Application of Zigbee for Wireless Sensor Network Technology

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Abstract— Now a day there is a trend of wireless application, varieties of technology available to implement this but none of them met with the sensors and control devices a communication standard which requires high data rate, low latency, low energy consumption and lower bandwidth. Zigbee technology met with all this communication standards. Its excellent and best characteristics make this communication best suited for wireless sensor network technology, several embedded applications, and industrial control and also for home automation. This paper will provide idea of Zigbee technology and varies applications.
Key words: Sensor, Wireless Network, Protocol, WLAN, Router

I. INTRODUCTION

Network and communication technology developed in fast manner so wiring problem of network get solved with the use of wireless network. Specially wireless sensor network in this sensors based on available application are deployed in the field in order to do remote sending of farm, weather effect, industrial automation control and many more. WSN can do data collection, transmission, and processing. It has many advantages compared to traditional wired network due to low power consumption, low cost and high data rate. It is most widely used in network communication applications.

Previous technology Bluetooth and Wi-Fi has disadvantage of high power consumption, connectivity issue, limited distance connection, low speed. New technology immerge which is zigbee technology to meet with this requirements. In this paper we will discuss about zigbee technology and its applications

II. ZIGBEE TECHNOLOGY

Zigbee communication is specially built for control and sensor networks on IEEE 802.15.4 standard for wireless personal area networks (WPANs), and it is the product from Zigbee alliance. This communication standard defines physical and Media Access Control (MAC) layers to handle many devices at low-data rates. These Zigbee's WPANs operate at 868 MHz, 902-928MHz and 2.4 GHz frequencies. The date rate of 250 kbps is best suited for periodic as well as intermediate two way transmission of data between sensors and controllers [8].
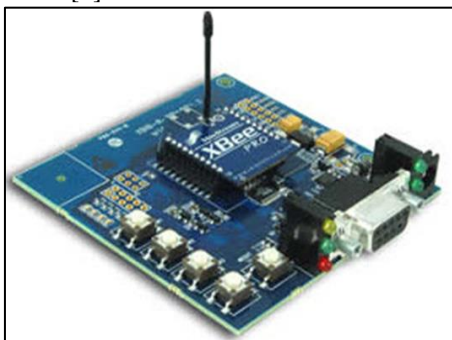

Fig. 1: Zigbee Modem

Zigbee is low-cost and low-powered mesh network widely deployed for controlling and monitoring applications where it covers 10-100 meters within the range. This communication system is less expensive and simpler than the other proprietary short-range wireless sensor networks as Bluetooth and Wi-Fi.

Zigbee supports different network configurations for master to master or master to slave communications. And also, it can be operated in different modes as a result the battery power is conserved. Zigbee networks are extendable with the use of routers and allow many nodes to interconnect with each other for building a wider area network.

ZigBee uses the avoidance collision mechanism in CSMACA and pre-set a prior particular time slot for a fixed bandwidth communications service in order to avoid competition and conflict when sending data. MAC layer adopts a fully confirmed data transport mechanism, and each packet sent by the receiver must wait for confirmation [1].

Zigbee has self-organizing features that one node can sense other ones without any human interventions, and connect with each other automatically to create a completed network. It also obtains self-recovery function that the network can repair itself when a node is added or deleted, the position of a node is changed, or a breakdown occurred. It can also adjust the topology structure to ensure that the whole system can work normally without any human interventions [9].
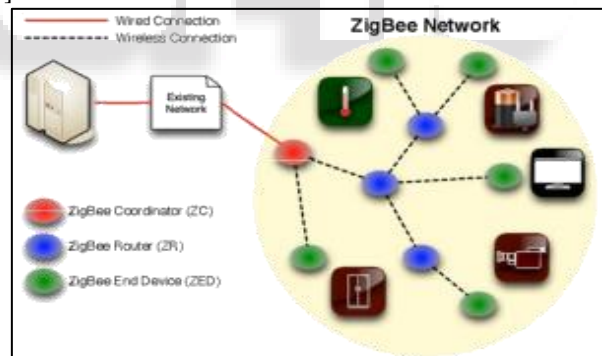

Fig. 2: Zigbee System Architecture

Zigbee system structure consists of three different types of devices such as Zigbee coordinator, Router and End device. Every Zigbee network must consist of at least one coordinator which acts as a root and bridge of the network. The coordinator is responsible for handling and storing the information while performing receiving and transmitting data operations. Zigbee routers act as intermediary devices that permit data to pass to and forward through them to other devices. End devices have limited functionality to communicate with the parent nodes such that the battery power is saved as shown in the figure 2. The number of routers, coordinators and end devices depends on the type of network such as star, tree and mesh networks.

