Modern Implementation of IOT in Low Power Wireless Technologies Using LORA WAN

[1]Mr.A.Muralikrishna, [2] S.Manikandan,
[1]Research Scholar, [2]Research supervisor,
Department of Electronics and Communication Engineering,
Carrier Point University,
Kota, Rajasthan.

ABSTRACT: This Research paper deals **t**he data processing systems and monitors the embedded systems of wireless technologies in internet protocol. Wireless technologies are using a low cost, mobility pose, fading, interference, energy, and security. Wireless technologies are consisting of a several factors of reliability, latency, scalability and efficiency of energy. The MAC and physical layer technologies are require a wireless communications. Emerging IOT applications are supported and exploit new strategies and satisfy the application of various domains. The homes of smart, healthcare of smart, automation industrial, and smart cities are used the wireless communication. To communicate each other and does not use wires then create a IOT with the help of radio frequency(RF),light and sound, and the Bluetooth.

INDEXTERMS:IOT,RF,WSNs,WPANs,M2M,WSANs,CPSs,LLNs,FFD,RFD,TDMA,SO and TSMP.

I. INTRODUCTION

The Internet of Things (IOT) is used to inter-networking; it is consisting of a sensing, computation, and communication. A different type of task is interacting to the network.IOT is used to the domain application of smart homes, medical care, automation industrial, transportation intelligent, management resource, cities of smart, management energy, etc. Smart sensors are containing a monitoring control task differently. An application-dependent terms are includes a communication of Machine-to-Machine (M2M), Wireless Sensor Networks (WSNs), Wireless Personal Area Networks (WPANs), Wireless Sensors and Actuators Networks (WSANs), Cyber-Physical Systems (CPSs) are used in the IOT [1].

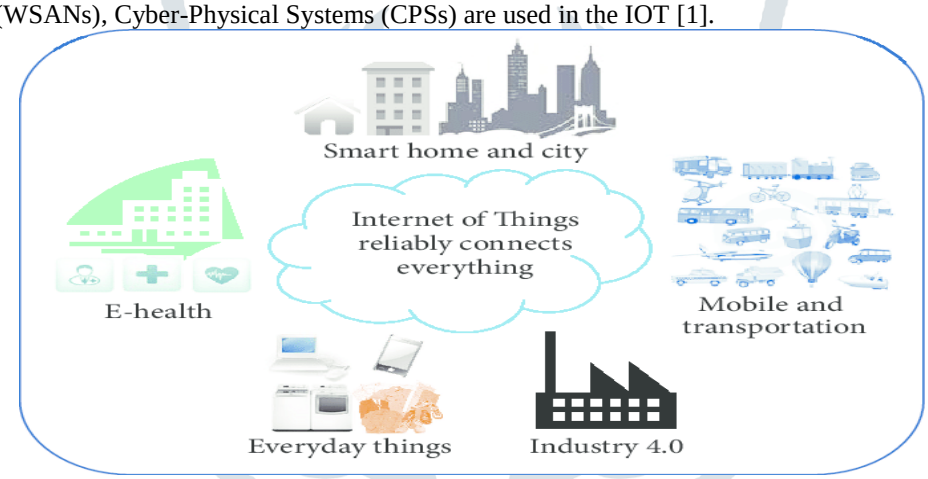


Figure: 1 Applications of IOT in different domains.

The communication concepts are includes smart objects with IOT for create a smart decision. The computing intelligence, technologies of network, protocols of inter networking, and the applications are embeds with this process. Exchange of information is support and utilize by the wired and wireless networks. It is called as the network of local access backbone. It is support the multi-hop communication of wireless networks and it is accessed locally. Low-Power and Lossy Networks (LLNs) are described as unreliable. These networks are highly accessible. IOT services are focus to the mobile users. The autonomous operation, are help to the IOT. Smart processes and systems are industrial application used in the smart factory [2].

The networking requirements are transforming a several application and communicate to the IOT. Wireless network connectivity is a reliable and it is used an application of automation process industrial control, healthcare, situations of emergency, recovery and the home safety. Data transfer actions are performed in the particular time and consist of different objects. Machines and controllers real time communication is required by the industrial system control process. The power is saved by the node and performs a low power operation. The network lifetime are prevented and avoid the communication of unnecessary. The technologies are developed and used a different features and protocols. Quality of Service is used in the different IOT application. Low-power wireless standards and technologies are consisting of reliability, latency, scalability, and energy consumption in the process.

The IOT is used to develop working with the help of sophisticated standards protocols. Low-power wireless standards and technologies are analyzed and it is present the Thread, Wireless HART, IPv6 Low Power Wireless Personal Area Network (6LoWPAN), IPv6 TSCH (6TiSCH) etc. Bluetooth Basic Rate, data rate, low energy are used in the different type of technologies. The standards and technologies are designed by the layer of Medium Access Control (MAC).The IOT application is require a resource object and develop a protocol design. IEEE 802.15.4 are consist a several standards and it is describe a Bluetooth, radio, and the link layer. BR/EDR and BLE are known as the different Bluetooth version. Different standards and technologies are used to share the band of 2.4GHz.

II. IEEE 802.15.4

Low Rate Wireless Personal Area Network (LR-WPAN) is specifying the PHY and MAC layer. Monitoring a low data rate, control application are developed and it is used a power consumption of low. It is used some features .They are, low-power, low cost, data rate moderate and it is includes the automation of home, automation of industrial, cities of smart, and Wireless Body Area Networks (WBANs). Upper layer medication is use the technology of PHY layer. A flexible protocol is used by the MAC layer. Some of the topology is used in this IEEE 802.15.4.They are star, tree, and peer to-peer network topologies. Full Function Device (FFD) and Reduced Function Device (RFD) are used to the network. The coordination of the network, routing, and sensing are performed by the FFDs. Sensing tasks are performed and a nodes are constrained by the RFDs. The personnel area networks (PAN) are formed, maintained, and managed by the FFD. At a time a single PAN is manage by the FFD [3].

2.1 PHY LAYER

ISM frequency band of the 2.4GHz is used by the PHY layer. Different places are allocated for the different frequency bands. The physical channel is consisting of the PHY Protocol Data Units (PPDUs) and transmission and it is provide a services PHY layer. Some of the functionalities are used to perform the operation of radio transceiver, detection of energy, indication link quality, Assessment of clear channel, frequency channel selection, and transmission of packet. The MAC layer is used to avoid interference and it is used to estimate the power and bandwidth signals are received. Before a transmission creation to determine any activity on the channel and it is used a method of reliable of CCA. Channel energy based on the multiple sampling work. The IEEE 802.15.4 standard bands are defined by the different channels. The bandwidth is used by each channel and includes the bandwidth of 2.4GHz, data rate of 250kbps. A larger bandwidth is support for the use of Direct Sequence Spread Spectrum (DSSS) in IEEE 802.15.4.

The three states are includes to operate a MAC sub-layer, and the radio transceiver. They are, transmit, receive, or sleep. The states of transceiver energy consumption is includes a transmission, reception, and sleep. The incoming packets are listening by the device in the state of idle listening. Receiving or transmitting a packet are listening in the energy consumed transceivers of IEEE802.15.4. In the MAC protocol duty cycling is implemented by the IEEE802.15.4 and it is used to save a power. Transceivers are turning off a node and allow the duty cycle to save energy [4].

III. MAC LAYER

Two channel access modes are used in the MAC, it is flexible one. It is consist of the mode of beacon enabled and non-beacon enabled.

3.1 BEACON ENABLED (BE) MODE

A super frame structure is used to communication and it is start with the beacon period. An active period and an inactive period are two types to develop an operation process. The Contention Access Period (CAP) and Contention Free Period (CFP) are called as the active period. Duty cycling is allowed by the inactive period. The time slots are used in the active period. At the network beacons information of super frame are broadcasted. The PAN coordinator is generating a specific frame for beacon. Two beacons are bound the super frame. New packets are transmitted and the pending request packets are accessed. The channel is minimized and uses the algorithm of Binary Exponential (BE) back off. The transmission of Time Slots (GTSs) are used the Time Division Multiple Access (TDMA). The coordinator of the node is allocated GTSs.

