



Annex to Spectrum Management Strategy

Detailed stakeholder comments and
Ofcom's response

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Annex 1: Detailed stakeholder comments and Ofcom's response

- A1.1 This annex provides a summary of comments received from stakeholders in response to our consultation on our Spectrum Management Strategy published on 2nd October 2013, together with our response to these comments. We received 44 responses to our consultation, of which 6 were confidential. The list of organisations that submitted non-confidential responses¹ is shown in the first table below.
- A1.2 This summary is set out with a separate table relating to the each of the 13 questions we asked in the consultation. Where stakeholders have made the same, or very similar, comments to multiple questions in their response we have included the comment only once under the question to which the comment has greatest relevance.
- A1.3 We have limited this summary to comments received that are directly relevant to our spectrum management strategy. This Annex does not summarise the additional, and more detailed comments that we received on the sector roadmaps published in an Appendix alongside our consultation document. As explained in Section 2 of the main document, these issues will be addressed and incorporated where appropriate, when the sector roadmaps are updated and published later in the year. Similarly, where stakeholders have taken the opportunity in their responses to comment on the specific application of our spectrum management approach to a policy issue that is the subject of a separate consultation exercise, we refer to that separate consultation exercise rather than responding to the comments here.

¹ Which are available on our website at <http://stakeholders.ofcom.org.uk/consultations/spectrum-management-strategy/?showResponses=true>.

Organisations from whom we received non-confidential responses:

<ul style="list-style-type: none">• ARM• Arqiva• BBC• BEIRG• British APCO• BT• David Hall Systems Ltd• Digital TV group• Digital UK Dynamic Spectrum Alliance• EADS Group• EchoStar• EDF	<ul style="list-style-type: none">• European Satellite Operators Association (ESOA)• Espirito Ltd• FCS• Huawei• JRC (Joint Radio Company)• JRC Annex• Met Office• Ministry of Defence• Motorola Solutions UK Ltd• Mr Colin Goodall• Mr J.P. Gilliver• NATS• Nordisk Mobiltelefon	<ul style="list-style-type: none">• O3b Limited• Qualcomm• Radio Society of Great Britain (RSGB)• Samsung Electronics UK• Sky• Spectrum Bridge Inc• TAUWI (Telecommunication Association of the UK Water Industry),• techUK• UK Space Agency (UKSA)• Vodafone• Voice of the Listener and Viewer (VoLV)• Wi-Fi Alliance
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Question 1: Have we captured all the **major trends that are likely to impact spectrum use** over the next ten years in this section and the separate Appendix on sectoral developments? Are there other market, technology or international developments that could lead to significant changes in spectrum demand and supply over the next 10 years?

Theme	Stakeholder comments	Our response
Overview	<p>We received broad agreement from stakeholders that we had identified the major trends likely to impact spectrum use over the next ten years. Stakeholders have also identified specific additional trends in their own sector that they felt had not been given adequate attention in the consultation. These more detailed comments on trends in individual sectors will be addressed and incorporated into our next iteration of the sector roadmaps planned to be published later this year.</p> <p>A number of stakeholders made comments against this Question that were repeated under the Questions on the individual priorities. Where we have confirmed specific sector-based priorities (namely mobile data, Programme Making and Special Events (PMSE), Machine to Machine (M2M) / Internet of Things (IoT) and Emergency services) we have provided a detailed summary of specific comments under the question addressing that priority and only drawn out the major themes and our response under this question.</p>	<p>Having carefully reviewed comments made by stakeholders we believe that we have, in the main, captured the most significant key trends that will impact on spectrum use over the next ten years.</p> <p>The only exception to this is that we had not placed increased emphasis on the potential implications of the increasing demand for M2M / IoT applications in our consultation. As a result we have now, in our statement, identified M2M as an additional priority for our work going forward.</p>
Comments related to trends in mobile data	<p>MNOs and many other stakeholders agreed that mobile data growth is likely to continue and the benefits to consumers are likely to remain high.</p> <p>Many stakeholders emphasised the difficulties and inherent uncertainty in forecasting demand for mobile data. Stakeholders, particularly those representing the broadcasting sector and the satellite sector, questioned whether the existing projections of the level of demand for mobile data were robust and some encouraged Ofcom to undertake its own analysis to test these projections.</p> <p>Stakeholders from a variety of sectors argued that increased spectrum access is not the only method of meeting growing demand for mobile data and urged caution on making more spectrum available for mobile until these other methods had been exhausted.</p>	<p>We agree that projections of demand are difficult and subject to large uncertainty. We believe, however, that as there remains a sufficient risk in terms of lost benefits to citizens and consumers that could arise if there was a lack of available spectrum to meet growing demands of mobile data that it is right to highlight this risk.</p> <p>We agree that a variety of mitigation techniques will help to address the increased spectrum demand from all sectors and so mitigate some of the pressure on spectrum access. We set this out clearly in our methodology for assessing priorities in our consultation where we specifically identified the development of more spectrally efficient technology and the changing deployment of spectrum by users (including specifically for mobile - Wi-Fi off-load and small cell deployment).</p> <p>We also note the interest in higher frequencies to develop</p>

Theme	Stakeholder comments	Our response
	<p>In particular, Wi-Fi was highlighted as being a critical tool for MNOs to deliver high bandwidth services and to effectively extend data coverage indoors. Arqiva stressed the significance of Hotspot 2.0 that will enable more seamless transitions between the two technologies. They argued therefore that the increasing prevalence of public Wi-Fi hotspots should be factored into Ofcom's assessment</p> <p>Samsung noted that the growth of mobile broadband market is providing the catalyst for research and development investment into new technologies and that Samsung is carrying out technological investigations and research into use of frequencies above 20 GHz for mobile network applications.</p>	<p>new technologies to support mobile data services and acknowledge that these frequency bands may therefore come under increasing pressure from new demand.</p>
<p>Comments related to trends in broadcasting services</p>	<p>Many stakeholders representing the broadcast sector and broadcast consumers emphasised the importance of the DTT platform in delivering enduring benefits of free-to-air TV and Public Service Broadcasting (PSB). Arqiva argued that demand for linear TV is likely to remain resilient in future in face of increased alternative methods of viewing content including IPTV.</p> <p>Vodafone argued, on the other hand, that Ofcom should pay particular attention to longer term trends and, in particular, the potential for IPTV to overtake DTT after 10 years.</p> <p>Arqiva and Digital UK said they expect TV to be watched in future in UHD and HD, rather than HD as SD as now. Arqiva added that it expects UHD and HD to be broadcast with even greater spectrum efficiency than today.</p> <p>We received no comments on trends of radio broadcasting.</p>	<p>The extent to which consumer viewing of linear TV remains robust in the face of developments in IPTV in the much longer term (beyond 2030), and the specific role of the DTT platform in delivering the benefits of free-to-view TV and PSB, are both important issues that will influence how the future of free-to-view TV will evolve . This will be considered in our priority on the Future of free-to-view TV.</p> <p>We agree, and highlighted in our consultation, that there is the potential for increased demand for more data hungry broadcasting formats such as HD and UHD TV to become standard. We also highlighted that while more efficient codec standards such as HEVC (High Efficiency Video Coding) might be expected to mitigate this demand, the technical and commercial viability of UHD broadcasting on DTT is likely to remain uncertain for the foreseeable future.</p>

Theme	Stakeholder comments	Our response
Comments on trends in licence exempt	<p>A large number of stakeholders emphasised the importance of increased spectrum being made available for Wi-Fi particularly for use in off-loading for mobile networks. Many felt Ofcom had under-estimated its potential role in future, to reduce pressure on demand for additional spectrum for mobile.</p> <p>A number of stakeholders also highlighted the importance of licence exempt use within the context of M2M applications. This is discussed in more detail in Question 11 where we discuss other priority areas raised by stakeholders, including M2M.</p>	<p>We recognise the role that Wi-Fi might play in future in off-loading traffic from mobile networks. However, we also recognise this is only one of a number of solutions that operators may consider deploying. We discuss the role of Wi-Fi in future in more detail in our spectrum sharing statement we also publish today².</p> <p>We also recognise the potential role licence exempt use may play in the delivery of M2M applications and will take this forward in our work on the M2M priority.</p>
Comments on trends in business radio and Utilities	<p>JRC, the spectrum management organisation responsible for providing communications services to the UK Energy Industry, noted that data demands on private mobile networks are likely to grow significantly, and cited Emergency Services needs as an example. Equally TAUWI, an industry body for the Water sector, stressed that the water industry makes use of a variety of technologies and types of spectrum access to support various critical applications and the delivery of statutory requirements and demands are expected to grow.</p> <p>FCS argued that, while voice is currently considered the most critical type of Business Radio (BR) communication, BR wideband (data) applications will become increasingly critical to businesses. FCS also argued that requirements around resilience, criticality and coverage will mean that dedicated spectrum access and specific technologies for business radio terminals will remain important for meeting growing data requirements.</p> <p>JRC also stressed that intelligent utility networks will need suitable spectrum for large scale operations. TAUWI also highlighted that telemetry data volumes in their sector will increase 10 fold over the next 10 years with growing needs for accurate, timely and granular information.</p>	<p>We recognise that the demand for mobile data is likely to grow for professional users as well as residential consumers.</p> <p>We also recognise that whilst voice is a critical application for many professional users of mobile services that it is possible that mobile data becomes increasingly critical to their businesses.</p> <p>There are, however, a range of scenarios as to how the demand for critical voice and data might be delivered in future. This includes continued use of private networks as well as the potential for some of these services to be provided by the public network operators.</p> <p>Following comments from stakeholders, we have also decided that the specific challenges and potential benefits that could arise from the demand for increasingly intelligent M2M applications means that this area (incorporating new and similar “Internet of Things” applications) should be a specific priority area of work for us going forward. We have, therefore, pulled out this aspect of our future work as a specific new priority.</p> <p>In particular, we recognise the important potential</p>

² <http://stakeholders.ofcom.org.uk/consultations/spectrum-sharing/>

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	<p>JRC referred to proposals made by the European Utility Telecom Council for spectrum requirements in the period 2015-2020 and submitted a socio-economic study providing indications, based on US evidence, of potential benefits associated with ensuring spectrum availability for future smart grids.</p>	<p>benefits that might be expected from smart grids and other intelligent operation of critical national infrastructure and this will also remain an important aspect of our other programmatic and project based work in future, such as our review of UHF bands I and II.</p>
<p>Comments on trends in satellite use of spectrum</p>	<p>Many satellite stakeholders argued that meeting the future needs of the satellite sector should be made a priority for Ofcom and cited a range of activities that would be needed, particularly in relation to the work of CEPT and the many Agenda Items related to satellite sector at WRC-15. A number of satellite stakeholders also argued that we had understated the importance of Ka-band to the sector in future.</p> <p>EADS said a key trend for satellite operators and manufacturers is the saturation of the geostationary arc and frequencies in some bands, stating this is one reason for the development of Ka-band as an extension to Ku-band capacity over Europe. ESOA also commented that the satellite sector is facing shortages in their existing bands (L, C, Ku etc.). Vodafone also expressed the view that they expect substantial growth in satellite use of Ka-band, but no reduction in C- and Ku-band, in the next 10 years. Arqiva also highlight the important role of C-Band spectrum in the 3.8 - 4.2 GHz range for satellite services.</p> <p>O3B strongly opposed what it saw as Ofcom encouraging relocation or migration of commercial communications satellites or other space systems from 18 - 55 GHz. It argued that the satellite industry invests large amount of time and effort in developing satellites and ground segment equipment that can operate in certain frequency bands. It is therefore not technically or economically feasible for the satellite industry to be 'relocated' from one frequency band to another. Other stakeholders, including ESAO also emphasised the long investment lifecycles of the sector arguing that reliable access to spectrum over the long term is essential for the sector.</p> <p>ESOA forecast that satellite will play a key role in home</p>	<p>We have carefully considered all of the points made by the satellite sector, particularly about the need for future actions on the international stage and have met with representatives of the sector to ensure we understand their concerns. However, we remain of the view that the issues raised are already covered within our programmatic work without requiring us to create a major new priority to address the challenges of the sector.</p> <p>We understand that a major constraint on the use of spectrum by satellites is the availability of orbital slots, which can require the use of different (often higher) frequencies by satellites as these slots become more and more congested in some key locations. We reflected this in our assessment that the sector will increasingly need to use additional bands at higher frequencies to meet additional demand. This is what we meant when we referred to satellites "moving to higher frequencies". We did not mean to imply that satellite stakeholders should be forcibly moved to higher frequencies, as some stakeholders had inferred.</p> <p>We understand that the satellite sector have long investment lifecycles and seek long term access to spectrum (as do many other sectors that use spectrum e.g. radar use although we recognise that retro fitment is possible in some cases for radar unlike satellite). This is clearly a relevant factor when considering changes in the arrangements for spectrum access.</p> <p>We agree that satellite plays an important role in delivery of TV services in UK and that there is a potential for more take-up of satellite provided residential broadband.</p>

