JRC Response to the Call for Input on

Fixed Wireless Spectrum Strategy

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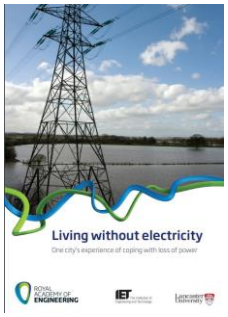
SUMMARY

- The Joint Radio Company Ltd (JRC) thanks Ofcom for the opportunity to respond to this Call for Input, especially the opportunity for end users to represent their views directly to the regulator, rather than requirements being represented (or in some cases mis-represented) by third parties.
- Almost all products and services offered to citizens and consumers rely on the reliable supply of electricity and / or gas (gas may be used for electricity generation).
- Electricity and gas networks are critical infrastructure utilities whose resilient fixed wireless systems require enhanced technical planning especially when considering the appropriate spectrum in which they need to operate.



"In December 2015, life for more than 100,000 people in Lancaster reverted to a pre-electronics era. A flood at an electricity substation resulted in a blackout over the entire city that lasted for more than 24 hours. Suddenly people realised that, without electricity, there is no internet, no mobile phones, no contactless payment, no lifts and no petrol pumps. Although these dependencies were not difficult to see, few had thought through the implications of losing so many aspects of modern life at once."

"The biggest impact on most people was that few knew what was happening. By looking out of the window, it was obvious that there was a widespread power cut but none of the usual sources of information – TV, internet, text messages or social media – was working. Although there was FM radio coverage, many people did not have a suitable battery powered radio and reporters in the area had serious difficulties in communicating with their studios."

"It is perhaps ironic that, in a society with huge commitment to digital infrastructure, the most reliable source of news was a commercial station using technology that would have been familiar to the engineers on the 1960s Radio Caroline pirate radio ship."

"Living without electricity" **Royal Academy of Engineering, May 2016**

- Control and operation of energy networks often have special requirements not generally required by other services, eg:
    - 96 hours power resilience
    - Low latency (down to 6mS end to end)
    - Guaranteed asymmetry (maximum 400uS)
    - Coverage to the remotest of rural areas.
    - Long paths to reach remote locations, sometimes over water.
    - 99.999% availability.
- Smart grids will require an increase in data rates within the 1.4 GHz band in addition to an increase in data rates of 9.6 kbit/s in 12.5 kHz narrow band UHF channels to ~64 kbit/s in 12.5 / 25 kHz UHF channels. (The increase in data rates within both bands is expected to be met by improvements in technology.)
- The energy sector finds the current situation whereby Ofcom manages fixed link spectrum with individual link-by-link licensing generally acceptable. We have not observed alternative mechanisms elsewhere in the world which operate more effectively than in the UK with Ofcom.
- Industrial and commercial installations require long term stability and support, often extending into decades. This market should not be conflated with consumer markets where products are updated annually and support often ceases after a couple of years.
- The spectrum access and planning requirements devised for smart meters should not be confused with the enhanced requirements of smart grids.
- Utilities generally prefer fixed links operating at 14 GHz or below since they are less affected by rain. Utility networks are especially vulnerable to storm damage, and it is unhelpful if the vulnerability of the communications services correlates with the conditions under which the utility networks themselves are under greatest stress.
- For critical services, utilities often use duplicated services for resilience. The radio frequency band used for a fixed link has been identified as a common mode failure scenario, with some utilities requiring redundant routes to use a different frequency band to the primary path, with both paths implemented below 20 GHz .

The Joint Radio Company Ltd (JRC):

JRC Ltd is a wholly owned joint venture between the UK electricity and gas industries specifically created to manage the radio spectrum allocations for these industries used to support operational, safety and emergency communications.

JRC manages blocks of VHF and UHF spectrum for Private Business Radio applications, telemetry & tele-control services and network operations. JRC created and manages a national cellular plan for co-ordinating frequency assignments for a number of large radio networks in the UK.