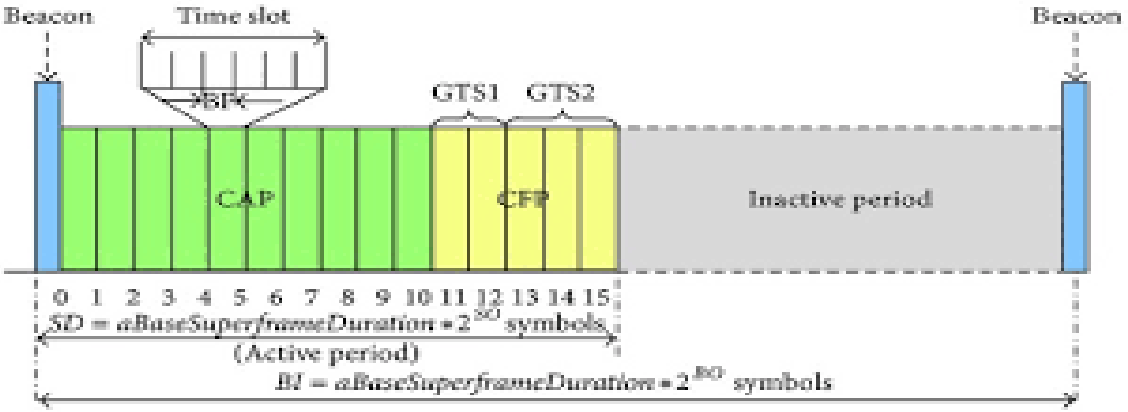


Figure: 2 super frame structure of the BE MAC mode of IEEE 802.15.4 standard

The active and inactive periods, are included by the super frame. Super frame Order (SO) and Beacon Order (BO) are the parameter to configure in the process. A Beacon Interval (BI) is processed by the network coordinator and it is includes the super frame structure. The active duration of the super frame is consisting of the Super frame Duration (SD). BO and BI related to the below values.

$0 \leq BO \leq 14$ ---------- (1)

$BI = \alpha \times 2BO$ symbols---------- (2)

A Base Super frame Duration is defined as α. The SO is equal to zero, and then a number of symbols are formed by the super frame. The beacon frame is defined by SO and it is activate a duration of period.

$0 \leq SO \leq BO \leq 14$ ---------- (3)

$SD = \alpha \times 2SO$ symbols---------- (4)

The value of SD=15.36× 2SO ms with a BI = 15.36 × 2BO ms are calculated in the 2.4GHz. The value of BO and SO adjusted a BI value between the 15ms to 245s.

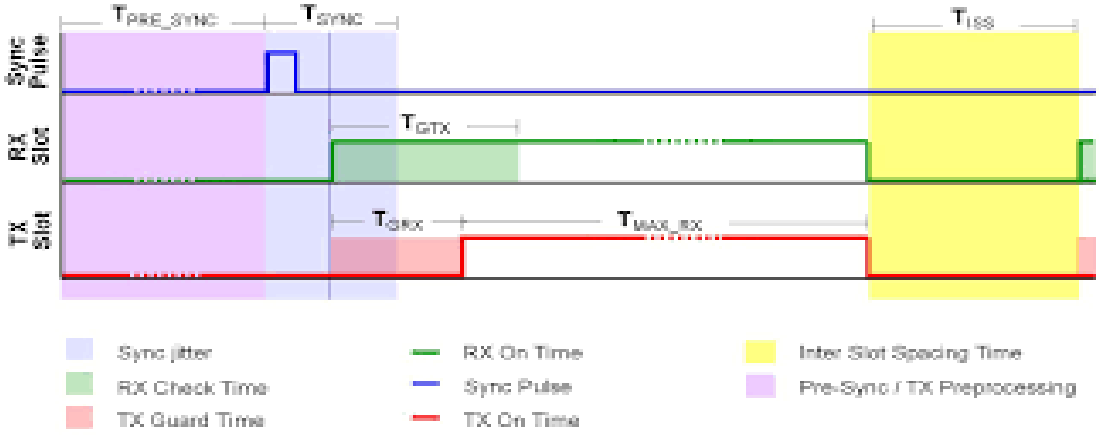
3.2 NON-BEACON ENABLED (NBE) MODE

In this mode GTS allocation is not necessary. A single CCA operation is utilize an unslotted CSMA/CA and access the channel. Back off boundaries are described as without synchronization.

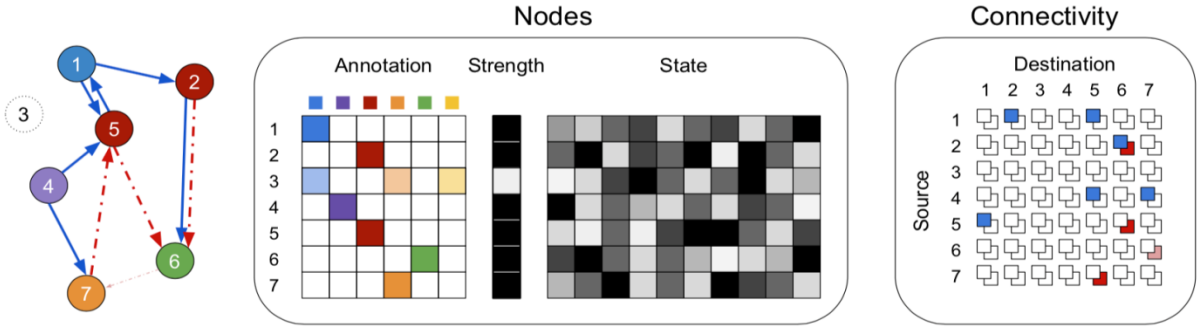
3.3 THE Time-Slotted Channel Hopping (TSCH)

The latest generations of MAC protocols is called as the TSCH MAC. It is includes the low power operation and the reliable. Low-power mesh networks requirements are satisfy by the automation of industrial process. IOT protocol stack is considered by the MAC candidate in the TSCH. Channel hopping is the process of multiple communication channels and access time-slotted with incorporates mechanisms. The nodes are avoiding inherently and access the time-slotted channel. The wireless medium is access in network and communications are building then information is exchanged. When the sender transmits TSCH achieves low-power [5].

TSCH is improved a design with the help of Time Synchronized Mesh Protocol (TSMP). The Dust Networks are designed in the MAC protocol. MAC protocol is accepted widely by the TSMP. The packet formats of higher layer medications are design TSMP. The TSCH slot frame and its functionality are used in this process. MAC protocol of IEEE 802.15.4 is a combination of the back off algorithm and it is used an approach of single channel. Shared medium collisions are avoided. A low duty cycle is maintained and utilizes a channel hopping and use the multi-channel approach in the TSCH. TSCH highly reliable and robust and use the multi-path fading external interference. An average current consume is calculated as the 50 µA at 3.6V.



(a)TSCH slot frame, it also shows sequence of transmission events within a timeslot for a transmitter-receiver node pair



(b)The associated topology where dotted arrows show transmission in shared slots and solid arrows represent transmission in dedicated slots

Figure: 3 TSCH slot frame schedule based on the associated topology

3.4 TSCH Slot frame

Each node is providing a time slot frame and it is communicated to the network and other related information is updated. A slot frame size is does not define by the TSCH. The application programmer is design the parameter of slot frame size. The slot frame size calculated in the range of 0 to 1000 time slots. The nodes of beacons are sent to the network. Maximum size packets ACK are received after maximum size packets send.

