## BASIC DETAILS

Consultation title:

**Ofcom's "Consultation on the way forward for the future use of the band 872 - 876 MHz paired with 917 - 921 MHz": Consultation Response by Silver Spring Networks**

To (Ofcom contact): Mark Austin

Name of respondent: James Pace

Representing (self or organisation/s): Silver Spring Networks

## CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

| | | | |
|---|---|---|---|
| Nothing | X | Name/contact details/job title | |
| Whole response | | Organisation | |
| Part of the response | | If there is no separate annex, which parts? | |

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. X

Name James W Pace Signed (if hard copy)

# Ofcom's "Consultation on the way forward for the futureuse of the band 872 - 876 MHz paired with 917 - 921 MHz"

## *Consultation Response by Silver Spring Networks*

### Executive Summary

Silver Spring Networks is grateful to Ofcom for the opportunity to respond to this consultation. Silver Spring Networks believes that Ofcom should make the 872 - 876 MHz and 917 - 921 MHz bands available on a lightly licensed basis for Smart Grid communications, benefiting UK energy consumers, retailers and distributors, the UK economy, and the planet as a whole. Our response can be summarised as follows:

1. The UK needs an intelligent electricity grid, to combat climate change, address supply-demand imbalances, and increase energy independence. This "Smart Grid" will use widely-distributed intelligent devices and software to monitor and control electricity flows. The Smart Grid, leveraging modern communications technologies and based on open standards, will empower consumers, facilitate the integration of renewable energy sources and electric vehicles, and enable an exciting new world of intelligent energy management over the next ten years.

2. The Smart Grid will depend on a highly capable communications platform. This Smart Grid communications platformmust meet a demanding set of requirements, principally Coverage, Capacity, Responsiveness, Reliability, Longevity, Security and Affordability.

3. While each may well play an important role, none of the communications technologies currently available in the UK (such as power line carrier, GPRS or 3G cellular, or fixed consumer broadband)can fully meet these requirements. The combined requirement of ubiquitous reliable coverage at very low operating cost are particularly challenging for current technologies. This lack of viable communications options is holding back deployment of Smart Grid in the UK, while other countries move ahead aggressively.

4. In countries where suitable spectrum is available, utilities have overwhelmingly chosen sub-GHz wireless mesh for Smart Grid communications over the above alternatives. For example, utilities representing over 40 million homes in the US and Australia are now implementing wireless mesh-based communications

platforms for Smart Grid, almost all in the 902-928 MHz ISM band. These networks have been expressly designed to meet the Smart Grid communications requirements described above. UK utilities have shown strong interest in having wireless mesh as an option for UK Smart Grid.

5. Wireless mesh applicable to Smart Grid is being standardized at IEEE, ETSI and IETF, which will create a worldwide ecosystem, expanding choice and driving down cost. UK consumers, retailers and distributors would benefit if they had access to this ecosystem.

6. Current frequency allocations and rules do not permit a practical, cost effective use of ubiquitous wireless mesh as an option for Smart Grid in the UK.

7. The 872-876 MHz and 917-921 MHz frequency bands, at reasonable power levels and channel widths, are ideally suited for Smart Grid, in terms of range andpenetration. The proximity of these bands to the ISM band used in the Americas and Australia offers the potential for the UK to benefit from substantial economies of scale, since it should be possible to use the same radios across all markets.

8. By immediately allocating these bands on a lightly regulated basis for “smart utility networking”, Ofcom can enable the rapid deployment ofcost-effective, standards-based communications technology that willplace the UK among the worldwide leaders in deployment of Smart Grid, with substantial benefits to UK consumers, the energy sector and the environment.Making such an allocation will unlock substantial competition and innovation in Smart Grid communications, both between rival suppliers and operators of wireless mesh technology as well as with suppliers of other communications technologies. The result for UK consumers and energy providers can only be increased choice, greater innovation and lower prices.

## Full response

### 1. The UK Needs a Smart Grid

Among the many developments since Ofcom's first 872/917 consultation in 2006, the dramatic increase in the importance of energy policy is one of the most significant. First, awareness of the deleterious impact of globalclimate change is now mainstream. Along with other major developed nations, the UK has committed to substantial reductions in carbon emissions over the next several decades. Secondly, a potential electricity supply-demand imbalance in 2015 could produce serious shortages and drive prices to unaffordable levels. Finally, dependence on imported fossil fuels is now widely seen as a potentially dangerous exposurefor the UK in an unstable world.

In response to these challenges, the UK, EU and other governments havecommitted to execute several major initiatives over the coming decade. These include deployment of smart meters and consumer devices to increase energy efficiency, extensive deployment of renewable energy sources such as wind and solar, and the mass introduction of electric vehicles. An intelligent electricity grid (the "Smart Grid"), using widely-distributed intelligent devices and software to monitor and control electricity flows, will be essential to the successful execution of these initiatives. This Smart Grid, leveraging modern networking technologies and based on open standards, will enable an exciting new world of intelligent energy management over the next ten years.

Smart meters will give consumers more visibility into their energy consumption and enable utilities to manage demand more effectively, for example through time-of-use pricing. Inside the home, web portals, smart thermostats, displays, and energy-aware appliances and software will automatically optimize use of electricity and gas to minimize carbon emissions. Refrigerators, clothes dryers and water heaters will temporarily reduce their consumption during peak hours, with changes that are imperceptible on an individual basis but thatcollectively add up to gigawatts of saved energy.Consumers will make energy choices via computer, interactive TV or mobile phone – or increasingly let the Smart Grid do it for them. Millions of distributed renewable energy sources such as wind generators, solar panels and heat pumps will substitute for traditional centralised carbon-generating power stations. Tens of millions of electric vehicles will charge at night using plentiful clean power, and feedback to the grid to handle peak load during the day. Intelligent distribution grid equipment, such as transformers and capacitor banks, will eliminate the substantial power losses now incurred in energy distribution and enable energy providers to deliver energy more efficiently and reliably than ever before. All of these elements, and many more resulting from the billions of pounds being invested in new energy technologies, will together form the Smart Grid – an "Energy Internet" that will dramatically increase efficiency and enable widespread use of renewables, with an equally dramatic impact on carbon emissions.