The VHF and UHF frequency allocations managed by JRC support telecommunications networks to keep the electricity and gas industries in touch with their field engineers. These networks provide comprehensive geographical coverage to support the installation, maintenance and repair of plant in all weather conditions on a 24 hour/365 days per year basis.

JRC's Scanning Telemetry Service is used by radio based Supervisory Control and Data Acquisition (SCADA) networks which control and monitor safety critical gas and electricity industry plant and equipment throughout the country. These networks provide resilient and reliable communications at all times to unmanned sites and plant in remote locations to maintain the integrity of the UK's energy generation, transmission and distribution.

JRC manages the microwave licenses for the majority of UK gas and electricity transmission and distribution businesses. JRC protects these microwave links and the above UHF telemetry links from potential interference from wind turbines, and advises wind farm developers on mitigation methods to avoid interference with all forms of radio communication services.

JRC also undertakes radio consultancy work associated with critical national infrastructure radio services, and participates in European and international regulatory consultation groups.

JRC works with the Energy Networks Association's Future Energy Networks Groups assessing ICT implications of Smart Networks, Smart Grids & Smart Meters.

Internationally, JRC supports or participates with global utility telecoms organisations under the umbrella of the Global Utility Telecom Council:

- US Utility Telecom Council (UTC)
- European Utility Telecom Council (EUTC)
- Latin American Utility Telecom Council (UTCAL)
- Canadian Utility Telecom Council (UTCC)
- African Utility Telecom Council (AUTC)

Consultation questions – JRC response

Question 1:
a) Please indicate which user type given in Table 1 best describes your use of fixed wireless links?

Answer 1a) Critical Infrastructure utilities (electricity and gas)

b) If you are a telecom network operator or an organisation providing wireless solutions for different user types, please indicate where possible, a breakdown of the percentage of fixed wireless links used to support the different user types i.e. mobile network operator, emergency services etc.

Answer 1b) not applicable to the critical infrastructure energy utilities.

Question 2:

a) Please indicate the applications provided by your use of fixed wireless links and the benefits these provide to citizens and consumers.

Answer 2a) typically the supervision and control of the electricity and gas grids. The benefits of which include: almost all products and services offered to citizens and consumers rely on the reliable supply of electricity and / or gas (gas may be used for electricity generation).

b) For each application, please indicate the frequency band used and the rationale for choosing that band, i.e. the application specific characteristics that affect your specific choice of frequency band.

Answer 2b) typically, the electricity grid is controlled using 12.5 kHz narrow band channels within the 400 MHz band and wideband channels within the 1400 MHz band. Microwave bands are typically used for backhaul, e.g. 7.5 / 13 GHz. The microwave band used will typically depend on the path length, and ideally will be below 20 GHz for critical links as performance is increasingly adversely affected by rain above that frequency.

c) For each link, please provide details of the application supported.

Answer 2c) now: critical infrastructure utilities electricity grid.
Future: critical infrastructure utilities smart grid.

Question 3:
a) How do you envisage the current and future applications provided by your use of fixed wireless links to change in the next 5-10 years?

Answer 3a) JRC expects a significant increase in the number of 400 MHz channels that will be required, e.g. 2 x 3 MHz. Likewise, a significant increase in 1400 MHz spectrum will be required, e.g. 10 MHz in 1400 MHz region.

b) What market trends and drivers will affect the use of fixed wireless links to deliver the relevant applications in the future?

Answer 3b) the increase in spectrum will primarily be required for resilient systems to control the smart grid, including such features as embedded generation, renewable energy, storage facilities and demand management.

c) What bands will be relevant to support the future changes?

Answer 3c) ultimately, all costs needed to upgrade the current grid to a smart grid will be passed on to the citizen / consumer. These costs may be minimized by re-using the current infrastructure. It will therefore be ideal if the same general 400 MHz and 1400 MHz bands could be used for this migration. (NB: whilst different technologies to those currently used may be suitable for smart grids, it will be necessary to keep tight control over their operation. It is therefore unlikely that an adapted generic system will be suitable for smart grids.)

d) Could your use of fixed wireless links be provided by alternative solutions? If so please give details of alternatives.