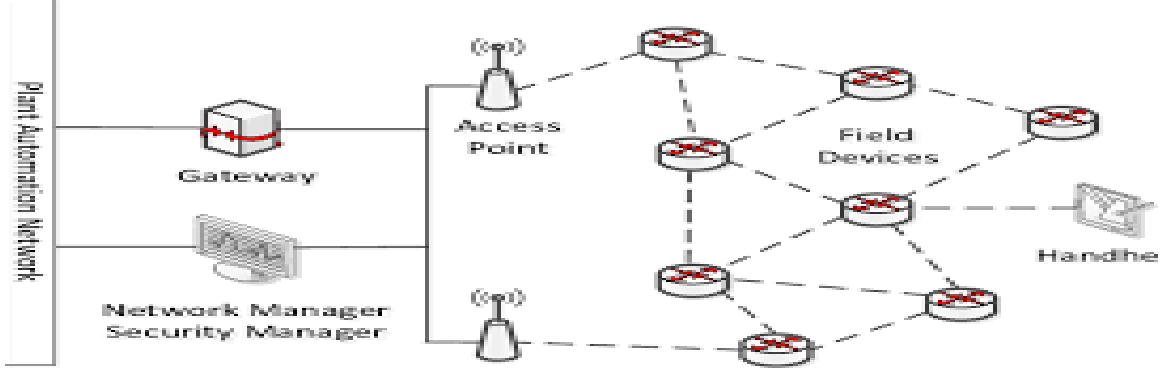


Figure: 4 Wireless HART network architecture showing communication among different kinds of devices

IV. WIRELESSHART

Open wireless industrial standard is called as the Wireless HART. Measurements of industrial process and application control are designed with the systems of HART legacy. The capabilities of self-organizing and self-healing are used to mesh network then it is a communication protocol of secure and reliable. Before the release of Wireless HART, a Bluetooth and ZigBee are require a prevalent industrial control application. End-to-end delay and reliability are offered by the ZigBee and Bluetooth [6].

4.1 IPV6 OVER LOW-POWER WIRELESS PERSONAL AREA NETWORKS (6LOWPAN)

The internet is used to integrate a constrained devices of standardize 6LoWPAN. The 6LoWPAN and Routing over Low Power and Lossy Networks (ROLL) are creating by the IETF. LLNs over IPv6 are developing the routing solution and it is focus by the ROLL. IPv6 protocol is high overhead and complexity and it is difficult to the constrained environments. The MAC payload of IEEE 802.15.4 is described and calculated as cannot be larger than 127 bytes. The specification of the IEEE 802.15.4 is fit to the IPv6 packets. The packet size is small, address length is different, and bandwidth is small, nodes of high density, devices of battery operator, quality of poor link, and the duty cycling are used in the Low Power Wireless Personal Area Networks (LoWPANs). The network layer service is develop and optimized a successful sub layer.

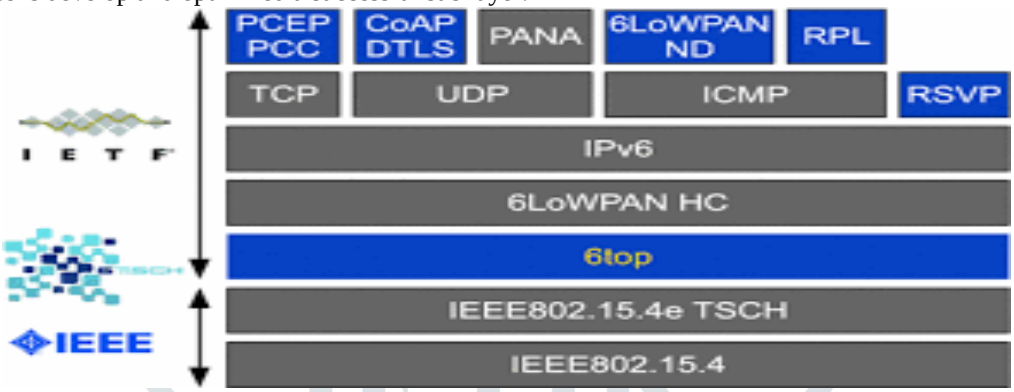


Figure: 5 Envisioned 6TiSCH protocol stack

In the IEEE802.15.4network Header compression (HC) are define a 6LoWPAN and it is consist of an adaptation layer then IPv6 packets are transmitted. The Maximum Transfer Unit (MTU) is support the fragmentation packet and reassembly. Multi-hop connections are allowing IPv6 requirements and it is forward to the data link layer. Two header compression techniques are defined by the adaption layer of 6LoWPAN. An IPv6 link-local address is used by the IPv6 packets compression and includes the 6LoWPAN-HC2 technique. The compression of UDP, TCP, and ICMP are used the 6LoWPAN-HC2 technique. The compression of two nodes is performed by the HC1 and HC2 techniques.

V. BLUETOOTH BASIC RATE AND ENHANCED DATA RATE

An Asynchronous Connection-Less (ACL) link is used for sharing a file and designs a BR/EDR. The broadcasting data is used a link of single point-to-multiple point and it is support the connection of asymmetrical and symmetrical. In v1.2 is used the link of Synchronous Connection-Oriented (SCO) of BR/EDR. Time slots are used to the time transmission and it is provide a new link of three symmetrical point-to-points. ACKs are not delivered in the SCO packets and delay of voice transmission is avoided [7].

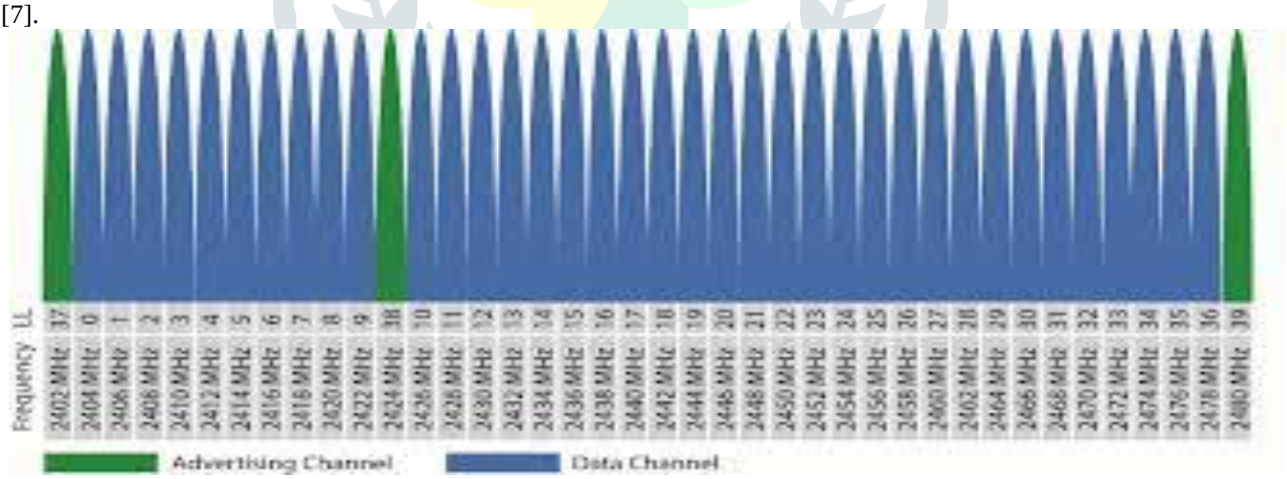


Figure: 6 BR/EDR, BLE, IEEE 802.15.4, and IEEE 802.11 sharing 2.4GHz frequency band

Voice transmission reliability is improved and achieves a high quality. The packets of damaged and lost are retransmit. Other wireless protocols are improving the Adaptive Frequency Hopping (AFH). The Differential Phase Shift Keying (DPSK) modulation technique is used a version of 2.1Mbps. The data rate is improved and user requirements are satisfy by the EDR. The 802.11radio is delivering a data rate of 24 Mbps. The power is save by the BR/EDR radio in the higher AMP.

