

## **Response to the UK consultation on a Smart Metering Implementation Programme : Design Requirements**

This document contains responses to the Consultation being run by Ofgem E-Serve on behalf of the Bluetooth Special Interest Group.

### **Introduction – The Bluetooth SIG**

The Bluetooth Special Interest Group (SIG) is an industry based standards organisation responsible for developing and maintaining the Bluetooth short range wireless standard and administering a qualification and interoperability program to ensure that all products released to the market based upon that standard meet interoperability, backwards compatibility and compliance requirements. The Bluetooth standard and IP contained within it are licensed free of charge on a RANDZ basis to Bluetooth members. Membership currently stands at over 13,000 companies worldwide. Membership is open to all, with a free membership level available to those companies that want access to use the standard. Paid membership levels confer the right to participate in specification development.

The Bluetooth SIG is active in the smart energy field, with the Bluetooth wireless standard already being used in numerous devices. The Bluetooth SIG contains a Smart Energy Engineering Task Force, which is working with a variety of smart metering standards bodies and which has produced this response. The Bluetooth SIG has recently released a low energy version of the Bluetooth standard, which is targeted at secure, ultra-low power applications and is particularly relevant to smart metering and home area automation. It uses a 2.4GHz radio design that is robust, even in the presence of interference from other radios. The Bluetooth SIG believes that this is an ideal solution for smart metering.

### **Detailed Response:**

The following is the Bluetooth SIG Smart Energy Group's response to the questions in the Design Requirements which relate to the HAN or devices which connect to it.

**Question 1.** *Should the HAN hardware be exchangeable without the need to exchange the meter?*

There are reasons for and against making the HAN hardware exchangeable. There is a level of risk which the meter manufacturers and installers will need to balance against costs, which will change over time throughout the deployment process.

In the short term there is still considerable risk in specifying the HAN, as any proposed technology will need the standards organisations to work hard to deliver a robust specification and implementation in the timescale. This argues the case for an exchangeable HAN module. However, the cost of an exchangeable HAN module is unlikely to be possible within the estimate of £1-£3. The additional materials and connectors are more likely to push the cost to at least double this estimate.

At a later point in the program this mandate could be removed once the stability and efficacy of the HAN solution is proven. This solution has the lowest operational risk.

If an exchangeable module is used, then a number of other questions need to be considered:

- Should a standard interface be mandated to allow interoperability between different manufacturers and suppliers? Standards like UMI and USNAP have been formed to address this [1][2].
- How will association and security keys be handled in the case of a exchangeable unit? If they are held on the unit itself, it would open the possibility of a removed HAN module accidentally being installed in a neighbour's meter, and then connecting to the original WAN gateway. To prevent this, the keys could be stored in the meter itself, but this would need to be specified in the technical requirements. If it is not, then it will be manufacturer specific, which opens up a security hole.

The Bluetooth SIG's opinion is that exchangeable HAN modules will of necessity add complexity to the cost and architecture of the meter, particularly in terms of the security aspects. Defining and testing these is a significant risk to the timescales. As exchangeability is largely a short term risk prevention strategy, it may be better not to mandate it. However, if manufacturers wish to add it, they must be able to prove that it does not compromise security.

If mandated, it should be specified within the functional requirements as to whether the exchangeable module should be "hot swappable", which means an ability to swap it without affecting the meter operation.

**Question 2.** *Are suitable HAN technologies available that meet the functional requirements?*

The Bluetooth SIG does not believe that there are currently mature technologies available, but that it should be possible for the industry to define them within the required timescales. This will be impacted by requirements and any security or interference issues that are revealed over the next twelve months. The Bluetooth SIG believes that Bluetooth low energy is the most complete specification currently available for the HAN.

**Question 3.** No response.

**Question 4.** *Do you believe that the Catalogue is complete and at the required level of detail to develop the technical specification?*

The Bluetooth SIG has not identified any additional requirements in the functional catalogue.

**Question 5.** *Do you agree that the additional functionalities beyond the high-level list of functional requirements are justified on a cost benefit basis?*

The Bluetooth SIG has no issue with the cost analysis for these features, but believes that there is a real risk in achieving these costs for the HAN, which should be taken into account when selecting the HAN technology.

