ZigBee Wireless Technology in Internet of Things

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Abstract— Internet of things (IoT) is not only a concept, it's a network, the true technology-which enable network of all networks. ZigBee protocol is a new wireless mesh network standard as IEEE 802.15.4 defines for LR-WPAN which gives interoperability, low cost, low latency, ultra-low power and very less complicated Solution. ZigBee protocols provide easy interoperability in Internet of Things with other wireless protocols. The Low cost wireless technology allows to widely using for wireless device control, monitoring and sensing applications and the consumption of Low power fashion which provides longer life with small coin cell batteries. ZigBee is being widely used for sensing data and many other research fields. In this paper author focuses on the impact and importance of ZigBee Technology as an innovation which brings low cost, less power consume and faster connectivity. This paper also contains different wireless protocols, similar service and their trade-offs.

Key words: IEEE 802.15.4, Mesh, IoT, ZigBee

I. INTRODUCTION

The technology ZigBee which is specially adopted for wireless sensor networks for huge application area as home/office automations, agricultures, health, flood monitoring etc. In technology era WSN is one of the most inspiring, research technologies in markets today. In the IoT technology WSN have a more significant impression in all major research area, Industries, home automation and our daily lives. ZigBee name got from the flying/travelling of bees Zig and Zag while they tracking of different flowers and carries resources from one place to other bees. ZigBee has its own global standard for wireless network connectivity and interoperability of others wireless Products. IEEE has been introduced ZigBee as a standard of IEEE 802.15.4 and ZigBee alliances group to provide the standard general applications for these. ZigBee wireless protocol standard gives better security, support application on the top of IEEE802.15.4 PHY and MAC layer standard with 2.4 GHZ Radio Frequency worldwide with data rate of 250 Kbps best suited, periodic, irregular, or signal transmission from sensing device or an input device [1].

The Network layer ZigBee supports multiples network topologies including Cluster Tree, star and mesh network topologies with interoperable feature and data security application profile. In every Mesh topology there is a coordinator who is responsible for creates a network and choosing key network parameters. In IoT ZigBee protocol has self-managing features without any human action one device or node can be communicates with distinct node, and they connect with each other automatically to setup a completed network. ZigBee network is protected with an AES 128-bit network key. ZigBee offers global wireless and green standard connecting to world to control the wide range wireless devices intelligently and help together to needed demands of customers through Internet of Things.

In the IoT wireless sensing devices are IPv6 enabled and they sensing the information from real world and wireless networks they (IEEE802.15.4) access the channel using CSMA/CA method [2] (Figure 1) because devices are sensing the data continuously.