Theme	Stakeholder comments	Our response
	<p>broadband and video, given what they said were the spectrum and cost efficiency benefits of broadcasting signals over satellite, and the 100% coverage ensured by satellite footprints. It also said satellite was playing an increasing role in communications for mobile users. It argued that increases in satellite spectrum demand would not be limited to the 28 GHz band.</p> <p>EADS also stated that it anticipated that satellite provision of M2M communications will expand over the next 10 years and represent a huge revenue opportunity for the sector. It therefore expressed strong interest in the development of a regulatory framework to enable proper spectrum access, terminal deployment and service provision.</p> <p>UKSA stated that the consultation underestimates the increasing value and need for spectrum for satellite uses. They noted that the space sector is growing by 7.5% per year and asserted that its spectrum requirements are therefore growing. They noted that they have commissioned a report on future demand and need for spectrum for Space services, although this reports in Spring 2014 and asked Ofcom to take this into account in its strategy.</p>	<p>However, the scale of demand for services other than TV broadcasting, particularly residential broadband, remains unproven. As indicated in our consultation we will continue to monitor developments on this area and, if the need for specific action arises, then we will consider this in light of developments.</p> <p>We accept that the burgeoning M2M market offers opportunities for the satellite sector, as it does for other sectors. As we take forward our work on the M2M and IoT priority we will consider how to ensure that there are no unnecessary regulatory barriers to the satellite sector being able to address this market.</p> <p>We are delaying publishing an update to the sector roadmaps specifically so that we can incorporate additional research by stakeholders on trends in their industry and will consider UKSA's report when we do so.</p>
Comments on Science use of spectrum	<p>MetOffice expressed appreciation that the use of spectrum by space borne Earth Observation (EO) was recognised in our consultation. However, it noted there was no recognition of ground based EO uses such as Metoids and meteorological radar. They agreed factually with the space roadmap except that they believe that consideration of spectrum for passive use of EO should be reviewed and included. They would also like the Title of sector to be changed to Space and Science and for terrestrial uses of science to be included.</p> <p>MetOffice emphasised that although they had quite static requirements, the bands that they use are subject to study for</p>	<p>We agree with the many stakeholders in both the satellite and science community that said it would be better to separate these two distinct uses of spectrum. In the update of the sector roadmaps, planned for later this year, we therefore intend to treat commercial satellite" and "science" uses of spectrum as separate sectors. At this point we will also provide a greater focus on terrestrial science uses of spectrum (such as Metoids and meteo radars) where these are licensed by us.</p> <p>We understand MetOffice's concerns on potential future impacts on their use of spectrum that could arise from</p>

Theme	Stakeholder comments	Our response
	<p>potential reallocation at WRC-15 (e.g. L-band Metsat; S-band radar; C-band EESS³) and that consideration of the impacts to such incumbent services must be a priority (including the potential for displaced or disrupted services to then seek new spectrum).</p> <p>MetOffice also asked for reassurance that a lack of a specific priority for environmental science does not imply they will be disregarded by Ofcom.</p> <p>UKSA made the point that although broadcasting and telecoms dominate the Space economy one should not underestimate the value of science applications, especially those relating to EO.</p>	<p>changes of use in adjacent bands. As part of our work on change of use we will assess coexistence challenges and mitigation options as an integral part of the work and will consult, both formally and informally, with all potentially impacted users.</p> <p>As we have made clearer in our Statement, there is no intention to reduce the programmatic resource which is committed to individual sectors as a result of the prioritisation of our discretionary resource. We can therefore assure MetOffice that we will continue to place the appropriate emphasis on science use going forward, based on the needs of the sector as we understand them.</p>
<p>Comments on trends in Emergency Services (ES)</p>	<p>British APCO, Motorola Solutions and a confidential response discussed the challenges of continuing to provide critical voice services, meeting growing data requirements and providing specific ES functionalities, and noted the importance of international harmonisation.</p> <p>British APCO argued that data applications for Emergency Services providers are already as critical as voice ones, but welcomed the ESMCP⁴ process as it aims to replace existing contracts before their expiry. British APCO also argued that public safety will require significant capacity in the 700 MHz band for growth and harmonisation, and would benefit hugely from capacity at 450-470 MHz. A confidential response contended that provisions for ES spectrum access should be made ahead of commercial allocations.</p> <p>Motorola Solutions highlighted the importance of maintaining</p>	<p>Stakeholders have generally agreed, unsurprisingly, that the needs of the Emergency services are becoming even more important for a variety of reasons, many of which we outlined in our consultation.</p> <p>Stakeholders have expressed a variety of views about the specific needs of the ES sector (including opinions on the requirements for any shared solutions) and about possible spectrum solutions. The government's ESMCP programme is the right vehicle for taking these into account: we have identified support to this programme as one of our key priorities.</p>

³ Earth Exploration Satellite Service

⁴ Emergency Service Mobile Communications Programme - a Government-led initiative charged with developing solutions to the future needs of the Emergency services including mobile broadband capabilities.

Theme	Stakeholder comments	Our response
	<p>“instant” spectrum access for ES providers, noting that models for shared spectrum access could only work where appropriate priority is given to Public Safety users providing critical services.</p> <p>Growing Emergency Services needs were also highlighted by JRC.</p>	
Comments on trends in aeronautical and maritime	<p>NATS agreed with our view that re-purposing of spectrum is unlikely to be required to meet the growing aeronautical demands. NATS also provided some additional comments about how aeronautical use was presented in the roadmaps.</p>	<p>We will address NATS specific comments in our next iteration of the roadmap for aeronautical use.</p>
Comments on trends in PMSE	<p>PMSE stakeholders emphasised the need to find access to spectrum with a greater degree of security of tenure than currently.</p> <p>BIERG emphasised that PMSE use is growing in size and importance.</p>	<p>Our priority on PMSE will address the challenges facing PMSE use of spectrum, recognising both the increase in PMSE use and its recent, and prospective, reductions in spectrum access.</p>
Comments on trends in wireless back haul and fixed links	<p>We received no comments on trends in this sector’s use of spectrum.</p>	<p>-</p>
Comments on need to keep strategy under review	<p>Arqiva highlighted that, while Ofcom has captured most major trends in its analysis, at least one new disruptive use of spectrum is likely to emerge over the next 10 years. Other stakeholders also emphasised the importance of keeping the strategy under review.</p> <p>Tech UK, BT and the Voice of the Listener and Viewer noted that, as it is impossible to predict all future developments, our strategy should remain flexible and account for future uncertainties. Tech UK took the view that our analysis of future developments should remain an ongoing exercise and encouraged Ofcom to engage with the Spectrum Policy Forum to take this forward.</p>	<p>We agree that it is likely that new and disruptive developments (in technology and business models) will occur that cannot be anticipated now. This is one of the reasons that it will be important for us to keep our strategy under review and refine it in light of unforeseen developments.</p> <p>We also agree that we need to continue to monitor changing spectrum demands. As consumer behaviour, markets and technologies continue to evolve our strategic direction and priorities are likely to require adjustments over time. We welcome the work of the Spectrum Policy Forum and, as noted above, we have deferred the update</p>

Theme	Stakeholder comments	Our response
		of our sector road so that we can take the prospective outputs of the Forum into account when we do so.

Question 2: Do you have any comments on this summary of our **approach to spectrum management** and on the principles discussed in Annex 5?

Theme	Stakeholder comments	Our response
<p>Comments supporting a market-led approach</p>	<p>Vodafone emphasised the importance of the continued application of market mechanisms. Sky stressed that Ofcom should rely more on liberalisation and market mechanisms, arguing that the market failures that Ofcom cites in support of the rationale for regulatory intervention are in fact the result of a regulatory framework that has not fully implemented a market-based approach.</p> <p>Arqiva agreed that consideration of downstream competition should be a factor of spectrum management and a confidential response also stressed the importance of undertaking comprehensive competition assessments to ensure investment and innovation continue.</p> <p>A confidential respondent stated its view that Ofcom should facilitate spectrum trading by creating more transparency over allocations and facilitating a 'market place' where holders can list allocations they wish to trade. Tech UK also stated that Ofcom should increase transparency on the status of different spectrum bands and their potential availability for sharing opportunities by setting up a spectrum inventory that stakeholders can access. Similar points about transparency, of spectrum availability were put forward by the BBC.</p> <p>The BBC argued that the case for spectrum re-purposing should be assessed, taking into account all the costs associated with clearing the existing service set against the likely incremental benefit of the new use.</p> <p>A confidential respondent argued that changes to spectrum use should be made only after setting out comprehensive transition plans for displaced services.</p> <p>The MoD noted that the principles of spectrum management we set out should apply equally to commercial media and public sector spectrum holders.</p>	<p>We agree a market-led approach to spectrum management remains important in many cases to securing the efficient use of spectrum, but recognise that there are a variety of reasons why we need, on occasion, to take regulatory action to secure the optimal use of spectrum. These include:</p> <ul style="list-style-type: none"> • The need for changes to international agreements; • Where it is necessary to mitigate coexistence challenges, particularly where they are complex and there are co-ordination challenges; • Where there are implications for competition in relevant markets; and • Where our wider duties and the citizen interest are of specific relevance. <p>Many of these reasons, we believe, would remain regardless of how far we are able to facilitate a market-based approach to spectrum. We agree, however, that if there is more that we can do to enable markets in spectrum then we should do so. One initiative that we have committed to in our Strategy is to provide an improved quality and quantity of information about how spectrum is accessed and used in UK, as suggested by a number of responses. We will also consider suggestions for ways in which we might be able to alleviate market impediments including to trading.</p> <p>On the issue of transparency of decision making on changes to the use of spectrum, we always consult formally on such issues, often through a series of consultations focused on specific areas of the decision, such as potential coexistence issues and mitigation options, before undertaking a full cost benefit assessment</p>

