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Connecting IOT with diffrent wireless technologies

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Abstract : *In the rapidly growing Internet of Things (IoT), applications from personal electronics to industrial machines and sensors connect wirelessly to the internet. Covering a wide range of use cases in various environments and serving different requirements, no single wireless standard can effectively overcome. The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to attach and exchange data. Each thing is exclusively particular through its embedded computing system but is* capable to inter-operate within the accessible *Internet* infrastructure
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I. Introduction

With different communication protocols, choosing the right wireless connectivity technology for an IoT application can be quite challenging. In this paper, we will review the predominant wireless connectivity technologies, discuss their key technical concepts and engineering trade-offs, and provide guidelines for selecting the right wireless technology for different applications. We will focus specifically on wireless technologies that operate in the industrial, scientific and medical (ISM) band where spectrum use is free, rather than technologies like cellular where the licensed spectrum drives up cost. Federal Communications Commission (FCC) in the U.S. and the Conference of Postal and Telecommunications Administrations (CEPT) in Europe standardize radio transmissions worldwide. These agencies allocate frequency bands for specific use and drive radio transmitter standards and certification plans. To function a radio transmitter in a area of chosen frequency channel specific spectrum in most area is designated as "licensed," which means that users need to buy a license from the local regulator. A familiar example for licensed frequency-band use is cellular communication. Government auctions worldwide sell spectrum bands to mobile operators to regulate commercial frequency distribution The International Telecommunication Union's Radio communication (ITU-R) Sector coordinates the shared global use of the radio spectrum in reserve several frequency bands in the field of industrial, scientific and medical (ISM) applications. country to country ISM bands are unlicensed and different. popular ISM bands in recent years have included 433MHz, 868MHz, 915MHz, 2.4GHz and 5GHz for worldwide The 2.4GHz band became very popular because it is used for unlicensed use in all regions and such band's distribution makes development and distribution of 2.4GHz-based products across nations . Creating opportunities , IoT lets objects to be sensed or controlled remotely transversely existing network infrastructure..

II. Communication Protocols

Communication systems defined a set of rules and standards to format control and data exchange. The most common model in data communication systems is the Open Systems Interconnection (OSI) model breaking communication into functional layers and enables easier execution of scalable and interoperable networks. The OSI model shown in Figure 2 has different seven layers; along with how these map to the different protocols of a wireless the TCP/IP stack. Wireless connectivity protocols are generally implemented at layer 2, layer 1 represented the physical layer such as Ethernet or, in the case of wireless connectivity, the modulation implementation

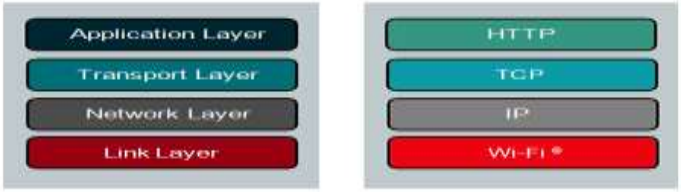

Figure 1. Simplified OSI model (left) and an example of a TCP/IP protocol stack (right).

There are two sublayer wireless protocol the logical link control (LLC) layer and the media access control (MAC) layer.Function of network layer is to address and routes data throughout the network. IP is the internet's network layer protocol, provide an IP address to devices and carrying IP packets from one device to another communication sessions between applications running on two ends of a network is carried by transport layer, here multiple applications can be run on one device using its own communication channel .The transport layer allows multiple applications to run on one device, each using its acquire communication channel.

To IP or not to IP

The Internet of Things (IoT) is all about connecting things to the internet. Devices that connected to the internet use the IP to exchange the data and devices in a local network can use non-IP protocols to communicate in local network. The gateway communicates with local devices using a non-IP method on one side, and with other devices on the internet with IP on the other side.To exchange the Devices that (directly) connect to the internet must use the IP in order to exchange data with devices and servers. devices in a local network can use non-IP protocols to communicate within the local network that is to the internet through an internet gateway. The gateway communicates with local devices using a non-IP method on one side, and with other devices on the internet with IP on the other side. The gateway restructure data with a TCP/IP stack taken from local network to enable communication with an internet service. The advantage of using the IP in IoT node devices is that it allows the use of a network (IP)-layer gateway.