Of course, this new world will evolve gradually rather than happening in one fell swoop. However, the fundamental building blocks are falling into place, and the trends are inexorable. Smart meters are now widely available and being deployed in the millions in many countries. Web-based consumer energy portals fed by data from smart meters are being offered by providers from Google to Greenbox. Whirlpool and GE have recently announced plans for mass deployment of IP-addressable smart appliances such as refrigerators and clothes dryers, to be monitored and controlled by the Smart Grid. Virtually every major car manufacturer has announced extensive plans for electric vehicles.

Governments around the world have recognized the vital importance of a smart electricity grid, and are establishing policies to encourage its implementation. In the United States, Smart Grid has been official government policy since 2007, and the Obama administration recently awarded approximately $4 billion of stimulus funding for smart grid projects. In Australia, the government has aggressively pushed smart metering and is now soliciting proposals for Smart Grid city projects. China is actively pursuing implementation of a Smart Grid, initially at the transmission network level. The EU has mandated carbon reduction targets coupled with the deployment of smart meters to 80% of homes by 2020, while the UK government has mandated deployment of smart meters to all homes in that timeframe. Both are now actively studying how best to expand this initial step to a full Smart Grid implementation. The Conservative party has articulated similar objectives in its paper on a carbon neutral Britain.

## 2. The Smart Grid Poses a Demanding Set of Communications Requirements

The Smart Grid will depend on a highly capable communications platform. This Smart Grid communications platformmust meet a demanding set of requirements, principally Coverage, Capacity, Responsiveness, Reliability, Longevity, Security and Affordability.

<u>Ubiquitous coverage</u>: The Smart Grid communications platform should reach every device that generates, distributes or consumes energy.

<u>Adequate, expandable capacity</u>: While the requirement is primarily for monitoring and signalling rather than carriage of large volumes of data, the Smart Grid communications platform should still provide substantially more bandwidth than required for traditional metering networks. An ever-increasing number of energy devices and applications will be connected over the coming 15-20 years, placing increasing bandwidth demands on the network. 50-100 kilobits/second initially, with easy scalability up to 1 megabit/second, is a reasonable design goal.

<u>High responsiveness:</u> To enable active management of the grid, the Smart Grid communications platform should provide round-trip network times in the seconds, and sub-second response times for mission-critical distribution automation applications.

<u>Reliability</u>: The Smart Grid communications platform should provide extremely high availability and reliability, in excess of 99.99%.

Longevity:The Smart Grid communications platform will be expected to serve for at least fifteen years without replacement of the end-points.

Security: Security is obviously a critical consideration. While high levels of security can be implemented on most communications networks, networks that are open to consumers (e.g., home broadband connections) are seen by many utilities as vulnerable and therefore unsuitable for Smart Grid.

Affordability: Since the primary use of the Smart Grid will be more efficient use of energy rather than generation of new revenues, affordability will be key to success. In the case of new communications networks for Smart Grid, the ability to achieve the above requirements at low capital investment cost will be critical. Low operating cost will also be essential in the case of both existing and new networks. Operating models that offer "all-you-can-eat" at a low fixed price, rather than a data- or time-based variable charge, will encourage the maximum introduction and use of exciting energy management applications. For example, communications meeting the above requirements, at an operating cost of no more than a few pennies per month per device, are now enabling rapid deployment of smart metering and additional Smart Grid services in the US and Australia.

It will be vitally important for the UK energy sector to have access to allmajor communications options to maximise the chances of being able to meet all of these critical requirements.

### 2A. Smart Grid Use Cases Illustrate Requirements

The following discussionof use cases may help to illustrate the basis for these requirements:

The rollout of smart meters to all UK households by 2020 is established Government policy. But what is a "smart meter"? And what requirements are imposed on the underlying network in order to make the smart meter useful and cost effective?

The primary business driver for early iterations of "smart meters" was automated meter reading (AMR). In many jurisdictions, utility personnel read meters as infrequently as once per year. By using AMR to read the meter remotely once a month, bills would be more accurate and theft could be detected. There were other operational efficiencies to be gleaned, but the primary driver was revenue assurance. The requirements for once-a-month meter reads resulted in unsophisticated networks in terms of reliability, responsiveness (latency), and throughput. In fact, in the US, many of these networks were "one-way", "drive-by" networks, where an RF receiver in a truck would drive slowly through a neighborhood, sweeping up asynchronous RF-based meter reads.

Functionality on electric meters continued to evolve, though, to include functions like granular recording of time-stamped electrical usage data, instrumentation to measure and record Volt/VAR information, remote disconnect capability including load limiting, and a home area network interface to communicate with networked, in-home devices such as thermostats, water heaters, and smart appliances. The ability to read downstream gas meters, too, became a requirement. With this functionality, utilities can offer new services and new pricing structures.

And consumers can benefit. It has been shown that consumers reduce energy usage by simply being aware of their usage. Consumers today are oblivious to their usage of electricity because their utility bills lack granularity and the feedback loop is, to put it mildly, slow. Imagine having a three-course meal in a restaurant. Now imagine getting a bill months after the fact that simply enumerated “calories consumed" and "£". Or, worse, imagine getting an estimated bill. This sounds absurd, but this is the predicament of the electricity consumer today.Smart meters allow for direct, immediate consumer engagement by providing detailed billing usage information and an interface for in-home display of real-time usage information.