		<p>when all of the costs associated with a change of use are considered.</p> <p>On the issue of developing Transition plans for displaced services, the need for any such transition plan is dependent on the specific case in question. In some cases there is no need for a transition plan as users are informed many years in advance of a need to vacate spectrum and there are a variety of options for spectrum to which they could relocate (e.g. where a bands is closed for fixed links use). In such cases users are expected to do so at a time that makes sense in terms of their own equipment investment cycle. In other cases, such as for DTT, the high power nature of its use would require extensive transition planning, including with neighbouring administrations, which would need to be in place before a change of use could be effected.</p> <p>We note that in DCMS's UK Spectrum Strategy the government commits to the application of the same principles of spectrum management regardless of who the user is, whilst recognising that there are specific challenges associated with assessing the value to society of spectrum used to provide public services.</p>
<p>Comments highlighting the possible limitations of a market-led approach</p>	<p>Espirito Ltd argued that our application of market-based principles to spectrum management seems to have achieved less than originally expected in the SFR, specifically in respect of release of spectrum by the public sector.</p> <p>Respondents from the Science, Business Radio, Utility and Emergency Services sectors highlighted the limitations of market mechanisms in capturing wider social value or (more broadly) other types of benefits that do not translate directly into commercial revenues, highlighting also the specific social value of their own uses:</p> <ul style="list-style-type: none"> • The Met Office and UKSA highlighted the role of Science applications when noting the importance of considering social value when managing spectrum. • JRC cited the examples of PMSE, Emergency Services and GSM-R in illustrating the challenges of 	<p>The highly heterogeneous nature of spectrum use, and the complexities of managing coexistence between adjacent users, means that market-led activity will always be less prevalent than in most other sectors of economic activity. However, a number of licensees have been able to change the services they provide and the technology they use with only limited oversight from us. There has also been a modest but meaningful level of trading, a number of which have been value-creating for the parties involved. Where market mechanisms can drive value enhancing changes in use then this is usually preferable to regulatory action.</p> <p>We agree that a reliance on market mechanisms might not always maximise the benefits to society where there are significant indirect benefits of use. In these cases there is a strong role for us to ensure that these benefits (and value to society) are taken into account when</p>

	<p>applying market mechanisms to spectrum use</p> <ul style="list-style-type: none"> FCS made a similar point on business radio use of spectrum and noted that it expects regulatory intervention to remain the norm in managing spectrum for BR uses. It also suggested that Ofcom's technology neutral approach might need to be revised to enable BR assignments to be managed in the most efficient way. <p>British APCO and Motorola Solutions contended that spectrum access for Emergency Services should be prioritised over commercial uses and provided for without the use of market mechanisms.</p> <p>The BBC said that introducing spectrum trading or leasing would be challenging in relation to its use of spectrum due to the public status of the BBC and its coverage obligations.</p>	<p>making decisions. This is one of the reasons discussed above for why in our re-articulation of our strategic approach we say we will use market mechanisms where possible and effective and we will use regulatory action where necessary.</p> <p>On the subject of access to spectrum by the Emergency services we note that the decision on how wireless communication services should be provided for Emergency services is one for the government (albeit that we provide expert advice on spectrum matters in this context). If the government determines that access to spectrum is critical to the delivery of these services we will work with them to determine how best this should be made available, noting that the government ultimately has the power to direct Ofcom to make specific frequencies available for Emergency services use if it wishes.</p> <p>We agree that, where Ofcom acts as the band manager for specific blocks of spectrum (licensing individual assignments as in the case of business radio), then the technical coordination process has to take into account the specific technical characteristics of the users. In this sense, there is no such thing as pure "technology neutrality".</p> <p>We recognise that there are particular challenges with the licences that are used for Broadcast services being made tradable. The major challenges, however, relate to the specific conditions that are included in the broadcasting Act licences that are often associated with this specific type of use. The public status of an organisation would not, and does not, however preclude a licence held by such an organisation being tradable nor does the inclusion of coverage obligations preclude licences being tradable.</p>
<p>Comments highlighting the importance of International engagement</p>	<p>Vodafone highlighted the increasing relevance of the international dimension in providing the impetus for changes in spectrum use. This point was also expressed by a confidential respondent.</p> <p>TechUK highlighted effective representation of UK interests in</p>	<p>We have always recognised the importance of the International dimension of spectrum use, and particularly in relation to harmonisation of use and in change of spectrum use. We have consistently invested substantial resources to contribute to and influence the international debate. We have, in this Statement, also committed to</p>

	<p>EU and international discussions as one of the key challenges for future spectrum management. A confidential response argued that Ofcom should be more proactive in leading negotiations on international harmonisation.</p> <p>The BBC argued that UK spectrum policy should reflect UK interests in spectrum use outside of UK as well as in UK. As currently Ofcom's international engagement appears to be solely driven to influence European or International decisions for the benefit of national spectrum issues.</p> <p>The UKSA and BT also would like to see Ofcom promoting all UK interests internationally.</p> <p>ESOA urged Ofcom to focus more on the impact that international developments have on national spectrum management for satellite systems. MoD argued for a proper and balanced representation of Public Sector interests in international fora.</p>	<p>devoting more resource to influencing the high level policy debate in Europe and more widely as well as continuing our contributions on the more technical aspects of the international work.</p> <p>On occasion UK the government has specific industrial policy or other wider UK interests that it wishes to protect or support that would influence the UK position on International debates. This can, in particular, be the case for satellites issues, including where other administrations' industrial policy stance has the potential to disadvantage UK satellite interests if not adequately countered. In such cases, we discuss these issues with the stakeholders involved and with the government and develop positions designed to protect the interests of the UK as well as drive increased benefits from spectrum use for UK consumers and citizens. Where there are potential conflicts between these two objectives we discuss with the government how best to strike the balance between these objectives on a case by case basis dependent on the potential benefits and/or detriment of specific positions.</p>
<p>Other issues</p>	<p>Vodafone, Tech UK and a confidential respondent expressed a preference for simple auction formats.</p>	<p>When designing spectrum auctions we always seek to keep these as simple as possible whilst still meeting our objectives. However, there may be cases where achieving our objectives may require a more complex auction design. For example, more complex auction designs may be required to deal appropriately with substitution or aggregation risks where there may be competition concerns in relation to the auction outcome, or where there may be concerns that strategic bidding behaviour may result in a less efficient outcome. In addition, it is sometimes but not always the case that a less complex auction design makes it more complex for participants to bid</p>

<p>Comments on relationship to UK Spectrum Strategy</p>	<p>BT stressed that it will be important for Ofcom to align its spectrum management strategy with the government's policies and the UK Spectrum Strategy.</p> <p>Tech UK encouraged Ofcom to work with the government on its UK spectrum strategy to ensure coordinated decision-making.</p> <p>Tech UK argued that our list of future priorities imply a high workload for Ofcom and the government and hopes appropriate resources will be made available.</p>	<p>The scope of our strategy is determined by Ofcom's role as the body that authorises spectrum use, which at present we do in relation to around 75% of total spectrum access. However, our spectrum management strategy is also a significant contributor to the government's overarching UK Spectrum Strategy which covers all spectrum, including that used and managed by the government departments.</p> <p>We agree with stakeholders, therefore, that it will remain important for us and the government to continue working closely together. This will include ongoing support to the government on changes to public sector spectrum access, whether these relate to spectrum release or to new access requirements, or whether they relate to wider public policy objectives of the government.</p>
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Question 3: Do you think we have adopted the right approach to analysing future trends and developments that could raise the need for future regulatory action?

Theme	Stakeholder comments	Our response
<p>Comments that support our approach to analysing the need for future regulatory action</p>	<p>TechUK broadly agreed with the approach and noted that future analysis of supply side trends will require an active inventory and engagement with other spectrum managers (e.g. JFMG) and BIS.</p> <p>A confidential respondent commented that Ofcom's overall approach seems appropriate and UKSA generally agreed with Ofcom's approach. The Met Office also agreed that Ofcom's approach is generally valid and sensible. Huawei, Samsung, TAUWI, British APCO, Espirito and a confidential response all agreed with the overall approach.</p>	<p>We intend to take this approach forward within the individual sector roadmaps we published alongside the consultation.</p>
<p>Comments suggesting a limitation of our approach to analysing the need for future regulatory action</p>	<p>A confidential response considered that we shouldn't conflate wireless broadband and mobile services as they are not fully substitutable and some bands may be suitable for one and not the other. Another confidential response argued that services based on fixed wireless access using licensed LTE spectrum will be an important growth area in coming years.</p> <p>ESOA and O3b stressed that the space sector requires long-term certainty to spectrum access to reflect its long investment cycles and therefore that the strategy should span a period of longer than 10 years, specifically recognising the needs of satellite operators.</p> <p>The MoD said that Ofcom had failed to consider Defence and National Security needs.</p> <p>Voice of the Listener and Viewer argued that, while Ofcom's consultation covered all the major sectors, there is a bias in favour of commercial mobile applications at the expense of PSB services on DTT.</p> <p>MetOffice cited some concerns on the selection of major spectrum sectors as it thought that these were not exhaustive and may exclude consideration of those not captured. In</p>	<p>The term mobile and wireless broadband in our consultation was intended only to encompass mobile data and, in this Statement we have renamed this sector as "mobile data" to provide better clarity to stakeholders. We agree the wireless fixed broadband is an important use of spectrum, which can be delivered through a variety of spectrum options.</p> <p>We agree that it is important to consider our strategy for spectrum management over the long term given the long investment cycles and the length of time it takes any change of spectrum use to be effected. However, when trying to forecast potential trends and thereby identify potential strategic issues it is difficult, if not impossible, to look very much further ahead than ten years with any degree of confidence.</p> <p>In our consultation document we discussed that the framework for managing spectrum use in UK in practice differentiates between uses that are authorised by Ofcom and Crown use of spectrum. We have not included an analysis of Crown uses of spectrum, of which Defence and National Security is a major component, since the focus of our spectrum management strategy is on the</p>

	<p>particular, access to spectrum for environmental monitoring and scientific innovation which will be essential to the future economy of the UK.</p>	<p>former and because Crown use of spectrum is in practice managed by the government. We do, however, recognise the value of MoD use of spectrum (as well as the value of other public sector uses). The Armed Forces use the spectrum for a multitude of purposes, such as personal and command radios, satellite communications, air traffic control, navigation, bomb disposal, air to ground communications and for support to training exercises all over the country.</p> <p>We do not accept that our methodology for analysing future trends provides any bias to mobile at the expense of PSB services on DTT. We have been very clear that we recognise the current importance of the DTT platform in the delivery of the benefits to consumer and citizens of free-to-view TV and particularly PSB. On the specific issue of the 700MHz strategy implementation, we are currently undertaking a detailed cost benefit assessment of a potential change in use that will consider all costs and benefits associated with a potential change.</p>
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Question 4: What are your views on the **results of our analysis of future developments** summarised in this section and discussed in greater detail in the Appendix to this consultation? Please provide evidence in support of your views wherever possible.