Answer 3d) the electricity grid covers even the remotest parts of the UK. The system to control it has to therefore cover those areas. The costs of these utility monitoring and control networks is ultimately passed on to the citizen / consumer through their energy bills. Thus although fibre and copper telecoms networks are used where available, radio is a very cost effective, quick to deploy solution and can be repaired more rapidly to restore energy supplies when damaged by severe weather or third parties.

Question 4:
a) How will Fixed Service equipment continue to evolve to meet the increasing capacity requirements?

Answer 4a) the current 9.6 kbit/s in 12.5 kHz narrow band systems are expected to increase to 64 bit/s in 12.5 / 25 kHz narrow band channels (compliant with ETSI EN 300 113). And the number of those links are expected to increase significantly. Likewise, the number of 1400 MHz links are expected to increase significantly and that equipment will transmit higher data rates within the existing bandwidths. Higher data rate systems will be deployed at higher frequencies, preferably below 20 GHz for any critical applications.

b) What is the timescale for implementation in equipment?

Answer 4b) the critical infrastructure power utilities are keen to be given access to the required 400 MHz and 1400 MHz spectrum so that the smart grids may be rolled out, especially to facilitate connection of more renewable generation to help the UK achieve its 2020 carbon reduction targets.

Question 5:

a) What capacity enhancing techniques are you deploying or intend to deploy?

Answer 5a) ***the current 9.6 kbit/s in 12.5 kHz narrow band systems are expected to increase to 64 bit/s in 12.5 / 25 kHz narrow band channels (compliant with ETSI EN 300 113). Likewise, the existing 1400 MHz systems will be upgraded to transmit higher capacities within the same channel widths. Adaptive modulation is also being deployed where possible.***

b) How does this affect your future demand for spectrum?

Answer 5b) the increase in data rates will require an increase in EIRPs. This will result in greater re-use distances. In turn, this will require additional spectrum. Additionally, more spectrum will be required to enable the increasing number of links to be rolled out.

c) Do you see any barriers in the current authorisation approaches preventing use of such technology? If so, please indicate the changes you consider would be required to facilitate this?

Answer 5c) whilst there appears to be few barriers to using updated versions of tried and tested technologies, new technological advances require guaranteed access to suitable and affordable spectrum on a timely basis. This is challenging for regulated industries which have to justify expenditure to other independent regulators operating on different time cycles to Ofcom.

Question 6:
a) How do you expect future mobile backhaul network architecture to evolve as part of the 5G ecosystem?

Answer 6a) not applicable to electricity and gas utilities.

b) How would this impact on future demand for fixed wireless links as a backhaul solution in the next 5-10 years and beyond? Please explain in terms of specific frequency bands i.e. which bands will be important for macro and small cell backhaul and why.

Answer 6b) not applicable to electricity and gas utilities.

c) What is the most appropriate authorisation regime to facilitate this?

Answer 6) not applicable to electricity and gas utilities.

Question 7:
For each Fixed Service band[42] currently identified for study for 5G under WRC-15 Agenda Item 1.13 and 3.6–3.8 GHz band, please explain the impact on your backhaul use should the bands be identified and be repurposed for 5G given that the viability of in-band sharing between mobile access and backhaul is currently being studied.

Answer 7) the critical infrastructure utilities typically use the 400 / 1400 MHz and 7.5 / 13 GHz bands. Assuming that adequate access to these bands is available in the future then the impact should be minimal.

Question 8
a) What is the current use in the block assigned bands at 10 GHz, 28 GHz, 32 GHz and 42 GHz bands and how do you expect usage in these bands to evolve given that the 32 GHz and 42 GHz bands are also being considered for study for 5G globally?

Answer 8a) the critical infrastructure utilities have not been block assigned spectrum within these bands.

b) For each band, please provide details including geographic location of each fixed wireless link deployed and the application it supports. Where these bands are used for fixed wireless links, please give details in terms of the capacity supported and total numbers of links deployed.

Answer 8b) not applicable to the critical infrastructure electricity and gas utilities.