5.1 Radio frequency

The radio frequencies are used to data transmitting in the RF communication. At different frequencies are used in the different type of technology; it is used to cover a different type of distances. The technologies are described as Wi-Fi, Zigbee, SigFox and LoRa. The communication of short and mid range is used a WiFi. The application of smart homes and industrial are used in this process. In smart cities require a long range communication of Lora WAN.

5.2 WiFi

The Institute of Electrical and Electronics Engineers (IEEE) 802.11 are assigning the standard of communication. The band width of 2.4-5GHz is operated. In wireless transmission 5G networks and the WiFi are perform the important role. The Wi-Fi trademark is used in the Wi-Fi Alliance. A WiFi technology is support the lot of products and it is include a cost. An interoperability change is increase in this process.

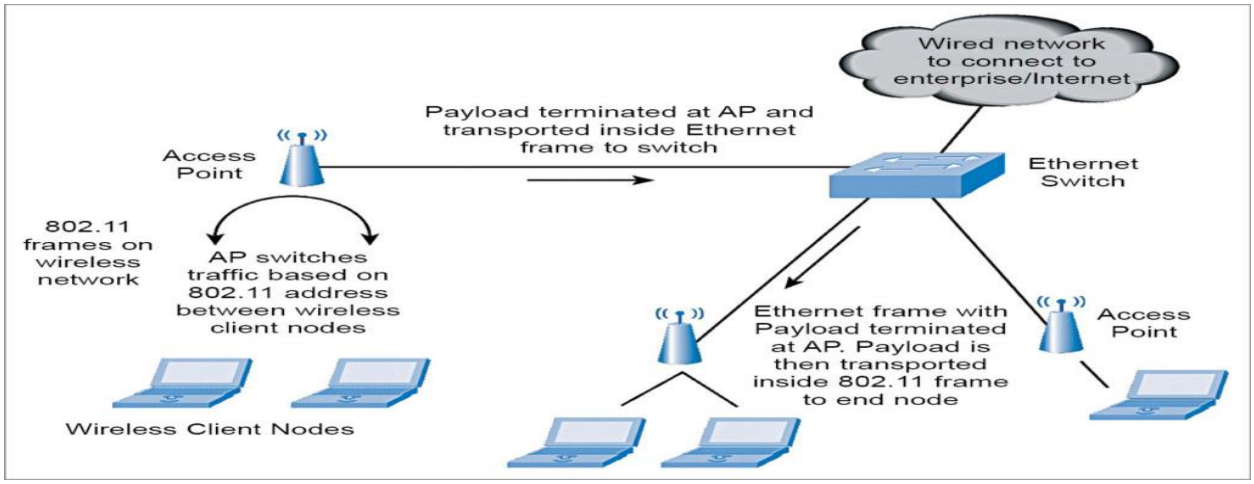


Figure: 7 WiFi Technologies

5.3 SigFox

Multiple devices are connecting to the IOT and distribute an energy and cost in the efficient way. Manual intervention is not used in the devices. The IOT application is used to by the cellular data technology. To transmit data with the use of communication networks and it is manage a lot of power save. An application of multitude is used the Sig Fox. These technologies are adopted by the smart cities. Management of the smart waste, control of the fire-hydrant, monitors the air-quality and updates a level of real time water. It is called as the network of globally. In the network is used travel to the different countries not requires a separate subscription of Sigfox. Many technologies connect and used a lot of protocol in the eco system. In the network smart meters are used to collect a data and require a technology to develop devices and connect it [8].

5.4 Zigbee

RF-based communication technology is called as the ZigBee .It is flexible and lightweight. IEEE is used to assign a 802.15.4 in the industrial application. The bandwidth of same is used in the WIFI and ZigBee. The high level security is provided and it is offer less power then, it is includes an exchange of data. Multilevel parking monitoring systems are used in the sensor networks and it is based on the ZigBee. Measure a warehouse, system control, monitoring system environment are used in this technology. Information's are transmitting using sensor, required products are communicated in the travel data [15].

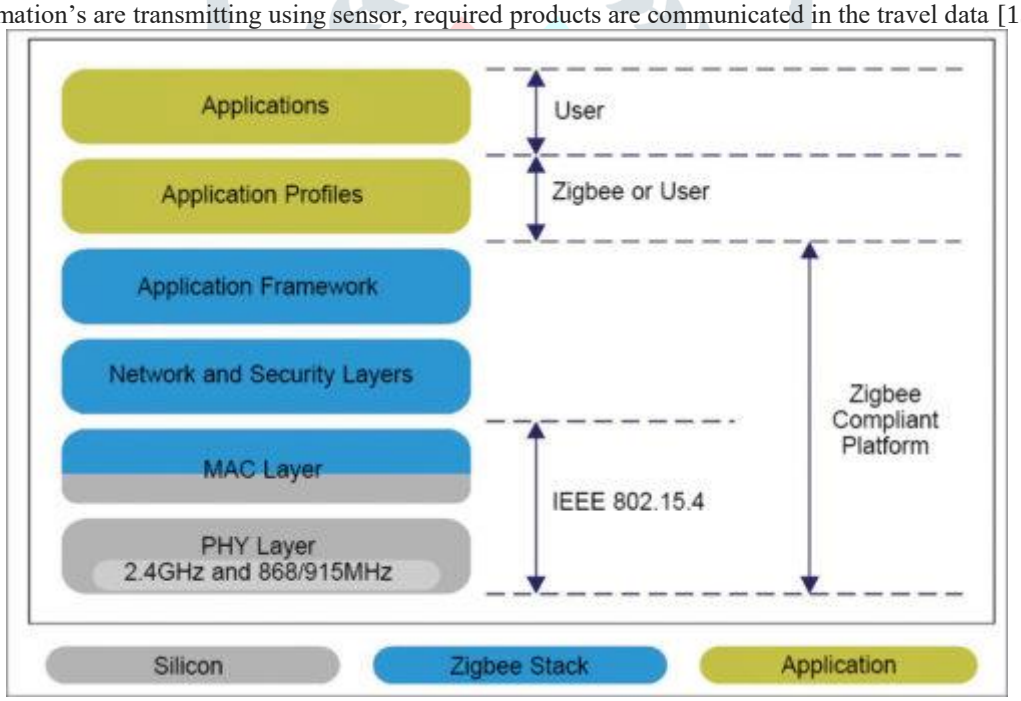


Figure: 8 ZigBee architecture diagram

5.5 IOT communication through light

Different type of IOT objects are used to transfer a data with the help of light. IoT communication technologies are used to the Li-Fi, IR and the laser.

5.6 LiFi

Optical wireless communication technology is used by the LiFi and it is similar to the WiFi.It is used to transfer a data and utilize a spectrum of, infrared and ultrasonic. The vehicles are operated remotely and use an application of Li-Fi and communicate patient data in the hospital.

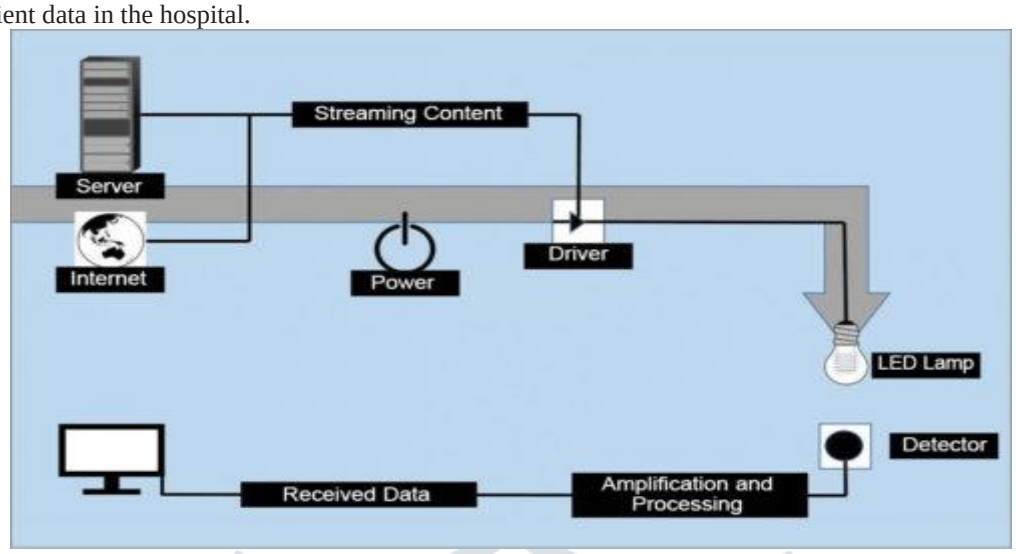


Figure: 3 Li-Fi architecture diagram

5.7 Infrared (IR)

IR is used to communicate of electromagnetic and light range is allowed in the communication of data with short distance. The personal computers and digital assistants are used in these devices.

