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ZIGBEE TECHNOLOGY: A GLOBAL STANDARD FOR COMMUNICATION

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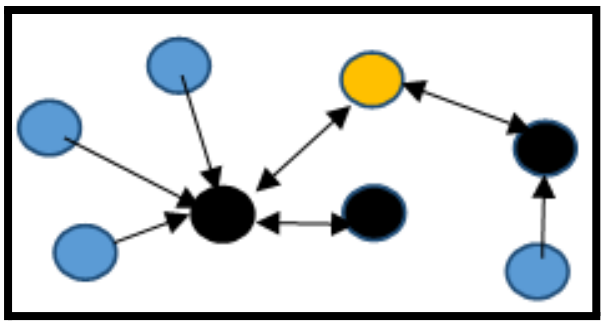
1. INTRODUCTION:

ZigBee is an open global standard used for communicating without material contact. It is specially designed to be operated on less-power digital radio signals within the range of an individual person that is personal area networks. ZigBee is operated on IEEE 802.15.4and is being used to build networks that lacks low data transmission rate, energy efficacy and security issues regarding networking. It is involved in a number of applications such as industrial and home automation systems, hospitals, heating and cooling control and designed for small scale projects which may need wireless connection. ZigBee is designed to make things work easily and cost effective than other wireless technologies.

2. TYPES OF ZIGBEE DEVICES:

Types of ZigBee devices are:

- ZigBee Coordinator (ZC)
- ZigBee Router (ZR)
- ZigBee End Device (ZED)



igBee End Device

igBee Router

igBee Coordinator

***ZigBee Coordinator*:**

- Each network must have at least one coordinator.
- It is used to form a network.
- It is responsible for security protocols
- Manages the other functions that define the network.
- Cannot be shut down at all.

ZigBeeRouter:

- It is used to combine already available networks and send, receive, and transmit data and act as a messenger between any other devices.
- Buffer wireless data packets for end device children who are currently not working.
- Other routers and end devices can be connected in the network.
- Needsawaken all the time.
- Each network may have multiple router(s).

End device:

- It is used to combine already available networks and send and receive data, but cannot act as messenger between any other devices.
- Other devices cannot be combined in the network.
- Uses low cost hardware.
- It can be switched off according to need in order to save energy by entering a not responding sleep mode for some time.
- It always needs a router or a coordinator as its parent device in order to join the network and save messages when in sleep mode.

3. ZIGBEE PROTOCOL ARCHITECTURE:

Zigbee protocol architecture is works on IEEE 802.15.4 PHYSICAL and MAC layers of a personal, low-area and wireless network. It also defines networking, application and security layers of the protocol. Zigbee is the primary protocol which builds on 802.15.4.

- ***Physical Layer:*** Physical layer's job is to perform modulation to transmit signal and demodulation to receive signal. This layer has a frequency of 2.5GHz, 868 MHz, 914MHz at the date rate 240 kbps, 20

kbps, 40 kbps having number of channels as 10-26, 0, 1-9respectively.

- ***MAC Layer:*** MAC layer is used to form networks, channels to be shared and stable transmission of data by accessing different networks with the carrier sense multiple access collision avoidance (CSMA). It also includes facilities such as transmission retry and acknowledgment management.

- ***Network Layer:*** Goal of network Layer is to perform all network related operations including setting up network, connecting end device and disconnecting networks, routing, topologies, etc. It is responsible for traversing the data packets from source and destination in both unidirectional and bidirectional forms.

- ***Application Support Sub-Layer:*** This permits to interface with the network layer for data managing services. This layer manages to make connection between two devices according to their services and demands.

- ***Application Framework:*** It adds two features of data services – 1. Key value pair 2. Generic message services. It provides the environment to execute application objects to send and receive data and for recognizing, initiating and wrapping up other devices to the network.

4. ZIGBEE TOPOLOGIES:

ZigBee uses coordinators, routers and end devices in order to form network circuit called topologies. It follows different topologies so as to perform information transmission and retransmission. The network forming must have at least one coordinator so that to connect with end devices and routers.

Zigbee supports only3 network topologies:

- ***Star topology:*** In a star topology, the network consists of one central controller that has dedicated point-to-point link with each device. Packets between the devices have to go through the Zigbee coordinator. This topology is very transparent and easy to expand and is used in industries where all the end point devices are needed to communicate with the controller.