Question 9:
What impact does the change in the provision of national emergency service network have on both the future demand and supply of spectrum to support the backhaul requirement for the emergency service network? Please explain in terms of frequency bands, particularly but not limited to the 1.4 GHz, 26 GHz, 38 GHz bands?

Answer 9) not applicable to electricity and gas utilities.

Question 10:
a) How do you expect future public safety use of fixed wireless links to change in the next 5-10 years?

Answer 10a) not applicable to electricity and gas utilities.

b) Please indicate the market and technology drivers affecting your future use of fixed wireless links, and whether your use could be provided by alternative solutions. If relevant, please explain in terms of frequency bands, particularly but not limited to 1.4 GHz, 26 GHz and 38 GHz?

Answer 10b) the electrification of transport and heat will increase demand for electricity in the foreseeable future. This cannot be accommodated simply by increasing the scale of the electricity network, so will have to be accommodated by deployment of more sophisticated control and operation of current networks. This will require more complex and resilient operational telecoms infrastructure.

Security concerns are tending to favour physical separation of these critical communications from publically accessible networks as the most effective means of combatting security vulnerabilities. Making independent networks highly resilient is achieved most cost effectively by use of the minimum amount of infrastructure, favouring lower frequency bands which achieve path lengths in the region of 40 km at 99.999% availability with failure modes which do not correlate with severe weather incidents.

Question 11:

Please indicate whether you consider that the guard band and centre gap of the 6 GHz band would be a suitable substitute for current and future 1.4 GHz applications, particularly in terms of costs to provide for like for like links and if not, the costs of alternative solutions. Please provide detailed evidence to support your answer.

Answer 11 i) whilst the use of 6 GHz may be suitable in some circumstances, the use of 1.4 GHz is preferred typically because of the low environmental impact, e.g. a shrouded yagi is considered less intrusive than a dish.

Answer 11 ii) also, the mast to support a shrouded yagi (beam width: +/-14 degrees) can be a simple pole on the side of a building whereas a significantly more rigid structure, e.g. a lattice tower, is likely to be need for a 0.6m dish (beam width: +/- 3 degrees). (NB: some 1.4 GHz systems use equally unobtrusive 0.5m flat panels with a beam width of +/- 11.5 degrees. These can also be mounted on simple poles, often wooden poles which are viewed more favourably by citizen/consumers as being less visually intrusive and more compatible with a rural environment.)

Question 12:

a) How do you expect the utility sector's future use of fixed wireless links to change in the next 5-10 years?

Answer 12a) within the critical infrastructure utility sector, e.g. electricity and gas, the current 9.6 kbit/s in 12.5 kHz narrow band channel 400 MHz systems are expected to increase to 64 bit/s in 12.5 / 25 kHz narrow band channels (compliant with ETSI EN 300 113). Likewise, the existing 1400 MHz systems will be upgraded to transmit higher capacities within the same channel widths. With the increasing use of IP protocol which is more data intensive than legacy protocols, microwave links will be used where appropriate, e.g. for high data rate backhaul.

b) Please indicate the market and technology drivers affecting your future use of fixed wireless links, and whether your use could be provided by alternative solutions. For example, which part of the smart grid network will require fixed wireless links? If relevant, please explain in terms of frequency bands, particularly but not limited to the 1.4 GHz, 26 GHz and 38 GHz bands.

Answer 12b i) the choice of technologies used by the energy sector for the control of their grids is driven by their operational requirements, not a desire to deploy any particular technology. Longevity of technology is perhaps one of the key differentiators of the technology choice for utilities from more consumer-focused industries. With the reduction in manpower since privatisation there is no longer adequate skilled manpower in the industry with the relevant authorisation for any large-scale technology transition in limited timescales.

Answer 12b ii) one technology issue is the risk of broadband systems being assigned in spectrum adjacent to narrow band systems, e.g. thereby raising the noise floor and perhaps causing intermodulation within the receiver(s).

