Your response

Question	Your response
Question 1: Do you have comments on the overall approach to the review?	Confidential? – No We would especially like to draw Ofcom's attention to the "elephant in the room", or what we see as the most overriding challenge within the next 3-5 years for spectrum efficiency, spectrum management and spectrum utilisation. That is Broadcasting and OTT services. After decades of technological superiority, today broadcasting technology is generally ineffective at spectrum utilisation compared to modern competing technologies and there are serious problems when meeting the television and media needs of consumers. As more and more consumers shift to alternative streaming TV and VOD services, the "one-to-all" broadcasting approach, where all consumers receive all broadcasting signals whether they want it, need it or care for it – seems to no longer be an efficient use of a valuable and scarce resource. Although OTT is superior to broadcasting in many ways, such as AV quality, interactivity, versatility, monetisation and others, it does have some basic technology challenges which prevents OTTfrom overtaking broadcasting as the preferred distribution technology. Those challenges are that: OTT is not scalable (unicast, one-to-one), hence it is also disproportionately expensive to scale (cost and spectrum usage), OTT is not reliable and OTT is best suited for mobile devices. As a side note, although there is much hype on how 5G will fix all future streaming problems, there are also inherent system bottlenecks in 5G that will prevail when live streaming 2K, 4K, 8K, VR etc with low latency at scale. And 5G distribution is more expensive compared to broadcasting.

	"*The TV networks holding back the future*" is the headline in a recent case from Australia nailing the dilemma, see it here, but please also remember the note on 5G above (thanks). In light of the above points, we strongly recommend Ofcom also focus on the importance of incentivising broadcasters to transitioning towards broadcasting all their content in native IP (not the same as OTT) as this has significant spectrum upsides: major benefits in spectrum savings, enhancing resiliency to interference, enabling network convergence, enabling easier network/spectrum sharing and easier facilitation of new innovative partnerships among various stakeholders. Finally, a native IP broadcasting technology would be able to reach all screens on all networks in one system. Spectrum savings could be therefore monetised and the profit used to offer incentives to leverage the transition. In "The Next-Generation Television Broadcasting Test Platform in Copenhagen", cf. IEEE here, we have for almost a year been testing and demonstrating how merging the best from broadcasting, OTT and proven opensource technologies (named OTT Broadcast), can be extremely spectrum friendly. It can provide personalised premium consumer TV and media experiences on all screens at an attractive cost for broadcasters and operators and can ease the creation of new innovative and disruptive services and partnerships due to it all being is based on native IP and software. As Ofcom calls for innovative and disruptive ideas to manage future spectrum challenges, we would recommend Ofcom to try out a different mind-set when addressing the spectrum management challenges by adopting a service perspective – looking at the spectrum challenges from a service provider and not a solution provider, as these are two very different perspectives. It is the services running in the spectrum that creates value. By itself, 5G is just a technology (albeit a great one) but it cannot create much

	value alone. It is the services that run on 5G technology which drive the revenue and create most of the value. Improved spectrum utilisation could create revenues in a similar way.
Question 2: Have we captured the major trends that are likely to impact spectrum management over the next ten years?	Confidential? No No. We think you have missed the single most important trend that will have the biggest impact on spectrum management: television and video consumption. In other words, television and video services which uses the spectrum, cf. our final point in Q1 above. Today TV and video content already represents around 80% of the total mobile data traffic, including cellular and Wi-Fi. As 2K, 4K-, 8K-, VR video streaming becomes "the new normal" this will only further increase the pressure on available spectrum capacity – or lack thereof. Existing (inefficient) broadcasting and OTT (distribution) technologies will continue to consume more and more of the available spectrum in UK. As spectrum is not infinite, new disruptive solutions are needed, as innovation will only be a short-term painkiller. We encourage Ofcom to focus on disruptive technologies and services to dramatically reduce the spectrum usage by adopting broadcasting and OTT services. This is firmly supported by "The Next-Generation Television Broadcasting Test Platform in Copenhagen", cf. IEEE here
Question 3: Could any of the future technologies we have identified in Annex 6, or any others, have disruptive implications for how spectrum is managed in the future? When might those implications emerge?	Confidential? – No Maybe, but not really for broadcasting or video streaming services that already consume the majority of spectrum today and will consume even more spectrum in the future. More efficient (and expensive) encoding technologies and bigger and more advanced (and expensive) CDN's will only off-set a part of the increasing total AV media consumption.