NETWORK RANGE

PANs are usually is wireless technology which cover a range of about 10m. Wireless PAN devices typically have low radio transmission power working on small batteries.Wireless LANs (WLANs) usually cover a range up to 100m. A biggest example is a home Wi-Fi network provided that internet access to personal computers, smartphones, and other IoT devices like thermostats and home appliances The internet is considered a WAN and consist of a complex mix of wired and wireless connections.

Figure 2. Diffrent ranges and application wireless technologies connecting LAN,WAN,PAN,MAN

III. Network Topology And Size

Wireless networks are described with different topologies– the way nodes in a network are arranged and how they connect to each other. The two fundamental network topologies are star and mesh are shown in Figure 4. In a star topology, all of the nodes connect to one central node, which is typically also used as the gateway to the internet. A popular example of a star topology is a Wi-Fi network, where the center node is called an access point (AP) and the other nodes are called stations. In a mesh network, every node can connect to multiple other nodes. One or more nodes in the network serve as an internet gateway. In Figure 4, every node in the network connects to every other node. In real life, a mesh topology is simpler. A popular example of a mesh network is a Zigbee network, where multiple lights form a mesh network to expand the area

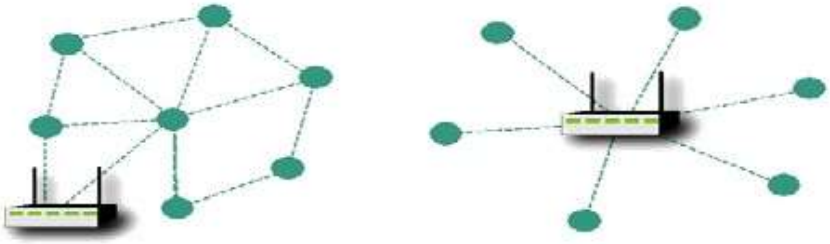

Figure 3: Mesh Topology and Star Topology

WI-FI

Wired IEEE 802.3 Ethernet standard is now replaced by Wi-Fi technology, based on the IEEE 802.11 standard

Wi-Fi technology primarily described by the link layer of a local network. Although Wi-Fi technology mainly defines the link layer of a local network and integrated with the TCP/IP stack so that user can say they are using Wi-Fi, along with TCP/IP for internet connectivity The huge success of Wi-Fi is largely due to the remarkable interoperability programs run by the Wi-Fi Alliance and to the increasing demand for easy and cost-effective internet access. Wi-Fi is already integrated into all new laptops, tablets, smart phones and TVs. Taking advantage of its existing ubiquity, Wi-Fi is also widely used in IoT applications that can influence installed Wi-Fi infrastructures exclusive of custom gateways. 2.4GHz ISM license free band where WI-FI operate most probably insted in the 5GHz band, where more channels exist and higher data rates are available.Wi-Fi and TCP/IP software are quite large and complex. For laptops and smartphones with powerful microprocessors (MPUs) and large amounts of memory having no issue for connectivity devices with little processing power such as thermostats and home appliances are not possible in regarding cost-effective. Today, silicon devices and modules embeded with the Wi-Fi and TCP/IP software in the device. These new devices reduces most of the operating cost from the MPU and enable wireless internet connectivity with the smallest microcontroller (MCU). The latest Wi-Fi silicon devices apply advanced sleep protocols and fast on/off times to increase the average power handling capability. Since most IoT products do not need the maximum data rates that Wi-Fi offers, intelligent power-management design can well draw bursts of current from the battery for very short intervals and keep connectivity of product to the internet for over a year using two AA alkaline batteries. Today, you can buy sports based on Wi-Fi- watch that uploads workout data to the internet.

IV. Bluetooth

Bluetooth technology is invented by Ericsson technology in 1994 as a basic standard for wireless communication between phones and computers. The operating band is 2.4GHz ISM band with IEEE standard 802.15.1. The Bluetooth is basically classified as Classic Bluetooth and Bluetooth low energy. Bluetooth 4.1, is introduced in 2013 with improved power consumption which also allow to specify custom reconnection timeout intervals relatively than a fixed timeout period, enabling devices to spend a lot longer in ultra-low-power states. Enhancement of Bluetooth 4.1 improved coordination of Bluetooth and 4G radios so that both could concurrently operate at maximum performance. The specification of Bluetooth 4.2 is established in 2014, with characteristics of higher performance; greater range, privacy and security enhancements; and simpler internet connectivity. By increasing the packet capacity from 27 bytes to 251 bytes, data throughput reached to 800Kbps. Bluetooth low energy 4.2 added industrial-strength security with elliptic curve cryptography (ECC)-based key.In 2016, Bluetooth 5 standard is introduced with the specialization of doubles speed (up to 2Mbps) and provides an eightfold increase in data broadcasting capacity by increasing the advertising data length. Bluetooth 5 offers a choice of data rates – 2Mbps, 1Mbps, 500Kbps, and 125Kbps .

