency and resilience of the electricity distribution network. The extent and speed of smart grid rollout will depend on a mix of economic and regulatory factors.
- **Satellite service demand—**the main potential growth area for satellite demand is for consumer broadband terminals, demand for which is likely to depend on the availability of alternative terrestrial platforms and will therefore be influenced by a mix of economic, regulatory policy and network investment considerations.
- **Demand for other fixed link applications—**demand for wireless capacity in the broadcast, local authority, public safety and utility sectors will be dependent in part on the state of the economy (in terms of how much is available to invest and pressure to reduce costs e.g. by wider CCTV deployment or automation) and government initiatives such as moves to improve energy efficiency or enhance the capabilities of the emergency services.

The downstream services considered in the analysis included the following:

- Mobile (cellular) networks
- Rural fixed wireless access (FWA)—includes potential provision of fixed broadband services via next generation mobile networks
- Satellite broadband
- Broadcasting
- Local Authorities
- Public Safety communications.

The four scenarios that were developed are summarised below, in terms of the key parameters described above and the likely impact on downstream service demand.

Table 0.1. Downstream Service Scenarios

	Scenario A	Scenario B	Scenario C	Scenario D
	Fibred Nation	**Green Agenda**	**Economy Constrains**	**We Want It Now**
Economy	Weak	Strong	Weak	Strong
Level of regulatory intervention	High	Moderate	Low to moderate	Low - considered unnecessary as market is thriving
Fibre cost and availability	Improving due to economic PIA access. Becomes very good in urban/suburban areas, poor in rural	Improving due to economic PIA access	No change from present, leading to slight increase in usage.	Little change from present
Fixed broadband status	Regualory push for universal broadband	Regulatory push and strong market demand for rural broadband	Terrestrial platforms see little improvement, especially in rural areas w/o cable provision	Strong market demand in al areas
DEMAND FOR MOBILE AND SATELLITE SERVICES				
Mobile demand	Low to moderate growth	High growth in all areas	Low growth due to state of economy	High growth in all areas
Mobile coverage (3G)	Good due to coverage obligations	High demand and ARPU stimulates rural expansion	Slow rollout in rural areas	High demand and ARPU stimulates rural expansion
Mobile coverage (4G/LTE)	Limited to main urban areas	Rural coverage stimulated by incentives to use as substitute for fixed broadband in notspots	Limited to urban traffic hotspots	Rural coverage stimulated by high level of market demand
Mobile capacity	Limited due to low revenue / investment	High, supplemented by widespread WiFi offload in urban hotspots and subscribers' homes	Limited due to low revenue / investment	Very high to meet soaring consumer demand
Satellite broadband	Strong demand in rural areas to meet universal service objective	Demand limited as fixed / mobile alternatives widely available	Moderate demand in rural notspots but limited by high tarrifs	Some demand in rural notspots but unable to compete with terrestrial offerings in longer term
Network sharing	Pervasive in order to reduce costs	Increasing sharing in macro networks but operators deploy own micro / pico cells in busy areas	Pervasive in order to reduce costs	Networks co-opreate in rural areas to maximise coverage and capactiy
Network consolidation	Further consolidation to three networks to reduce costs	No consolidation - 4 operators	Further consolidation to three networks to reduce costs	No consolidation - 4 operators
Satellite broadband	Strong demand in rural areas to meet universal service objective	Demand limited as fixed / mobile alternatives widely available	Moderate demand in rural notspots from enterprise users. Little consumer demand	Some demand in rural notspots but unable to compete with terrestrial offerings in longer term
DEMAND FOR OTEHR APPLICATIONS				
Broadcasting	More fibre migration in urban areas; expansion of DAB network in rural areas	More fibre migration in urban areas; expansion of DAB network in rural areas	Demand for improved mobile DTT / DAB reception leads to additional relay transmitters	Continued expansion of DAB network to match current FM coverage by 2015
Local Authorities	Mainly use fibre except in rural areas	Mainly use fibre except in rural areas	Many local authorities invest in wireless CCTV to tackle crime and cut costs	Widespread deployment of wireless CCTV in all areas
Public Safety	Slow development of public networks drives expansion of private networks by individual regional users. Dedicated LTE public safety network rolled out in part of digital dividend spectrum.	Agreement reached to use public networks - no dedicated network. Supplemented by ongoing rollout of regional broadband networks by individual users.	National public safety broadband network rolled out in 2015 using UHF spectrum.	Public safety broadband network rolled out in 2015 but high spectrum demand from mobile networks means higher frequency has to be used.
Utilities	Fast rollout of smart grid network with dedicated spectrum	Regulatory push provides dedicated spectrum for smart grids but weak economy slows rollout of smart grids despite availability of dedicated spectrum	Slow development of smart grids using dedicated spectrum	No dedicated spectrum for smart grids – have to make use of existing fixed link bands for backhaul, public networks or licence-exempt for WAN
Fixed wireless broadband	Deployed in some areas to support USO	Requirement largely met by mobile LTE networks	Localised demand for dedicated broadband wireless using LTE or WiMax in fixed mode	Some deployments using LTE technology