The additional functionality on electric meters also allows the introduction of time differentiated pricing and demand responsive appliances. While primarily *shifting*consumption, this can also serve to *reduce*overall consumption. Many studies have shown that critical peak pricing to programmable communicating thermostats (PCTs) will reduce load. Critical Peak Price signals to PCTs adjust the temperature imperceptibly during peak load periods. The consumer does not try to make up for lost heating or cooling post facto: he just saves money, and the grid saves peak energy, with an almost imperceptible change in comfort. This same mechanism, of course, is applicable for peak load reduction with heating during UK winters.

Given the additional functionality in the smart meter, new requirements are imposed on the networks that support the smart meter. Communicating to appliances beyond the meter in the home, remote disconnect (and reconnect), and on-demand meter reads require reliable, responsive, and cost effective networks. This expansive set of requirements calls for a communications network with uniquely addressable (e.g., IPv6) devices, available on-demand and not constrained to once-a-week or even once-a-day, off-peak outbound reporting.

Smart metering can be considered the foundational application of the smart grid. As smart grid applications are deployed, the requirements on the underlying network become more rigorous. While UK transmission and distribution networks are very reliable, the introduction of renewable (and distributed) generation in place of fossil fuels will reduce carbon emissions, but this will also have consequences on the distribution network. The introduction of electric vehicles (EVs) will also reduce carbon by moving from petroleum-based fuels to a cleaner electric infrastructure. This shift, though, will also have consequences on the utility distribution network. When all of the neighborhood vehicles are garaged at 6PM, charging regimes will need to be coordinated to prevent transformer failure (and the resulting outage). And EVs, too, will be a source of storage and load dispatch as battery technologies mature over the next 6 – 10 years. Ultimately, distribution network operators still have a remit for grid reliability.

The requirements for networking the smart grid compound the requirements for networking smart meters. Coordinated charging regimes and distributed resources require intelligence at the edge and low-latency, peer-to-peer communications. These applications do not require high throughput: in fact, the communicationsduty cycle is infrequent. The devicesmay only transmit for a few seconds per day -- but when they do, reliability and responsiveness are paramount.

It is important to note that the requirement for security pervades all of the requirements mentioned above. Privacy is one important aspect of security: consumer data must be protected and payload encryption (application layer) is mandatory. The requirements should not stop there, however: ensuring integrity at the link-layer across each and every adjacency is also critically important. Implementations of wireless mesh are field proven and do this today.

**3. Currently available communications alternatives will not fully meet Smart Grid needs**

Multiple networking technologies will be required to support the Smart Grid. Smart Grid architectures have distinct networks for backhaul (WAN), meters and other distribution grid devices (NAN, or neighborhood area network), and the home (HAN, or home area network). While they may well play an important role, none of the currently available technologies such as powerline carrier (PLC), cellular (e.g., GPRS, 3G), or fixed consumer broadband can fully meet the requirements described above. The combinedrequirements of ubiquitous reliable coverage and very low operating cost make the NAN particularly challenging for current technologies.

Powerline carrier (PLC) is an acceptable technology for basic meter reading, but very low throughput and slow, unpredictable response times lead many to question its suitability for the broader set of smart grid requirements.Its broadband cousin, BPL, offers higher throughput and better responsiveness, but at a very high capital cost and with very variable performance in the field.

Tower-based, star-topology (non-meshing) systems have also been proposed. These, too, might be well suited for basic meter reading. However,potentiallylow upstream throughput and long round-trip times may make it difficult to meet the latency requirements for full Smart Grid -- for example,hundreds or thousands of electric vehicles simultaneously presenting security credentials upstream prior to charging. The lack of operating history for these new networks also creates additional risk that many utilities find unappealing.

Existing networks offer the ability to leverage past investment in a shared infrastructure. However, these too may have difficulty in fully meeting the requirements:

Consumer broadband connectivity (e.g., cable modem, DSL), or fibre to the curb or home, has been experimented with by some small utilities in other countries. However, most utilities are very reluctant to share a mission-critical grid management connection with a consumer who has PCs, routers and other devices connected over the same link. The main concerns are security, performance degradation from other uses such as movie downloading, and fear of disconnection if the consumer's service is discontinued for any reason. Lack of ubiquity is the biggest challenge of all.

Given the perceived shortcomings of the other currently available solutions, GPRS or 3G are often mentioned as the "default" choice for smart metering. Given the wide deployment and market power of the UK's mobile operators, cellular undoubtedly has a role to play in Smart Grid. Indeed, the coverage to *mobile* handsets is to be applauded. However, once again, this option will only partially meet requirements at scale, for a number of reasons. By most estimates, GPRS coverage of indoor electric meters is only 80 - 85% owing to the fact that *you cannot move your electric meter* or other grid devices. The cost of building out the cellular network to provide 100% coverage is likely to be cost-prohibitive, especially given the other requirements to be met: very low capital and operating cost; flat rate "all-you-can eat" pricing independent of time of day and data volume; 15 year service longevity (and no SIM card change-outs) in an industry where planned obsolescence is acceptable and, in fact, occurs every few years. Network capacity to handle millions of additional smart grid devices at neighborhood level is also a potential concern. For instance, the ability for star-topology, base stations to field tens of thousands of asynchronous "last gasps" during large-scale outages renders is questionable.

Even if one makes the generous assumption that ubiquitous coverage can be achieved, operating cost is still likely to be a major deterrent to full Smart Grid use of cellular networks, Baringa Partners(working withDECC)estimated a charge of £4.80 per year per household for once-a-day *off-peak* meter reads. This hardly meets the requirement for smart grid communications. On-peak charges, for example, for EV charging coordination would presumably be substantially more. By comparison, US utilities using wireless mesh in the 900 MHZ band communicate with the meter, and devices beyond the meter, multiple times per day for US$0.24 or less per year.