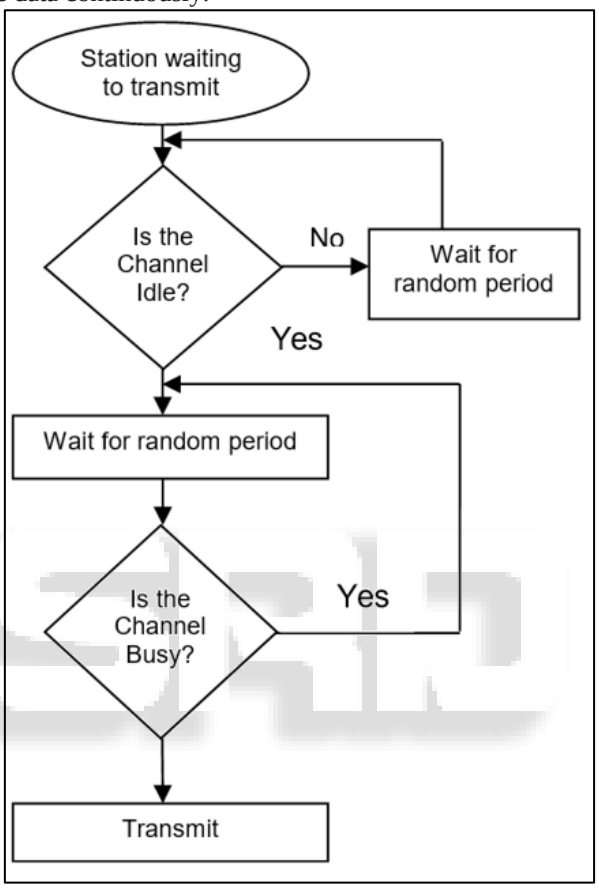

Fig. 1: CSMA/CA Work Flow Chat

ZigBee uses the asynchronous connection means that router will remain wakeup all the time, so that the power consumption for the router relatively high compared to the end node, end node wakeup anytime without any disturbance because they sensing information and send it to the central node. ZigBee might be a best because of lots of merits such as size is very small, ultra low power, low latency, low cost and easy interoperability with other IoT protocols. ZigBee protocol is best key for short range communication and low data rate transmission in wireless technology in internet of things.

II. ZIGBEE (IEEE 802.15.4) –GENERAL CHARACTERISTICS

In 2003, ZigBee has been standardized as IEEE 802.15.4 protocols for interconnecting the devices via radio channel using PAN. The ZigBee PHY layer of IEEE 802.15.4 standard has three frequency bands as 868MHz in 20kbps, 915MHz in4okbps, and 2.4GHz in 256kbps data rates as European, North American and World Wide Applications. Due to low propagation losses in ZigBee it provides longer

range at lower frequency. Low data rate gives better sensitivity and larger coverage area. Main feature of the PHY layer in IEEE802.15.4 are activation and deactivation of radio channel, link quality Intimation, detection of energy, selection of channel, acknowledgement, clear of channel assessment, security and receiving and transmitting the radio packets to the entire physical medium [3].

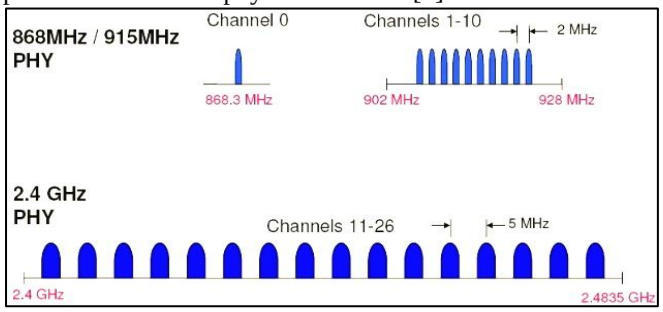

Fig. 2: PHY Layer

ZigBee has low duty cycle devices as controls and sensors with low latency, high security and high performance. The power consumption is very less so it provides long lasting battery life up to month to years. Another interesting characteristics is that's Zigbee supports multiple topologies as Mesh, Star, Cluster Tree. According to the latest version of ZigBee 3.0 average communication range is up to 300+ meters in line of sight and up to 75-100 meters indoors. ZigBee supports AES-128 bit data encryption in Network and as well as application layer [4]. ZigBee is easy to install, easy to use, market flexibility, reliability because if one device is fails then standard allows other device to still communicate in together and is widely usable protocols for small devices in Internet of Things.

III. PROTOCOL STACK & ARCHITECTURE

In Internet of Things area ZigBee has huge application with their specification, advantages and their trade-offs. ZigBee protocols are intended for low power, low energy consumption and low data rate tolerating devices. A ZigBee high level wireless protocol which is using low power and very small, digital radios based on IEEE802.15.4 protocol standard. ZigBee Mesh network protocols standard provides data security, network privacy, and application services are handle on the top of the IEEE802.15.4 PHY and MAC layer wireless standard [5]. The below figure shows different layers of ZigBee protocol stack. The Current ZigBee Pro which is consume very low power networking design for IoT applications with facilities easy to use and advanced support for large networks consists of thousands of devices [6], ZigBee 3.0 technology provides the widest range of device types like low-power, low cost wireless network technology today.

