Connecting BT-LE sensors to the Internet using Ipv6

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Introduction

Bluetooth Low Energy (BT-LE) [1] is a radio technology targeted for devices that operate with coin cell batteries which means that low power consumption is essential. BT-LE can also be integrated into existing BT devices so that devices such as mobile phones and PCs can operate with existing BT accessories as well as BT-LE accessories. An example of a use case for BT-LE accessory is a heart rate monitor that sends data via the mobile phone to a server on the Internet. BT-LE is designed for transferring small amount of data (in most cases less than 10bytes) less frequently (e.g. every 500ms) at modest data rates (e.g. 300kbps). BT-LE is aimed at enabling low cost sensors to send their data over the Internet via a gateway such as a mobile phone. BT-LE is especially attractive technology for Internet of Things applications, such as health monitors, environmental sensing and proximity applications. Several chip vendors (e.g. Nordic, Texas Instruments, CSR, Broadcomm) are already supplying BT-LE devices which will enable application vendors to sell BT-LE capable products such as heart monitors and key rings on the market. BT-LE is expected to be supported in majority of mobile phones very soon. According to forecasts a wave of billions of BT-LE enabled smart objects is expected to hit the market during the next few years.

Connecting these smart objects to the Internet would create new business potential beyond local application scenarios, such as point-to-point communication between e.g. a sensor and a phone. In the longer term there may be more situations where the BT-LE sensor does not want to communicate with the phone as such, but with some kind of a server over the Internet. Examples of such use-cases could be sensors transmitting information about patient's health (heart rate, blood sugar) to a server that can provide instructions for remote care, sensors collecting environmental data and transmitting the data to a server for aggregate analysis or a home automation system combining local sensor measurement information with weather forecast information on an Internet server. In these scenarios a mobile phone or home gateway is needed to provide the Internet connectivity for the sensor. It is currently possible to support these types of applications with proprietary application layer gateway solutions, as depicted in Figure 1. However, the proprietary solutions must be tailored separately for each application for each phone/operating system thus not providing the desired scalability. Additionally, all these gateway solutions are BT-LE specific, while many applications could use other low power radio technologies as well. The most flexible approach would be to have the sensor communicate with the server all the way over IP. Considering the expected explosion in the number of sensors, IPv6 would be the ideal protocol due to the large address space it provides. For this to happen there must be a way to transmit IPv6 packets over the BT-LE link in a power efficient manner along with efficient application protocols that enable the integration of BT-LE devices into services.

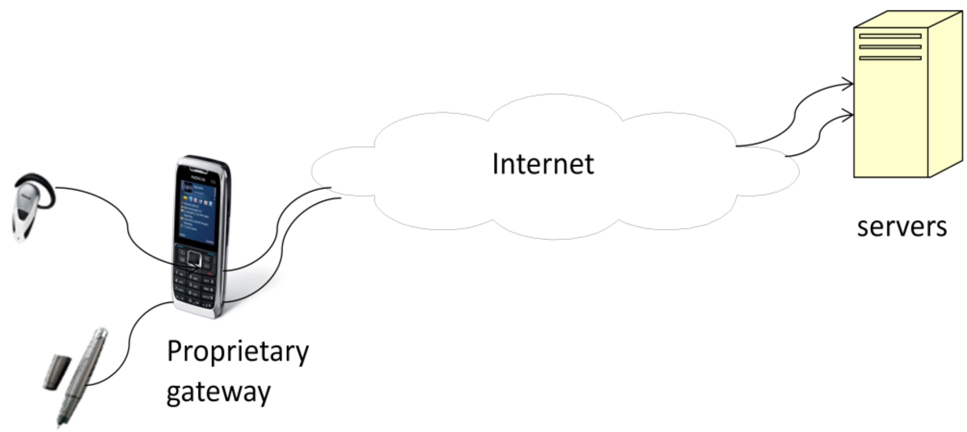

Figure 1 Sensors connecting to Internet server without IP

Background on Internet of Things enablers

Several low-power radio technologies have been developed for supporting Internet of Things related use-cases. BTH, BT-LE, IEEE 802.15.4 (6LoWPAN, ZigBee, Wireless HART), Z-Wave and ANT are currently seen as the most prominent solutions in this field. WiFi low power provides an alternative solution but gives only general guidelines for optimizing power consumption rather than detailed technical specifications. Ideally the sensors should be able to connect to the Internet with any ultra low power radio technology depending on the application requirements. The 6LoWPAN standard [2] describes how to run IPv6 over IEEE 802.15.4 family radios, but at the moment there is no specification on how to run IP/IPv6 over other constrained links such as Z-Wave or BT-LE. Furthermore, attempting to connect billions of constrained sensors via mobile phones and home gateways presents challenges in dealing with network mobility, application protocol efficiency, naming, security and privacy.