In summary, none of the communications alternatives currently available in the UK will fully meet the Smart Grid requirements described above.Conversations with utilities suggest that the lack of viable communications options is holding back deployment of Smart Grid in the UK, while other countries move ahead aggressively.

## 4. In countries where suitable spectrum is available, utilities have overwhelmingly chosen sub-GHz Wireless Mesh for Smart Grid communications

After testing many different communications options over several years, utilities in the US and Australia have overwhelmingly selected a technology known as wireless mesh (or Radio Frequency (RF) mesh) for the NAN portion of large smart metering/smart grid deployments. The long-reach, pervasive sensor networking fabric that wireless mesh enables is ideally suited to supporting a broad set of applications at the edge. In essence, energy devices are equipped with a radio module that enables them to communicate with each other in a “peer-to-peer” network that provides highly reliable paths back to a central access point in the neighborhood. Existing backbone networks operated by telecoms providers are then used to transport traffic between these neighborhood mesh networks and the electricity or gas utility. The result is an extremely cost-effective, ubiquitous and secure end-to-end network from the utility to the consumer, expressly designed to meet the Smart Grid communications requirements described above. In fact, the capital cost of Smart Grid infrastructure is typically less than US $5 per home covered by the network.

Utilities selecting this communications technology for their Smart Grid needs include Southern California Edison, HydroOne, Centerpoint, Pacific Gas & Electric, Florida Power & Light, Detroit Edison, Pepco Holdings, American Electric Power, Jemena, UED, Powercor, Oklahoma Gas & Electric, APS Energy, Toronto Hydro, and many more. In total, these US, Canadian, and Australian utilities represent over 40 million households, and the number continues to grow at a rapid pace. Wireless mesh based smart meters are now rolling out at the rate of approximately 50,000 a week in the US at one utility alone, and this trend is accelerating.It is important to note that these utilities have all of the other communications alternatives listed above available to them also, but have selected wireless mesh. This indicates the critical importance of this technology as an option for Smart Grid.

There are multiple competitors offering wireless mesh networking solutions for utilities, including large players in many metering markets such as Landis+Gyr, Itron/Actaris and Elster, as well as newer technology companies such as Silver Spring Networks, Trilliant, Smart Dutch,Nuri Telecom, and Eka Systems. Global companies with large European operations such as Texas Instruments, Freescale, NXP, Atmel, and Analog Devices provide a wide range of components for these solutions. Many of these companies are now participating in IEEE Task Group 802.15.4g (see below), which will produce an international standard for Smart Grid applications using wireless mesh. The resulting commoditization of core components will further drive down costs and drive further competition, to the benefit of energy providers and consumers.

In the US, Australia and some other countries, wireless mesh systems generally use the 902-928 megahertz radio frequency band (the ISM band) at power levels of up to 1 watt, which the communications authorities have made available on an unlicensed, cost-free basis. Range and penetration are good in this frequency band, enabling high performance without massive infrastructure investment.

## 5. Wireless Mesh applicable to Smart Grid is being standardized at IEEE, ETSI, and IETF, which will create a worldwide ecosystem, expanding choice and driving down cost.

The IEEE established the 802.15.4g Task Group for Smart Utility Networks in January 2009. The charter of IEEE 802.15 Smart Utility Networks (SUN) Task Group 4g is “to create a PHY amendment to 802.15.4 to provide a global standard that facilitates very large scale process control applications such as the utility smart-grid network capable of supporting large, geographically diverse networks with minimal infrastructure, with potentially millions of fixed endpoints.” Given the societal importance of Smart Grids, this effort has been fast tracked. This work is to be completed by the end of 2010, which will allow silicon vendors to produce commoditized platforms.

In September 2009, a new work item was created in ETSI ERM TG28 for a similar European Smart Utility Networks standard. The goal is to transpose the IEEE 802.15.4g work (as applicable) onto a European standard. This, too, will create commoditized silicon for deployment across Europe. ETSI ERM TG28 is currently targeting 870 – 876 MHz as an operating band – dovetailing with the lower band subject to this consulation.

More recently, in the IETF, IPv6 standards for unique addressability, payload efficiency, routing, security, and services for plug-and-play applications are in the process of being driven by the needs of the energy sector. The working groups include 6LoWPAN (IPv6 Over Low Power Lossy Networks), ROLL (Routing Over Low Power Lossy Networks), and 6LoWAPP. In fact, energy and utility applications will be the “anchor tenant” driving the acceptance of the Internet of Things.

The European Commission is investing significant sums of money in developing technologies, applications and services that will form the “Internet of Things” (IoT). Much of that work is occurring in the ETSI M2M working groups. As the “Internet of Energy”, Smart Grid will be one of the first examples of the “Internet of Things”.

**6. Despite strong interest from UK utilities, current frequency allocations and rules do not permita practical, cost effective use of ubiquitous Wireless Mesh as an option for Smart Grid in the UK.**

Smart Gridcommunications networks will need to reach devices such as domestic gas, water and electricity meters that are commonly installed inside homes, and in some circumstances in basements. The need for such devices to communicate with each other between buildings, and potentially between basements, limits the set of frequencies and power levels that are usable. Propagation at frequencies much above 1 GHz does not permit such connections to be established, even at reasonably high power levels. The licence exempt bands below 1 GHz typically have a power restriction of 25 milliWatts or less which also restricts inter-property communication.