	We see an imminent need for Ofcom to grasp the nettle of the ineffective and heavy usage of the scarce spectrum capacity by broadcasting and OTT services, especially now that alternative viable substitute services exist. We also foresee Network Convergence in general (also non-wireless) which will have disruptive implications in the near future for wireless spectrum management. Convergence in wireless networks (terrestrial, satellite, mobile and Wi-Fi) is a major driver for more efficient usage of any given/available spectrum (utilisation) and also a key enabler for fair and seamless access to any content on any network, from any device connected to the network to receive a service from any connection. It is well known that broadcast distribution technologies consume a lot of spectrum/data capacity compared to OTT technologies and this can have a significant impact on consumers, business and society. See also The TV networks holding back the future. Just imagine the extra capacity available if you could transform broadcast distribution networks into more efficient and effective standard managed IP distribution networks? We don't foresee that any of the identified technologies by Ofcom will have an innovative or disruptive effect on the existing legacy broadcasting and OTT technologies. Especially as broadcast technologies can only be leveraged none to minimal by these normally very powerful technologies identified by Ofcom. Perhaps a useful analogy is "A pig is still a pig, even when wearing lipstick." Instead we recommend updating existing broadcasting technologies to support true native IP in combination with proven, modern, effective technologies to elevate a secure, robust, scalable (e.g. multicast ABR) low latency, maximum AV quality broadcast streaming which is combined with a well-defined, unified service layer to seamlessly

	enable personalised, valuable consumer services with native IP streaming. Please note that the term "native IP" is not an unambiguous definition as in real life it comes with different exotic flavours in various solutions and interpretations.
Question 4: Do you agree that there is likely to be greater demand for local access to spectrum in the future? Do you agree with our proposal to consider further options for localised spectrum access when authorising new access to spectrum?	Confidential? – No Maybe, Maybe and Maybe. While spectrum sharing has the potential, from a service perspective we don't see that spectrum by itself will be able to solve the problem of increasing demand for connectivity and data heavy services which includes, but is not limited to, premium video services by broadcasting and OTT. In order to proactively address the inevitable problem of always being behind with technologies, and to feed the needs of a data hungry market, we think it is essential Ofcom has a more service-oriented mind-set in order to identify the current and coming trends from the web world of services. For example: • Which kind of services are consuming the most spectrum and why? • How would these services benefit from a more dynamic and even local spectrum allocation? • Could the services be split into smaller sub-services and delivered with a more dynamic distribution strategy? This thinking will be a valuable tool for Ofcom to define underlying spectrum drivers and a more will provide a versatile framework on how to manage the spectrum challenge. We think this will enable Ofcom to find a higher level of efficiency in spectrum understanding and utilisation, enabling more capacity and access in the spectrum to be allocated to new stakeholders providing innovative and affordable service and therefore enrich users' experience.

	Therefore, we also recommend to localise the access to the UHF band for data casting services, and intelligently use an innovative and service-oriented technology solution that is able to combine different dynamic casting opportunities (multicast/broadcast) to deliver highly demanded content in a much more uniform way, while allocating a small portion of the band to the rarely watched content. Furthermore, the demand for sharing and managing access to many segments of spectrum, including the higher frequency bands, is increasing for connecting the unconnected and serving the spectrum needs for services and applications. As more content is created and as the video content is the major consumer of spectrum capacity, the need for more capacity in a finite spectrum will become scarce. At this point, the sharing of access to the spectrum and operating in higher bands alone won't be enough. Imagine, that by 2023, 29 billion connected devices alone will be consuming the available spectrum mainly for video (Ericsson forecast). This makes efficient spectrum usage even more vital. We believe there is a need to rethink how broadcasting is conducted in the future. There is need for an innovative and efficient solution to effectively manage the spectrum and the huge demand for television and video consumption in a very near future. USA propose a new broadcasting standard ATSC 3.0, in Europe DVB is considering a native IP strategy and in Copenhagen we have elevated the best from ATSC 3.0, DVB, OTT and proven open-source technologies to do a native IP streaming with a well-defined service layer to enhance and monetise the streaming more. You can read more about it here in this DVB article here. Imagine a broadcasting and OTT service that is able to super aggregate any kind of video service, unify its distribution at scale with low