The projected impact of each downstream service on fixed link demand depends not only on the anticipated growth in downstream service demand but also the likely demand for fixed link capacity generated by each service. For example, applications requiring high bandwidths such as video imply a high demand for fixed link backhaul capacity whereas narrow band applications like telemetry (widely used by utility companies) or audio broadcasting imply a much smaller demand. The fixed link backhaul demand generated by mobile networks will also be muted by the increased use of fibre in some scenarios, but this is less likely to be the case for

public safety networks where high resilience demands the use of radio links to all transmission sites. The following table summarises the likely impact of each downstream scenario on overall fixed link capacity demand under each of the four scenarios.

Table 0.2. Estimated impact of downstream services on overall fixed link capacity demand

	Scenario A ***Fibred Nation***	**Scenario B** ***Green Agenda***	**Scenario C** ***EconomyConstrains***	**Scenario D** ***We want it now***
Mobile ***Mobile Broadband Backhaul***	Low *Due to increased use of fibre in urban areas and limited rural coverage*	Low-Medium *Increased use of fibre in urban / suburban areas. Growing rural demand*	Medium *Low rate of traffic growth and limited rural coverage*	Medium-High *High traffic, more limited fibre use, extensive rural coverage*
Fixed Wireless ***For rural broadband coverage***	Medium *Moderate take up and user data rates*	High *High take up and high user data rates*	Low *Low take up and low user data rates*	High *High take up and high user data rates*
Satellite ***Note - impacts 18 GHz only***	High *Satellite required to meet USO – could require all of band*	Low *Good terrestrial rural broadband – no new spectrum required*	Medium *Demand from rural business users – may require part of band*	Low *Good terrestrial rural broadband – no new spectrum required*
Broadcasters ***Rural DAB, mainly 1.4 GHz. 2 Mbps links***	Medium *Limited coverage expansion (180 sites)*	High *Extensive coverage expansion (380 sites)*	Low *No coverage expansion*	High *Limited coverage expansion (180 sites)*
Public Safety ***Mobile Broadband Backhaul***	High *National UHF mobile broadband network (c 3,600 sites)*	Medium *No dedicated national network – only regional deployments*	High *National UHF mobile broadband network (c. 3,600 sites)*	Very High *National L-band mobile broadband network (c. 7,200 sites)*
Local Authorities	Medium *Moderate demand growth, high b/w links*	Low *Low demand growth - mostly use public nwks*	High *High demand growth, high b/w links*	Medium *Moderate demand growth, high b/w links*
Utilities	Low *Mostly narrow band links*	Low *Mostly narrow band links*	Low *Mostly narrow band links*	Low *Mostly narrow band links*

0.4 Development of Spectrum Demand Scenarios

The downstream service scenarios described above were used to derive a set of corresponding spectrum demand scenarios for the fixed link frequency bands. This involved analysis of the current use of each frequency band based on Ofcom data and consideration of the impact that each of the four downstream service scenarios would have on demand for wireless fixed links with particular bandwidth and path length characteristics. These characteristics determine the frequency range within which the fixed links must operate, enabling us to estimate the potential demand for fixed links in different frequency ranges under each scenario. Six specific frequency ranges were considered, with bands within these ranges being considered broadly substitutable for one another, namely:

- Below 3 GHz
- 3 – 10 GHz
- 10 – 20 GHz
- 20 – 30 GHz

- 30 – 50 GHz
- Above 50 GHz.