As detailed in the IEEE 802.15.4g work product, sub-GHz spectrum with reasonable transmit power levels is ideal for ubiquitous, utility-scale networks. Currently available unlicensed 2.4 GHz RF spectrum has been tried, but, in practice, it has proven impractical to implement wireless mesh using this frequency band across utilities’ large service territories. The charter of the 802.15.4g task group (and its approval by IEEE governance) tacitly acknowledges this, as 2.4 GHz 802.15.4 (DSSS) is considered suitable for short-range applications in the home area networking space.

Narrow-band (e.g., 200 KHz), frequency hopping, FSK-based technologies with adequate transmit power levels have proven to cover the utility service territory footprint both capably and very cost effectively. The narrow channels provide enough bandwidth (initially 50 – 100 kilobits/second) for sensor network data requirements; frequency hopping provides for the robustness and resiliency needed for utility applications; FSK-based technologies are simple and cost effective; and the transmit power levels enable longer-reach point-to-point connectivity and, with meshing, a network with a large diameter (resulting in lower infrastructure costs). Additionally, all current proposals in IEEE 802.15.4g allow for incremental scalability to up to 1 megabit per second.

## 7. 872-876 MHz and 917-921 MHz are ideal for Wireless Mesh for Smart Grid

The 872-876 MHz and 917-921 MHz frequency bands, at reasonable transmit power levels and channel widths, are ideally suited for smart metering and smartgrids, in terms of range andpenetration.The proximity of these bands to the ISM band used in the Americas and Australia offers the potential for the UK to benefit from substantial economies of scale, since it should be possible to use the same radios across all markets. While higher power levels are recommended for Smart Grid networks, UK consumers would benefit from commoditized silicon even if some regulatoryjurisdictions treated these radios as SRDs (short range devices).

## 8. Ofcom should allocate 872-876 MHz and 917-921 MHz on a lightly-licensed basis for Smart Grid use

By immediately allocating these bands on a lightly regulated basis for “smart utility networking”, Ofcom can enable the rapid deployment ofcost-effective, standards-based communications technology that willplace the UK among the worldwide leaders in deployment of Smart Grids, with substantial benefits to UK consumers, the energy sector and the environment. Making such an allocation would unlock substantial competition and innovation in Smart Grid communications, both between rival suppliers and operators of wireless mesh technology as well as with suppliers of other communications technologies. The result for UK consumers and energy providers can only be increased choice, greater innovation and lower prices.

We encourage Ofcom to seek input fromUK energy suppliers andUK Distribution Network Operators regarding their desire to have sub-GHz wireless mesh as an additional communications option for smart metering and Smart Grid. We also encourage you to reach out to utilities in the US and Australia that have deployed these ubiquitous, reliable, responsive smart grid networks. Finally, we thank you for the opportunity to share our thoughts. Should there be any questions, we would relish the opportunity to discuss.

For questions regarding this response please contact:

James Pace
Senior Director, Business Development
Silver Spring Networks
pace@silverspringnet.com

## About Silver Spring Networks

Silver Spring Networks (SSN) is a leading smart grid solutions provider that enables utilities to achieve operational efficiencies, reducecarbon emissions and empower their customers with new ways tomonitor and manage their energy consumption.

SSN provides hardware, software and services that allow utilities to deploy and run unlimited advanced applications, including SmartMetering, Demand Response, Distribution Automation and DistributedGeneration, over a single, unified network. SSN's Smart EnergyPlatform is based on Internet Protocol (IP) standards, allowingcontinuous, two-way communication between the utility and everydevice on the grid.

SSN utilities are now deploying over 15 thousand meters per day.

Deployments with leading utilities in the US and abroad, includeFlorida Power & Light, Pacific Gas & Electric, Pepco Holdings,CitiPower/PowerCor, Sacramento Municipal Utility District,American Electric Power, Oklahoma Gas & Electric, Jemena Electricity Networks Limited and United Energy Distribution, among others.

In 2008, the World Economic Forum honoured Silver Spring Networks as a Technology Pioneer.

Silver Spring Networks (UK) is a Limited Company, registered in theUK with Registration #06976503.

## Q and A from Ofcom's "872 - 876 MHz paired with 917 - 921 MHz" Consultation

**Question 1: Do you believe that the uses listed in this section are possible candidates of the 872/917 MHz bands?**

Yes. The list of uses that Ofcom has drawn up does provide a (non exhaustive) list of possible candidates.

**Question 2: Are there additional applications/services (not listed above) that could make viable use of the 872/917 MHz bands that Ofcom should be aware of?**

Whilst Ofcom has identified meter reading as a possible application, it has failed to address the wider 'Internet of Energy' (IoE) applications such as Smart Metering and Smart Grid technology. These technologies are significantly more sophisticated than traditional wireless meter reading devices, allowing utilities not just to take readings, but also to interact with remote devices to bring about immense consumer benefits.

Such devices will often be installed on domestic gas, water and electricity meters that are commonly installed inside properties and in some circumstances in the basements of these properties. The need for devices to communicate with each other between properties and potentially between basements limits the set of frequencies and power levels that are usable. Propagation at frequencies much above 1 GHz does not permit such connections to be established, even at reasonably high power levels. The licence exempt bands below 1 GHz typically have a power restriction of 25 milliWatts or less which also restricts inter-property communication.

As such, the 872/917 MHz bands are ideally suited to IoE applications as long as sensible power levels are permitted. In the USA and Australia, these devices are already, successfully, using these frequency ranges with power levels of 30dBm, providing live, commercial services. Taking a move to open up this frequency range to these applications would be a tremendous step forward towards the UK achieving many wider environmental and economic social and consumer policy objectives.

**Question 3: What services do you believe should be authorised to use this band? Could you supply relevant information supporting your preference and include any economic data relating to the value of the spectrum in providing these services?**

Our response makes a case for using this band for smart grid services. This is inclusive of smart metering, the first and most visible application of smart grid in the UK today. Arguably, smart grid and smart metering are "anchor tenants" of a pervasive Internet of Things.