	latency and QoE, saving 50% - 70% of the currently consumed spectrum. Moreover, also providing automated intelligent real time stats on data consumption for accurate spectrum monitoring.
Question 5: Do you agree with the actual and perceived barriers identified for innovation in new wireless technologies, and our proposed ways of tackling those?	Confidential? – No Yes, we agree in general with the barriers identified. Further to what is proposed, we believe the major barrier to spectrum innovation is not mentioned; that is the legacy in broadcasting technologies – end to end. It is well known that broadcasters are running out of capacity, because broadcast distribution technology is consuming a lot of (expensive) spectrum, and they need to use OTT technology to all screens in home. Today many broadcasters are about to redefine the broadcasting experience using multiple systems e.g. broadcast and OTT (and HBB, IPTV, etc.). Consumers require more advanced technical features as premium Audio Video quality, unified, multi-screen, low latency, reliable, scalable, secure, personalised TV and entertainment streaming with value adding personalised services – at low system- and distribution cost. All these requirements are simply not possible for legacy broadcasting technologies as there are much more compelling and competitive offerings on the market. But broadcasting technologies is not only very spectrum hungry, there are also other side-effects: A BBC research white paper found that distribution and consumption of BBC television services (alone) accounted for approximately 0.6% of all UK electricity use in 2016. Not sure how much better OTT is doing or other broadcasters. Just Imagine broadcasters have the opportunity to free up more than 70% of their consumed capacity by reshaping their TV offering using

	very secure, robust, low latency IP multicast to directly reach all screens using existing infrastructure. This could also replace legacy STBs with future friendly virtualised STBs connected to an in-home media gateway that will upgrade new and legacy TV's and mobile devices and make them all enter the world of IoTV. *Welcome to the future of the Smart Home*. We recommend Ofcom incentivise and prioritise new innovative services which can demonstrate a dramatic increase in efficient (total) spectrum utilisation for given services. All service providers should care about the usage of finite and valuable resource like spectrum.
Question 6: Do you agree with Ofcom's proposals to improve our outreach and reporting activities, and spectrum information tools? • **Are there additional ways that Ofcom could better engage with existing and future users and providers of wireless communications?** • **Please explain any specific areas where you believe more or better provision of information could provide value to stakeholders**	Confidential? No. Yes, Yes and Yes. We find there is too much focus on spectrum technologies and not so much focus on the services which are (mis-)using the spectrum. Essentially, it is the services which create value for businesses and consumers and not the technology itself. We recommend that Ofcom should have more focus on the service perspective and the services to be enabled in the spectrum. We believe a different mindset could enable a higher degree of transparency and foster new innovative ideas which would lead to more efficient spectrum services and spectrum management. A service approach will by definition focus on a service to manage consumer/business problems and avoid having a great technology (engineering masterpiece) looking for problems to solve, as seems to be the case with 5G. Looking at spectrum only, we find it difficult to come up with transparent solutions without looking at the services / service verticals to be enabled.

	With respect to what is proposed, we would emphasise the importance of innovation in video services' platforms and particularly the importance of IP multicasting delivery protocols with services, as it is a vital technology for spectrum efficiency in wireless networks, especially when it comes to the audio visual data transmission. Ofcom should incentivise new and existing stakeholders to support innovation in spectrum friendly unified television. And video service distribution should be able to reach all viewers, on all screens, on all networks.
Question 7: Do you agree that it is important to make more spectrum available for innovation before its long-term use is certain? Do you have any comments about our proposed approach to doing this?	Confidential? No Yes and Yes. It is crucial if Ofcom want to promote and enable disruptive services to converge the network and create disruptive spectrum innovation. This should be done with a focus on services which can converge the network while creating premium value for all users. Services are what monetise the spectrum and create real value. It will not only help in testing the spectrum behaviour when carrying innovative services, but it will make it much more attractive to propose new ways of utilising spectrum in different bands as well. Based on our experience, a major challenge is the habitual thinking when discussing spectrum. The typical bands used for delivery to end users are often based on well-defined service providers seeking to use the band for very specific services. The most versatile services are typically for ISPs or more precise WISPs, as any OTT service can be adapted and carried using the provided spectrum. An alternative approach is to turn the entire ecosystem 180 degrees. Look at the spectrum from a pure service-oriented approach. Call in the interested (serious) parties from the world of web services and let them help define the innovative approaches to the spectrum in the different bands. They should be the people

	defining the modern and required verticals, and not a 5G technology vendor nor telco. The work could be done in a collaboration with specific and regional Centres of Excellence, calling in partners from the industry, both service providers and operators, in order to bridge the true gap between the service operators and service enablers. Service providers will any day be in more contact with end users and trends, than operators and regulators of the spectrum. It is exactly the same for traditional broadcasters. A true NextGen Broadcaster should be looking much more towards the world of web services, instead of trying to wrap their existing services by cherry-picking features of much more modern and versatile OTT services. This is exactly the approach our company took with the formation of the OTT-Broadcast (OTT-B) consortium, which added NextGen TV to the ecosystem of IoT and not vice versa. Let spectrum be a carrier for specific service verticals in order not to end up with a solution looking for a problem. This has been the story too many times like use cases for DVB-H, MediaFLO, Fast-OFDM, 5G Broadcast etc. In the NextGen TV platform in Copenhagen, we have developed a broadcasting and OTT platform which fetches live broadcast TV from satellite and distribute in IP multicast over terrestrial networks and played out in broadcast quality on all screens and smart speakers in home with a dynamic offloaded to any native edge network, like 5G, saving 55% of the spectrum. This is achieved only due to the fact, the distribution is “smart”, and not just the AI encoding of the content or smart devices used for consumption by end users.
Question 8: Do you agree that it is important to encourage spectrum users to be ‘good neighbours’ to ensure more efficient use of the spectrum? Do you agree with our proposals to: **a) increase realism in coexistence analysis at a national and international level?**	Confidential? – No. Yes, yes partly and yes. We believe in network transparency to be a major driver for spectrum innovation and spectrum management.

