Bluetooth and its Low-Energy Profile.

Bluetooth is a Personal Area Network (PAN) technology that is based on IEEE 802.15.1. It is a short-range wireless communication specification for portable personal devices that was created by Ericsson. The Bluetooth SIG made their specifications public in the late 1990s, at which point the IEEE 802.15 Group took over and established a vendor-independent standard based on the Bluetooth work. IEEE 802.15 sublayers include

- RF layer
- baseband layer
- link manager
- L2CAP

Bluetooth has progressed through four iterations, with all Bluetooth standards remaining downwardly compatible. BLE is a subset of Bluetooth v4.0 that includes a completely new protocol stack for the speedy establishment of basic links.BLE is an alternative to the "power management" features introduced as part of the standard Bluetooth protocols in Bluetooth v1.0 to v3.0 (Bluetooth is a trademark of the Bluetooth Alliance, a commercial organisation that certifies the interoperability of specific devices designed to the respective IEEE standard).

Bluetooth low energy

Bluetooth Low-Energy (BLE) or Bluetooth Smart uses a short-range radio with minimal power to operate longer (even for years) compared to previous versions.

The range (approx. 100 meters) is ten times as high as that of classic Bluetooth, while the latency is 15 times shorter [18]. BLE can be operated with a transmission power between 0.01 mW and 10 mW. With these properties, BLE is a technology candidate for IoT applications [12]. The BLE standard was developed by smartphone manufacturers and is available in most modern smartphones. The feasibility of using the BLE standard has been demonstrated in vehicle-to-vehicle communication. The BLE standard was rapidly developed by smartphone manufacturers and is now available in most smartphone models. Furthermore, this standard's feasibility was demonstrated in vehicle-to-vehicle communication [18], and wireless sensor networks [35].

BLE is more efficient than ZigBee in terms of energy consumption and the ratio of transmission energy per transmitted bit [54]. The BLE network stack is as follows: At the lowest level of the BLE, the stack is the physical layer that sends and receives bits. This layer provides link-layer services, including media access, connection establishment, error control, and flow control. Afterward, multiplexing for data channels, fragmentation, and assembly of larger packets is provided by Logical Link Control and Adaptation Protocol (L2CAP). The other upper layers are the Generic Attribute Protocol (GATT), which enables the efficient data collection from sensors, and the Generic Access Profile (GAP), which is used to configure and manage the application in different modes such as scanning and to promote as well as connection initiation and management [54]. Using BLE, devices can work as masters or slaves in a star topology. For the detection mechanism, slaves send advertisements through one or more dedicated advertising channels. In order to be discovered as a slave, these channels are scanned by the master. Except for the time that two devices are exchanging data, they are in sleep mode for the rest of the time.

The IOT's sense of touch: beacons and taggants

As of this writing, Bluetooth Low Energy (BLE) technology is just starting to roll out to the public, most notably in the "iBeacon" feature of Apple's iOS7. It has been seen as a rival to Near Field Communication (NFC) technology (which iOS8 also embraces), or as a convenient way to pipe coupons into your phone. But history will look back at BLE as a major step forward in manifesting the Internet of Things (IOT), and in eroding any remaining illusions of privacy we have in our physical whereabouts.

BLE is a means of transferring data. "Beacons" – devices that use BLE – are tiny, wireless sensors that transmit data within a 10-meter range. At present, they support only low data rates and can only send (and not receive) small data packets, but these are perfect for interacting with iPhones and wearable computing devices such as smart watches and fitness trackers.[47] In light of the current proliferation in such devices, therefore, it's safe to say that in the near future we may carry a half-dozen devices or more that are equipped with BLE or similar technology.

One of the most obvious applications of BLE is micro-location geofencing. GPS technology is great for determining your approximate location to within a few feet, but it relies on satellites that can't see into buildings very well. A mobile device running BLE technology, however, can interact with nearby beacons to determine its precise location, even indoors.

Set up around a store, they can detect shoppers entering and exiting, and send them coupons (customized to your unique shopper profile) or even internal directions – *Minority Report* without the retinal scans. You will soon be able to even pay for goods without ever pulling out your phone, just like the newest vehicles will open their doors even when your key stays in your pocket. PayPal is already developing just such an app using BLE.

The real potential of BLE lies not in coupons, but in the IOT–the burgeoning trend towards making physical objects internet-connected and digitally interactive. Just like humans cannot meaningfully interact with the world around them without their five senses, so too will IOT-enabled objects lack interactivity without some means of sensing and communicating with their surroundings. BLE beacons are a major step toward providing that ability.

In all likelihood, some improved version of BLE technology, or its next-generation replacement with even broader capabilities, will be available either when this book is released, or shortly thereafter. Moreover, as discussed in Chapter 2, the need for digital sensors to precisely locate physical objects may lead to the deployment of beacons or taggants on the micro- or even nano-scale. Each of these devices – including present-day beacons and RFID tags as well as taggants and other future technologies – will be able, in theory, to have its own unique IP address on the internet. The migration begun in 2012 of the Internet Protocol address system from IPv4 to IPv6 increased the total number of IP addresses from a mere 4.3 billion – a number we've already reached – to 340 undecillion (i.e., 340 trillion trillion trillion). Now, literally every Barbie doll, toilet paper roll, and random chatski can have its own unique IP address on the internet. Each becomes a data point capable of reporting its exact physical location on a real-time, global map. Once more people are using this infrastructure, its consequences will become more apparent.