**Question 4: Do you agree with the methods used to assess the potential to interfere with adjacent band services in a full licensed approach?**

The methods which Ofcom has adopted are appropriate in comparing the likely interference caused by the types of service which Ofcom foresaw the band being used for, however they do not properly address the issue of devices with small transmit durations and low duty cycles.

**Question 5: Do you consider that the proposed technical licence conditions would be justified and appropriate?**

See our response to question 8.

**Question 6: Do you agree with the methods used to assess the likelihood of services interfering with adjacent band services under the light regulatory approach?**

See our response to question 7.

**Question 7: We would like stakeholder views on the cost and performance impact of the UMTS900 filters described above.**

Given that there is a high probability that the 872/917 MHz frequency bands will be used elsewhere in the world for high power RFID applications or similar applications which yield signal strengths in excess of those which Ofcom is considering for licence exempt access, it would appear sensible and thus not unlikely for manufacturers of UMTS base stations operating in the adjacent frequency bands to fit additional filtering to their transmitters as a matter of default, rather than forcing operators to retrofit equipment to all their sites at a later date. As such, we would question whether there will be any need for operators to fit additional filtering for devices with power levels up to those being proposed for RFID (36dBm), though for higher power services it may well be pertinent.

The frequency hopping nature of SSN's technology would further reduce the likelihood of any harmful interference being caused.

**Question 8: Are there are any other methods that would give the same protection as the filters? What costs and performance impacts would these have?**

Ofcom has failed to consider the duty cycle and transmit period of devices operating in adjacent bands. GSM, UMTS, LTE and most other alternative technologies which may operate in the adjacent bands, have a time-slot based structure with error coding being applied to ensure that the loss of certain portions of data can be largely corrected for. As such, any transmission whose duration and duty cycle permitted the error correction coding inherent in the adjacent technologies to correct any reception errors that occurred would therefore not represent harmful interference. Thus higher power devices with small duration transmit times and low duty cycles would be much less likely (or at least no more likely) to cause a material impact on adjacent services than lower power devices whose transmit times were greater.

**Question 9: What are your views on the need for and justification of such mitigation measures and how their cost should be borne?**

If related to Question 7: We do not believe that for the reasons given our answer to question 7, that any additional form of mitigation would be required for co-existence of IoE devices in the 872/917 bands.

If related to Question 8: We believe the additional duty cycle and burst length limits should be an integral part of the EN governing access to the spectrum and so costs would be borne by the manufacturers of compliant equipment.

**Question 10: Stakeholders views are sought on whether the spectrum should be awarded as a single lot by frequency, or whether it should be split in to smaller frequency lots.**

From the perspective of IoE devices that typically require an absolute minimum of 4 MHz to operate efficiently, the ideal situation would be for both frequency ranges to be made available for conformant devices. However, splitting the spectrum up in other ways would still be beneficial in permitting the establishment of a service. The use of one of the two 4 MHz blocks for IoE applications and the other for, say, SRD or RFID would still provide a workable initial set of frequencies on which services could be rolled-out. Alternatively, a scenario in which 2 x 2 MHz taken from each of the two sub-bands was used for IoE with the other 2 x 2 MHz used for different services would also be a good start.

We would also like to draw Ofcom's attention to the issue of re-usability. We recognise that in the future there may be other pieces of spectrum that become available in which IoE devices could operate (e.g. digital dividend). The tuning range of our equipment is such that if and when these bands became available we would be in a position to be able to re-organise our network to take advantage of spectrum in the new bands. The extent of such re-tunability means that it may be possible for us to vacate some or all of the 872/917 MHz bands, allowing them to be re-used if an alternative application demanded.

Further, our network management software allows us to configure specific devices to only transmit on specific frequencies and we could create 'not spots' in specific areas where alternative frequencies, or a restricted range of frequencies must be used. This would, for example, allow us to use UHF television white-space spectrum. This flexibility provides enormous regulatory benefits for Ofcom in that it would be possible to re-tune the network to fit any spectrum that became available. The fact that the stations in the network are, to all intents and purposes, fixed in location means that Ofcom’s vision of dynamic spectrum access [1] becomes not just a possibility but also a reality.

**Question 11: We would like stakeholder’s views on whether the packaging should be split GB/NI or if we should proceed with UK wide packages.**

Given the ubiquity of the utilities that would be users of IoE devices across both GB and NI, a UK wide package would be most appropriate. We are aware that the band is in use by Digiweb in the Republic of Ireland and thus that potential cross-border restrictions may apply in NI, however the restrictions that these issues would present are relatively small compared to the overall consumer benefit that would be generated.

**Question 12: Would it be practical for RFID users and adjacent operators (e.g. GSM, UMTS, GSM-R) to co-ordinate locally on a case-by-case basis? The answers to this will help Ofcom develop its views on whether a database would be required.**

We cannot comment on the practicality of RFID users co-ordinating on a case-by-case basis, however in the case of applications such as IoE where devices are fixed in a specific location, it would be possible for these locations to be recorded and, should it prove necessary, for them to be co-ordinated with adjacent users (assuming a willingness from the adjacent operators of doing so).

**Question 13: Do you agree with Ofcom's preliminary proposal that the separation distances suggest a light licensing regime if SRD/RFID use in this band were to be supported? If not, how should the interference into adjacent bands be managed?**

Most planning is done based on the European Commission's definition of harmful interference, which includes the need to consider interference that may 'endanger or obstruct communication'. These are not real effects but are instead threats to services and a lot of planning is often based around minimising such threats. There is, however, clearly a need to protect adjacent services from 'degrading or interrupting communication', which not only has a material impact on the service concerned but is also a measureable result. As long as any service in the 872/917 bands does not cause 'degrade or interrupt' then 'no harm is done'. It is therefore incumbent on any user of the bands to satisfy themselves and adjacent users that no harm is done. Managing the interference as a real and measureable consequence of the use of the spectrum and correcting any problems that occur, rather than setting out with unreasonable expectations of protection is a much more reasonable and flexible approach.