The bands below 3 GHz and above 50 GHz have particular characteristics that limit their use to particular applications (narrow bandwidths and very short hops respectively) and were therefore considered separately from the microwave bands in the 3 – 50 GHz range, where the greatest demand currently exists. The typical link lengths and data bandwidths supported in each frequency range have been estimated based on current Ofcom licensing data and the typical planning criteria used in the frequency assignment process and are presented below.

Table 0.3. Assumed frequency range for links of a specified link length and capacity

Path Length	Capacity < 140 Mbps	Capacity ≥ 140 Mbps
Less than 2 km	Above 30 GHz	Above 30 GHz
2 – 5 km	Above 30 GHz	20 – 30 GHz
5 – 10 km	20 – 30 GHz	10 – 20 GHz
10 – 25 km	10 – 20 GHz	Under 10 GHz
Over 25 km	Under 10 GHz	Under 10 GHz

Spectrum demand trends were developed for typical urban, suburban and rural areas as well as nationally. The principal demand trends by downstream service and frequency range are summarised below.

0.5 Impact of Downstream Service Scenarios on specific frequency ranges

Note: in the following tables symbols are used to indicate the anticipated trend in fixed link spectrum demand, as illustrated in the key below.

▼▼ Large decline in spectrum demand

▼ Small decline in spectrum demand

◄► Little or no change in spectrum demand

▲ Small increase in spectrum demand

▲▲ Large increase in spectrum demand

Note that the tables show projected trends within each service rather than an absolute comparison between services (i.e. one service using more than another). The latter is illustrated in the graphs in figure 0.1 below.

Table 0.4: Impact of mobile cellular networks on fixed link spectrum demand

Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
Below 10GHz	▼▼	▼	◄►	▲
10 – 20 GHz	▼▼	▼	◄►	▲
20 – 30 GHz	▼▼	▼	◄►	▲
Above 30 GHz	▼▼	▼▼	▼	▼

In Scenario A there is a substantial decline in demand across all bands due to the relatively weak growth in data traffic, limited rural mobile broadband coverage and increased use of fibre for backhaul. In Scenario B the decline is smaller, especially below 30 GHz, due to increased traffic growth and greater coverage expansion in rural areas. There is little change in Scenario C as fibre migration is more limited, whilst in Scenario D high traffic growth and rural coverage expansion increases demand below 20 GHz, Note than in both scenarios C and D fibre migration in urban areas reduces demand above 30 GHz.

Table 0.5: Impact of Rural FWA on fixed link spectrum demand

Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
3 – 10 GHz	◄►	◄►	◄►	◄►
10 – 20 GHz	▲	▲▲	▲	▲▲
20 – 30 GHz	▲	▲▲	▲	▲▲
30 – 50 GHz	◄►	◄►	◄►	◄►

The impact of FWA deployment is likely to be limited to rural areas beyond the reach of high speed DSL services and would predominantly require medium to long haul high capacity links operating in the 10 – 30 GHz range. Demand growth would be higher under scenarios B and D due to the assumed higher take-up and higher user data rates associated with the more favourable economic conditions.

Table 0.6: Impact of the broadcast sector on fixed link spectrum demand

Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
3 – 10 GHz	◄►	◄►	◄►	◄►
10 – 20 GHz	◄►	◄►	◄►	◄►
20 – 30 GHz	◄►	◄►	◄►	◄►
30 – 50 GHz	◄►	◄►	◄►	◄►

Backhaul links for the digital terrestrial TV networks are substantially complete and no further significant changes are anticipated. With the exception of Scenario C we expect continued expansion of the national DAB networks into rural areas. This is likely to increase demand for spectrum in the 1.4 GHz band but will have little impact on the microwave bands.