Figure: 9 IR Transmitters

5.8 Bluetooth

Using Bluetooth technology cell phone is connecting by the Wireless headphones. IEEE is assign the 802.15.1 then various devices of commercial and personal is used by the Bluetooth. Wireless headphones are small products used to develop a process.

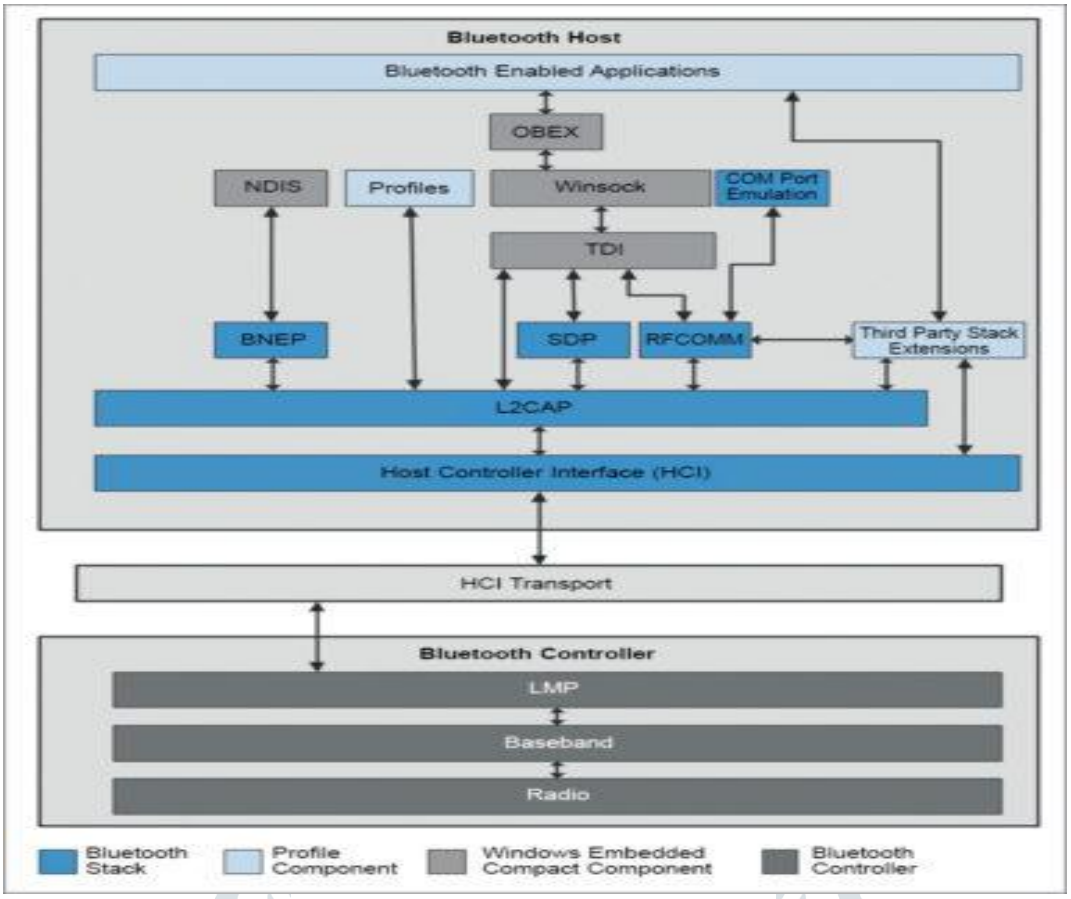


Figure: 10 Bluetooth architecture diagram

Table: 1 comparison of various RF communication Technologies

COMPARISON OF VARIOUS RF COMMUNICATION TECHNOLOGIES

	Low power wide area networks (LPWAN)							Short range networks				
Technical capabilities	LoRaWAN	Neul	NWave	SigFox	Weightless -N	Weight-less -P	Cellular	BLE	WiFi	Thread	ZigBee	Z-Wave
Range	2-5km urban; 15km suburban; 45km rural	Up to 10km	Up to 10km	Up to 10km urban; 50km rural	5km	2km	35km GSM; 200km 3G/4G	80m	50m	Mesh	100m/Mesh	30m/Mesh
Deep indoor performance	Yes	ISM yes, whitespace no	Yes	Yes	Yes	Yes	No	No	No	No	-	-
Freq. band	Varies, Sub-GHz	ISM or whitespace	Sub-GHz	Frequency-independent; 868/902MHz	Sub-GHz	Sub-GHz	900/1800/1900/2100MHz	2.4GHz	2.4GHz	2.4GHz	915MHz/2.4GHz	900MHz
ISM	Yes	Yes, depends on base-station	Yes	Yes	Yes	Yes	Depends	Yes	Yes	Yes	Yes	Yes
Fully bi-directional	Yes, depends on mode	Yes	No	No	Uplink only	Yes	Yes	Yes	Yes	-	Yes	Yes
Data rate	0.3-50kbps adaptive	10-100kbps	100bps	10-1000bps	30kbps-100kbps	Up to 100kbps adaptive	35-170kbps GSM/3-10Mbps LTE	<1mbps	600Mbps max	-	250kbps	10-100kbps
Power profile	Low	Low	Low	Low	Low	Low	Medium	High	High	Low	Low	Low
Authentication	Yes	-	Yes	Yes	Yes	Yes	High security, backed by major telecoms	Trusted devices problematic	Yes	Yes	Yes	Yes
E2E encryption	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Over-the-air soft-ware upgrades	Yes	-	No	No	No	Yes	Yes	Yes	Yes	-	Yes	Yes
Supports sensors moving between hubs	Yes	-	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes, mesh-based	Yes, mesh-based
Location aware	Yes	-	No	No	No	-	Yes	No	Yes	-	-	-
Operational model	Public or private	-	Public or private	Public	Public or private	Public or private	Public or private	Public or private	Public or private	Private/ WiFi backbone	Public or private	Public or private
Standard	LoRaWAN	Weightless	Weightless	No	Weightless	Weightless	GSM, LTE etc	Bluetooth 4.0	IEEE 802.11	Thread, based on 6LoWPAN IEEE 802.5.4	ZigBee	Z-wave
Scalability	Yes	Yes	Yes	Yes	Limited	Yes	Yes	Yes	-	Yes	Yes	Limited

(Source: https://s3-eu-west-1.amazonaws.com)

The foolproof security is mass adoption in the IOT. The consumer data is shared and it is safely informed. The conventional method is used wires the data is transmitting and receive in the wireless technology. The different technology factors are used the quality of power and energy .It is require a coverage range and bandwidth.