Zigbee protocol architecture consists of a stack of various layers where IEEE 802.15.4 is defined by physical and MAC layers while this protocol is completed by

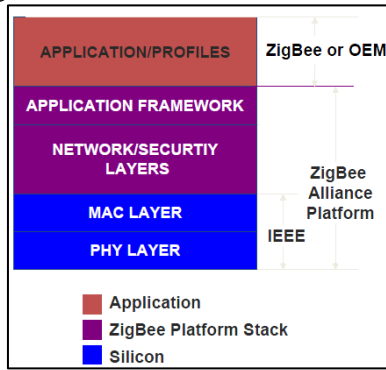accumulating Zigbee's own network and application layer as shown in figure 3.

Fig. 3: Zigbee Protocol Architecture

−   Physical Layer: This layer does modulation and demodulation operations up on transmitting and receiving signals respectively [2].
−   MAC Layer: This layer is responsible for reliable transmission of data by accessing different networks with the carrier sense multiple access collision avoidance (CSMA). This also transmits the beacon frames for synchronizing communication.
−   Network Layer: This layer takes care of all network related operations such as network setup, end device connection and disconnection to network, routing, device configurations, etc.
−   Application Support Sub-Layer: This layer enables the services necessary for Zigbee device object and application objects to interface with the network layers for data managing services. This layer is responsible for matching two devices according to their services and needs.
−   Application Framework: It provides two types of data services as key value pair and generic message services. Generic message is a developer defined structure, whereas the key value pair is used for getting attributes within the application objects. ZDO provides an interface between application objects and APS layer in Zigbee devices. It is responsible for detecting, initiating and binding other devices to the network.

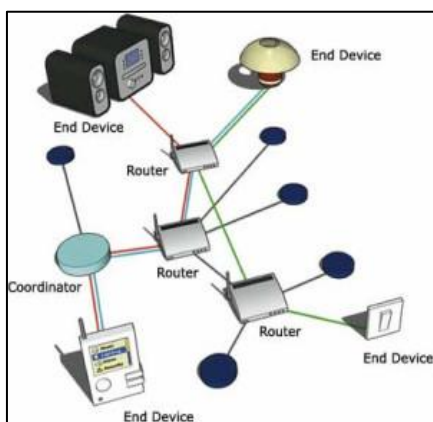## III.   ZIGBEE TOPOLOGY IN OPERATING MODE

Fig. 4: Zigbee operation mode

In Zigbee data is transferred in two modes: Non-beacon mode and Beacon mode. In a beacon mode, the coordinators and routers continuously monitor active state of incoming data hence more power is consumed. In this mode, the routers and coordinators do not sleep because at any time any node can wake up and communicate. However, it requires more power supply and its overall power consumption is low because most of the devices are in an inactive state for over long periods in the network.

In a beacon mode, when there is no data communication from end devices, then the routers and coordinators enter into sleep state. Periodically this coordinator wakes up and transmits the beacons to the routers in the network. These beacon networks are work for time slots which means, they operate when the communication needed results in lower duty cycles and longer battery usage. These beacon and non-beacon modes of Zigbee can manage periodic (sensors data), intermittent (Light switches) and repetitive data types.
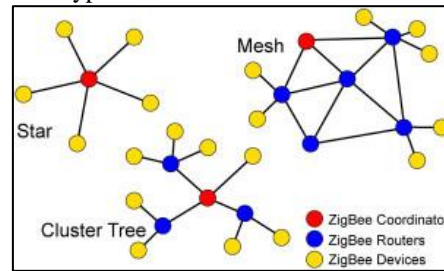

Fig. 5: Zigbee topologies

Zigbee supports several network topologies as shown in figure 5. However, the most commonly used configurations are star, mesh and cluster tree topologies. Any topology consists of one or more coordinator. In a star topology, the network consists of one coordinator which is responsible for initiating and managing the devices over the network. All other devices are called end devices that directly communicate with coordinator. This is used in industries where all the end point devices are needed to communicate with the central controller, and this topology is simple and easy to deploy[3][4].

In mesh and tree topologies, the Zigbee network is extended with several routers where coordinator is responsible for staring them. These structures allow any device to communicate with any other adjacent node for providing redundancy to the data. If any node fails, the information is routed automatically to other device by these topologies. As the redundancy is the main factor in industries, hence mesh topology is mostly used. In a cluster-tree network, each cluster consists of a coordinator with leaf nodes, and these coordinators are connected to parent coordinator which initiates the entire network.

