Building the Internet of Things with Bluetooth Smart

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Abstract

The Internet of Things, or the IoT, is an emerging, disruptive technology that enables physical devices to communicate across disparate networks. IP has been the de facto standard for seamless interconnectivity in the traditional Internet; and piggybacking on the success of IP, 6LoWPAN has been the first standardized technology to realize it for networks of resource-constrained devices. In the recent past Bluetooth Low Energy (BLE) a.k.a Bluetooth Smart - a subset of the Bluetooth v4.0 and the latest v4.2 stack, has surfaced as an appealing alternative, with many competing advantages over available low-power communication technologies in the IoT space such as IEEE 802.15.4. However, BLE is a closed standard and lacks open hardware and firmware support, something that hinders innovation and development in this field. In this article, we aim to overcome some of the constraints in BLE's core building blocks by making three contributions: first, we present the design of a new open hardware platform for BLE; second, we provide a Contiki O.S. port for the new platform; and third, we identify research challenges and opportunities in 6LoWPAN-connected Bluetooth Smart. We believe that the knowledge and insights will facilitate IoT innovations based on this promising technology.

Keywords: Internet of Things, IoT, Bluetooth LE, BLE, Open Hardware, Open Source, Contiki O.S.

1. Introduction

We can automate different functions in our everyday life by embedding a tiny computer with limited storage and communication capabilities in physical objects around us. The network of these smart objects or *things* using the Internet protocol (IP) is called the 6LoWPAN [1] or IPv6 over low-power wireless personal area networks, and the interconnection of 6LoWPAN networks with the Internet form the Internet of Things (IoT). IPv6, potentially, offers unlimited address space to connect billions of uniquely identifiable smart *things* with the Internet. 6LoWPAN is an IoT enabling technology that makes it possible to run the heavyweight IPv6 protocol in resource-constrained devices, by offering compression and fragmentation capabilities. Unlike conventional wireless sensor networks (WSN), 6LoWPAN networks are being deployed in environments where people are an integral part of the system.

Low-power IEEE 802.15.4 [2] is the de facto link and physical layer standard for 6LoWPAN networks. However, new technologies are emerging; and among the few energy efficient communication technologies, Bluetooth Low Energy (BLE) is an appealing alternative. BLE, marketed as Bluetooth Smart, is a lightweight variant of Classic Bluetooth targeted for low-power resource-constrained devices. Since the introduction of BLE in Bluetooth 4.0[3, 4], there has been a widespread adoption of this technology by big and small technology vendors. Currently, most high-end smartphones support BLE.

Bluetooth 4.2 [5], released in December 2014, further brings Internet Protocol (IP) capabilities to Bluetooth - which means that we are now able to connect a Bluetooth device with the Internet using standardized mechanisms. In addition to the IP support, Bluetooth 4.2 offers National Institute of Standards and Technology (NIST) standardized advanced Elliptic Curve Cryptography (ECC) based security, enhanced

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