

# 11 Internet of Things (IoT) Protocols You Need to Know About

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by [RS Components](#)

There exists an almost bewildering choice of connectivity options for electronics engineers and application developers working on products and systems for the Internet of Things (IoT).

Many communication technologies are well known such as WiFi, Bluetooth, ZigBee and 2G/3G/4G cellular, but there are also several new emerging networking options such as Thread as an alternative for home automation applications, and Whitespace TV technologies being implemented in major cities for wider area IoT-based use cases. Depending on the application, factors such as range, data requirements, security and power demands and battery life will dictate the choice of one or some form of combination of technologies. These are some of the major communication technologies on offer to developers.



**Bluetooth**

An important short-range communications technology is of course Bluetooth, which has become very important in computing and many consumer product markets. It is expected to be key for wearable products in particular, again connecting to the IoT albeit probably via a smartphone in many cases. The new Bluetooth Low-Energy (BLE) – or Bluetooth Smart, as it is now branded – is a significant protocol for IoT applications. Importantly, while it offers similar range to Bluetooth it has been designed to offer significantly reduced power consumption.

However, Smart/BLE is not really designed for file transfer and is more suitable for small chunks of data. It has a major advantage certainly in a more personal device context over many competing technologies given its widespread integration in smartphones and many other mobile devices. According to the Bluetooth SIG, more than 90 percent of Bluetooth-enabled smartphones, including iOS, Android and Windows based models, are expected to be 'Smart Ready' by 2018.

Devices that employ Bluetooth Smart features incorporate the Bluetooth Core Specification Version 4.0 (or higher – the latest is version 4.2 announced in late 2014) with a combined basic-data-rate and low-energy core configuration for a RF transceiver, baseband and protocol stack. Importantly, version 4.2 via its Internet Protocol Support Profile will allow Bluetooth Smart sensors to access the Internet directly via 6LoWPAN connectivity (more on this below). This IP connectivity makes it possible to use existing IP infrastructure to manage Bluetooth Smart 'edge' devices. More information on Bluetooth 4.2 is available [here](#) and a wide range of Bluetooth modules are available from RS.

Standard: Bluetooth 4.2 core specification

Frequency: 2.4GHz (ISM)

Range: 50-150m (Smart/BLE)

Data Rates: 1Mbps (Smart/BLE)



**Zigbee**

ZigBee, like Bluetooth, has a large installed base of operation, although perhaps traditionally more in industrial settings. ZigBee PRO and ZigBee Remote Control (RF4CE), among other available ZigBee profiles, are based on the IEEE802.15.4 protocol, which is an industry-standard wireless networking technology operating at 2.4GHz targeting applications that require relatively infrequent data exchanges at low data-rates over a restricted area and within a 100m range such as in a home or building.

ZigBee/RF4CE has some significant advantages in complex systems offering low-power operation, high security, robustness and high scalability with high node counts and is well positioned to take advantage of wireless control and sensor networks in M2M and IoT applications. The latest version of ZigBee is the recently launched 3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard. An example product and kit for ZigBee development are TI's CC2538SF53RTQT ZigBee System-On-Chip IC and CC2538 ZigBee Development Kit.

Standard: ZigBee 3.0 based on IEEE802.15.4

Frequency: 2.4GHz

Range: 10-100m

Data Rates: 250kbps



**Z-Wave**

Z-Wave is a low-power RF communications technology that is primarily designed for home automation for products such as lamp controllers and sensors among many others. Optimized for reliable and low-latency communication of small data packets with data rates up to 100kbit/s, it operates in the sub-1GHz band and is impervious to interference from WiFi and other wireless technologies in the 2.4-GHz range such as Bluetooth or ZigBee. It supports full mesh networks without the need for a coordinator

node and is very scalable, enabling control of up to 232 devices. Z-Wave uses a simpler protocol than some others, which can enable faster and simpler development, but the only maker of chips is Sigma Designs compared to multiple sources for other wireless technologies such as ZigBee and others.

