



# IJRASET

International Journal For Research in  
Applied Science and Engineering Technology



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# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

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**Volume: 7      Issue: V      Month of publication: May 2019**

**DOI: <https://doi.org/10.22214/ijraset.2019.5434>**

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# The Internet of Things (IoT) Protocols and Connectivity

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**Abstract:** This paper addresses the Internet of Things protocols and connectivity. In 2008 the number of things connected to the Internet was greater than the people living on Earth. Within 2025 the number of things connected to the Internet will be about 50 billion. The internet has initially started with the Internet of Computers and file transfer protocol, and now its world wide web (WWW) and hence user communicate each other and exchange information. Now the internet not only used to communicate and exchange the information by human but things can be used on the internet for communication and exchange and this term is called internet of things (IoT). In this paper we will present different IoT protocols and their connectivity.

**Keywords:** Internet of Things (IoT), IoT Protocols, MQTT CoAP.

## I. INTRODUCTION

The next wave in the era of computing will be outside the realm of the traditional desktop. In the Internet of Things (IoT) paradigm, many of the objects that surround us will be on the network in one form or another. Radio Frequency Identification (RFID) and sensor network technologies will rise to meet this new challenge, in which information and communication systems are invisibly embedded in the environment around us. This results in the generation of enormous amounts of data which

A huge ecosystem of connected devices, named the Internet of Things, has been expanding over the globe for the last two decades. Now, the overwhelming number of objects around us are enabled to collect, process and send data to other objects, applications or servers. They span numerous industries and use cases, including manufacturing, medicine, automotive, security systems, transportation and more.

The IoT system can function and transfer information in the online mode only when devices are safely connected to a communication network. What makes such a connection possible? The invisible language allowing physical objects to “talk” to each other consists of IoT standards and protocols. General protocols used for personal computers, smartphones or tablets may not suit specific requirements (bandwidth, range, power consumption) of IoT-based solutions. That is why multiple IoT network protocols have been developed and new ones are still evolving. There is a multitude of great choices for connectivity options at the engineers’ disposal. This article explains complicated abbreviations and helps you make sense of the Internet of Things standards.

## II. IoT PROTOCOLS BACKGROUND

The first devices connected to the global net appeared in 1982. It was a Coca-Cola vending machine that could control the temperature of the machine and keep track of the number of bottles in it. The term “Internet of Things” is considered to be formulated in 1999 by Kevin Ashton, an RFID technology researcher [1].

In the 1990s, all IoT-related activities came down to theoretical concepts, discussions and individual ideas. The 2000s and 2010s was a period of rapid development, when IoT projects began to succeed and found certain practical applications. Multiple small and large projects were created, from intelligent lamps and fitness trackers to self-driving cars and smart cities. This was made possible because of the emergence of wireless connections that could transfer information over a long distance and the increased bandwidth of Internet communications [2]. The IoT grew to a completely “different Internet,” so that not all existing protocols were able to satisfy its needs and provide seamless connectivity. That’s why it became a vital necessity to create specialized IoT communication protocols and standards. However, some existing technologies (e.g. HTTP) are also used by the Internet of Things.

## III. DIFFERENT IoT PROTOCOLS

Can you build an IoT system with familiar Web technologies? Yes you can, although the result would not be as efficient as with the newer protocols. HTTP(S) and Websockets are common existing standards, which can be used to deliver XML or JavaScript Object Notation (JSON) in the payload. JSON provides an abstraction layer for Web developers to create a stateful Web application with a persistent connection to a Web server. IoT Protocols are broadly divided into two basic types: IoT Network Protocols i.e. communication protocols and IoT Data Protocols. Few IoT Data protocols are MQTT, CoAP, DDS, AMQP. And IoT network protocols are ZigBee, Bluetooth, LoRaWAN, Wifi,



#### D. Data Distribution Service (DDS) [6]

It enables scalable, real-time, reliable, excessive-overall performance and interoperable statistics change via the submit-subscribe technique. DDS makes use of brokerless architecture and of multicasting to convey high-quality QoS to applications. DDS can deploy in platforms ranging from low-footprint devices to the cloud and supports green bandwidth usage in addition to the agile orchestration of system additives. The DDS – IoT protocols have fundamental layers: facts centric submit-subscribe (dcps) and statistics-local reconstruction layer (dlrl). Dcps plays the task of handing over the facts to subscribers, and the dlrl layer presents an interface to dcps functionalities, permitting the sharing of distributed data amongst IoT enabled objects.

#### E. ZigBee [7]

ZigBee is a low-power, low data-rate wireless network used mostly in industrial settings.

The Zigbee Alliance even created the universal language for the Internet of Things — Dotdot — which makes it possible for smart objects to work securely on any network and seamlessly understand each other.

- 1) Standard: ZigBee 3.0 based on IEEE802.15.4
- 2) Frequency: 2.4GHz
- 3) Range: 10-100m
- 4) Data Rates: 250kbps

#### F. LoRaWAN [7]

LoRaWAN (Long Range Wide Area Network) is a protocol for wide area networks. It is designed to support huge networks (e.g. smart cities) with millions of low-power devices.

LoRaWAN can provide low-cost mobile and secure bidirectional communication in various industries.

- 1) Standard: LoRaWAN
- 2) Frequency: Various
- 3) Range: 2-5km (urban area), 15km (suburban area)
- 4) Data Rates: 0.3-50 kbps

#### G. Wifi [8]

Wi-Fi is the technology for radio wireless networking of devices. It offers fast data transfer and is able to process large amounts of data. This is the most popular type of connectivity in LAN environments.

- 1) Standard: Based on IEEE 802.11
- 2) Frequencies: 2.4GHz and 5GHz bands
- 3) Range: Approximately 50m
- 4) Data Rates: 150-200Mbps, 600 Mbps maximum

#### H. Bluetooth [7]

Bluetooth is a short-range communications technology integrated into most smartphones and mobile devices, which is a major advantage for personal products, particularly wearables.

Bluetooth is well-known to mobile users. But not long ago, the new significant protocol for IoT apps appeared — Bluetooth Low-Energy (BLE), or Bluetooth Smart. This technology is a real foundation for the IoT, as it is scalable and flexible to all market innovations. Moreover, it is designed to reduce power consumption.

- 1) Standard: Bluetooth 4.2
- 2) Frequency: 2.4GHz
- 3) Range: 50-150m (Smart/BLE)
- 4) Data Rates: 1Mbps (Smart/BLE)

## IV. CONCLUSIONS

The Internet has changed drastically the way we live, moving interactions between people at a virtual level in several contexts spanning from the professional life to social relationships. The Internet of Thing has become the basis of digital transformation and automation, developing new business offerings and improving the way we live, work and entertain ourselves. Choosing the appropriate type of connectivity is an inevitable part of any IoT project. This paper gives you a general idea of how to link your smart thing to the net through different protocols.



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