The £1-£3 price point for HAN hardware depends strongly on the choice of technology. Bluetooth chips have an annual sales volume in excess of one billion chips. This volume means that the price of a Bluetooth low energy solution (chip plus antenna plus associated components) will be around £2.00 in 2013. In contrast, ZigBee, which is shipping just a few tens of millions of chips each year will cost around £4.50 at the same point.

The ongoing demand for Bluetooth chips is resulting in a new generation of chips being designed every 18 months, with each iteration driving the price down. That should see a Bluetooth low energy solution fall to below £1 by 2017. Other low power wireless standards like ZigBee are iterating only once every three to four years and are unlikely to meet a £3 price point before 2020. (The cost of designing a new wireless chip is between £2 million - £7.5 million, so low volume wireless standards face a Catch 22 situation – they do not have the volume to afford to design cheaper chips, which means the chip cost remains too expensive to grow volume. This also puts them at risk of market failure.)

The choice of HAN standard therefore includes an added risk of chip availability. The number of companies making Bluetooth chips is still growing, despite the fact it is a mature market. In comparison, the number of companies making ZigBee chips is shrinking, as the market is not growing fast enough to support small semiconductor companies and they run out of cash. If the route for them to get to hundreds of millions of chip sales per year is more than a few years, then the long term availability of these radios cannot be guaranteed. If that happens there is a risk that all of the meters and IHDs that employ them may need to be replaced.

The UK meter market by itself is not large enough to guarantee the long term availability of a wireless HAN technology. It needs to select an appropriately sized global standard.

**Question 6.** No response.

**Question 7.** *Do you agree that the proposed approach to developing technical specifications will deliver the necessary technical certainty and interoperability?*

The Bluetooth SIG agrees with Option 2 as the best approach to achieve the technical specification in the required timescale.

Technical interoperability may be defined within a standard, but real-life interoperability does not just come from the specification, but also from the test specifications for that standard, the qualification around that, the enforcement of the qualification program and the infrastructure that the standards body puts in place to deliver all of these. That is a considerable task, which needs to be accounted for.

The technical specification must allow for manufacturers to provide a common, mandated level of interoperability, but with the ability to add additional functionality

which allows them to add differentiation to their products. Without that, they are unlikely to accept the standard.

The Bluetooth SIG considers itself to be preeminent in this field, having qualified over 19,000 distinct products over the last ten years. The Bluetooth SIG has no concern about our ability to extend this process to smart meters. However, the Bluetooth SIG has severe doubts that any other short range organisation could cope in the timescale.

**Question 8.** *Do you agree it is necessary for the programme to facilitate and provide leadership...?*

There is a definite requirement for suppliers to engage in developing the technical specification, as they are responsible for contributing to the underlying technical standards. However, there is a risk to the timescale as the specification requirements for smart metering are being driven by different bodies around the world, including governments and other standards organisations, such as NIST, SGiP, ITU and ETSI. Where there are differences in the requirements imposed by these groups, the resulting specification may be delayed.

To accommodate this, it is important the UK government engages with companies that are active within these specifications to try and ensure that the first release of smart energy versions of HAN standards are not delayed because of features that are not relevant to the UK rollout. In other words there is a need for intervention with the key players to try and ensure that UK requirements are prioritised. Otherwise, the UK may need to introduce significant risk by adopting a technical standard prior to its completion. UK companies have a particularly strong role in driving the Bluetooth low energy standard, which would minimise the risk if it is chosen for the HAN.

Important aspects of the HAN standard, such as robustness to interference, power consumption and security are largely defined by semiconductor companies, regardless of the standard. So it is important that the UK initiative includes them in driving the standard forward.

**Question 9.** *Are there any particular technical issues (e.g. associated with the HAN) that could add delay to the timescales?*

Aside from the issue of ensuring that requirements from other countries do not delay the standards, the following issues need to be considered:

- **Susceptibility to interference.** Is the radio robust? The Bluetooth SIG, backed with research [3] from IEEE standard groups (802.15.2) and independent researchers, believes that Adaptive Frequency Hopping is the only coexistence mechanism that works in a real world environment. Adaptive Frequency Hopping is a core feature of the Bluetooth standard, but is not supported by any other current wireless standard.

To add this feature to any other standard would push the delivery of the technical requirement out by at least two years.

- **Security.** Where a technology has not had significant review or concerted attempts to breach it made by the professional hacking community in its working environment, it cannot be considered secure.