- ***Mesh topology:*** Mesh topology, also called as peer-to-peer network, in which each device is connected with other devices to establish multiple pathways. This topology contains a single controller, multiple routers, and any number of end devices. It destroys dead zones and adding or removing end device is much easier than star topology.
- ***Cluster tree topology:*** A cluster tree topology is a special case of tree topology with a parent-child relationship that form a cluster. A cluster Id is assigned to each cluster. ZigBee does not sustain cluster tree topology, but IEEE 802.15.4 does sustains it.

5. CHARACTERISTICS OF ZIGBEE:

- Low battery wastage.
- ZigBee end device lasts longer without getting replaced easily.
- Low cost.
- Low data rate.
- Easy to implement.
- Can implement larger number of end devices.
- Can automatically establish its network whenever needed.
- Uses small data packets as compared with Wi-Fi and Bluetooth.
- Less range.
- Higher output results and low latency
- Low power frequency.

6. WIFI IEEE 802.11 vs Bluetooth IEEE 802.15.1 vs ZigBee IEEE 802.15.4:

Table 1: Comparison Table

	WiFi IEEE 802.11	Bluetooth IEEE 802.15.1	ZigBee IEEE 802.15.4
Application	Wireless LAN	Cable replacement	Control and monitor
Frequency bands	2.4GHz	2.4GHz	2.4GHz, 868MHz, 915MHz
Battery life (days)	0.1–5	1–7	100–7,000
Nodes per network	30	7	65,000
Bandwidth	2–100Mbps	1Mbps	20–250Kbps
Range (meters)	1–100	1–10	1–75 and more
Topology	Tree	Tree	Star, tree, cluster tree, and mesh
Standby current	20 * 10–3 amps	200 * 10–6 amps	3 * 10–6 amps
Memory	100KB	100KB	32–60KB

7. APPLICATIONS OF ZIGBEE TECHNOLOGY:

- ***Industry Automation:*** Zigbee lovers communication cost and takes care of various parameters and critical equipment and optimizing the control process for higher accuracy.
- ***Home Automation:*** Zigbee works well with appliance control, electricity control, heating and cooling system control, security equipment operations and control, supervision and much more.
- ***Smart Metering:*** It includes consumption of electric energy, generators, gas, water or heat consumption data, and security over power, theft, etc.
- ***Smart Grid monitoring:*** Zigbee operations in this smart grid involve remote temperature monitoring, optimizing the production, distribution and consumption of power, fault locating, effective power management, and many more.
- ***Smoke Alarms:*** smoke detector just senses smoke and warns by alarm. They are cheap, battery-powered ionization smoke alarms easily available across the places.

8. ADVANTAGES OF ZIGBEE:

- Long lasting battery life.
- Low electricity consumption.
- Easy to be installed and implemented.
- It allows large number of end devices i.e. 6500 devices approximately.
- Cost effective.
- It is more stable and self-curing
- It does not have central controller
- Easy to manage and control home appliances from remote
- Easy expandable network
- Easy to add or remove the end devices

9. DISADVANTAGES OF ZIGBEE:

- More security issues as compared to other wireless technology.
- Low transmission rate.
- Costly replacements
- Does not support a large number of end devices together.
- It cannot be used as outside wireless communication scheme
- Short coverage range

10. FUTURE SCOPE:

Zigbee Technology has gained popularity amongst people which shows that it has an upcoming brightly rising future by rapidly increasing automation and smart metering in this world of wireless technology. In future, more machines and operators will be based on this wireless technology. People are relied on wireless things. Zigbee will be the future of networking. Network range can be increased by combining different topologies and making it mesh wireless network. Mini and micro memory Cards can also be added onto so as to make the system easier. By adding GPS and GPRS will add sugar to the system. All in one we can say that it will be having a great successful future scope. It's a long way to go in this field!!

11. CONCLUSION:

Here concluding, ZigBee has made the automation much easier and provides more security factors making it efficient and robust. ZigBee Technology needs to be improved in case of Automation System in homes and buildings as their power implementations are causing much failures. Moreover, ZigBee distributes a limited amount of resources to use. The end devices or nodes are basically running on battery and have limited power and memory buffer. ZigBee is giving lower-cost. ZigBee applications are spreading across the globe and works non-profitably. ZigBee is helping out the consumers with flexibility, adaptability, and ease of use by constructing wireless intelligence and capabilities into many devices. In all ZigBee networks and technologies, there are many ways to make them configured and implemented in many different ways.

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