b) encourage spectrum users to be more resilient to interference? **c) ensure an efficient balance between the level of interference protection given to one service and the flexibility for others to transmit?** **Do you have any comments on which of these will be the most important?**	The realism approach plays a key role in roaming. This will open the door for services to travel globally, creating fair access to content and the right path. As more broadcasting, OTT services and real time information becomes the new normal there will be a need for an intelligent and simple television and video platform that supports smart distribution protocols to operate in sync with consumers' behaviour, adding more reliability, flexibility and efficiency to the network resources. Please, do also consider that a traditional roaming approach, charging per mb consumption or peak usage only, can also be a barrier for innovative new consumer services. Resiliency to interference may include, but not limited to, collision detection, interference cancelation mechanisms, retransmissions and prior knowledge to data recovery. In terms of video applications, the data recovery in VOD, is simple, while e.g. in 4K live sports it is vital. This is a serious technical challenge both BBC Research and mediathand (independent of each other) have looked in to and after a post discussion between the parties, mediathand is now working on a sustainable solution to manage this challenge. The solution will be demonstrated in the Next Generation TV platform in Copenhagen with a microservice for a innovative IP multicast repair mechanisms for data recovery, protection and intelligence to avoid delays introduced by retransmission, and by this adding significant resilience to interference. With respect to what is proposed, imaging the importance of saving 50% - 70% of the spectrum consumed by video services.
Question 9: Are there any other issues or potential future challenges that should be considered as part of this strategy?	Confidential? – No. Yes. Challenge1: The huge data consumption by 2K, 4K, 8K, VR etc …. Broadcasting and OTT

	streaming will in the near future drain the spectrum capacity. Therefore, service providers shall focus on selecting video platforms, which are able to harmonise among the data rate efficiency and quality. Challenge 2: The front hauling bottle necks in 5G networks along with immense expense in back hauling 5G. Therefore, the convergence in wireless networking will be a great asset in backhauling the 5G network with broadcast networks. Challenge 3: Complexity in transitioning broadcaster to IP due to legacy. Therefore we offer painless and secure transitioning to IP using same infrastructure with no need for new STBs. Challenge 4: Data privacy is a major topic on the broadcasters' and mobile operator's table. Challenge 5: Smart distribution, where hybrid distribution and spectrum efficient services is incentivised. Just take a look at the increase in video, and therefore data consumption, which will create bottlenecks in the networks. More efficient encoding is only a small patch on a giant open wound and will not fix the underlying problem. In the Copenhagen testbed we promote smart distribution using an adaptive hybrid multicast distribution of video and normal data packages. Challenge 6: We recommend a more service-oriented approach for Ofcom allowing and incentivising service providers to introduce new innovative or disruptive spectrum efficient services.
Question 10: Do you agree that continued use of our existing spectrum management tools (as set out in sections 4-7) will be relevant and important for promoting our objectives in the future, in light of future trends?	Confidential? No. No – in itself it's not sufficient to manage the broadcasting and streaming problems to come. But if the regulators think in an a more service-oriented way and utilise the power of the innovative video distribution solution in line with the mentioned set of spectrum management tools, then these spectrum tools

	will be more relevant, more efficient and future proof. The Next Generation TV platform in Copenhagen provides intelligent data recovery mechanisms for much better resiliency to interference, unified QoE, and the saving 50%-70% of capacity which gives more room for other types of services to operate over the spectrum. This will leverage the ability of the existing spectrum tools to provide much better management of the spectrum shared among service providers.
Question 11: Is there anything else we should be considering doing, or doing differently, to promote our objectives?	Confidential? – No. Yes If Ofcom consider offloading some of the effort, for example spectrum efficiency, data recovery, super aggregation of video services, virtualisation of STBs for smart and green distribution over networks, simple and secure transitioning of broadcasters towards an all IP world, this would be of a great help to Ofcom's objectives in terms of managing and sharing spectrum based and services consuming the spectrum.