

Facebook, Inc. submits the following information in response to Ofcom's consultation entitled "Fixed Wireless Spectrum Strategy," published on July 11, 2016, primarily to respond to Questions 4, 5 and 14 of this consultation (as indicated below). We also respond to Questions 1, 2 and 3 with a description of relevant Facebook activities.

Facebook's mission is to give people the power to share and make the world more open and connected. Over 3 years ago, Facebook launched Internet.org to address the broader issue that today, nearly 4 billion people—60% of the people on the planet—are still not connected to the Internet. And because the rate of Internet penetration growth has slowed from 14% in 2010 to under 7% in 2015, Facebook also launched its own Connectivity Lab to develop new technologies that specifically focus on connecting the unconnected. Connecting these people—most of whom live in the developing world—is a complicated effort that requires not just bringing network infrastructure to more people, but also requires addressing the regulatory environment, access technology standards, and other issues that affect the awareness, availability, and affordability of internet access.¹ A crucial part of this Facebook effort is progressing on UK soil: a UK-based team is responsible for designing Aquila, Facebook's High Altitude Platform Station (HAPS) system, which has already soared to the skies in a concept-proving, full-scale flight test.²

¹ Internet.org by Facebook, State of Connectivity 2015 – A Report on Global Internet Access at 6-8 (Feb. 22, 2016).

² See <http://www.theverge.com/a/mark-zuckerberg-future-of-facebook/aquila-drone-internet>.

Spectrum policy is a key part of the regulatory environment that affects both the affordability and availability of the internet. There is no greenfield spectrum left. Improving connectivity in the United Kingdom and around the world means pursuing spectrum policy that maximizes the utilization of this limited resource and promotes the expansion of both the capacity and coverage of wireless networks. Ofcom is in a position to adopt spectrum policies that meet these objectives in the United Kingdom, while also setting an example for the rest of the world and enabling a technology-friendly wireless environment from which the UK will benefit as a global technology leader.

As part of its Fixed Wireless Spectrum Strategy, Facebook urges Ofcom to concentrate on the following two areas to maximize the utilization of spectrum and expand the capacity and coverage of networks.

First, Ofcom should adopt flexible spectrum policies that maximize use by promoting sharing across a wide variety of users and platforms, particularly new platforms like HAPS (addressed by Question 14 of this consultation). To this end, Facebook supports the use of sharing technologies to allow cooperative spectrum sharing among users.

Second, Ofcom should enable access to additional unlicensed spectrum (relevant to Questions 4 and 5 of this consultation). Unlicensed spectrum drives innovation and investment in a range of technologies that can supplement and support mobile networks and expand broadband access at low cost.

1. Ofcom's Fixed Wireless Spectrum Strategy should promote sharing among users and platforms, particularly new platforms like HAPS.

Connecting the unconnected around the world and improving rural connectivity in developed countries will require a wide variety of technical solutions. In some places, such as dense urban areas, terrestrial systems are efficient both for end users and for backhaul links. But in remote, sparsely-populated areas, where there are significant gaps in infrastructure, and the economic barriers to installing terrestrial infrastructure are considerably higher, satellite delivery is likely to be appropriate. And in medium-density suburban and rural areas, where broadband infrastructure must be deployed over a wide area to be cost-effective, broadband connectivity delivered from high altitude solar planes can provide an efficient component of the solution.

As part of its project Aquila, a UK-based Facebook design team is designing a remotely-piloted high-altitude solar-powered aircraft that will maintain nominally fixed station keeping at altitudes above 20 km in the stratosphere to maintain coverage of a given service area on the ground for 3-12 months at a time. Aquila aircraft are being designed to cover a 100-kilometer diameter area generating data capacity in excess of 10 Gbps. Each aircraft would be connected to other aircrafts through laser links and connected to ground stations through broadband wireless links. Although Aquila has the wingspan of an airliner, it is designed to consume at its peak only 5,000 watts (the equivalent of three hair dryers) allowing it to stay airborne for long periods of time. Facebook is designing and testing these aerial platforms to provide backhaul links from fiber points of presence to service aggregation points such as cell towers or WiFi access points, enabling both licensed (e.g., LTE) and unlicensed (e.g., WiFi) services to

the end user. Earlier this summer, Facebook achieved a new milestone in project Aquila with a successful first test flight of a full-scale aircraft. There is much more testing and technology development left to be done to make Aquila a reality, but these initial full-scale test results have been promising.