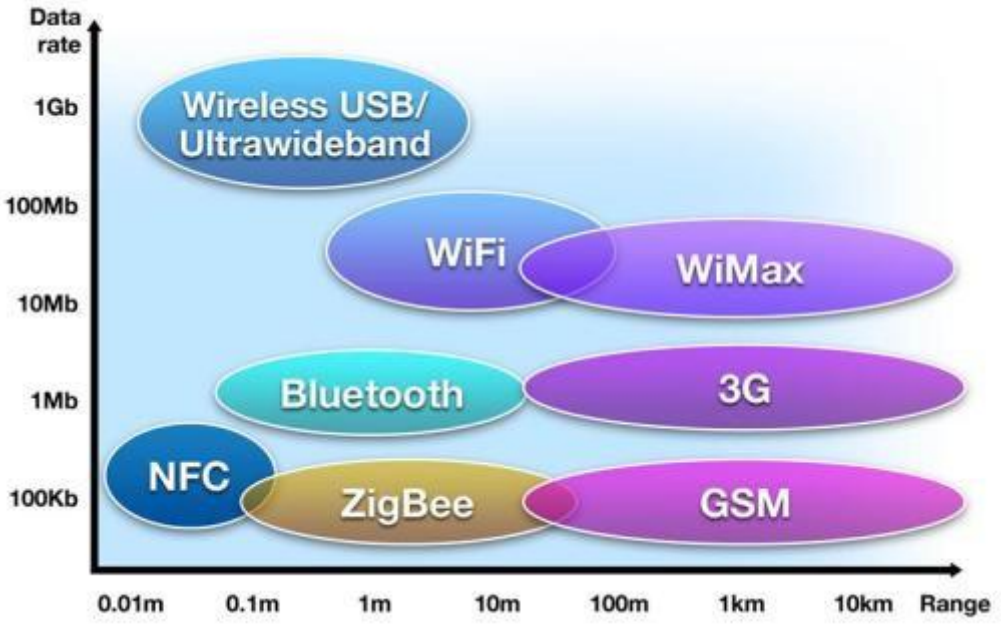


Figure: 11 Wireless USB

5.9 ZigBee (IEEE 802.15.4)

The LPWAN is an open global standard and use the M2M networks for design a ZigBee. The ZigBee is very cheap and run in the power conventional technology. A couple of industrial applications are using a solution. In mesh networks 128-bit AES encryption are utilized and the nodes are connected to the number of pathways. Multiple devices technologies are connect a automation devices [14].

5.10 WiFi (IEEE 802.15.4)

Two devices are used to communicate with the help of radio frequency waves and WiFi. The routers and personal computers, desktops, or mobile phones are used to connect by the Wi-Fi application technology. A local wireless network is consisting of 802.11 standards and it is set by the IEEE. The 2.4 GHz and the 5.0 GHz bands are used by the WiFi technology.

5.11 Bluetooth and BLE (IEEE 802.15.1)

The data is transfer with the short distances and used technologies. The sophisticated data transfer is used by the phone with Bluetooth devices. Low power consumptions are used in the tracker fitness, smart watches. Bluetooth Smart is used by the BLE. It is support in the smart phones and manufactures of computer, and operating system. The exchange of data is includes the UHF radio waves and it is operate a WiFi, in the value of 2.4 GHz.

5.12 WiMax (IEEE802.16)

Microwave Access the Worldwide Interoperability of the WiMax. Wireless data network is delivering use this technology. LTE networks are improving a speed and decide a switch in this technology [9].

5.13 Z-Wave

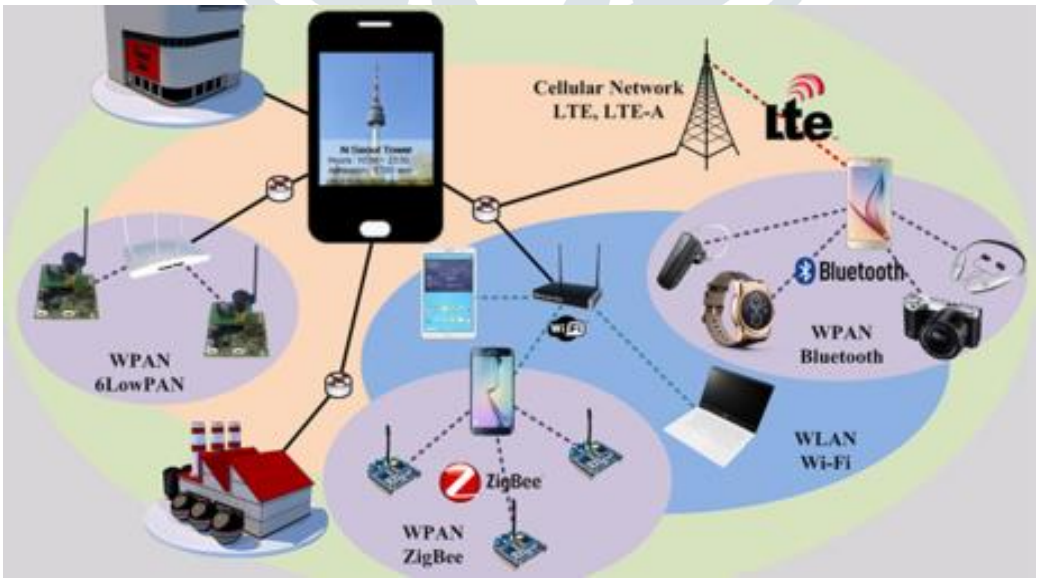
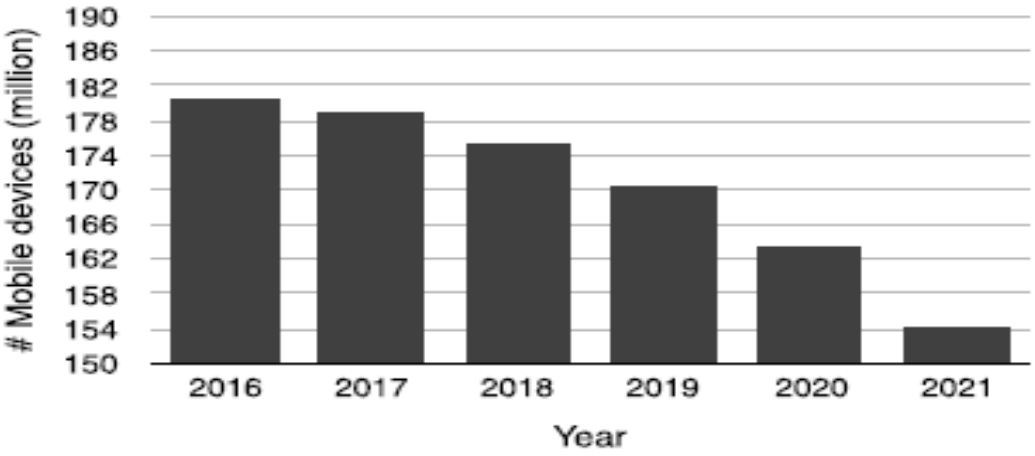