Theme	Stakeholder comments	Our response
	<p>Stakeholders provided a wide range of comments on the results of our analysis. Where those comments had the potential to impact on our strategy we have summarised and addressed these under Question 2 above.</p> <p>Where they do not have the potential to have a direct impact on our strategy, but rather are detailed comments on the proposed sector roadmaps we will pick these up when we update the sector roadmaps as explained in the right hand column.</p>	<p>We are aware of a number of stakeholder initiatives to investigate demand for spectrum in a variety of the sectors we discussed in our appendix of sector roadmaps that have not completed in time for the publication of this statement. Having reviewed the high level comments received from stakeholders on whether or not we have captured the key trend relevant to the strategy we have now decided to delay updating the roadmaps until the results of this work is available.</p> <p>We are aware, in particular, that the Spectrum Policy Forum (SPF) is undertaking a wide ranging review of spectrum needs of the different sectors that use spectrum. For this reason we have decided to delay updating the sector roadmaps for all of the sectors we authorise use until the results of SPF's work is available. This delay will also enable us to incorporate, where appropriate, other work being undertaken on specific sector demands such as that commissioned by the UK Space Agency.</p>

Question 5: Do you agree that a consideration of **mobile and wireless data demands** should feature as a priority area in our work programme for the next ten years? Have we captured all the major issues that we should consider within this area?

Theme	Stakeholder comments	Our response
Overview	<p>Most respondents expressed a view on this priority. Stakeholders from the mobile sector and device manufacturers were strongly in favour of this being a priority area. There was also general agreement from stakeholders from other sectors that mobile data should be one of Ofcom's priorities, although many also emphasised that it should not be the only priority for Ofcom. Specific comments received on this priority are summarised below.</p>	<p>We have clarified in our Statement that this priority is focused on mobile data and not wireless delivery of fixed broadband services.</p> <p>We recognise that mobile data is only one important area for our work in future and in our statement we have identified priority areas involving other (including, for example, priorities on DTT, Emergency Services, PMSE and M2M). These priorities have been identified after comprehensive assessment of future developments in 12 major sector uses of spectrum and consultation with stakeholders.</p>
Comments which agreed with the mobile data priority	<p>Vodafone argued out that mobile will be a key part of deploying broadband to digital "have nots". It also stated that mobile frequency bands need to be harmonised at EU or international level to encourage device compatibility and stressed that the optimum location for mobile spectrum is at the upper end of the 470-790MHz band.</p> <p>Arqiva agreed that spectrum required for mobile broadband has severe impact and high urgency. It encouraged the release of both high and low frequency spectrum to ensure that service provision is optimised.</p> <p>TAUWI, FCS, Huawei, Qualcomm, Samsung, British APCO, Espirito, MetOffice and three other confidential responses also agreed that mobile data demands should be considered a priority.</p> <p>A confidential response argued that increase in technological efficiency will be slower than increases in demand for mobile data meaning that an additional spectrum layer will be required.</p> <p>TechUK agreed that mobile data should be a priority and encouraged Ofcom to consider longer term issues, citing</p>	<p>We agree that for many uses of spectrum, including mobile, international harmonisation (at the EU or wider level) is critical and have emphasised this once again in our Spectrum management strategy Statement.</p> <p>We are currently consulting on the specific bands that may of interest in future for mobile use in our Mobile Data strategy. We, therefore, do not address, here in any detail the comments we received on the specific relevance of particular bands.</p> <p>We agree, however, that as manufacturers look to the development of new 5G technologies that there has been discussion of the increased importance of higher frequencies in future and we will continue to monitor developments. We will, therefore, remain mindful of the potential importance of bands at higher frequencies as we make take our mobile priority forward in future.</p> <p>This priority will focus on the mobile data demands that are met by public mobile networks, which may incorporate some of the demand currently met by private networks. We will take forward work looking at demand for private networks that relates to much of the Utilities</p>

	<p>potential allocations for 5G at 20-50 GHz that could be discussed at WRC18.</p> <p>Motorola encouraged Ofcom to consider issues around mobile coverage measurement and information to consumers.</p> <p>JRC said it was unclear whether this priority relates only to public networks data or private networks, too. Noting that private mobile networks provide high levels of social value and require dedicated network provision with high levels of resilience, widespread coverage, longevity of support and guaranteed access.</p> <p>Qualcomm argued that increased consumption of video on mobile networks means consumers are downloading much more data than they upload. It argued, therefore, that Supplemental Downlink (SDL) - which uses new spectrum aggregation techniques in 3G and 4G technologies - will help to cope with this trend.</p>	<p>use of spectrum through our M2M / IoT priority and other uses through our existing project and programmatic work including the work looking at 420 – 470MHz</p> <p>We can confirm that this priority will address the important issue of how to improve mobile coverage.</p> <p>We note the comments on asymmetric data demand and are working with Qualcomm on its request to vary its licence in a way that will support SDL use.</p>
<p>Comments that advised caution about a mobile data priority</p>	<p>TV broadcasting stakeholders, including BBC, Digital UK called for Ofcom to undertake a rigorous assessment of future mobile data demand before taking any action in this area. They also cautioned against prioritising mobile broadband to the detriment of DTT. In particular, Digital UK contended that we placed too much emphasis on uncertain future mobile data demands at the expense of the enduring importance of DTT. BBC urged Ofcom to exercise real caution, given that current data demand forecasts show a remarkably wide variation between high end and low end estimates</p> <p>Arqiva and a confidential response pointed out that preparing to clear and award more spectrum to mobile is not the only solution - technology, infrastructure and Wi-Fi should also play a role. BT also highlighted the likely growing role of fixed networks in meeting growing demands for mobile data, through Wi-Fi, greater use of small cells and providing mobile backhaul. BEIRG acknowledged the importance of mobile broadband but also contended that Ofcom should look at alternative means of delivery to additional spectrum allocation. Digital UK also stressed that Wi-Fi and other high frequency off-loading techniques will play a greater role than previously</p>	<p>We agree that the demand for any services is difficult, if not impossible, to accurately predict. However, there is clear evidence that demand for mobile data has been growing at a high rate and that there is therefore the potential for this growth to be sustained or increased. We believe, therefore, that there is a sufficient risk of a loss of benefits to citizens and consumers that might arise if there is insufficient spectrum to meet the growing demands of mobile data that it is right to highlight this risk and act on it.</p> <p>Given the long timescales needed to effect change in spectrum use it is therefore important for us to consider how best to provide options in future, if the need does arise, to provide greater access to spectrum for mobile uses. As part of our work in this area, therefore, we will continue to monitor developments, both in terms of how spectrum demand evolves and how options to meet this demand are developed.</p> <p>We agree that there are means of addressing demand for services that use spectrum other than additional</p>

	<p>anticipated.</p> <p>Space and satellite stakeholders acknowledged the likely increase in mobile data but argued that accommodating this should not come at the expense of their sector. EADS Group noted that satellite services could be part of the solution to meeting the demand, as hybrid networks integrating satellite technology are the most economical solution to distribute content. ESOA stressed the criticality of the C band for fixed satellite services, and O3b Limited said that high frequency bands (3 - 50 GHz) are of high importance and value for satellite communications.</p> <p>MoD commented that some might argue that Mobile and wireless have been given too great a priority in recent years.</p>	<p>allocations of spectrum. In our consultation we specifically included an evaluation of the role of technology and user deployment in meeting demand for services delivered by all the major sectors for which we authorise use. However, these come at a cost and it is important therefore when deciding on potential changes of use that we consider the full range of costs and benefits associated with change of spectrum use, which includes the costs of using methods other than additional spectrum to meet growth in demand for services looking for additional allocations.</p> <p>In addition, our consultation on our Mobile Data Strategy has specifically considered a range of technological developments which could help carry growing mobile data traffic, including Wi-Fi off-loading as well as the specific bands that may be of interest for mobile in future – we therefore do not discuss these issues further in this statement.</p>
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Question 6: Do you agree that the future of **PMSE spectrum access** should feature as a priority area in our work programme for the next ten years? Have we captured all the major issues that we should consider within this area?

Theme	Stakeholder comments	Our response
Overview	Around a third of stakeholders commented on this proposal and whilst they broadly agreed that PMSE serves an important function they had different views on its relative significance.	Although we received more limited comments on this priority than some others, those we did receive in the main agreed with the priority and we will progress with this as priority work area going forward.
Comments that agreed with a review of the future needs of PMSE as a priority	<p>BEIRG emphasised their belief that there is a need to identify a long-term, permanent home for exclusive PMSE use, proposing the 1427-1525MHz band as a possible location. It argued that any move of PMSE should include a compensation scheme for replacing equipment.</p> <p>TV broadcasters welcomed PMSE's inclusion as a priority. The BBC highlighted the need to secure enough affordable spectrum for PMSE with some level of certainty to enable the industry to have sufficient confidence to invest in equipment. It also suggested Ofcom should consider the international dimension of PMSE, as harmonisation would help broadcasters who operate across borders. Digital UK said it hoped that sufficient security of access can be found for wireless microphone use of UHF spectrum - an arrangement which they argued can only be facilitated by sharing arrangements with DTT as the primary user.</p> <p>TechUK agreed with this priority and suggested this should consider increasing need for PMSE broadband solutions (e.g. HD cameras)</p> <p>Espirito agreed with this priority and observed that there is already high quality research in this area dating back to the Spectrum Efficiency Scheme, which should not be duplicated.</p> <p>Arqiva, Sky, Voice of the Listener & Viewer, BT, techUK, a response from an individual and a confidential response also endorsed PMSE as a priority.</p>	<p>We note BEIRG's opinions on the need for access to exclusive use of spectrum and their suggestion for a potential band for future PMSE use and we are considering these issues in the context of our PMSE Review. We note that our Mobile Data strategy consultation also identified the 1427-1525 MHz band as a potential future band for mobile.</p> <p>On the subject of compensation, this is an issue that, as appropriate, falls to be addressed on a case-by-case basis, in consultation with the government</p> <p>On the subject of affordable access to spectrum for PMSE use we note that accesses to spectrum by the sector is predominantly on a shared basis with incumbent primary users. Consequently, where PMSE continue to access spectrum on a shared basis any opportunity cost is likely to be low.</p> <p>However, it should be noted that our PMSE Review will include an analysis of licensing practice and our current fees structure later this year.</p> <p>We recognise the benefits a harmonised solution for PMSE could provide and are actively contributing to the work of the European Commission in this area. In our UHF Strategy statement we said that PMSE would continue to be able to access spectrum interleaved with DTT broadcasting and this will secure the ongoing delivery of audio services for PMSE such as microphones, in ear monitors and talkback/intercom</p>

		<p>systems.</p> <p>Additionally, as part of our PMSE Review we are exploring alternative sharing arrangements in other bands, one of the criteria for which is an assumption of long term security of access for PMSE.</p> <p>Our PMSE Review is taking account of the previous research under the Spectrum Efficiency Scheme although the spectrum access environment for PMSE has changed significantly over the last few years both in terms of spectrum supply and demand.</p>
<p>Comments that advised caution about a review of the future needs of PMSE as a priority</p>	<p>Two of the four mobile respondents questioned the relative value of PMSE. Nordisk Mobiltelefon asked why PMSE has been given more prominence in the strategy than professional voice (business radio).</p> <p>Vodafone suggested that the opportunity cost of PMSE in its current bands is considerable. It further suggested encouraging migration of PMSE through discounted licences or gradually introducing AIP for existing bands. It also identified 2025-2110MHz as a potential band in future for radio microphones.</p> <p>MoD suggested that all sectors should get similar attention, rather than individual ones being a priority. It noted that National Security needs to be considered when planning greater spectrum access and autonomy for PMSE.</p> <p>Sky suggested that a shift to more efficient equipment should be facilitated and noted that future developments in cognitive sensing and geo-location technology may enable PMSE to be treated as another type of white space device. BT and DSA noted that Ofcom should consider how to facilitate moves to more efficient technologies.</p> <p>.</p>	<p>We proposed a review of the future use of spectrum by PMSE as a priority in our consultation in light of a succession of reductions in the spectrum PMSE has access to as a result of recent awards (i.e. the 800 MHz and 2.6 GHz awards); and the potential further loss of access to spectrum as a result of future awards. We believe it is therefore important that the needs of PMSE are considered carefully in order to determine an appropriate strategy for the sector.</p> <p>We do not agree that the opportunity cost of PMSE in its current bands is considerable because it accesses spectrum predominantly on a shared basis with a Primary use with the Primary generating the high opportunity cost,</p> <p>On the suggestion that radio microphones could access 2025-2110 MHz in future, we note that this band is already heavily used for wireless cameras and, in many cases, is fully utilised to support news gathering and events. As events typically require both cameras and microphones (and other PMSE audio applications such as in-ear monitors and talkback/intercom systems) we think there is limited scope for the band to support all applications – but we will consider this in our work in this priority area. In addition, current thinking and practice suggest that wireless microphone equipment typically operates below 2 GHz but we are undertaking technical work to look at what the upper, practical, frequency limit might be. This work is being carried out within our PMSE Review.</p>

		<p>Ofcom works closely with MoD over PMSE access to MoD spectrum and is always aware of the importance of understanding the implications for defence and security needs.</p> <p>We note Sky's point on geolocation databases; some work has been done in this area in Germany, and our review will explore this issue further. We are also working with PMSE stakeholders, not only to identify possible spectrum solutions but also to assess whether the sector can utilise existing spectrum more efficiently, either through developments in equipment or better spectrum planning.</p>
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Question 7: Do you agree that the implementation of our **700 MHz strategy and the longer term future of DTT** should feature as a priority area in our work programme for the next ten years? Have we captured all the major issues that we should consider within this area?