Facebook first broached HAPS in comments it filed with Ofcom in August 2015. There, Facebook expressed its views in favor of more spectrum for HAPS.³ Facebook's HAPS platform will require at least 2 GHz of radio spectrum to achieve necessary target throughput goals. More recently, the mission of attaining that necessary additional spectrum came closer to fulfillment. As noted in the Fixed Wireless Spectrum Strategy Consultation,⁴ the International Telecommunication Union agreed at the 2015 World Radiocommunication Conference (WRC-15) to consider the need for additional spectrum identifications for use by HAPS during WRC-19. Specifically, WRC-15 recognized HAPS are one possible means for providing fixed broadband connectivity that would enable wireless broadband deployment in underserved and unserved communities worldwide; and that HAPS can provide broadband connectivity with minimal ground network infrastructure. WRC-15 also invited the ITU-R to study appropriate modifications to the existing restrictions on HAPS. It also identified additional spectrum for study, including sharing and compatibility studies to ensure the protection of existing services. The preparatory work for WRC-19 has begun, with

³ <http://stakeholders.ofcom.org.uk/binaries/consultations/space-science-cfi/responses/Facebook.pdf>.

⁴ Ofcom Fixed Wireless Spectrum Strategy Consultation, Article 2.36.

studies regarding the spectrum requirements of HAPS systems underway. Facebook respectfully requests UK support for these efforts.

The bands identified by WRC-15 for study as a home for HAPS include the 38-39.5 GHz band. As Ofcom notes, the 38 GHz band has also been identified for 5G mobile services.⁵ These two objectives are *not* mutually exclusive. In fact, this is why Facebook believes that it is critical that Ofcom pursue spectrum policy that is flexible and promotes sharing among a variety of users and platforms, including between mobile and HAPS, especially in light of the fact that backhaul links from HAPS will play a vital role in terrestrial IMT deployment. Facebook's aim of increasing global connectivity is platform-agnostic. In fact, Facebook believes that connecting the unconnected and underserved will require a multi-platform approach that relies on satellite, mobile, and new technologies like HAPS to bring connectivity solutions to different areas facing unique challenges. And further, mobile connectivity is a key on-ramp to the internet. Around the world, growth in mobile broadband subscriptions far outpaces growth in fixed broadband subscriptions particularly in developing nations.⁶

⁵ *Id.* WRC-15 also identified the bands at 21.4-223 GHz and 24.25-27.5 GHz for HAPS for study in Region 2. These bands require co-existence with FSS, IMT, and Earth observation satellites, making sharing an important consideration for HAPS in these bands as well. Although the bands were only identified for study in Region 2, Facebook encourages other countries and Regions to follow these studies and support an identification for their country or region if they see value for themselves in HAPS delivering broadband connectivity through those bands.

⁶ International Telecommunication Union, ICT Facts and Figures (May 2015), available at <http://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx>.

As Cisco projects global mobile data traffic to increase tenfold by 2019,⁷ it makes sense for the ITU to be considering additional mobile allocations which may be suitable for adding capacity to mobile networks through small cells and other innovations.

Although Facebook's connectivity efforts have been focused on the developing world, Facebook believes that HAPS could play a role in delivery of broadband Internet access to underserved areas of the UK. Facebook is working to develop the technology so that service providers can ultimately adopt the technology and deploy it anywhere there is demand. The UK government has faced some significant issues in finding providers to cost-effectively deliver the services required to meet its rural broadband targets.⁸ As Facebook has noted in the past, it would welcome the opportunity to work with Broadband Delivery UK at the Department of Culture, Media and Sport, Ofcom and others to be part of the solution. Facebook has already engaged in preliminary discussions with UK operators interested in exploring HAPS as a potential solution to reaching unserved and underserved areas in the UK.

To facilitate the potential use of HAPS in the UK, Ofcom's policies should be flexible and accommodate sharing across all platforms. Facebook believes that the HAPS authorization regime should be as inclusive and encouraging of sharing as

⁷ Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014-2019 White Paper, available at http://www.cisco.com/c/en/us/solutions/collateral/serviceprovider/visual-networking-index-vni/white_paper_c11-520862.html.