Our Position

With the anticipation that Internet/network oriented use cases for sensors are becoming more common, we want to prepare technical enablers for them using BT-LE and other radios. Otherwise there would be a risk that either certain type of sensor/phone/Internet apps would not appear at all, or that instead of BT-LE they would be based solely on proprietary technologies. Out position is that IPv6 and embedded web services provide the ideal starting point, but work is still needed. In the rest of this paper we use BT-LE as an example use case.

The first thing needed is to design and implement a generic BT-LE <-> Cellular IP router and a CoAP proxy on top of it, as depicted in Figure 2.

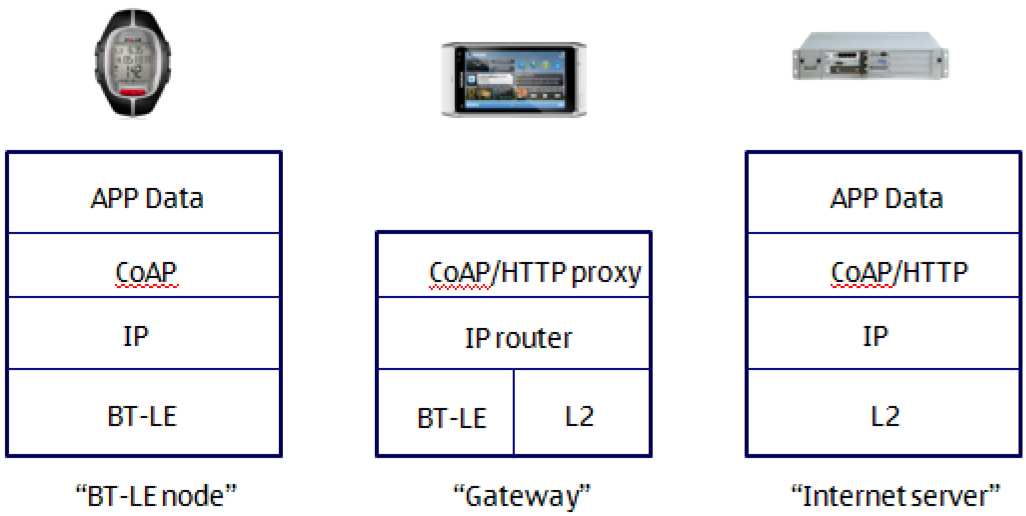

Figure 2 IP over BT-LE

At the moment there is no specification on how to run IP/IPv6 over BT-LE. The 6LoWPAN standard provides useful generic functionality like header compression, link-local IPv6 addresses, Neighbor Discovery and stateless IP-address autoconfiguration but can not be applied to BT-LE as such. The BNEP protocol [3] has been developed for encapsulating any network protocol for Bluetooth L2CAP. BNEP assumes that L2CAP supports connection oriented channel. In the current BT-LE specification only support for the connectionless channel has been defined. We propose to specify a connection oriented channel for BT-LE and then run BNEP, parts of 6LoWPAN, IPv6 and application protocols. Considering application protocols, IPv6 can in principle support any protocol. BT-LE technology, however, sets limitations to protocol overhead such as header sizes. CoAP [4] is an application protocol specifically designed for resource constrained environments. CoAP could be run on top of IPv6 supporting requests from the server and requests of cached replies from a CoAP/HTTP proxy in the phone. Figure 3 shows the resulting protocol stack in a sensor.

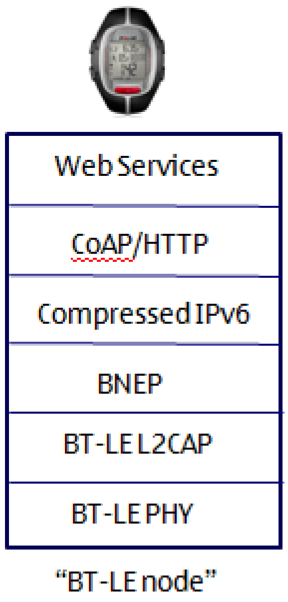

Figure 3 IPv6 over BT-LE, complete stack in the sensor

Standardization Needs

We see the need to standardize this kind of solution in BT-SIG and publish it later as an informational RFC in IETF. Our plan is to do major part of the standardization and technology promotion in collaboration with various industry partners such as other device manufacturers, chip vendors, and sensor application/protocol stack vendors. In this way we can guarantee wide acceptance of the standard globally. Technical specification of the solution is expected to be finalized by the end of April 2011, after which the standardization work can be started. Along with standardization, the solution will be implemented in a prototype to assess its feasibility and energy consumption.

In addition to solving the problem of IPv6 over BT-LE and embedded web services, we see several other challenges that still need to be addressed. These include the assignment of global IPv6 addresses via Cellular routers, mobility solutions, the naming and identification of sensor nodes and resources independent of their network location, and finally security and privacy.

References

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