Zigbee

2.4GHz ISM band is also used by IEEE standard 802.15.4 called as Zigbee. It is based on the IEEE 802.15.4 link layer and operates in the 2.4GHz ISM band. Its networking layer has been designed operations in mind from the ground up; providing the ability to scale the network geographically through multihop operations, as well as fault tolerance , increased reliability are created as backup paths through the mesh. One of Zigbee's major benefits is that it provides a complete solution which enables device interoperability between different manufacturers. The broad availability of Zigbee solutions is a further advantage for OEMs that own entire ecosystems and want to sell services to their customers that leverage accessible products and solutions. mesh and direction-finding management with a very tiny energy footprint. Devices using Zigbee are typically low data rate emitting sensors and actuators and – with the low-power performance of the underlying 802.15.4 link layer radio and the efficiency of a whole protocol suite designed to transport application and management data in short frames – greatly minimizing a time and therefore power consumption. Zigbee also supports the Green Power feature set, an addition to the Zigbee specification for even more energy-constrained devices.

THREAD

Thread is based on the IEEE 802.15.4 specification and operates in the 2.4GHz ISM licenses free band, like Wi-Fi, Bluetooth low energy and Zigbee. Silicon vendors like Google, Samsung and similar wanted to directly connect low-power IoT nodes to IP networks formed the Thread Group which define a standard. It ensures device interoperability in the smart home automation . Thread announced the extension to commercial building applications also. It provides data rates of up to 250kbps and support 250 devices in one local network mesh.

Thread uses lower-overhead higher-level protocols such as User Datagram Protocol (UDP). Thread has

advantage of low-power operation, IPv6 addressability and mesh networking. Thread builds on this base feature set to add superior security, reliability, scalability and ease of commission.

V. Sub-1 Ghz

In 2.4GHz band lower ISM frequency bands available, such as at 433MHz, 868MHz and 915MHz . These bands are commonly known as Sub-1 GHz. Proprietary protocols running over radio transceivers operating in the Sub-1 GHz band is used by many industrial applications. Security systems and industrial control and monitoring are other industrial application where Sub-1 GHz systems need an application-layer internet gateway to connect to the IoT. Sub-1 GHz solutions can offer very low power and long ranges with a simple star topology. Note that there is a direct correlation between range, data rates and power consumption. The longer the transmission range, the lower the data transmission rate. Low data transmission rates in turn direct to improved power consumption, as the device must be active longer to transmit data.With star topology it offer very low power and long ranges. Direct correlation between range, data rates and power consumption is necessary to maintain. While the 2.4GHz band is the most well-known ISM band, almost all countries make lower ISM frequency bands available, such as at 433MHz, 868MHz and 915MHz. These bands are commonly known as Sub-1 GHz. Many industrial applications today use proprietary protocols running over radio transceivers operating in the Sub-1 GHz band. The radio transceiver provides the link layer of the network .
Wireless Smart Ubiquitous Network (Wi-SUN)-based frequency hopping provides more robust transmission. Since a 15.4 network requires a gateway to connect to the internet, a reference implementation of a gateway must take the 15.4 packets (typically using a virtual serial interface for the radio) and make them available through TCP/IP-based network applications, from which the data is easily sent to the cloud. It must also provide some network formation and management functions that interact with the link-layer protocol on the nodes.

VI. Conclusion

There are numerous wireless technologies in the world. Each one has advantages, and no one is ideal. The question that need to answer is, "Which technology, or combination of technologies, is the best one for my application?" This paper has helped you better understand the popular wireless Technologies for IoT, and their strengths and weaknesses. Additional considerations that go beyond the scope of this paper include cost, ease of integration and security. We see great improvement on total solution cost and ease of integration in many new products that use wireless connectivity, but you should consider cost and integration efforts further in the context of specific applications. Security aspects of IoT applications include the supported capabilities of each of the protocols, as well as additional hardware and software considerations, also beyond the scope of this paper. Zigbee is an open typical designed, promoted and maintained by the Zigbee Alliance, a group of more than 400 companies from different industries.

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