Standard: Z-Wave Alliance ZAD12837 / ITU-T G.9959

Frequency: 900MHz (ISM)

Range: 30m

Data Rates: 9.6/40/100kbit/s

## **6LoWPAN**

### **6LowPAN**

A key IP (Internet Protocol)-based technology is 6LowPAN (IPv6 Low-power wireless Personal Area Network). Rather than being an IoT application protocols technology like Bluetooth or ZigBee, 6LowPAN is a network protocol that defines encapsulation and header compression mechanisms. The standard has the freedom of frequency band and physical layer and can also be used across multiple communications platforms, including Ethernet, Wi-Fi, 802.15.4 and sub-1GHz ISM. A key attribute is the IPv6 (Internet Protocol version 6) stack, which has been a very important introduction in recent years to enable the IoT. IPv6 is the successor to IPv4 and offers approximately  $5 \times 10^{28}$  addresses for every person in the world, enabling any embedded object or device in the world to have its own unique IP address and connect to the Internet. Especially designed for home or building automation, for example, IPv6 provides a basic transport mechanism to produce complex control systems and to communicate with devices in a cost-effective manner via a low-power wireless network.

Designed to send IPv6 packets over IEEE802.15.4-based networks and implementing open IP standards including TCP, UDP, HTTP, COAP, MQTT, and websockets, the standard offers end-to-end addressable nodes, allowing a router to connect the network to IP. 6LowPAN is a mesh network that is robust, scalable and self-healing. Mesh router devices can route data destined for other devices, while hosts are able to sleep for long periods of time. An explanation of 6LowPAN is available [here](#), courtesy of TI.

Standard: RFC6282

Frequency: (adapted and used over a variety of other networking media including Bluetooth Smart (2.4GHz) or ZigBee or low-power RF (sub-1GHz))

Range: N/A

Data Rates: N/A



## Thread

A very new IP-based IPv6 networking protocol aimed at the home automation environment is Thread. Based on 6LoWPAN, and also like it, it is not an IoT applications protocol like Bluetooth or ZigBee. However, from an application point of view, it is primarily designed as a complement to WiFi as it recognises that while WiFi is good for many consumer devices that it has limitations for use in a home automation setup.

Launched in mid-2014 by the Thread Group, the royalty-free protocol is based on various standards including IEEE802.15.4 (as the wireless air-interface protocol), IPv6 and 6LoWPAN, and offers a resilient IP-based solution for the IoT. Designed to work on existing IEEE802.15.4 wireless silicon from chip vendors such as Freescale and Silicon Labs, Thread supports a mesh network using IEEE802.15.4 radio transceivers and is capable of handling up to 250 nodes with high levels of authentication and encryption. A relatively simple software upgrade should allow users to run thread on existing IEEE802.15.4-enabled devices.

Standard: Thread, based on IEEE802.15.4 and 6LoWPAN

Frequency: 2.4GHz (ISM)

Range: N/A

Data Rates: N/A



## WiFi

WiFi connectivity is often an obvious choice for many developers, especially given the pervasiveness of WiFi within the home environment within LANs. It requires little further explanation except to state the obvious that clearly there is a wide existing infrastructure as well as offering fast data transfer and the ability to handle high quantities of data.

Currently, the most common WiFi standard used in homes and many businesses is 802.11n, which offers serious throughput in the range of hundreds of megabit per second, which is fine for file transfers, but may be too power-consuming for many IoT applications. A series of RF development kits designed for building WiFi-based applications are available from RS.

Standard: Based on 802.11n (most common usage in homes today)

Frequencies: 2.4GHz and 5GHz bands

Range: Approximately 50m

Data Rates: 600 Mbps maximum, but 150-200Mbps is more typical, depending on channel frequency used and number of antennas (latest 802.11-ac standard should offer 500Mbps to 1Gbps)



**Cellular**

Any IoT application that requires operation over longer distances can take advantage of GSM/3G/4G cellular communication capabilities. While cellular is clearly capable of sending high quantities of data, especially for 4G, the expense and also power consumption will be too high for many applications, but it can be ideal for sensor-based low-bandwidth-data projects that will send very low amounts of data over the Internet. A key product in this area is the SparqEE range of products, including the original tiny CELLv1.0 low-cost development board and a series of shield connecting boards for use with the Raspberry Pi and Arduino platforms.