Theme	Stakeholder comments	Our response
Overview	This priority prompted a large number of comments from over two-thirds of responses. Stakeholder all agreed that this was a priority area of work for us, but had different views on how we should proceed and the issues that will be of main importance.	Although we received a mixed response on how we should proceed with this priority it is clear that stakeholders agree that these are two important and linked areas of our work going forward. We will be taking this work forward as a priority.
Comments that agreed with a priority on implementing our 700MHz strategy	<p>Mobile operators argued that the 700MHz band should be released for mobile as soon as possible, stressing that this would help meet the demand for mobile data and secure maximum benefit for consumers. A number of stakeholders from the mobile sector and device manufacturing also raised the need to manage future coexistence issues between TV and mobile use now by influencing TV receiver performance. We summarise the main points we received from stakeholders agreeing with this priority below.</p> <p>A confidential respondent argued that broadcasters and TV manufacturers' expectations should be set now, so that devices can be protected from interference, and stressed that new licensees should not have to compensate DTT providers.</p> <p>Device manufacturers welcomed moves to make 700 MHz a global band for mobile. However, a number suggested that there is a need to ensure the availability of suitable TV antenna types and filters for domestic and communal amplifiers.</p> <p>A confidential respondent argued for release of 700MHz from 2015. This respondent warned there could be a capacity crunch if more isn't done to free up spectrum for mobile data.</p>	<p>Ofcom's UHF strategy implementation project is taking forward a substantial programme of work examining the case for a change of use at 700 MHz and considering how best to manage any future transition.</p> <p>Many aspects of stakeholders' comments relate directly to work we are consulting on, or will soon consult on, in this work and therefore we do not directly address them here.</p> <p>On the subject of compensation, this is an issue that, as appropriate, falls to be addressed on a case-by-case basis, in consultation with the government</p> <p>On the issue of future proofing consumer equipment (including TV antenna) to facilitate an easier potential change of use in future of 700 MHz, we can confirm that is part of the work we will be taking forward in our work on implementing the 700 MHz strategy.</p>
Comments advising caution on proceeding with the implementation of the 700MHz strategy priority	The BBC and Digital UK urged Ofcom to ensure that: the Freeview platform is not damaged in any future implementation of the 700MHz strategy, DTT coverage is maintained, affected viewers are supported, and that those who benefit from clearance should meet costs.	We understand incumbents' concerns about a change of use for 700 MHz and potential impacts on the DTT platform. In taking this priority forward Ofcom will work to ensure that, if we determine that a change of use of 700 MHz is justified, this happens in a way that is consistent with the objectives we set out for the DTT

	<p>A confidential response said that Ofcom should ensure that our actions do not stifle the future growth of the DTT platform and undermine its position as the most cost-effective means of providing a low cost, universal access alternative to pay TV.</p> <p>Voice of the Listener and Viewer stated that if clearance is carried out, DTT will be in danger of being uncompetitive and subject to interference from 4G services and WSDs. It also argued that the implementation of newer technologies to improve efficiency of DTT spectrum will bring cost and inconvenience to consumers.</p> <p>Digital TV Group stated that Ofcom needs to balance the competing needs of delivering its duties to ensure a wide range of TV services and to promote PSB while also ensuring the UK is following the international trend in freeing up UHF spectrum for data use in the most spectrally efficient manner.</p> <p>A confidential response argued that further clarity is required before taking decisions on the 700 MHz band, including on the benefits to the UK deriving from internationally harmonised use, the costs of a potential replan, the definition of an efficient managed transition plan, the future evolution of DTT towards the use of DVB-T2 and the provision of connected services.</p> <p>Tech UK argued that final decisions should only be taken after a full analysis of the cost and benefit of a change of use.</p> <p>UKTV said it did not believe that the full value of DTT - both socio and economic - has been considered in Ofcom's analysis so far. Voice of the Listener and Viewer questioned whether mobile wireless demand justifies the allocation of so much spectrum.</p> <p>BBC argued that decisions on spectrum use should not be focused on the total economic surplus of any one use over another. Instead it should focus on the incremental value.</p>	<p>platform.</p> <p>We agree that it is important when making decisions about the future use of 700MHz that we balance the needs of delivering on all of duties, including ensuring a wide range of TV services and securing the efficient use of spectrum.</p> <p>In making a decision on the future use of the 700 MHz band we will consider all of the likely costs and benefits of a change in the context of the longer-term future of DTT as part of our consultation process, building on responses to our call for input.</p> <p>On the specific point made by the BBC about the need to consider incremental value of additional spectrum rather than the total economic surplus of one use over another, we agree with this principle and will address this point in more detail as we progress with this work.</p>
<p>Comments on the need for a priority on the future of DTT</p>	<p>Broadcasters and BEIRG stressed the need to secure the ongoing delivery of benefits associated with incumbent DTT and PMSE services. Samsung and Qualcomm also stressed the ongoing importance of TV.</p>	<p>We agree with the many stakeholders who emphasised the importance of protecting the benefits to consumers of free-to-view TV including the PSB benefits that are provided through this mechanism. We have therefore renamed this priority to reflect that our focus will be on</p>

	<p>Arqiva expressed surprise that our consultation forecasted DTT remaining an important platform for universal delivery of PSB until the 2020s and not 2030 and stated their belief that it is very unlikely that, without regulatory intervention, IPTV on-demand programming will replace linear TV and that rather they will remain complements.</p> <p>BBC and Digital UK highlighted risks related to the potential co-primary allocation of spectrum in the 470-694 MHz range to mobile broadband, which they oppose. As a result, they took the view that the potential impact of future developments on DTT should be marked as red, not amber.</p> <p>Arqiva argued that, if 700 MHz is cleared and awarded to mobile broadband, then any legitimate demand for mobile spectrum could be met in part by spectrum around 450 MHz with less overall disruption than attempting to clear DTT from any spectrum between 470 - 694 MHz.</p> <p>TechUK highlighted the need for a long term plan for the UHF band (470 – 794 MHz) and to consider the most appropriate mix and coexistence amongst DTT, TVWS and mobile broadband.</p> <p>Some stakeholders noted the role of IPTV and new DTT standards in reducing DTT spectrum requirements. Vodafone, for example, encouraged Ofcom to consider the potential for IPTV to substitute DTT services by 2025 or 2030.</p> <p>The BBC encouraged Ofcom to consider how viable IP could be for delivering broadcast content in the long term. It suggested the extent to which IP could be an effective substitute for DTT would depend on the resilience of the network for mass consumption, low cost access to content for viewers, unmediated network access for broadcasters and EPG prominence for PSBs.</p> <p>A confidential response argued that services delivered by DTT should be limited to PSB and popular commercial stations in future. Channels with low audiences should be provided by other platforms to ensure optimal spectrum use.</p> <p>Huawei argued that, given the increased consumption of video</p>	<p>the future of free-to-view TV rather than having a specific focus on the DTT platform. We intend to publish a discussion document on the future of free-to-view TV and we will continue to engage with the industry on this issue.</p> <p>We also agree that there is a need to consider the longer term future of the band 470 – 694 MHz and we understand the broadcasting sector’s concern about this band being subject to further consideration for future mobile allocation in CEPT taking into account sharing and compatibility studies.</p> <p>We are currently heavily engaged in the international debate on the future of the 470-694 MHz band, both at European and ITU level, which is informed by our UHF Strategy and our view of the very important role the DTT platform currently performs in providing low cost universal access to the public service TV channels and in sustaining viewer choice. We will be publishing a consultation to seek views on the development of the UK position on WRC-15, which will directly address this issue and we welcome responses from stakeholders.</p> <p>We agree that in taking this work forward we will need to consider the implication of new technologies and platforms over which TV might be provided and changing consumer preferences in future in order to understand the spectrum demand for broadcasting TV services in the longer term.</p> <p>We also agree that the value free-to-view TV provides to consumers depends on maintaining a sufficient level of choice of TV content, which includes non PSB channels and will take this into account as we progress our work on this priority.</p>
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	<p>on multiple platforms, broadcasters and mobile broadband operators would benefit from a shared platform. Transition to single frequency networks, DVB-T2, MPEG-4 and newer video compression schemes would reduce broadcasting spectrum requirements and facilitate the convergence process.</p> <p>Sky stressed that technological developments can provide further efficiencies in the delivery of DTT TV services, such as DVB-T2, MPEG 4 or new delivery mechanisms such as eMBMS, which could reduce the need for spectrum for DTT. It also argued Ofcom should incentivise greater efficiency via the prices it sets for DTT spectrum.</p> <p>QVC argued that Ofcom must consider the presence, investment and contribution of non-PSB channel providers like itself, and that there should be constraints on the amount of DTT spectrum available for PSB use.</p>	
<p>Comments suggesting alternative uses for 700MHz once cleared</p>	<p>TAUWI noted that a change of use to mobile would improve mobile coverage and provide an opportunity to reserve some of the 700 MHz spectrum for Utility operators.</p> <p>JRC argued that if usage is changed to mobile, a minimum of 2 x 10MHz should be allocated to Emergency Services to provide for their next generation mobile data network. FCS also noted the relevance of 700 MHz spectrum for Emergency Services use and said it was unclear how tensions between commercial public networks and Emergency services needs could be resolved.</p> <p>Motorola saw a long-term opportunity for Europe to identify part of this spectrum for many vital mobile services, such as safety of life and regional alarm. A confidential response expressed concern that Ofcom regards DTT use of the band as more important than ES/PPDR use on a commercial basis.</p>	<p>We recognise that there may be coverage benefits for mobile use of 700 MHz and this will be considered in our ongoing work. We do not, however, have plans at this time to reserve spectrum for any specific use, but rather would currently expect a competitive process (such as an auction) to be held to determine the future assignments (if any) of this spectrum. Depending on the interest expressed at this point from different potential uses of the band we will define technical licence conditions that will accommodate all uses for which we determine there is a realistic likelihood of demand.</p> <p>We recognise the opportunities that the 700 MHz band may offer for Emergency Services in the UK and elsewhere and we will continue to work with the government and its agencies as they investigate the options to meet future Emergency Services wireless communications needs.</p>

Question 8: Do you agree that a consideration of competing demands for spectrum at **450 -470 MHz** should feature as a priority area in our work programme for the next ten years? Have we captured all the major issues that we should consider within this area?