Table 0.7: Impact of the public safety sector on fixed link spectrum demand

Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
3 – 10 GHz	▲▲	▲	▲▲	▼
10 – 20 GHz	▲▲	▲▲	▲▲	▲▲
20 – 30 GHz	▲▲	▲▲	▲▲	▲▲
30 – 50 GHz	◄►	◄►	◄►	▲▲

The main demand driver for the public safety sector is likely to be the rollout of a national dedicated mobile broadband network to complement the existing narrow band Airwave network, which is assumed to take place in all the scenarios except B. In scenarios A and C it is assumed that the network will operate in the UHF band with relatively large cells requiring backhaul links in the 3–10 GHz range in rural areas, 10–20 GHz in suburban areas and 20–30 GHz in urban areas. In Scenario D the use of a higher frequency band (L-band) is assumed for the mobile network with consequently smaller cells and backhaul links in higher frequency bands above 10 GHz. The decline in spectrum demand below 10 GHz in Scenario D reflects the assumed decommissioning of existing regional deployments when the national network is launched. In Scenario B, these regional deployments are expected to continue using a mix of backhaul frequencies but mainly in the range 10–30 GHz. Significant growth arises in all scenarios due to the high bandwidths required to support video applications and the assumption that radio links will be deployed at all sites to optimise network resilience.

Table 0.8: Impact of Local Authority use on fixed link spectrum demand

Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
3 – 10 GHz	▲	▲	▲▲	▲
10 – 20 GHz	▲	▲	▲▲	▲
20 – 30 GHz	▲	▲	▲▲	▲
30 – 50 GHz	▲	▲	▲▲	▲

Demand growth is anticipated under all scenarios as local authorities make greater use of radio links to support wireless CCTV and corporate data networks. Demand

growth is highest in Scenario C due to a combination of crime and security concerns and a drive to reduce operational costs (driving increased CCTV take-up), limited fibre availability and limited capacity / coverage on commercial mobile networks.

Table 0.9: Impact of utilities on fixed link spectrum demand

Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
3 – 10 GHz	▲	▲▲	▲	▲
10 – 20 GHz	▲	▲▲	▲	▲
20 – 30 GHz	▲	▲▲	▲	▲
30 – 50 GHz	▲	▲▲	▲	▲

An increase in demand across all frequency ranges is anticipated under all scenarios, reflecting the mix of link lengths used in urban, suburban and rural areas. The impact is greatest in Scenario B due to the greater emphasis on smart grid deployment to support energy efficiency improvements.

Table 0.10: Impact of broadband satellite terminals on fixed link spectrum demand