Once a shortlist of HAN technologies is selected they should be subject to analysis and attack by independent security experts to determine whether they are robust. This should include investigation of current commercial implementations to determine whether the industry suppliers for that technology understand the practical issues of implementing security. Any major failures may remove a technology from the selection process, or require a new revision of the standard, which will in turn need to be tested. This could add around 12 months for each iteration.

- **IPv6.** There is a consensus within the smart energy market that IPv6 addresses should be given to each device. There are good reasons for this. However, using IPv6 addressing over a low data rate wireless link requires considerable additional packets to be transmitted, which have a major bearing on overall battery life.

A number of solutions, e.g. 6LoWPAN [4], which have been put forward as to how to mitigate this effect, all of which result in a gateway that needs to translate public IPv6 addresses to local ones. The technical specification should take note of the effect of these approaches to ensure that it does not make a choice which would cripple the life of the gas meter battery. Other approaches are available that may prove to be more power efficient, but need to be fully defined and agreed.

**Question 10.** *Are there steps that could be taken which would enable the functional requirements and technical specifications to be agreed more quickly than the plan currently assumes?*

As stated in the primary consultation response, the Bluetooth SIG does not believe that it is possible to accelerate the timescales for specification of the HAN without introducing considerable risk. If the timescale were to be shortened it would also certainly require a HAN technology to be chosen prior to its formal approval by the specification body. Hence the net effect of accelerating the timescales could well be a delay in successful deployment.

## **Additional Responses to specific HAN requirements**

**HA.1** *The HAN interface shall be based on open and non-proprietary standards.*

Agreed. Bluetooth is an open standard, licensed under a zero license fee RANDZ scheme.

**HA.2** *The HAN device shall only support authorised devices.*

Agreed.

**HA.3** *The HAN interface shall support real-time two way communications from mains powered nodes.*

The Bluetooth SIG would like to see “real-time” defined, as every wireless HAN introduces latency. Our preferred requirement would be to reword it to the form that “the HAN will transfer the meter state to the IHD and gateway in less than 5 seconds”. With this wording the requirement define a latency and is valid for both the electricity and gas meter. An additional requirement that the HAN will supply 5 second updates for mains powered nodes can then be added to supplement HA.11.

**HA.4** *The HAN interface shall support network coordinator functionality...*

The Bluetooth SIG strongly requests that this requirement should be removed. A Network Coordinator is only required within a mesh network, and the topology specified in the rest of this consultation is not a mesh. Of the 10 million plus smart meters deployed within the US, it is believed that not a single one is using a mesh topology. Nor is a HAN mesh indicated anywhere within either this document or the main prospectus. This requirement is irrelevant and adds cost for a function that is not used.

In addition, there is pending intellectual property conflict with regard to mesh networks. This should be taken into account, as it can impact manufacturers and deployment plans.

**HA.5** *The HAN shall be independently certified and tested for interoperability.*

Agreed. The Bluetooth SIG already has this structure in place, with over ten years of experience and the capacity to cope with a rapid deployment of new meters, gateways and IHDs.

**HA.6** *The HAN interface shall support operation over the radio physical layer.*

Agreed. Being pedantic, it may be worth stating that this it should use an available, license-free band.

**HA.7** *The HAN shall support appliance control events...*

Agreed. *Bluetooth* low energy supports this.

## **HA.8**

There is no HA.8

## **HA.9** *The HAN shall support the use of repeaters...*

Agreed. The Bluetooth SIG notes that this specifically contradicts the implication of a mesh topology that is introduced in HA.4, such that a HAN solution could not satisfy both requirements HA.4 and HA.9.

## **HA.10** *The HAN shall support acknowledgement of signals.*

Agreed. It should be noted that this is a broad requirement, and there are significant differences in power consumption between HANs and communication protocols that support baseband acknowledgement and host level acknowledgement. The former will offer significantly lower power consumption. Bluetooth low energy supports both methods of acknowledgement.

## **HA.11** *The HAN interface shall support 30 minute update frequency from battery powered nodes.*

Agreed. However, this requirement has limited meaning unless the battery capacity is specified.

## **HA.12** *The HAN shall be remotely upgradeable.*

Agreed. Be aware that to implement secure upgrading, the HAN will require additional flash memory, which will have a small cost impact.

An upgrade process over a low power, low data rate link may take several minutes, depending on the size of the firmware update. Normally it is good practice not to cause a radio to multitask whilst receiving an update. This will result in temporary disruption of the updates from the meter to the IHD during this process. The Bluetooth SIG believes that this is acceptable, and that a message should be sent to the IHD at the start of the process to inform the customer that an update is taking place. If this is acceptable it should be added to the technical specification for meter and IHD.