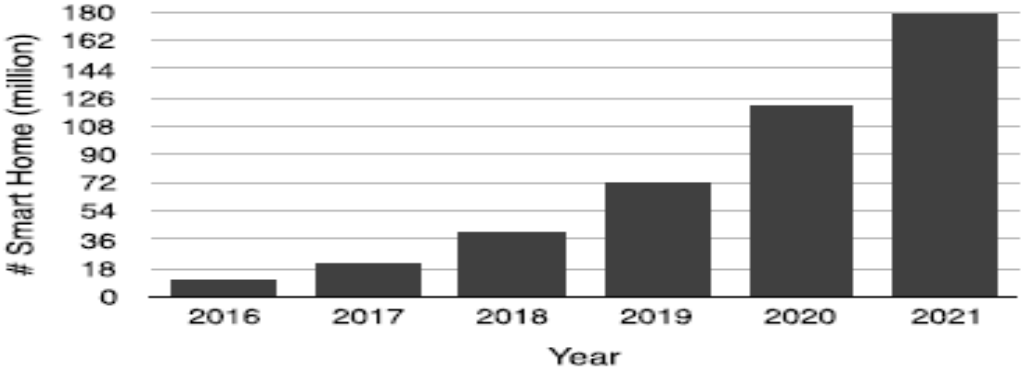
Figure: 12 Zwave technologies

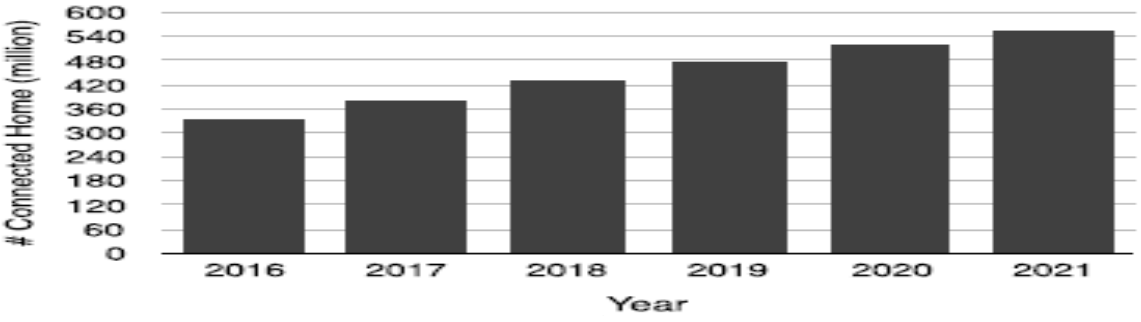
The technologies are used IOT products and it is widely used. Low energy radio waves are used in the mesh network. The wireless control application is used to communicate the machine to machine automate. This technology growth is based on the Z-Wave interface. It is used the products of 2400 ranges.

VI. SMART BUILDING

Building automation applications standards are targeted a Bluetooth and ZigBee. Z-wave is design the requirements of application in the home automation. The control applications of the SLC and access control are targeted by the Z-Wave. The sub1 GHz frequency band is used in the Z-wave. Globally the products are distributed and it is includes a various rules to operate a sub-1 GHz band. The power line and wireless mesh technology are combined and it is support the devices [13]. FSK modulation is used and wireless devices are used then operate a data rate of 904MHz. Smart sensors, and remote controls are used in the application of technology. Wireless technology environment is use the harvest power source [10]. The bandwidth data rate is operating in the range of sub-1GHz to 125kbps.







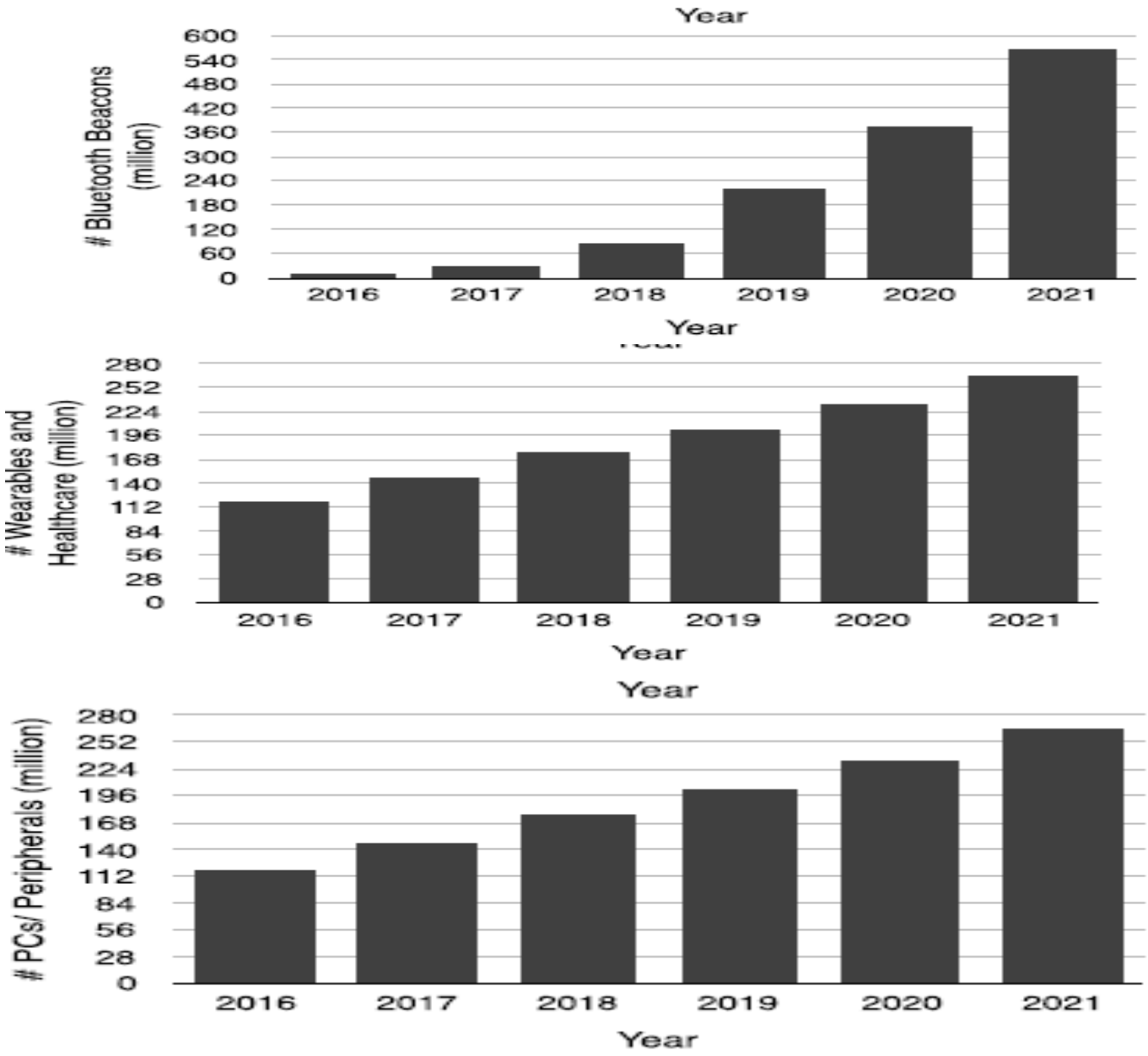


Figure: 13 Comparison of major Bluetooth applications market predicted by 2021

6.1 IEEE 802.15.4E

Six MAC modes are defined by the IEEE 802.15.4e. A deterministic TDMA mechanism is implemented in the TSCH MAC mode. To avoid the inevitable interference by the use of TDMA mechanism and includes the feature of channel hopping. Multi-channel is denoting a MAC protocol. Industrial automation is offer a high reliability of TSCH [11].

TABLE: 2 Industrial applications and their typical requirements

	Applications	Delay	Range (m)	Battery	Update Frequency
Monitoring and supervision	Vibration sensor	seconds	100	3 years	seconds - days
	Pressure sensor	milliseconds	100	3 years	1 second
	Temperature sensor	seconds	100	3 years	5 seconds
	Gas detection sensor	milliseconds	100	3 years	1 second
Closed loop control	Control valve	milliseconds	100	> 5 years	10 - 500 ms
	Pressure sensor	milliseconds	100	> 5 years	10 - 500 ms
	Temperature sensor	milliseconds	100	> 5 years	500 ms
	Flow sensor	milliseconds	100	> 5 years	10 - 500 ms
	Torque sensor	milliseconds	100	> 5 years	10 - 500 ms
	Variable speed drive	milliseconds	100	> 5 years	10 - 500 ms
Interlocking and control	Proximity sensor	milliseconds	100	> 5 years	10 - 250 ms
	Motor	milliseconds	100	> 5 years	10 - 250 ms
	Valve	milliseconds	100	> 5 years	10 - 250 ms
	Protection relays	milliseconds	100	> 5 years	10 – 250 ms