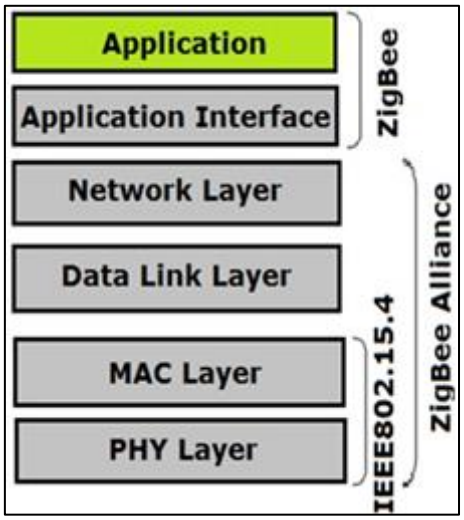

Fig. 3: ZigBee Protocol Stack

The ZigBee layer architecture has four distinct layers as PHY, MAC, Network and Application layer. The PHY and MAC layer are stated by IEEE 802.15.4 [7] standard protocols for wireless sensor devices which consuming very low power. Physical layer is mainly having two services as data service and management's service connecting to the physical layer. ZigBee Physical layer closed to hardware's and the ZigBee radio channel can be directly controls and communicates. Another feature of PHY layer is activation and deactivation of channel selection, radio transceiver and vice versa during transmission. The responsibility of MAC layer mainly is interacting between PHY and Network layer and also responsible for network discovery and providing PAN ID through beacon request.

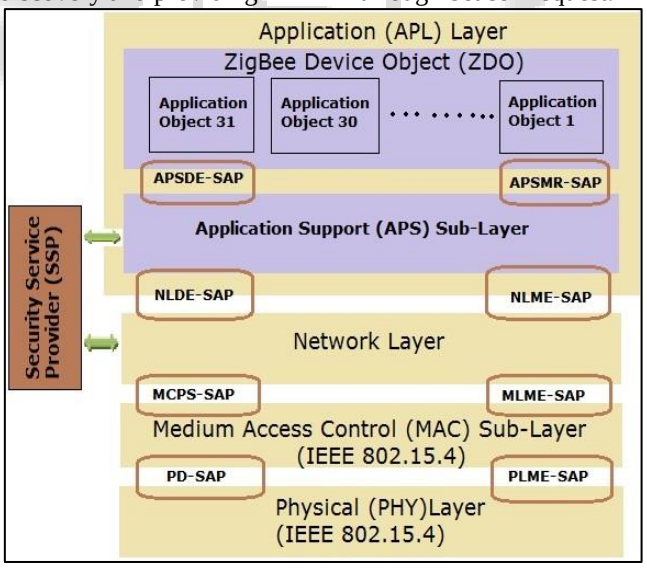

Fig. 4: Layer Architecture of ZigBee

The network layer is an interface between MAC and Application layer, which provides mesh network configuration (Formation and routing), manipulation. The network layer provides high security of entire data in the encryption form in ZigBee network. The highest layer of ZigBee protocol is application layer which has application support (APS) sub layer and ZigBee Device objects (ZDO) which contains manufacturer define applications. The APS sub layer does discovering and binding services and ZDO is responsible for local and over air managements of network.