A wireless update process is not trivial and needs to be specified to ensure that it provides a fail-safe mode of operation if the wireless link fails or is interrupted. Recommended upgrade processes for wireless devices are well documented [5].

## **HA.13** *The HAN device shall support gateway / bridging...*

Agreed. The Bluetooth SIG recommends that the security levels, authorisation and authentication architecture mandate separate domains for the utility / provider and consumer, so that they cannot access sensitive data, but have the ability to add local appliances.

## **HA.14** *The HAN shall support a defined application profile...*



Agreed. This should be easily extensible for the additional of controlled devices within the home.

**HA.15** *The HAN shall support alphanumeric messaging.*

Agreed. Bluetooth low energy also supports alphanumeric messaging to generic display devices, which includes mobile phones.

**HA.16** *The HAN shall support the security and privacy requirements.*

Agreed. See the comments regarding the testing of the security implementations in our response to the main prospectus.

**HA.17** *The HAN shall be capable of supporting other utility meters...*

Agreed. Although the Bluetooth SIG suspects that the requirements of water meters may be even more severe than those of gas meters.

**HA.18** *The HAN shall be capable of being physically switched off...*

Agreed. Bluetooth supports remote switch off.

**HA.19** *The HAN shall support addition of new devices.*

Agreed.

**HA.20** *The HAN shall be backwards compatible.*

Agreed. The Bluetooth SIG would like to stress the importance of this. The Bluetooth SIG has a statutory requirement in its bylaws to ensure that each specification is backwardly compatible with previous versions and this is rigorously tested prior to the adoption of each new specification. The Bluetooth SIG can demonstrate ten years of practical evidence of supporting backwards compatibility. It is not aware of any other standard that does more than pay lip service to this principle.

**HA.21** *The HAN shall be used by all smart metering system components...*

Agreed. Although it is outside the scope of this consultation, we would like to highlight that Bluetooth low energy also supports other devices outside the metering domain, such as assisted living sensors and health monitors. This would allow the UK government to consider use of installed gateways for future healthcare provision.

**HA.22** *The HAN shall not interfere with existing premise HANs.*

Agreed. However, this is only half of the problem. It is of even greater importance that the chosen HAN technology is resistant to interference from other wireless devices around the home. For this reason we propose the following additional requirement.



### Additional requirement

Requirement	The HAN's performance shall not be significantly affected by interference from existing premise HANs.
ID	HA.xx
Narrative	Interference from existing Wi-Fi networks, microwave ovens, video senders and other devices transmitting in the same band shall not result in delays of transmission that result in a failure to meet the requirement of HA.3.
Justification	Inability to communicate data to gateway or IHD.
Domestic / Non-Domestic	D/ND

There is a significant amount of evidence that radios that use a fixed channel are susceptible to disruption by other transmitting sources within the home [6]. The growing popularity of wireless products means that this is an increasing problem. It is already disruptive today and is likely to be significantly more so over the lifetime of the meters. Therefore it is imperative that a solution is chosen for the HAN that has a high expectancy of remaining reliable throughout the life of the meter, with the understanding that interference will only increase.

### Optional requirement

The Bluetooth SIG also suggests the following requirement:

Requirement	The HANs should be accessible from a suitably authorised device to allow service engineers and installers to download data from a meter.
ID	HA.xx
Narrative	Allows data to be recovered and maintenance functions performed if there is a failure in the gateway.
Justification	Service function
Domestic / Non-Domestic	D/ND

### References

1. USNAP Alliance - <http://usnap.org/>
2. Universal Metering Interface - <http://www.cambridgeconsultants.com/umi.html>
3. Dynamic Adaptive Frequency Hopping for Mutually Interfering Wireless Personal Area Networks - <http://www.computer.org/portal/web/csdl/doi/10.1109/TMC.2006.114>
4. 6LoWPAN - <http://datatracker.ietf.org/wg/6lowpan/charter/>
5. Essentials of Short Range Wireless, N Hunn, pp234-238. Cambridge University Press 2010. ISBN: 978-0521760690



6. Empirical Study and Practical Solution for Robust Sensor Networking in Apartments. Washington University in St Louis.  
<http://www.bluetooth.com/English/Products/Documents/channel-hopping.pdf>

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