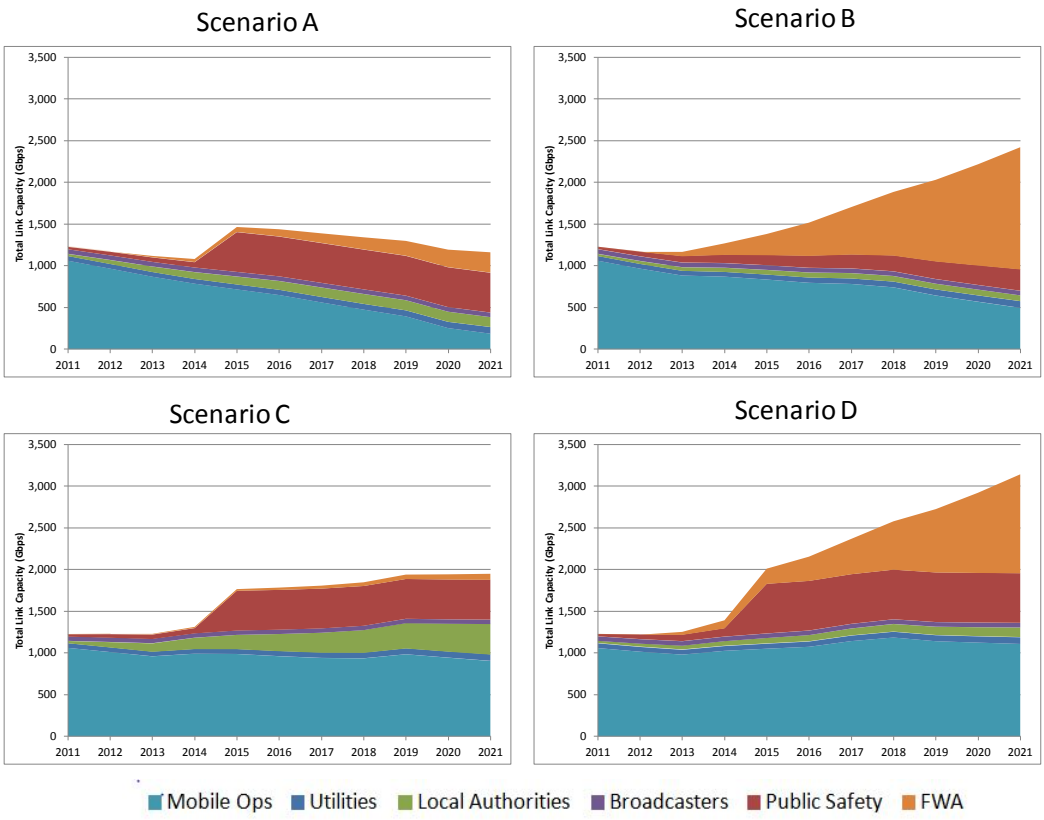
Impact by Frequency Range	Scenario A	Scenario B	Scenario C	Scenario D
3 – 10 GHz	◄►	◄►	◄►	◄►
10 – 20 GHz	▲▲	◄►	▲	◄►
20 – 30 GHz	◄►	◄►	◄►	◄►
30 – 50 GHz	◄►	◄►	◄►	◄►

High demand for consumer broadband satellite terminals could lead to pressure for more satellite spectrum to be made available in the 18 GHz band and is most likely to arise under Scenario A where the weak economy results in limited terrestrial coverage in rural