Theme	Stakeholder comments	Our response
<p>Overview</p>	<p>Around half of responses received commented on this proposed priority. There was some cautious support for a review, but many stakeholders highlighted concerns on how the work might be progressed. There was almost no interest in this band being used for LTE in support of public mobile use.</p> <p>We provide a summary of the comments received on this priority below.</p>	<p>We have concluded that this band does not warrant being highlighted as one of the priority areas but there remain a number of important issues that need to be examined in relation to this band. Consequently we will, continue with our review of this and the adjacent band (420 – 450MHz) with a view to understanding whether there could be benefits in reconfiguring all or parts of the band, not least to limit the effects of future interference from continental Europe given the UK's use of a reverse band plan compared to the harmonised European plan.</p>
<p>Comments that provided qualified support of a priority for 450 – 470MHz</p>	<p>Motorola argued that the band should not be used for LTE; different technologies should be considered that would benefit business radio. Vodafone also saw no reason to licence the band for LTE and Nordisk Mobiltelefon expressed scepticism for LTE at 450 MHz, stating it would not meet the needs of professional users, and suggested that 380-450 MHz should be rationalised as well, referring to the potential to release spectrum for M2M applications.</p> <p>A confidential response highlighted a need to examine the case for re-purposing lower frequency spectrum which could be used to provide better geographic coverage in the long-term.</p> <p>BBC argued that PMSE talkback is a very significant use of this spectrum and there is no identified alternative spectrum for this and urged Ofcom to consider this before making any decision on a change of use to LTE.</p> <p>JRC argued that a change of use to LTE in this band would cause significant issues. Any change to the band would imply numerous site visits to remote locations to adjust utility devices that operate 24/7.</p> <p>Motorola argued that Ofcom should exercise great caution</p>	<p>Stakeholders highlighted the potential complexity, cost and disruption of any reconfiguration of this band, and the likely timescales such an exercise would involve. We agree that these considerations need to form an important consideration for the review.</p> <p>Nonetheless our work on this band will still consider whether there could be value in a rationalisation or reconfiguration of the existing uses and users in the band to overcome long standing problems related to the historical planning of this band in UK and address the risk of rising interference. We also intend to extend the review to include the adjacent 420 – 450MHz band.</p> <p>On the subject of the use of digital technology, we note that there have been considerable moves by the industry to implement digital technologies without need of any action by us, other than to enable such a change through flexible licence conditions. At this time we do not see any need to deviate from this approach.</p>

	<p>when considering change of use to LTE as the Business Radio sector relies heavily on this band (majority of equipment sales are in this range). It further argued that private Business Radio networks are better than public mobile networks with it comes to delivering bespoke coverage solutions and reliability in case of crisis.</p> <p>Utilities stakeholders agreed that this area could form a priority but advised proceeding with considerable caution given the potential to disrupt essential services that currently use this spectrum. JRC noted that there are significant issues with deploying LTE in this band. TAUWI stressed that the water industry needs assurance of the continued availability of spectrum in this band. EDF highlighted the important use they make of this band and stressed the importance of keeping existing users informed of any review and how vital it is that sufficient notice is given in case of any replan or change of use</p> <p>FCS pointed out that its members are already reporting interference issues from continental Europe, but the high value and fragmentation of uses in the band would make any replan very difficult.</p> <p>Nordisk Mobiltelefon supported plans for a rationalisation of this band to benefit professional radio users. It suggested the band should be gradually digitised by encouraging band managers, enabling more efficient wideband technologies and permitting the aggregation of licences.</p> <p>BT agreed that this should be a priority but provided no further supporting commentary. TechUK agreed with this a priority and said that Ofcom should be aware of wider work elsewhere in Europe on 410-470 MHz and take this into account. Huawei and a confidential response also agreed that this should be a priority.</p>	
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<p>Comments suggesting Emergency Services use of the band in future</p>	<p>Huawei and EADS noted the band could be useful for delivery of communications for PPDR and PMR users and/or commercial mobile broadband services based on LTE. EADS also highlighted ongoing work in both EU and ITU on specific future allocations to PPDR.</p> <p>British APCO and two confidential responses welcomed a review of the band as a priority and also suggested it could provide helpful extra capacity for Emergency Services networks.</p>	<p>We note these comments. The decision on how to provide the future wireless communications needs for the Emergency services is being considered under the government's ESMCP project.</p> <p>On the work being taken forward in the EU and ITU on PPDR applications we agree this is important and we are proactively contributing to this. Greater detail is provided under Question 11.</p>
<p>Comments raising concerns about impact on adjacent users</p>	<p>MoD asked that it be kept informed about plans for the band as a change in use could adversely affect systems they have in the adjacent band.</p> <p>Voice of the listener and Viewer had concerns about possible interference with the bottom of the DTT band.</p> <p>Voice of the Listener and Viewer noted the proximity of 450 – 470 MHz to the bottom of the DTT band and stressed it would not want another source of unmitigated systematic interference to DTT from services operating in this band.</p> <p>EADS and O3B called for Ofcom to ensure the protection of existing services (especially satellite) in any reconfiguration of this band.</p>	<p>We recognise that any change of use creates potential coexistence challenges and we would not proceed without a clear understanding of what these might be and what mitigation, if required, was possible at what cost. However, as noted above, there was little support for LTE use in this band in support of public mobile networks.</p>

Question 9: Do you agree that **spectrum sharing** should feature as a priority area in our work programme for the next ten years? Have we captured all the major issues that we should consider within this area?

Theme	Stakeholder comments	Our response
Overview	This priority received the greatest number of comments with over three quarters of responses commenting and with the majority in favour of greater levels of sharing, although many highlighted potential issues that would need to be addressed.	<p>Taking account of the strong endorsement from stakeholders on the importance of sharing, we plan to make this an important aspect of our approach to spectrum management. We have re-positioned the issue as an important tool for delivering our strategy, rather than as a sector-focused priority, given its cross-cutting nature. See the main document for more explanation.</p> <p>We also published today a Statement on our Spectrum Sharing Strategy in which we discuss many of the issues raised by stakeholders, and summarised below, in more detail than we are able to as part of our spectrum management strategy.⁵ Where there are specific linkages these have been highlighted below.</p>
Comments that agreed with a priority on sharing	<p>Device manufacturers all endorsed the need for greater levels of spectrum sharing. Huawei suggested sharing is particularly effective at higher frequencies as reduced propagation properties can be exploited, and argued for enhanced sharing between mobile broadband and the Fixed Satellite Service (FSS) at 3800 - 4200 MHz. Qualcomm recommended the use of LSA (Licensed Shared Access), which they argued would enable Ofcom and MoD to make additional spectrum available in the 2.3 GHz band.</p> <p>Espirito and Qualcomm urged Ofcom to consider sharing opportunities for the 3.4 GHz band and conduct relevant technical studies and international engagement ahead of any 2.3/3.4 award</p> <p>The Dynamic Spectrum Alliance stressed that access to sufficient shared or licence-exempt access to spectrum is important to ensure investment in new technologies. BT was supportive of Ofcom's plans to investigate additional licence-</p>	<p>In taking our work forward on sharing we will look to undertake a fuller review of bands for opportunities for greater sharing over time. This will include consideration of bands at higher frequencies, recognising both the greater opportunities that may exist as well as the development of technology that enables higher frequency bands to be used cost effectively.</p> <p>On the subject of LSA we agree that this could form a useful addition to our mechanisms for authorising shared use, in future, and we will continue to proactively contribute to work in Europe taking this forward. This includes specifically the work in CEPT looking to develop harmonised approaches to both the outright release of spectrum at 2.3 GHz and the sharing of this band.</p> <p>On possible opportunities on sharing at 2.3 GHz, we note that this is considered in our Spectrum Sharing strategy Statement. We recognise this band is of interest to stakeholders. However, the MoD and other public sector</p>

⁵ <http://stakeholders.ofcom.org.uk/consultations/spectrum-sharing/>

	<p>exempt use at 5GHz and noted the importance of spectrum availability for dynamic shared access. Sky argued that facilitating the expansion of Wi-Fi - both in terms of coverage and capacity - should be a key priority. It stressed the importance of ensuring a greater amount of 5 GHz is allocated to licence-exempt use given the anticipated interference to 2.4 GHz that it suggested will occur as a result of the award of the 2.3 GHz band to mobile services.</p> <p>FCS recommended that Ofcom explore sharing solutions that ensure spectrum access to high priority uses, with low priority uses switched to other channels.</p> <p>A confidential response suggested ES/PPDR spectrum could be shared by commercial users when not being used by incumbent users but only where these services had priority over commercial use. Motorola also emphasised the importance of sharing between critical users (e.g. Emergency Services and MoD), whilst noting that models for shared spectrum access between commercial and Public Safety users could only work where appropriate priority is given to critical services.</p> <p>Utilities and business radio respondents supported Ofcom's focus on sharing. JRC suggested utility users could share spectrum access with the government at 450-470 and 1500MHz.</p> <p>A confidential response emphasised the need to harmonise shared, as well as dedicated spectrum, in order to reduce costs.</p>	<p>users are currently clearing their services from the upper 2.3GHz band to enable its release, with the majority of these services redeployed into the lower 2.3GHz band. As a consequence, the band is in a period of transition and it is not currently possible to determine whether sharing of the lower 2.3GHz band will be possible.</p> <p>On the potential for interference into Wi-Fi use at 2.4GHz from the release of 2.3 GHz for mobile use, we agree that our technical analysis suggested a slight risk of interference into 2.4 GHz Wi-Fi, in specific circumstances. Overall, the extent and severity of interference on a nationwide basis is not expected to be high. But, we note that recent measurements commissioned by Ofcom identified that the 2.4 GHz band is currently already congested in some locations. One of the mitigations is for users, however, to move to the far less congested 5 GHz Wi-Fi band.</p> <p>On the need for further spectrum available for Wi-Fi use we refer the reader to our spectrum sharing strategy statement that addresses this specific issue in detail.</p> <p>On the potential to extend licence exempt use of RLANs at 5GHz, we recognise the considerable benefits that could be derived from such a use of this band. However, we are also aware of the potential detriment that could be caused by harmful interference into the existing services in this band, including satellite earth observation, which deliver important citizen benefits. As a result we are progressing with work in the International arena to understand whether, or not, there is a potential for sharing in this band. We discuss this in more detail in our Spectrum Sharing strategy, published today.</p> <p>We agree with stakeholders that sharing offers the potential for greater spectrum access across a range of bands and that it will be important to consider new methods of sharing, as well as new bands for sharing, including those where tiered access to spectrum might be appropriate. We discuss this in more detail in our Spectrum Sharing strategy, published today.</p>
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<p>Comments advising caution about sharing as a priority</p>	<p>In the mobile sector, Vodafone acknowledged that sharing is a useful means of managing spectrum but argued that it does not need to be a distinct item on Ofcom's work programme.</p> <p>UKSA would prefer that other means of reducing the amount of additional spectrum needed for mobile data are pursued rather than spectrum sharing. It suggested greater use of optical systems indoors, better data compression and multicast over unicast protocols.</p> <p>A number of stakeholders raised concerns about the potential for new sharing services to cause interference into existing services. Digital UK said it supported the concept of utilising TV white spaces, but is concerned that Ofcom's approach could cause noticeable disruption to TV viewing. EADS and the Met Office highlighted potential coexistence issues at 5 GHz with RLAN and LE uses.</p> <p>MoD voiced concern about new uses, including those enabled by sharing, causing harmful interference to incumbent users.</p> <p>Respondents from the Space sector expressed concerns about the prospect of potential re-purposing of, or shared access to, spectrum that they currently access in favour of other uses, especially those based on IMT.</p> <p>Espirito Ltd took the view that Ofcom needs to address the issues surrounding safety cases and sharing with radar. BEIRG argued that shared access agreements that impact negatively on PMSE use should not be permitted and said Ofcom must take into account recommendations of the</p>	<p>Whilst we agree that more efficient use of spectrum should be developed by all spectrum users, including those in the mobile sector, growth rates for all services using spectrum imply that this may not be sufficient over the next ten years and therefore we need to look at other options to increase access to spectrum, including sharing.</p> <p>In taking white spaces forward Ofcom is developing the specific technical conditions of the sharing services in light of the need to manage the risk of harmful interference to existing users. We are aware of concerns about the potential extension of RLANs at 5GHz, as discussed above, and are taking these concerns seriously as we progress work to see whether, or not, sharing is possible.</p> <p>In any future work looking at the potential for greater sharing of spectrum bands, coexistence with existing services will form an important aspect of the decision to take this forward. As we discuss in more detail in the main document of this Statement, we expect to place more emphasis on the nature of the adjacent services, and the specific technologies they deploy, when determining the appropriate level of risk tolerance with respect to interference.</p> <p>Finally, we agree that an important aspect as we move forward on identifying new opportunities for sharing will be the communication with, and between, stakeholders particularly where these stakeholders have not</p>