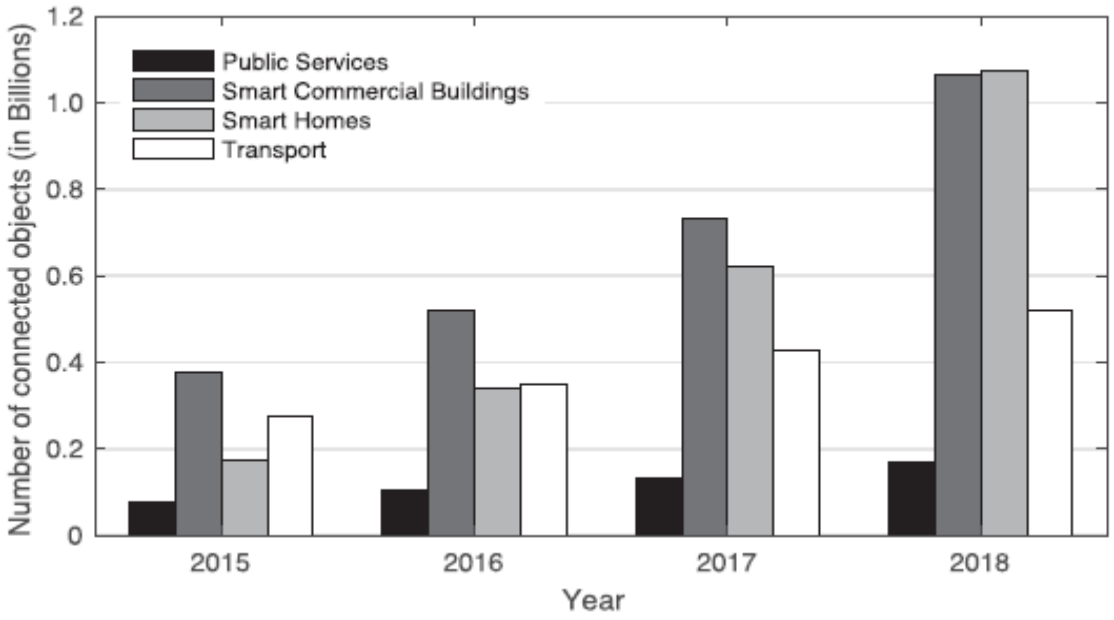


Figure: 14 Comparison of major applications based on the number of connected devices in smart cites

The applications are requiring traffic and schedule nodes. TSCH is built and maintained this application. To provide an IP network is analyze a standard of 6TiSCH and 6LoWPAN. Low-power wireless standards are interoperability in the traditional IP networks.

VII. COEXISTENCE OF BLUETOOTH WITH OTHER WIRELESS TECHNOLOGIES

Mathematical models of FH and AFH performance is avoid interference and AFH is identifying channels of good and bad. Good channels are transmitting in the node. Bad channels avoid interference and the AFH restricts busy transmission. A reliable connection is established by the Bluetooth. Two main methods are used. They are Received Signal Strength Indication (RSSI) and the Packet Error Rate (PER). Signal strength is impact a factor of channel noise. The signal strength is measured by the receiver side and the channel condition is informed to the transmitter. Noise based on the number of lost packets are measured by the transmitter of PER. The channel quality is checked. AFH and adaptive transmit power combination is used to deliver a packet to the performance ration of BR/EDR. The power consumption of BLE and ZigBee is used to show the BLE. It is transmitting a number of bytes and energy efficient. The BLE network is analyzed and use high interference. BLE reliable solution is show and compares the IEEE 802.11p and it is not require a high data rate. BLE is analyzed the advertisement channels performance. The same channels are scanning a multiple devices for increase a size of packets [12].

VIII.CONCLUSION

The proposed system is increase the reliability, timeliness, scalability, and efficiency of energy are used in the developing of IOT applications. Low-power wireless standards, technologies, and protocols are accepted in the domain application of the IOT. Analyze a different application of automation. The PHY and MAC layers are focused and used low-power wireless networks. The optimal wireless solution application is used based on the demands. In the wide area network and smart homes are used a protocols of Long Range Area-Wide Network [LORA WAN].The large number of devices are connected to the IOT. The field of networking and connectivity are processed by the wireless technology. It is includes a data transfer and the charge of wireless.

REFERENCES

[1] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, ‘‘Internet of Things (IoT): A vision, architectural elements, and future directions,’’ Future Generat. Comput. Syst., vol. 29, no. 7, pp. 1645–1660, 2013.

[2] A. S. Crandall and D. J. Cook, ‘‘Smart home in a box: A large scale smart home deployment,’’ in Proc. Int. Conf. Intell. Environ, 2012, pp. 169–178.

[3] Sensors Remind Doctors to Wash Up. Accessed:Jun. 3, 2018.[Online]. Available: https://www.ibm.com/blogs/research/2013/11/sensorsremind-doctors-to-wash-up/

[4] K. Michaelsen, J. L. Sanders, S. M. Zimmer, and G. M. Bump, ‘‘overcoming patient barriers to discussing physician hand hygiene: Do patients preferelectronicreminderstoothermethods?’’InfectionControlHospital Epidemiol., vol. 34, no. 9, pp. 929–934, 2013.

[5] I. Ungurean, N.-C. Gaitan and V. G Gaitan, An IoT architecture for things from industrial environment in Proc.Int. Conf. Commun. (COMM), 2014, pp. 1–4.

[6] C. Wang, Z. Bi, and L. D. Xu, ‘‘IoT and cloud computing in automation of assembly modeling systems,’’IEEE Trans.Ind.Inform., vol.10,no.2, pp. 1426–1434, May 2014.

[7] K. Dalal and P. Dahiya, ‘‘State-of-the-art in VANETs: The core of intelligent transportationsystem,’’IUPJ .Elect.Electron.Eng., vol.10,no.1, pp. 27–39, 2017.

[8] F. Camacho, C. Cárdenas, and D. Muñoz, ‘‘Emerging technologies and research challenges for intelligent transportation systems: 5G, HetNets, and SDN,’’Int.J.Interact.Des.Manuf., vol.12,no.1,pp. 327–335,2017.

[9] J. Serra, D. Pubill, A. Antonopoulos, and C. Verikoukis, ‘‘Smart HVAC control in IoT: Energy consumption minimization with user comfort constraints,’’ Sci. World J., vol. 2014, Jun. 2014, Art. no. 161874.

[10] T. Gea, J. Paradells, M. Lamarca, and D. Roldan, ‘‘Smart cities as an application of Internet of Things: Experiences and lessons learnt in Barcelona,’’ in Proc. Int. Conf. Innov. Mobile Internet Services Ubiquitous Comput., 2013, pp. 552–557.
[11] V. Scuotto, A. Ferraris, and S. Bresciani, ‘‘Internet of Things: Applications and challenges in smart cities: A case study of IBM smart city projects,’’ Bus. Process Manage. J.,vol. 22, no. 2, pp. 357–367, 2016.
[12] F. Shrouf and G. Miragliotta, ‘‘Energy management based on Internet of Things: Practices and framework for adoption in production management,’’ J. Cleaner Prod., vol. 100, pp. 235–246, Aug. 2015.
[13] C.-F. Lai,Y.-X. Lai,L. T. Yang, and H.-C. Chao, ‘‘Integration of IoT energy management system with appliance and activity recognition,’’ in Proc.Int.Conf.Green Comput.Commun.(GreenCom),2012,pp. 66–71.
[14] Z. M. Fadlullah, M. M. Fouda, N. Kato, A. Takeuchi, N. Iwasaki, and Y. Nozaki, ‘‘Toward intelligent machine-to-machine communications in smart grid,’’ IEEE Commun. Mag., vol. 49, no. 4, pp. 60–65, Apr. 2011.
[15] F. L. Lewis, ‘‘Wireless sensor networks,’’ in Smart Environments: Technologies, Protocols, and Applications. Hoboken, NJ, USA: Wiley, 2004, pp. 11–46