Standard: GSM/GPRS/EDGE (2G), UMTS/HSPA (3G), LTE (4G)

Frequencies: 900/1800/1900/2100MHz

Range: 35km max for GSM; 200km max for HSPA

Data Rates (typical download): 35-170kps (GPRS), 120-384kbps (EDGE), 384Kbps-2Mbps (UMTS), 600kbps-10Mbps (HSPA), 3-10Mbps (LTE)



**NFC**

NFC (Near Field Communication) is a technology that enables simple and safe two-way interactions between electronic devices, and especially applicable for smartphones, allowing consumers to perform contactless payment transactions, access digital content and connect electronic devices. Essentially it extends the capability of contactless card technology and enables devices to share information at a distance that is less than 4cm. Further information is available [here](#).

Standard: ISO/IEC 18000-3

Frequency: 13.56MHz (ISM)

Range: 10cm

Data Rates: 100–420kbps



### **Sigfox**

An alternative wide-range technology is Sigfox, which in terms of range comes between WiFi and cellular. It uses the ISM bands, which are free to use without the need to acquire licenses, to transmit data over a very narrow spectrum to and from connected objects. The idea for Sigfox is that for many M2M applications that run on a small battery and only require low levels of data transfer, then WiFi's range is too short while cellular is too expensive and also consumes too much power. Sigfox uses a technology called Ultra Narrow Band (UNB) and is only designed to handle low data-transfer speeds of 10 to 1,000 bits per second. It consumes only 50 microwatts compared to 5000 microwatts for cellular communication, or can deliver a typical stand-by time 20 years with a 2.5Ah battery while it is only 0.2 years for cellular.

Already deployed in tens of thousands of connected objects, the network is currently being rolled out in major cities across Europe, including ten cities in the UK for example. The network offers a robust, power-efficient and scalable network that can communicate with millions of battery-operated devices across areas of several square kilometres, making it suitable for various M2M applications that are expected to include smart meters, patient monitors, security devices, street lighting and environmental sensors. The Sigfox system uses silicon such as the EZRadioPro wireless transceivers from Silicon Labs, which deliver industry-leading wireless performance, extended range and ultra-low power consumption for wireless networking applications operating in the sub-1GHz band.

Standard: Sigfox

Frequency: 900MHz

Range: 30-50km (rural environments), 3-10km (urban environments)

Data Rates: 10-1000bps



Similar in concept to Sigfox and operating in the sub-1GHz band, Neul leverages very small slices of the TV White Space spectrum to deliver high scalability, high coverage, low power and low-cost wireless networks. Systems are based on the Icen1 chip, which communicates using the white space radio to access the high-quality UHF spectrum, now available due to the analogue to digital TV transition. The communications technology is called Weightless, which is a new wide-area wireless networking technology designed for the IoT that largely competes against existing GPRS, 3G, CDMA and LTE WAN solutions. Data rates can be anything from a few bits per second up to 100kbps over the same single link; and devices can consume as little as 20 to 30mA from 2xAA batteries, meaning 10 to 15 years in the field.

Standard: Neul

Frequency: 900MHz (ISM), 458MHz (UK), 470-790MHz (White Space)

Range: 10km

Data Rates: Few bps up to 100kbps



Again, similar in some respects to Sigfox and Neul, LoRaWAN targets wide-area network (WAN) applications and is designed to provide low-power WANs with features specifically needed to support low-cost mobile secure bi-directional communication in IoT, M2M and smart city and industrial applications. Optimized for low-power consumption and supporting large networks with millions and millions of devices, data rates range from 0.3 kbps to 50 kbps.

Standard: LoRaWAN

Frequency: Various

Range: 2-5km (urban environment), 15km (suburban environment)

Data Rates: 0.3-50 kbps.

<http://www.rs-online.com/designspark/electronics/eng/knowledge-item/eleven-internet-of-things-iot-protocols-you-need-to-know-about?/designspark/electronics/knowledge-item/eleven-internet-of-things-iot-protocols-you-need-to-know-about=>