areas but there is a strong regulatory drive to make high speed broadband available to all.

0.6 Projected fixed link capacity by user and frequency band

The following charts illustrate the projected national demand for fixed link data transmission capacity nationally by downstream service type and frequency band.

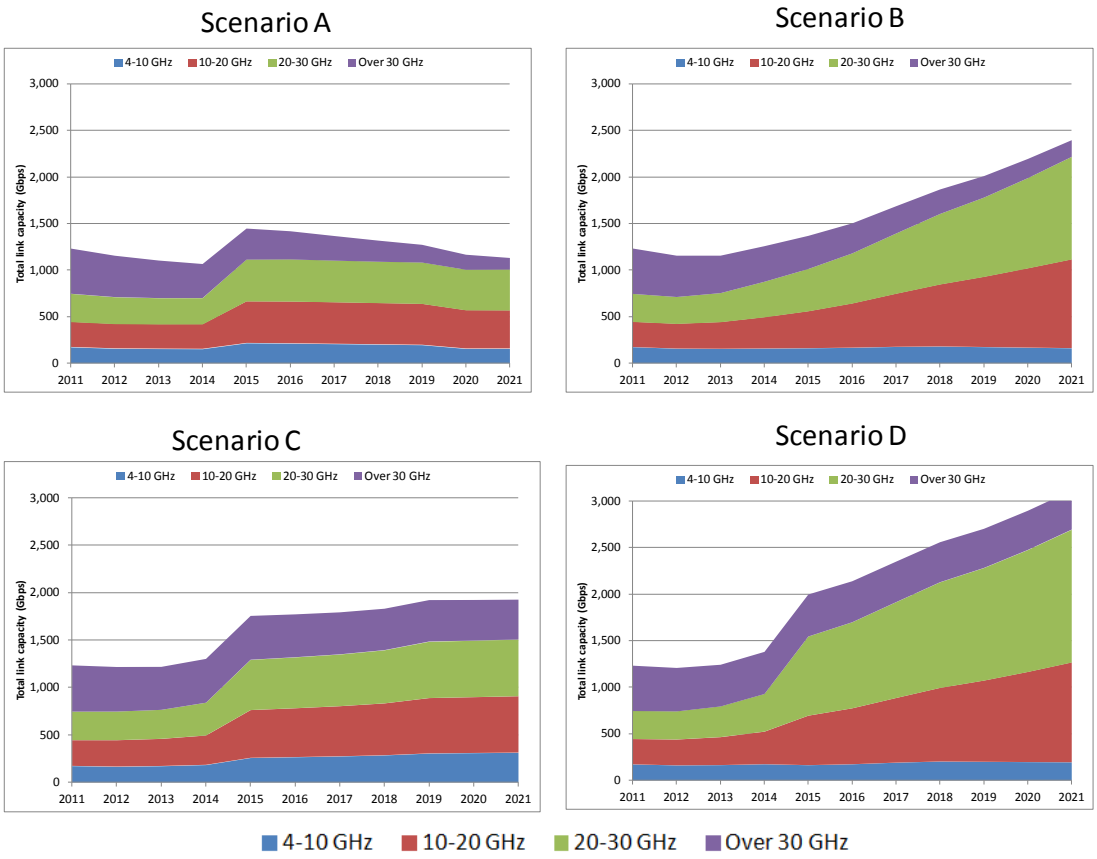
Figure 0.1. Projected fixed link capacity demand by downstream service type (total capacity nationally in Gbps)