We recognise the need to ensure that adjacent users are given some comfort that their service will be protected but do not believe that a registryof sites would be necessary. Given the short range nature of devices, if interference is caused, locating the offending device(s) would be straightforward and could be done through communication between providers. The same logic would, of course, hold true for any interference caused from adjacent band users into the 872/917 MHz bands.

[1] http://www.ofcom.org.uk/research/technology/research/emer_tech/dsa/

**Further Material, For Further Consideration…**

- Smart Grid, Smart City: A new direction for a new energy era. An altogether interesting read, this study estimates, that an Australian smart grid would reduce annual carbon emissions by a minimum 3.5 megatons and would yield at least AU $5 billion (US $4.3 billion) in gross annual benefits. While the coefficients are bound to vary, we invite you to extrapolate this across the considerably larger UK footprint.

- Understanding the Benefits of Smart Grid Implementation. A thorough presentation on US Smart Grid benefits… US $568B by 2050 with EVs. With excellent reports on distribution of benefits by value stream (i.e., advanced metering, distributed energy resources, demand response, energy efficiency).

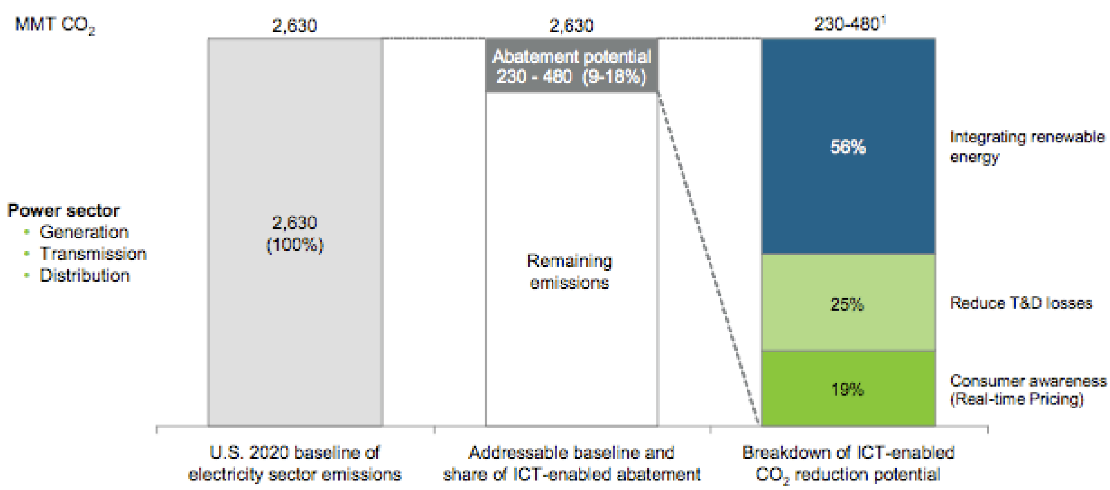
- Meeting the Energy Challenge: A White Paper on Energy (May 2007). Comprehensive insight into UK energy policy.

- Future Internet 2020 (May 2009). Commentary on the emergence of the Internet of Things. The Smart Grid appears to us to be the first iteration of IoT at scale.

- European Commission Recommendation on mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy. In sections (22) and (23), reiteration of the importance of smart metering and smart grids in maximising"energy savings in buildings, for the widespread deployment of electric vehicles, and for efficient energy supply and distribution and for integrating renewable energy sources."

- Smart2020: Enabling the Low Carbon Economy...uses a framework established in a global report previously issued by McKinsey and Company and includes analyses of how smart grid can reduce US GHG emissions by 2020. The following figure from this report summarizes the results of Boston Consulting Group's projections, which estimate that 230-480 million metric tons of CO2 could be avoided through smart grid-enabled technologies by 2020:

Figure 6: Smart Grid: U.S. impact 2020




- European Commission Slates € 1 billion for Green Cars. Independent of EC stimulus funding, vehicle makers are introducing EVs and they will have unintended consequences for the grid if not thought through. In the US, the gas equivalent of EV charging is $1.10/gal; current US average is $2.25/gal. These will be popular.

  EVs present a powerful opportunity for the electric grid to reduce US GHG emissions significantly by displacing internal combustion with electric power. Potential has been identified to reduce *total* US carbon emissions by as much as 27% through vehicle electrification, utilizing offpeak power generation and energy delivery capacity to charge plug-in electric vehicles. Such time-sensitive charging will require smart grid connectivity to manage the sizable power draw of EVs so as to minimize grid impacts by ensuring that charging only takes place off-peak.

- The Green Grid: A Report by the Energy Research Policy Institute. A rich resource for the effect of smart metering and smart grids on CO2 reduction.

  "Smart grid-enabled metering also makes possible continuous building commissioning, which alone can yield overall energy savings of 15%..."

In the US, smart grid infrastructure can improve grid efficiency to reduce line losses by networking distribution automation devices (e.g. – capacitor banks) to minimize reactive power flows through adaptive voltage control (i.e., Volt-VAR). Conservatively estimating 1% reduction in grid losses from smart grid-enabled distribution automation translates into at least 0.03 gigatons of CO2e GHG reductions by 2030.