	<p>Technical Working Group concerning the impact of WSDs on incumbent UHF users.</p> <p>TechUK noted that stakeholder communication will be very important, as incumbents and sharers become used to new ways of working.</p>	<p>traditionally needed to discuss potential spectrum coexistence issues that might arise from each other's use of spectrum.</p>
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Question 10: Do you agree that, in future, we should consider whether and how to play a greater role in supporting improvements to the **performance of RF transmitters and receivers**? What are your views on the potential future role for regulation in this area?

Theme	Stakeholder comments	Our response
Overview	Stakeholders generally agreed that better RF performance of transmitters and receivers would be beneficial and that there was likely a role for greater regulatory involvement. Some, however, cautioned against regulators' ability to effect change in this area alone as well as concern about the impact of any significant regulatory intervention in this area on costs of equipment.	We [recognise and share some of the concerns raised by stakeholders. However, we do] plan to place more emphasis on this area in our strategic approach to managing spectrum as explained in the main Statement.
Comments that agreed with a priority on r.f. performance	<p>Digital TV Group was supportive, pointing out that as demand for spectrum increases, Ofcom should adopt policies that encourage the development of spectrally efficient technologies. The Voice of the Listener and Viewer suggested regulators may need to take a more interventionist view of equipment performance, and a confidential response urged Ofcom to ensure that all DTT TV equipment sold in the UK is T2 capable.</p> <p>BT and Sky, welcomed an increased contribution by Ofcom in the development of international regulations on radio equipment and in industry standardisation work. . Huawei and Qualcomm also expressed general support for measures that enable better RF performance.</p> <p>Motorola recommended that Ofcom review minimum performance standards for SRD, PMSE and future unlicensed devices as well as TV receivers</p> <p>Respondents in the Utilities category were supportive of the suggestion. FCS noted that BR terminals are efficient in both receiving and transmitting, but saw growing risk of pollution from neighbouring spectrum uses with lax receiver selectivity or transmitter noise specifications.</p> <p>BBC agreed that Ofcom should become more involved in standards work and work less through mandates, but that</p>	<p>We welcome the support given by stakeholders to our greater focus on r.f. performance issues of transmitters and receivers and look forward to working with them to identify specific areas of focus in future.</p> <p>On the specific issue of TV equipment compatibility with T2 we note that this is a specific issue being considered within our work on the 700MHz priority and therefore we do not comment further here.</p> <p>We note the Radio Society of Great Britain's concerns. Ofcom is considering whether there is a need for new regulations under section 54 Wireless Telegraphy Act 2006 to cover individual examples of apparatus causing undue interference because, for example, it has become faulty or is being used improperly.</p>

	<p>regulations should be set at international level (e.g. CEPT, ITU, or ETSI) rather than national level.</p> <p>David Hall Systems encouraged Ofcom to take a more active role in supporting improvements to the performance of transmitters and receivers.</p> <p>The Radio Society of Great Britain stated that interference from non-radio electronic devices is a growing concern and could affect the noise floor not only at lower frequencies, but also in VHF and UHF spectrum. It suggested Ofcom could tackle this by more effective surveillance of compliance with EMC Directive Essential Requirements; and by introducing new interference Regulations under s54 of the WT Act, covering instances of interference (e.g. for ageing or poor maintenance) from electronic devices in continuing use.</p>	
<p>Comments offering cautious support of a priority on r.f. performance</p>	<p>Samsung said attempts to improve performance should be justified and balanced for all parties involved, citing economic factors and stability of immunity requirements as important considerations.</p> <p>Arqiva agreed in theory, but stated that given the international nature of equipment supply and number of standardisation bodies, it would be challenging for Ofcom to effect major change</p> <p>A confidential response warned against seeking unrealistic levels of performance based on theoretical analyses. It also welcomed fuller engagement based on collaboration which recognises the practical and cost issues associated with improved requirements and highlighted the importance of removing poorly designed equipment from use. They also stressed industry needs performance requirements to be specified from the start of the standards development process and applied to all market participants on a global basis.</p> <p>Tech UK noted that any changes to performance requirements need to be synchronised with equipment life cycles.</p> <p>Space and satellite respondents were broadly in agreement</p>	<p>We recognise that improving r.f. performance beyond a certain limit will inevitably come at an additional cost. However, we have observed that in many cases standards for equipment are out of alignment with what equipment manufacturers are capable of delivering at no significant additional cost and that are manufactured on a regular basis. We believe, therefore, that there are areas where it would be possible to “tighten up” existing and new standards to better reflect what is generally manufactured in practice and have only a minimal impact on all but the lowest specification equipment available on the market. We will, however, have to consider this on an individual case basis and balance any additional potential costs against the benefits that might be expected to be derived. We will do this in close collaboration with industry stakeholders.</p> <p>We also agree that, in general, industry is best placed to drive standards development. However, we believe there are opportunities for us to steer standards development in a way that could limit coexistence challenges in future and therefore reduce costs of assessing and managing coexistence issues in future. We agree that the UK cannot “go it alone” in this context and will need to work in collaboration at the international level.</p>

	<p>with Ofcom's proposed approach, although UKSA warned that overly tight specifications could stifle use or increase costs.</p> <p>In the mobile sector, Vodafone encouraged Ofcom to support improvements to RF transmitters, but give thought to technical conditions for Licence Exempt devices and receivers in harmonised standards. A confidential response suggested that Ofcom could play a useful advisory role in standardisation bodies, but urged against heavy handed regulatory intervention.</p> <p>Digital UK adding that existing standards bodies and industry are best-placed to drive standards development</p>	
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Question 11: Are there **other issues** or potential future challenges that you consider should **feature as a priority** in our work programme for the next ten years? Please provide evidence in support of your views wherever possible.

Theme	Stakeholder comments	Our response
Overview	A number of stakeholders from a variety of sectors identified three specific priorities that they considered should have featured on our list: Machine-to Machine (M2M), Public Sector Spectrum Release (PSSR) and the increasing importance of coexistence issues. Other stakeholders also identified further areas but with less consensus on their inclusion.	<p>We agree with stakeholders that M2M and PSSR should be made specific priorities in their own right rather than being encompassed with the mobile data priority as we proposed in our consultation.</p> <p>We also agree that managing coexistence issues will continue to present a particular focus of our work in future and have increased the emphasis on this aspect of our spectrum management strategy as explained in more detail in the main part of this statement.</p>
Comments suggesting the inclusion of M2M as a priority	<p>TAUWI noted its members increasingly need real-time access to remote data and this, combined with the growth of M2M applications, is likely to greatly increase the demands on public mobile networks.</p> <p>Motorola encouraged Ofcom to consider growing M2M traffic requirements. ARM highlighted the potential of strong growth of M2M applications across the sectors of energy, transport, health, insurance and smart cities.</p> <p>Vodafone noted that Home Automation applications might require shared access to new spectrum, potentially in the 870 MHz or 700 MHz range.</p> <p>EADS noted prospects for the expansion of satellite M2M applications and encouraged Ofcom to treat M2M as a priority area.</p> <p>Nordisk Telekom noted that M2M solutions with quality nationwide coverage could be facilitated through rationalisation of spectrum in the 380-450 MHz range.</p> <p>EADS said that M2M should be treated as a cross-cutting priority for all spectrum bands, including satellite.</p>	<p>We agree with stakeholders that this is an area that we should make a priority so we can better understand the evolving needs and ensure that our regulatory approach facilitates and encourages developments in M2M applications where these are likely to generate benefits to consumers and citizens.</p> <p>M2M applications are, of course not new, but have been used in sectors such as the utilities for many years. However, it is expected that there use will expand dramatically in future driven not least by the expansion of devices in the home and on the person that seek access to the Internet. When combined with the need to upgrade existing M2M applications to handle greater levels of data and at greater number of locations for some critical infrastructure services such as the management of the utilities networks it is clear that this area warrants specific attention.</p> <p>Understanding the potential impacts of the growth of the M2M market on spectrum requires a detailed grasp of the many and varied applications that are likely to emerge. M2M is an emerging area, likely to generate considerable benefits for citizens and consumers, and is significantly different from other uses of spectrum, such as mobile broadband. Given the importance and complexity of the</p>

		area, we intend to evaluate a number of inputs in further developing our thinking on the subject. As a first step, we have today published an independent consultants' report ⁶ which examines various M2M application characteristics and the implications for spectrum.
Comments suggesting the inclusion of PSSR as a priority	<p>BT suggested it may be useful to include the release of 500MHz public sector spectrum as a specific priority item. A confidential response stated that release of MoD spectrum at 2.3 and 3.4 GHz should be a priority. A separate confidential response said any reallocation of MoD use to other uses should be a priority.</p> <p>A number of responses also stressed the importance of the opportunities to share of MoD and other government spectrum. Many of these comments have been addressed under the sharing priority and are not repeated here.</p>	We agree that the extensive support we are providing to the government on PSSR warrants this being identified as a specific priority in its own right. This includes the work we are doing currently to prepare an auction of 2.3 and 3.4 GHz; and other Public Sector spectrum release activities (particularly release through sharing) in support of the government plans to release 500 MHz of spectrum below 5GHz before 2020.
Comments suggesting the inclusion of managing coexistence as a priority	<p>Several existing spectrum users (including those in the public sector) expressed concerns about the potential for interference from new spectrum users, with specific reference to the potential use of spectrum by LTE technologies and greater levels of spectrum sharing. Many of these comments are addressed under the sharing priority or other more relevant priorities (e.g. the 700MHz priority) and are not repeated here.</p> <p>Virgin Media and TAWI specifically stressed that coexistence issues should be a priority for Ofcom.</p>	<p>As competing demands for key spectrum resources grow, we agree that coexistence issues will be a key consideration when examining potential changes to spectrum use. This means that the implementation of our strategy is highly dependent our ability to understand new coexistence challenges and make the appropriate decisions on how to manage them.</p> <p>We intend, therefore, to maintain our recently increased focus on coexistence challenges.</p>

