Promoting investment and innovation in the Internet of Things:

A response from u-blox to Ofcom's consultation.

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1 Introduction

Based in Switzerland, u-blox is a global company designing and manufacturing products that are central to "M2M" communications and the future Internet of Things (IoT): chips and modules for positioning and communications. We are a leader in GNSS chips, with devices that will work on all the global GNSS satellite systems, to provide positioning and timing services for many applications from automotive navigation through asset tracking to frequency control in cellular networks. u-blox GNSS positioning chips are used in over half of all new cars with built-in navigation systems; and in LTE base stations made by global infrastructure manufacturers. Many of our positioning products are used in conjunction with a radio system to report the position of a vehicle or other asset, and we supply modules for 2G, 3G, and 4G cellular systems, Wi-Fi, and Bluetooth. We also offer cellular-based global services for cellular positioning and assisted GNSS. We are actively developing LTE chip technology in-house; and we are involved in standardisation activities in 3GPP GERAN and RAN, IEEE and IETF; including new work items on systems for low-cost IoT communications. We undertake R&D in Thalwil (Switzerland, our HQ); in Cambridge and Reigate (UK); Leuven (Belgium); Sgonico (Italy); Cork (Ireland); Malmo (Sweden); Oolu (Finland); Athens (Greece); Lahore (Pakistan); and San Diego (USA), and we sell globally.

Almost all our products are focused on locating and communicating with "things"; and the IoT is key for our future. Therefore we welcome Ofcom's initiative and the opportunity to inform your thinking. Our contribution is in two parts: this first part describes our view of the future IoT and how Ofcom can encourage its adoption to help make the UK a global leader. In a confidential annex we provide some further information that we hope will inform your internal debate.

2 Our IoT vision

The Internet is just a way for processors to exchange data; giving innovators the ability to freely connect and develop useful applications. Its enormous utility today is the result of programs hosted on large servers (such as the Google search engine) which can be accessed by clients running on simple low-cost hardware such as PCs, tablets and mobile phones. This combines with a flexible approach to standards-making and governance through the IETF, allowing for rapid growth and innovation and adaptation to changing circumstances.

This "client-server" architecture is likely to be common in the IoT. "Things" in general are likely to be fairly dumb, often with no man-machine interface. They will have simple sensor functions and potentially "actuators" (broadly interpreted), and will communicate with one or a small number of central servers, essentially computers, which will store and interpret the information; possibly send commands to the actuators based on the result; and share the information with humans and other servers. The basic client-server structure is embedded for example in the "Lightweight M2M" (LWM2M) architecture and protocols standardized by the Open Mobile Alliance (OMA) based on IETF specifications. The "server" may be a physical computer system located in a service provider's premises; or increasingly a virtualized function resident in the cloud.

Our focus today and likely in future will be to provide the radio devices used in "things" to locate themselves and communicate with the server. Our aim is to fill the positioning and communications sockets in our customers' products, whatever the radio interface used, working within the ambit of industry-

standard specifications. Our market focus is on "mission-critical" applications that have exacting requirements in terms of parameters such as temperature range (especially for automotive), location accuracy, radio performance, power consumption, reliability and so on.

The IoT is often seen as just more "M2M", dominated by telemetry and control: meter reading, energy and building management, environmental monitoring and other such "professional" applications. We believe that to meet its promise it has to go beyond this and harness the Internet ethos based on easily accessible, low cost, ubiquitous communications. An innovator with a new product and service idea must be able to take for granted universal, low-cost access to a communications pipe – this is a necessary condition for the IoT to thrive and deliver future Googles and Facebooks. Nowadays, the default method for communicating with any device has to be wireless.

3 Wireless communications for the IoT

Today, many IoT prototypes are built around local wireless access such as Wi-Fi or Bluetooth LE because these are easily available through a router or smartphone. But this approach is not viable for many mission-critical applications, where the availability of the router or phone can't be guaranteed and providing it just for the one application breaks the business case.

GSM is the most widely used wireless access for M2M today, as it meets most bandwidth needs; modules are relatively cheap; and coverage is generally good including in buildings. But GSM is still too expensive for many innovative applications: operators want to phase it out in favour of LTE; its coverage of critical areas such as basements, meter closets and manholes is poor; and its energy consumption is too high for extended operation unattended.

Newer cellular systems such as LTE and 3G are primarily optimized for mobile broadband, and modems are significantly more expensive than GSM. They also consume more energy and coverage is worse. Nevertheless they play their part in M2M, and it is interesting that some customers will choose to use 3G or 4G modules in applications simply for longevity even though the initial cost is much greater than GSM. For the future, we expect that 4G will play a role in M2M for those applications where large bandwidth is necessary, power is less of an issue, and the cost can be justified – an example would be a remote high-definition security camera. We note that there are developments in the LTE standards in Release 12 and Release 13 and these will certainly expand the opportunity for LTE in M2M.

But to enable the mass Internet of Things and catalyse its economic and societal benefits we believe there is a strong need for new standardized radio access systems that combine the following characteristics[1].

- Operation in licensed spectrum to allow controlled quality of service and provide global coverage, over existing or new cellular bands using existing sites, transceivers and antennas where appropriate.
- Support deep coverage of low-rate services into highly-shadowed locations such as basements, meter closets, manholes and even underground.
- Enable low-cost devices that could even be disposable.
- High capacity, commensurate with market predictions for the IoT.
- Support for very low device energy consumption, allowing operation for a decade or more on small primary batteries for applications such as water or gas metering or remote monitoring.
- Optimized for small payloads, which suit many IoT applications which can often tolerate quite high latency.