⁸ See UK Next Generation Network Infrastructure Deployment Plan (March 2015), available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/418567/UK%20Next%20Generation%20Network%20Infrastructure%20Deployment%20Plan%20March%2015.pdf.

possible. And, at least for backhaul links – Facebook’s primary use case, Ofcom should consider an unlicensed or light licensing regime, allowing for coordination among HAPS operators while protecting existing services. Facebook believes that an unlicensed, self-coordination approach will work with the incentives of IMT operators seeking to use HAPS for backhaul, without adding the cost of a licensed regime to HAPS deployment.

As a general matter, Facebook supports spectrum policies that maximize the use of scarce spectrum resources through sharing in all bands, not just HAPS bands. One way to facilitate sharing is through the use of dynamic sharing technologies. Spectrum sensing technologies, spectrum access systems, and related technologies can allow for greater use of spectrum by multiple types of users. Facebook believes that sharing technologies could help balance the needs of mobile network operators seeking to invest in wide-area network infrastructure as well as the needs of other platforms, all while keeping these bands open to the innovation that is yet to come. Sharing technologies can be implemented in spectrum bands with licensed users by establishing a tiered framework that would allow prioritized sharing between licensees and general access users. Such a framework mitigates the risk of licensed spectrum being left to lie fallow. Around the world, licensed spectrum resources are often significantly underutilized in lower population density areas. Yet this spectrum remains unavailable to others due to delayed buildout and weak license buildout requirements. If unused spectrum were instead open for unlicensed use through sharing technologies, this would go a long way towards solving the problem. Furthermore, under a tiered sharing structure buildout obligations could be much more relaxed and flexible without negative

consequences. This framework also creates a hospitable environment for new technologies, benefitting the UK in its role as a global technology leader.

2. Ofcom should designate more unlicensed spectrum.

Ofcom's Fixed Wireless Spectrum Strategy should support a balance between licensed and unlicensed spectrum to fuel innovation and connectivity around the world. As Ofcom considers opening up additional spectrum for WiFi in the 5 GHz band,⁹ it should also consider identifying additional unlicensed spectrum in the higher frequency millimeter wave bands. In 2015, more than half of global mobile data traffic was offloaded to fixed networks through WiFi or femtocell.¹⁰ And in the millimeter wave bands, unlicensed spectrum in many countries has created an environment for innovation that has led to new developments in both access and backhaul technologies that can add tremendous capacity to broadband networks at low cost, and can benefit immensely the UK technology sector. For example, in the 60 GHz band (57-64 GHz), new services have developed ranging from outdoor wireless links that extend the reach of fiber networks to personal networking technologies based on the WiGig standards 802.11ad and 802.11ay that deliver multi-Gigabit speeds between devices. And more is yet to come. The huge demand for network capacity is driving investment in 60 GHz unlicensed technologies for wireless backhaul and other uses, particularly as the

⁹ <http://stakeholders.ofcom.org.uk/binaries/consultations/5-GHz-Wi-Fi/summary/improving-spectrum-access-consumers-5GHz.pdf>.

¹⁰ Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014-2019 White Paper, available at http://www.cisco.com/c/en/us/solutions/collateral/serviceprovider/visual-networking-index-vni/white_paper_c11-520862.html.

technology is evolving to allow for non-line-of-sight applications. Facebook recently announced its Terragraph project, a low-cost high-throughput (multi-gigabit) multi-node mesh wireless network idea for dense urban topologies that could provide fiber-like reliability for access and backhaul without the cost. Extending unlicensed access to additional adjacent bands such as the 55 GHz and 65 GHz bands, and other bands, would increase such opportunities.

3. Conclusion

As Ofcom plans its Fixed Wireless Spectrum Strategy, Facebook urges Ofcom to adopt flexible spectrum policies that maximize use by promoting sharing across a wide variety of users and platforms and paves the way for new and innovative technologies like HAPS. In addition, Ofcom should enable access to additional spectrum for HAPS, and additional unlicensed spectrum. Unlicensed spectrum drives innovation and investment in a range of technologies that can supplement and support mobile networks and expand broadband access at low cost.