Projected national demand and how this is distributed geographically and between users varies significantly by scenario. In **Scenario A**, demand for mobile links falls away strongly as networks progressively migrate from radio links to fibre. There is a steady growth in demand for local authority links and in demand for FWA in rural areas, but the most significant factor is the launch of a national public safety broadband network, assumed to take place in 2015. In **Scenario B**, public safety requirements are met by a combination of reliance on commercial networks and limited regional deployments resulting in a more gradual demand growth. Mobile backhaul demand falls less slowly due to the more extensive coverage and take-up of 4G services. The biggest long term demand driver in this scenario is the growth in FWA demand in rural areas.

In **Scenario C**, mobile backhaul demand remains steady as there is less migration to fibre. Widespread deployment of wireless CCTV drives growth in local authority demand and as in Scenario A the launch of a dedicated public safety broadband network causes in a sharp increase in demand in 2015. **Scenario D** shows the highest level of overall demand for fixed link capacity, driven largely by rural FWA, high mobile broadband backhaul demand and the launch of the public safety broadband network, which in this scenario has to use a higher frequency band for the access network, requiring considerably more backhaul links.

Figure 0.2. Projected fixed link capacity demand by frequency band (total capacity nationally in Gbps)



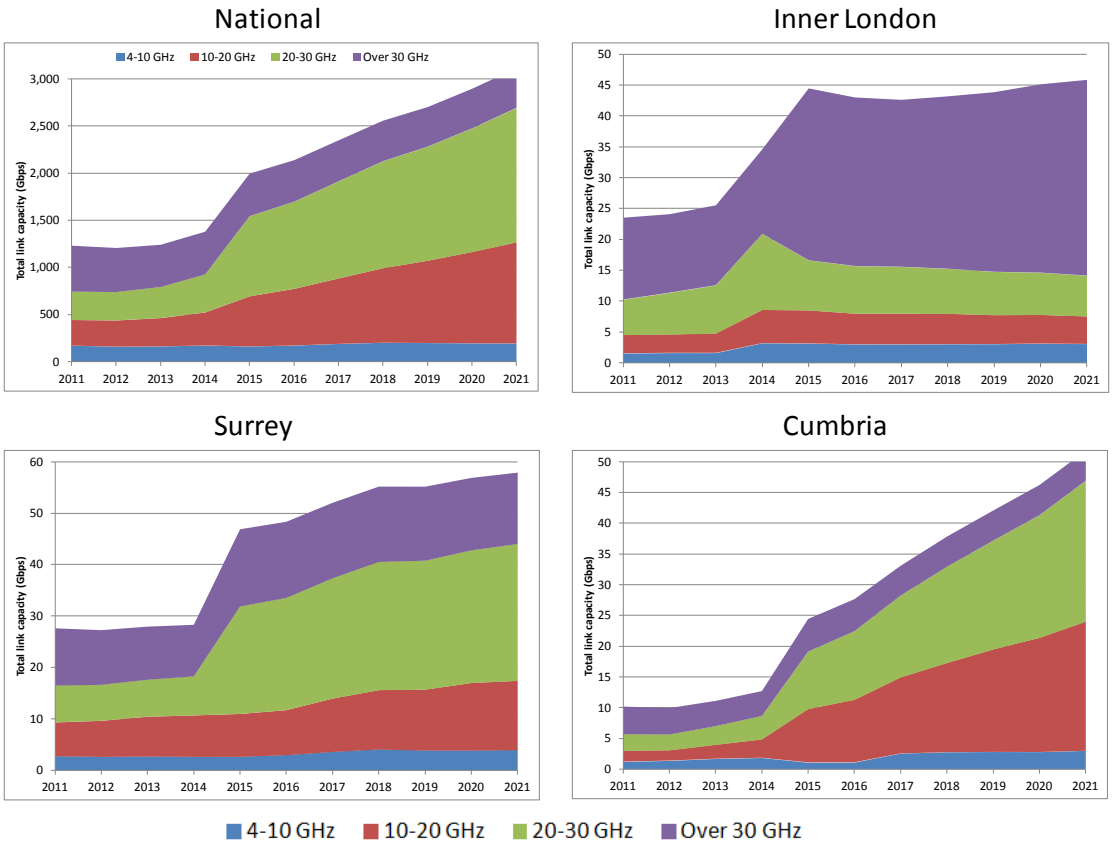
In **Scenario A,** there is a sizeable reduction in demand for links above 30 GHz as the majority of urban mobile backhaul links migrate to fibre. Demand in the 10–20 GHz and 20–30 GHz ranges grows significantly over the period, driven mainly by the launch of the public safety broadband network in 2015. Demand below 10 GHz also rises during the first part of the period but then declines—this reflects the rollout of 3G/4G mobile networks into increasingly rural areas (requiring longer link lengths) and the gradual migration of some of these links to fibre towards the end of the period.

In **Scenario B** the demand growth between 10 and 30 GHz is even more marked but in this case is mainly driven by the massive growth in fixed wireless access traffic in rural areas. **Scenario C** shows similar growth in this frequency range to Scenario A but there is also steady demand above 30 GHz and considerable growth below 10 GHz, reflecting the slower migration to fibre under this scenario. **Scenario D** shows particularly high growth in the 20 – 30 GHz range, largely a result of the higher frequency public safety network, which requires a larger number of smaller cells, favouring the use of frequencies above rather than below 20 GHz.

The figure below compares the projected fixed link capacity growth in three representative geographic areas, namely Inner London (entirely urban), Surrey (mixed urban /suburban / rural) and Cumbria (mainly rural) for Scenario D (the highest growth scenario). In London, there is growth in the short term, due mainly to

the launch of LTE mobile networks and the national public safety network but this levels off in the longer term as further growth is offset by greater use of fibre. In Surrey and Cumbria growth continues into the longer term, driven by expansion of rural mobile and FWA networks, leading to more than fivefold growth in the case of Cumbria.

Figure 0.3. Comparison of regional demand under highest growth scenario (Scenario D)



0.7 Projected Fixed Link Demand Estimates

Based on the estimates of fixed link capacity presented above, we have generated estimates of the total frequency span in MHz required in each of the four frequency ranges. The estimation methodology is described in chapter 7 of the main report and is based on band capacity estimations for the 38 GHz undertaken in a previous study and scaled to allow for longer hops and lower re-use in lower frequency bands. It should be noted that spectrum estimates are highly dependent on link densities and geometries and that actual demand in any frequency band will be very site specific. However, the estimates provide a broad indication of whether the spectrum available in particular frequency ranges is likely to be adequate to meet future downstream service demand.