[1] *"A Choice of Future m2m Access Technologies for Mobile Network Operators";* http://www.cambridgewireless.co.uk/docs/Cellular%20IoT%20White%20Paper.pdf

This approach has been dubbed "Low Power Wireless Access" (LPWA) though we prefer the term "Cellular IoT" (CIoT). Two separate market studies[2,3] have predicted a market for such devices of the same order as today's cellular market. A number of companies, including u-blox, Neul, and Huawei are promoting a new standard to meet these objectives in 3GPP GERAN.

We believe that Ofcom can make a major contribution to the development of the IoT by recognizing and supporting the emergence of such standards.

[2] Machina Research: "*Low Power Wide Area Wireless networks: a potential global market of 15.5 billion M2M connections*"; June 2014

[3] Analysys Mason: "*http://www.analysysmason.com/Research/Content/Reports/Low-powered-wireless-solutions-have-the-potential-to-increase-the-M2M-market-by-over-3-billion-connections/White-paper-PDF/*"

4 Actions by Ofcom

4.1 Allow flexibility in spectrum usage

Only the mobile carriers have the existing sites, links and spectrum to deploy effective and ubiquitous Cellular IoT networks in the UK. The standard referred to above can operate in existing bands such as the 900 MHz E-GSM band; in the guard bands of LTE or 3G systems such as at 800 MHz, and in other bands including dedicated spectrum for the IoT. In some cases the existing licence conditions will prevent its deployment as the bands may be dedicated for specific air interfaces.

Ofcom needs to be flexible with licence conditions in existing and new cellular bands for both trial and commercial rollout of Cellular IoT networks.

4.2 Allocate dedicated, appropriate spectrum for Cellular IoT

Whilst everyone recognizes the importance of the IoT for the future and the fact that it will be a critical national infrastructure, up to now the need for radio spectrum dedicated to the IoT has not been recognized. We welcome therefore the UK proposal to CEPT that part of the projected 700 MHz digital dividend band should be allocated for M2M communications. Given the huge potential numbers of IoT devices and the future importance of the sector, the UK market in itself will justify setting up networks and developing devices provided that they conform to emerging global standards. Allocating dedicated spectrum early will help UK industry and bring the benefits of the IoT to the UK earlier. Whilst many different interests need to be aligned to permit the re-farming of the complete 700 MHz digital dividend band, it ought to be easier to allocate a small part of the total for an important new application.

We believe that Ofcom should act boldly and allocate dedicated IoT spectrum in the 700 MHz band as soon as possible.

4.3 Allocate appropriate spectrum for IoT communications

What is the best frequency range for Cellular IoT? There are a number of factors here.

- The need for ubiquitous coverage for small inexpensive devices that may be located in difficult areas is best met, in general, by bands below 1000 MHz.
- Such devices, being small yet needing efficient radios, must have good antennas. The performance of an antenna is intrinsically related to its size, larger antennas being bigger. Generally speaking the maximum dimension of an efficient omni-directional antenna will be of the order of a quarter of a wavelength at its operating frequency. At 1000 MHz such an antenna is 75 mm long, comparable or bigger than the overall size of the "thing" in which it is embedded. Though frequencies less that 1000 MHz are preferred for propagation, we think that for general applications the frequency should be no lower than ~700 MHz to allow reasonable size antennas.
- Much lower frequencies such as VHF are subject to unpredictable anomalous propagation effects; and propagation into enclosed spaces (which often has to be through small apertures such as the slot between a metal door and frame) is poor.

- The proliferation of bands for LTE makes it very difficult to engineer cost-effective terminals for the global market. Emerging standards for IoT use half-duplex communications which greatly eases RF design (and makes it possible for example to manufacture quad-band GSM devices at little or no incremental cost compared to dual- or tri-band).
- We note also proposals emerging for systems that can operate in single GSM channels or in the guard-bands of LTE.

> *We believe that future IoT communication systems should operate in licensed spectrum between 700 MHz and 1000 MHz. With appropriate system design it should be possible to make multi-band devices, on similar lines to multi-band GSM, which can cover all the likely allocations in this range: the putative 700 MHz M2M band mentioned above; in LTE guardbands at 700 and 800 MHz; and in the 850 and 900 MHz cellular bands. This should lead to the global economies of scale that are needed to achieve the absolute minimum cost.*

4.4 Rely on the Internet dynamic

We believe that from most points of view the "Internet of Things" is an extension of the Internet itself. For some time there have been standards activities in the IETF and related organisations such as the IEEE and OMA to generate and promote standards for the IoT. These standards deal with aspects such as addressing, management and security. Even when issues arise, such as the recent security hole discovered in the TLS protocol widely used to manage end-to-end data protection, the mechanisms of the Internet community have proved to be quick and effective in identifying problems and promulgating solutions.

The IoT market is global, and the interests of UK companies or the branches of overseas companies based in the UK will not be well served by UK-only solutions.

> *Ofcom should encourage UK participation in global standards activities around the IoT in bodies such as the IETF, IEEE, and OMA. Where appropriate the UK Government should also play its part in specifying and adopting open international standards and avoiding UK-specific system solutions.*

5 Conclusion

On 26th April 1989 the UK Government published its "Phones on the Move" consultation. That led to the licensing of the 1800 MHz band for PCN and the extension of GSM to additional bands; and the creation of two new operators in the UK. It was arguably a key factor igniting the cellular economy. We think that this is the time to be similarly bold in kick-starting the UK economy into cellular IoT communications.