⁶<http://stakeholders.ofcom.org.uk/market-data-research/other/technology-research/2014/M2MSpectrum>

<p>Comments suggesting Emergency Services future needs as a priority</p>	<p>A confidential response said that ES/PPDR users should be prioritised in any work programme for the next 10 years before the needs and requirements of the commercial sector.</p> <p>British APCO stated it belief that there is no more important consideration than provision of Mobile Critical Voice and Data for public safety.</p>	<p>Whilst decisions on PPDR/Emergency services requirements are for the government, we identified the need for Ofcom to support this work as a priority in our consultation and we have confirmed this in our Statement.</p> <p>Specific work we are contributing to includes the work being taken forward in the EU on potential harmonisation of spectrum for PPDR applications where are proactively contributing to this debate with our objective to retain as much flexibility in the use of spectrum as possible, whilst still permitting the benefits of harmonisation to be realised.</p>
<p>Satellite</p>	<p>Many satellite stakeholders commented that they thought the challenges the sector are likely to face in future warranted specific inclusion as a priority. We have summarised the detailed comments in support of this argument under question 1 above and here only provide a general summary of comments.</p> <p>UKSA, EADS, ESOA, Echostar and the BBC all took the view that we should give satellite requirements greater priority. The UKSA highlighted a report on future spectrum demand for space services (satellite and science) due in Spring 2014.</p> <p>Many satellite stakeholders noted the increasing importance of the Ka-band to accommodate new commercial satellite services, as well as the need to identify additional spectrum to extend use in other satellite bands including Ku-band.</p>	<p>Our consultation acknowledged the importance of the space sector, both satellite and science. However, our analysis of future developments across sector uses of spectrum did not highlight specific challenges for space users that would require this being treated as a major priority, going beyond our substantial planned programmatic and project-based activities.</p>
<p>Comments suggesting other priority areas</p>	<p>A confidential response said it would welcome further attention to: a) Voice over LTE, b) Increased transparency to current spectrum allocations/usage, c) the creation of an active market for spectrum trading.</p>	<p>On Voice over LTE we note the ongoing work by industry to develop approaches and standards for carrying voice. At present we are unaware of any regulatory action that we can take, beyond that already proposed to make spectrum more readily available for R&D testing, to facilitate developments in this area.</p>

		<p>On increased transparency on usage we have included this as a clear focus of our future approach and work.</p> <p>On the creation of an active market for trading, we have ensured that there is a supportive regulatory market and we are open to suggestions as to how we could encourage a more active market, but are have not identified any significant action we could take to further encourage trading.</p>
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Question 12: Do you consider that tracking these **metrics** could be a useful way to help monitor the effects that our spectrum management strategy has on the nature of spectrum access and how this changes over time? Are there any other indicators that we should be seeking to track for these purposes?

Theme	Stakeholder comments	Our response
Overview	Stakeholder comments were very supportive of making the metrics available but many urged caution in their use.	Given the interest expressed by stakeholders in monitoring these spectrum attribution metrics we intend to do so going forward. They will not, however, represent targets or KPIs for our spectrum policy work, but rather will be monitored and published periodically. We have indicated in our statement how we expect some key aggregate metrics to change in future given the direction of travel of some of our key policy priorities.
Comments in agreement with the use of the metrics	<p>Arqiva expressed general agreement with our proposals. Voice of the Listener and Viewer agreed that characterising spectrum and its use through specific attributes seems valuable. It suggested a weighting to qualify the value of particular bands may be useful; such a weighting should express factors including current occupancy, level of demand, ease of access, regulatory restrictions and tradability.</p> <p>A confidential response agreed this would be a useful way to track the success of the strategy, to share more spectrum and de-regulate in as many ways as possible.</p>	In setting out the attribution metrics we have not sought to attribute relative “value” to bands. The value of spectrum bands at different frequencies is highly variable, with bands adjacent in frequency having potentially very different values, depending on whether they are harmonised for specific uses and the use itself.
Comments of cautious agreement on the use of the metrics	<p>Many stakeholders whilst supportive of making information on the metrics available urged caution in their use in terms of indicating value of spectrum or as targets or KPIs for our policy work. Specific comments received are summarised below.</p> <p>A confidential response argued that the metrics include no measurements for assessing the consumer/citizen voice or consumer appreciation</p> <p>Digital UK argued that Ofcom should not solely rely on quantitative metrics but should consider the implications of its strategy for citizen and consumer outcomes. The BBC argued that Ofcom should be looking to promote spectrum</p>	<p>In developing the metrics our aim has been to provide quantitative, rather than qualitative metrics; and to provide an overview of how spectrum is allocated and for what uses, rather than to provide a quantified measure of the value of spectrum in any way.</p> <p>It is further not intended that these metrics become targets in their own right. Rather the metrics will help us illustrate the impact of our strategic priorities and track how spectrum use changes over time. They are not intended to inform specific policy decisions.</p>

	<p>management approaches such as increased flexibility, but added that it would be concerned if an artificial incentive were put in place as a consequence of expected quantitative outcomes.</p> <p>Vodafone noted that the metrics we proposed could be a useful 'dashboard' of usage but risk skewing Ofcom's decisions by emphasising quantity over quality of spectrum. It suggested Ofcom should make it clear that these metrics are illustrators of how spectrum is managed, not KPIs.</p> <p>The UKSA noted that tracking metrics would be essential but our proposals do not include metrics on economic growth, public benefit or impacts. Similarly, EADS noted that whilst our proposed metrics may be useful in dispelling misapprehension on the current use of spectrum, they do not include target outcomes or success criterion.</p> <p>Motorola cautioned against value judgements that could arise from these metrics, noting difficulties in estimating true value of services such as PPDR. JRC noted that metrics should recognise that Ofcom-managed approaches are sometimes more appropriate than market mechanisms. FCS said it was unclear how these metrics could support management decisions.</p>	
<p>Other comments on the spectrum attribution metrics</p>	<p>NATS said it would have been preferable for the aeronautical sector to be considered directly alongside the other civil sectors.</p> <p>Espirito argued that Ofcom should take a long-term perspective on the proposed spectrum management metrics, but let commercial stakeholders come forward with technological solutions for short-term changes.</p>	<p>As we explained in the companion paper to the consultation, one of the main objectives of the metrics was to enable us to understand who uses spectrum and/or who prevents others from using spectrum. In the case of aeronautical use of spectrum the decisions on the use of the spectrum, including potential future changes, are highly constrained by the safety requirements of the aeronautical sector and are the responsibility of the specialist aeronautical regulator CAA. As such we considered that, for the purposes of our metrics, aeronautical use of spectrum would be best categorised as public sector. We recognise, however, that where non-Crown users look to use spectrum allocated to aeronautical use, they require authorisation from us.</p> <p>We agree that it is important to allow stakeholders to identify appropriate technological solutions with our role</p>

		<p>limited, as far as possible, to ensuring that sufficient options for such a choice are available from a spectrum viewpoint. Our development and use of the spectrum attribution metrics are not intended to signal a change in our approach to spectrum management; we continue to favour a market led approach, where possible and effective, but also take regulatory action where necessary.</p>
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Question 13: Do you consider that targeted **spectrum utilisation measurements** could be useful in informing future spectrum management initiatives? What type of specific uses or bands could be the subject of future measurement studies, and why? Please provide evidence in support of your views wherever possible

Theme	Stakeholder comments	Our response
Overview	There was general agreement on undertaking targeted measurement campaigns in future. Some stakeholders suggesting specific bands to target.	Noting that responses were generally in favour of our looking to undertake targeted measurements of utilisation we intend to take this work forward as part of our greater focus on making greater quality and quantity of information available on spectrum use.
Comments agreeing with proposal to consider undertaking targeted utilisation measurements	<p>The Dynamic Spectrum Alliance supported measurements especially for identifying spectrum suitable for sharing. Huawei suggested targeted spectrum utilisation measurements could be useful for sharing in the 3800 – 4200 MHz range.</p> <p>FCS suggested that utilisation measurements would be particularly relevant for environments where congestion is an increasing concern.</p> <p>David Hall Systems noted targeted spectrum utilisation measures will be particularly useful in understanding the effectiveness of current sharing and coexistence procedures and the actual use of frequency bands proposed for spectrum sharing arrangements.</p> <p>BT suggested that licence exempt spectrum use and individually assigned spectrum may be priorities for these measurements, as these bands may be ones where Ofcom is most able to initiate changes.</p> <p>The MetOffice noted how effective utilisation measurements could be useful in informing future decisions around spectrum re-purposing, to examine density and uptake of mobile bands and licence-exempt spectrum when proponents make requests for further allocations.</p> <p>The MoD noted that it would be important to measure effective spectrum use by those accessing spectrum on a shared basis, to understand whether new secondary users deliver benefits.</p> <p>Espirito expressed support for implementing a fully automated monitoring system privately funded and paying for itself by a</p>	<p>We agree with stakeholders that measurements of utilisation are likely to be most useful when targeted in specific bands and uses. We also agree that they are likely to be of specific use as an initial tool in identifying bands which might have the potential for greater levels of sharing.</p> <p>We also agree that utilisation measurements may be useful in assessing the use that new shared uses of spectrum actually make once given access to new bands in future.</p> <p>Ofcom will publish an exploratory study in the coming months which will summarise recent developments in the area. This will help us to better understand new measurement and analysis techniques to evaluate spectrum utilisation, and identify our next steps.</p> <p>We would be interested to hear of any initiatives to provide a privately funded monitoring system.</p>

	gain-share arrangement of the efficiencies achieved.	
<p>Comments that provided cautious support for the proposal to undertake targeted measurement of utilisation</p>	<p>Some stakeholders highlighted that some uses of spectrum would be difficult to measure and that results would need to be handled with care.</p> <p>Vodafone noted that utilisation measurements can be useful when effectively targeted, but will only capture a portion of actual use. Echostar noted that not all uses of spectrum are continuous and so absence of activity should not be taken to mean inefficient use, (e.g. satellite newsgathering).</p> <p>A confidential response stressed that ES/PPDR spectrum usage cannot be measured in the same way as commercially used spectrum. The BBC noted what constitutes efficient spectrum use varies significantly between bands and is difficult to define within any single band. Motorola highlighted that utilisation metrics can be useful when looking within a sector, and also argued it may not provide meaningful comparisons between different sectors.</p> <p>A confidential response said these should be done in the context of an evaluation of possible spectrum re-use strategies, as it is not clear that a general rolling program would give value for money.</p>	<p>We agree broadly with these observations. The intensity of use and the technologies deployed will differ across frequency bands and it may not be possible to infer broader spectrum utilisation metrics based on limited measurements. We recognise, therefore, that measurements will need to be targeted. We have no intention of rolling out a UK-wide or more general utilisation measurement programme.</p> <p>We also acknowledge that some approaches to spectrum monitoring require knowledge of the technologies being used. We are, however, interested in exploring approaches to measuring spectrum use that are where possible technology neutral.</p> <p>In all cases it will be most important for the results of such measurements to be interpreted carefully and the use of such measurements alone would not be considered sufficient evidence for a policy decision to be made on any future change of use.</p>