Answer 12b iii) although technological innovation may lead to more use of microgrids and embedded storage with the potential to reduce dependency on highly available grid scale electricity, this is conjecture at present. Thus the pressure is on electric utilities to reduce domestic power outages below an average of about 45 minutes per year at present; and to improve power quality in terms of factors such as harmonic distortion and flicker which have become more of an issue as power electronics become more common at distribution level voltages. These developments place more dependence on resilient operational telecoms. [One gas company reports that average outages in their network equate to loss of supply for domestic consumers once every 40 years.]

Answer 12b iv) the existing electricity / gas grid network radio systems require the ubiquitous coverage of the UK, including to the remotest rural areas, to enable the monitoring and control of the infrastructure by the network management systems. The smart grid network will require the same coverage and need a much greater density of links.

Answer 12b v) currently, access to remote infrastructure is typically by 12.5 kHz narrow band 400 MHz systems and wideband 1.4 GHz systems. Higher data rate links, e.g. backhaul, typically use 7.5 GHz and 13 GHz microwave links. Smart grids are expected to need more UHF and microwave spectrum. When considering spectrum above 13 GHz, utility experience is that such links are adversely affected by severe weather. Utility experience is that fixed links above 20 GHz do not deliver the design availability when operating at 99.99%or 99.999%

Question 13:

a) How do you expect the future requirements for fixed wireless links that support HFT applications to change over the next 5-10 years?

b) Please indicate the market and technology drivers affecting your future use of fixed wireless links. If relevant, please explain in terms of frequency bands, particularly the 70/80 GHz band.

Answer 13) not applicable to critical infrastructure utilities (electricity and gas).

Question 14:
a) What is the future demand for HAPS in the UK both in terms of being a network provider and service provider? Please provide details including specific applications and envisaged deployment scenarios for HAPS.

Answer 14a) not applicable to critical infrastructure utilities (electricity and gas).

b) How could sharing with existing fixed wireless links be facilitated? What would this mean in terms of the most appropriate authorisation regime to facilitate deployment of HAPS?

Answer 14b) not applicable to critical infrastructure utilities (electricity and gas).

Question 15:
a) How could the 8 GHz band and narrowband channels within the guard bands and centre gaps of the existing channel plans for the 6 GHz band meet future demand for fixed wireless links if additional spectrum could be made available?

Answer 15a) access to spectrum for general use by all will be appreciated.

b) What types of applications do you consider would be of interest for these bands?

Answer 15b) channel widths similar to those in the 1.4 GHz band.

c) What is the status of fixed wireless links equipment availability in these bands?

Answer 15c) unknown.

Question 16:
a) What is the demand for a combined Lower and Upper 6 GHz channel plan that could provide wider channels at 112 MHz bandwidth?

Answer 16a) not applicable to critical infrastructure utilities (electricity and gas).

b) What are the practical implications for existing equipment that operates under the existing band plans who wish to migrate to the new band plan?

Answer 16b) not applicable to critical infrastructure utilities (electricity and gas).

c) What is the status of Fixed Service equipment availability for the wider 112 MHz channels in the combined Lower 6 GHz and Upper 6 GHz band?

Answer 16c) unknown.

Question 17:

a) What are the applications envisaged in the W and D bands?

Answer 17a) no comment.

b) What is the timescale of equipment availability for these bands?

Answer 17b) unknown.

c) What would you consider to be the appropriate authorisation regime to facilitate access to spectrum in the W and D bands?

Answer 17c) no comment.

Question 18:

a) Do you have a view on potential frequency bands between 275–450 GHz that could be suited for Fixed Service and for what applications?

Answer 18a) Such high frequencies are unlikely to be of interest to the utility sector because of their short range.

b) What are the anticipated timescales for the development of equipment and applications for these bands?

Answer 18b) no comment.

Question 19:

a) What is the future demand for bands listed in Table 4 for Fixed Service applications?

Answer 19a) no comment.

b) What is the status of fixed wireless links equipment availability in these bands?

Answer 19b) no comment.

Question 20:

Are there other aspects of the review on which you have evidence that would help inform our consideration of future developments in the Fixed Service sector? If so, please provide as much evidence possible.

Answer 20) Radio fixed links provide a valuable complementary service to wired fixed services.