IV. ZIGBEE DEVICES & NETWORK TOPOLOGIES

In IoT wireless communication technology ZigBee also a low power network technology being widely used for monitoring, sensing and many other research fields, which supports different protocols to designed to carry small amounts of data packets over the short distance and it maintaining very low power consumption. ZigBee have mainly two types of devices such as Logical Devices, which have three types such as Coordinator, Router, End devices and other one is Physical devices which have Full Function Device (FFD) and Reduced Function Device (RFD). The FFD have full function, they have standard, admitting routing mechanism, coordinator jobs, detection task. The RFD do not have packet routing function and it linked with FFD. Some jobs of RFD are like reading temperature data, surprising lighting circumstance [8]. The ZigBee coordinator is single coordinator in each network and it is FFD because it has huge responsibility as unique network identifier, other functional parameter arranging and radio channel frequency. The coordinators have to manage entire network and talk with all the siblings. The Router also a FFD and it can be detects devices and routing the incoming as well as receiving data. Fundamentally the ZigBee router does all the task of the coordinator excludes the network start-up. The End devices are RFD, their primary task is to collect the resources from neighbor's area and transmitting them as a packets. All the end devices are connected to the router as well as Coordinator, they can be in sleep mode when they not receiving or sensing the information to preserve the power.

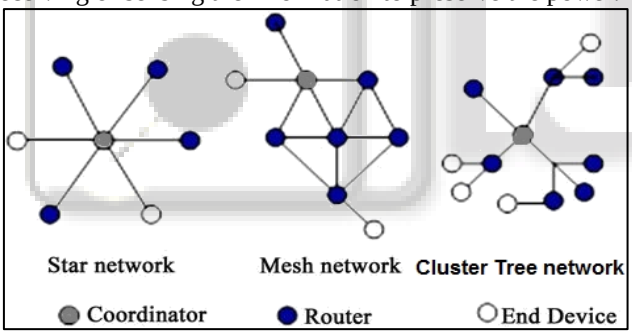

Fig. 5: Topology Model

The current ZigBee technology supports three diverse topologies- Star Topology, Mesh Topology, and Cluster Tree Topology. Star topology there is only one coordinator selected by all the end devices and routers which can handle whole network, responsible for receiving and sending of packets. In mesh topology all the nodes are connected to each other, there is multiple path to transmit the information if one link is failing to sending or receiving the data then through other path the data will be transmit in the network. In the cluster tree topology it's a combination of star and mesh topology, the coordinator is the root and their children are router and end devices. Child are allowed to communicate with parents directly as well as parent can communicate with other node directly.

V. ZIGBEE APPLICATIONS

ZigBee technology is a wireless sensor network system which basically used for remote monitoring and controlling of load parameters. There huge application of ZigBee in Internet of things such as Home Automation, control, commercial building automation [9], health wellness fitness, land slide monitoring [10], telecommunication and hugely used in industrial process monitoring, control and many other research fields.

VI. COMPARATIVE STUDY OF ZIGBEE WITH DIFFERENT WIRELESS TECHNOLOGY

In the Internet of Things all the protocols are wireless and all the diverse devices have IP enabled. In the below table we shown ZigBee technology protocols with other wireless communication technology protocols and their different trade-offs.

Wireless Protocols → Characteristics ↓	ZigBee	BLE	Wi-Fi	Thread
IEEE Standard	802.15.4	802.15.1	802.11	802.15.4
Frequency Access Band	2.4GHz, 868MHz, 915MHz	2.4GHz	2.4GHz, 5GHz	2.4GHz
Range (m)	1-100	10	100-150	30
Bandwidth	250kbps	1mbps	1gbps	250kbps
Node Per Network	65000	7	30-250	300
IP Support	No	No	Yes	Yes
Security Support	AES-128	AES-128	AES-128, 256	AES-128, ECC
Network Topology	Star, Tree, Mesh	Tree, Star	Star, Mesh	Mesh
Power Consumption Per Bit (μw/bit)	185.9	0.153	0.00525	11.7
Peak Current Consumption	30mA	12.5mA	116mA	12.3mA
Memory	32-60kb	100kb	100kb	50-100kb

Table 1

VII. CONCLUSION

In this study we address one of the important researches wireless technology protocols ZigBee in Internet of Things. In this study we describe ZigBee protocols stack, Architectures, different topologies, types of ZigBee devices, applications, and industrial market place. ZigBee supports easy Interoperability with other wireless communication protocols in Internet of things. ZigBee is a ultra-low power consuming wireless protocols in Internet of things which has a boarder range when we connect it to other wireless technology.

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