Our analysis has indicated the following:

- Demand above 30 GHz will either remain stable or decline under all four scenarios and will remain well below the currently available spectrum in this frequency range. This reflects varying degrees of migration from wireless backhaul to fibre in urban and suburban areas where these higher frequencies are predominantly used.
- Spectrum demand between 10 and 20 GHz is likely to exceed the available spectrum in the 13 and 15 GHz band, requiring continued access to the 18 GHz band in at least some geographic areas. The analysis suggests that not all of the 18 GHz band will be required to meet fixed link demand; however, this does not take account of the large number of legacy fixed network links currently operating in the band. Many of these are in urban areas and of short hop length, implying that they could be migrated either to fibre or to higher bands over the next decade.
- Congestion below 10 GHz may arise at some locations mainly due to very high bandwidth (311 Mbps or higher) backbone links to support mobile networks. In most cases this is likely to be resolvable by extending fibre connectivity to the highest capacity sites or making use of the 4 GHz band at these sites (we have assumed this band is not suitable for more widespread deployment because of the very large antennas required).
- Our analysis of 1.4 GHz also indicates there will be sufficient spectrum to meet anticipated demand in all the scenarios, due to the relatively narrow bandwidths associated with the majority of projected new links in this band (most are expected to be 50 kbps).

0.8 Conclusions

The relative abundance of spectrum above 20 GHz and the intensive frequency re-use that can be achieved at these frequencies means that no shortfall in spectrum in this frequency range is anticipated under any of the scenarios. The availability of additional spectrum above 60 GHz to cater for very short links and the migration of some network operators' links from existing Ofcom bands to their own bands (acquired at auction) will further reduce pressure on these higher bands. The situation in bands between 3 and 20 GHz is more challenging due the more limited availability of spectrum and demand growth arising from initiatives such as the rollout of mobile broadband and FWA into rural areas and the anticipated launch of a broadband public safety wireless network. There is considerable uncertainty about whether all or part of the 18 GHz band may be required to accommodate consumer satellite terminals in the future. If the whole or the majority of the band were to be re-allocated to satellite this could lead to congestion, particularly in the 13 and 15 GHz bands that are used for medium haul high bandwidth links.

Congestion may also arise in the 6 GHz and 7.5 GHz bands on a more localised basis, which could be relieved by greater use of the 4 GHz band. We note,

however, that the large antenna sizes required make this band less popular for fixed link deployment and that the propagation properties of the band make it potentially attractive for alternative uses such as mobile. There may be scope to consider a more flexible approach to using this band, for example to permit more compact, less directional antennas or to allow geographic sharing between fixed and non-fixed applications. Any such move would need to take account of any continued presence of satellite earth stations in the band.

Key trigger points and trends likely to influence fixed link demand have been identified as follows:

- cost and availability of fibre, particularly in urban and suburban areas
- demand for fixed wireless broadband access in rural areas
- launch and extent of coverage of 4G (LTE) mobile services
- roll out of a national public safety broadband network
- expansion of DAB coverage
- potential demand for satellite consumer terminals.

In terms of timing, there are two events that appear likely to result in a “step change” in demand for fixed links, namely the rollout of 4G (LTE) mobile services and the rollout of a national public safety broadband network. The latter is likely to have the greatest impact because of the necessity to deploy radio at every site (whereas 4G will mainly use fibre in urban and suburban areas) and because coverage is likely to be rolled out quickly to all areas of the country to meet the demanding needs of the public safety community. Ofcom should therefore monitor closely any developments relating to the potential future launch of such a network.

Another potentially significant development would be the emergence of a real market demand for consumer satellite broadband terminals which could under some scenarios lead to demand for more exclusive spectrum for satellite in the 18 GHz band. Ofcom should therefore monitor developments in this sector closely and may wish to investigate the feasibility of geographic sharing in this band to facilitate rural deployment of satellite terminals in rural areas whilst retaining fixed links in urban areas where demand is highest. Other developments that we have identified tend to be more gradual in nature and unlikely to cause any sudden change in demand for fixed link spectrum.