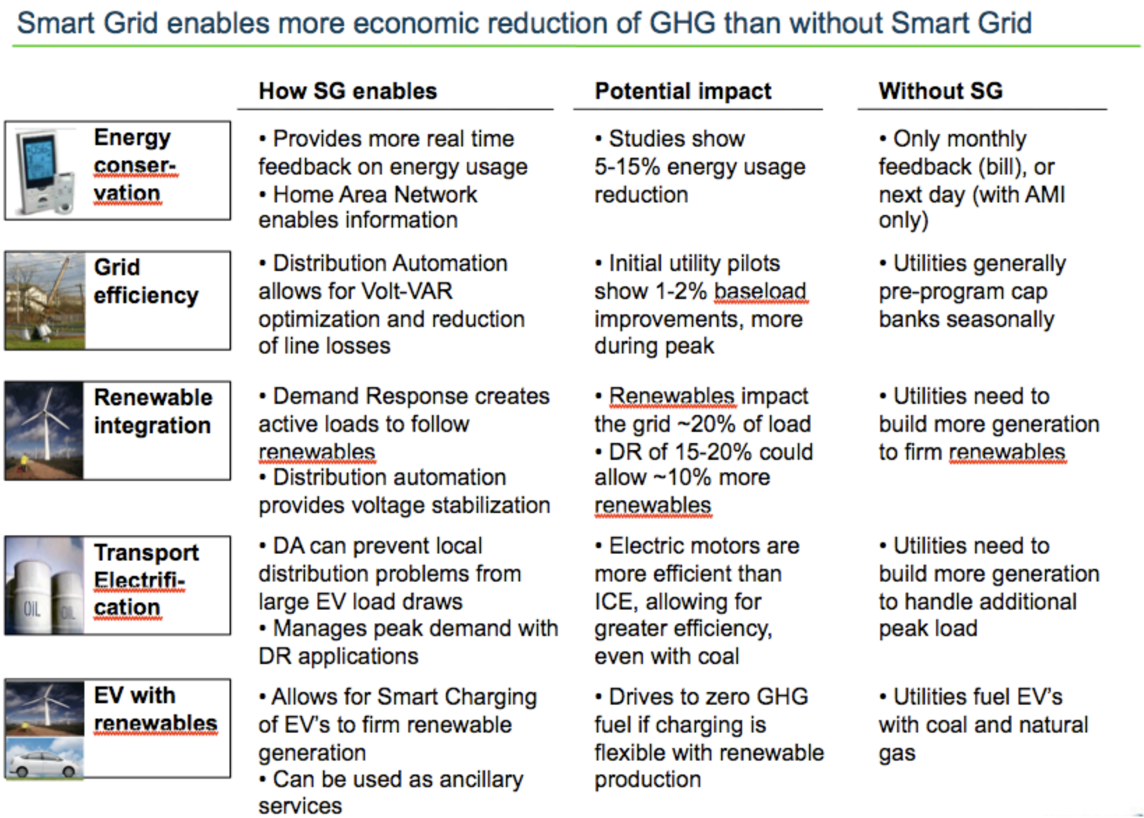
An interesting table from this study:

**Table 10-1**
**Smart Grid Energy Savings and Avoided $CO_2$ Emissions Summary (2030)**

| | Emissions-Reduction Mechanism Enabled by Smart Grid | Energy Savings, 2030 (billion kWh) | | Avoided $CO_2$ Emissions, 2030 ($Tg\ CO_2$) | |
|---|---|---|---|---|---|
| | | Low | High | Low | High |
| 1 | Continuous Commissioning of Large Commercial Buildings | 2 | 9 | 1 | 5 |
| 2 | Reduced Line Losses (Voltage Control) | 4 | 28 | 2 | 16 |
| 3 | Energy Savings Corresponding to Peak Load Management | 0 | 4 | 0 | 2 |
| 4 | Direct Feedback on Energy Usage | 40 | 121 | 22 | 68 |
| 5 | Accelerated Deployment of Energy Efficiency Programs | 10 | 41 | 6 | 23 |
| 6 | Greater Integration of Renewables | -- | -- | 19 | 37 |
| 7 | Facilitation of Plug-in Hybrid Electric Vehicles (PHEVs) | -- | -- | 10 | 60 |
| | **Total** | **56** | **203** | **60** | **211** |

- Sierra Club Presentation on California Statewide Pricing Program, Demand Response.... With more links to the original California studies. Many other jurisdictions have reported results consistent with these studies: with soundly constructed tariffs, consumers respond to price signaling. Peaks are shifted or reduced.

- A useful chart outlining Smart Grid's role in reducing green house gases…



Smart Grid enables more economic reduction of GHG than without Smart Grid

| | How SG enables | Potential impact | Without SG |
|---|---|---|---|
| Energy conser-vation | • Provides more real time feedback on energy usage<br>• Home Area Network enables information | • Studies show 5-15% energy usage reduction | • Only monthly feedback (bill), or next day (with AMI only) |
| Grid efficiency | • Distribution Automation allows for Volt-VAR optimization and reduction of line losses | • Initial utility pilots show 1-2% baseload improvements, more during peak | • Utilities generally pre-program cap banks seasonally |
| Renewable integration | • Demand Response creates active loads to follow renewables<br>• Distribution automation provides voltage stabilization | • Renewables impact the grid ~20% of load<br>• DR of 15-20% could allow ~10% more renewables | • Utilities need to build more generation to firm renewables |
| Transport Electrifi-cation | • DA can prevent local distribution problems from large EV load draws<br>• Manages peak demand with DR applications | • Electric motors are more efficient than ICE, allowing for greater efficiency, even with coal | • Utilities need to build more generation to handle additional peak load |
| EV with renewables | • Allows for Smart Charging of EV's to firm renewable generation<br>• Can be used as ancillary services | • Drives to zero GHG fuel if charging is flexible with renewable production | • Utilities fuel EV's with coal and natural gas |

- Another useful chart…