IV.   REMOTE MONITORING SYSTEM ARCHITECTURE

Framework for remote monitoring system architecture shown in Fig. 6 the entire system to monitor the host, GPRS module (or, a ZigBee coordinator node, a number of ZigBee routers, ZigBee node and a number of nodes of terminal equipment. This is a cluster tree network structure which is conducive to the number of network nodes and the physical expansion of the scope,

Complex, multi-node wireless network communication system is also an important reference value. The coordination of the network nodes, network management functions, the receiving terminal device node for the data upload, and transfer through the GPRS network to the monitoring center. Router Nodes for routing information

allow other node to join the network. Node will collect information from node coordinator on time to time basis to send command from monitoring host. ZigBee module used for GPRS networks and Internet networks for the realization of ZigBee network data to monitor the upload and download the host commands. Host real-time monitoring of the collection and storage from remote terminal nodes send information to coordinator in order to achieve effective monitoring and management of network.

Its functions are divided into two major parts, Data Monitoring: Data must be received from the ZigBee network and the corresponding data must be stored into the database. It receives command from gprs which will be sent to zigbee network to take actions [1], [2].

Data Management: The database information which can be collected from zigbee network like the production of the ambient temperature, pressure, overrun alarm, such as the peak period. In ZigBee it is collected from end-node using the occasional wake-up call on time to time basis. ZigBee routing node sends a message on Time to wake up each node from hibernation to start data acquisition. ZigBee routing nodes will collect the data which is sent to the ZigBee coordinator node using gateway GPRS module and the data uploaded to the remote monitoring center.
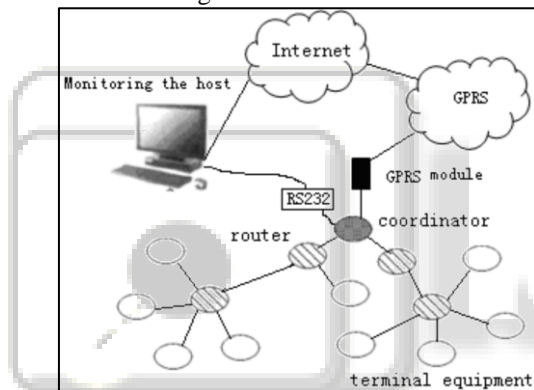

Fig. 6: Remote monitoring system framework

V. APPLICATION OF ZIGBEE TECHNOLOGY

Zigbee is a new short-range technology for wireless communication, it is specially designed for applications of wireless communication of low speed and low power dissipation, and it is ideally suited for establishing family wireless net. It is effortless to realize home temperature regulation, remote control of interior lighting systems, and automatic adjustment of curtain.

Zigbee wireless communication technology is applied in meter reading system in the monitoring center just needs to analyze and calculate data acquired from users and obtain electricity consumption of users. After that, electric charge of the month is deducted from electricity account of users.

Zigbee technology introduces an experimental home security monitoring and alarming system. It is capable of monitoring door and window magnetic contact, smoke, gas leak, water flooding, providing simple controls such as turning off the valves, and sending the alarms to the residential area security network, etc.

Zigbee wireless communication technology is applied in ARM NC system network and Experimental results showed that the improved method can guarantee the processing efficiency of NC system with satisfied accuracy and data transmission speed. It consists of laser railing security subsystem and data central monitoring subsystem, the communication between the two subsystems is realized by Zigbee wireless technology, a real-time human-machine interface can be provided for worker.

Zigbee wireless communication technology is applied in container Information system instead of present paper system. The strategy of networking and routing in order to keep energy load balancing between network nodes, to prolonged the lifetime of node and network effectively.

Zigbee technology is applied in the Miner's Lamp Monitoring. In This system can realize underground staff orientation and achieve monitoring and control of the state of charge on the miner's lamp, and the high effective control and management on use of miner's lamp [7].

–   Industrial Automation: In manufacturing and production industries, a communication link continually monitors various parameters and critical equipments. Hence Zigbee considerably reduce this communication cost as well as optimizes the control process for greater reliability.
–   Home Automation: Zigbee is perfectly suited for controlling home appliances remotely as a lighting system control, appliance control, heating and cooling system control, safety equipment operations and control, surveillance, and so on.
–   Smart Metering: Zigbee remote operations in smart metering include energy consumption response, pricing support, security over power theft, etc.
–   Smart Grid monitoring: Zigbee operations in this smart grid involve remote temperature monitoring, fault locating, reactive power management, and so on.

VI. PROBLEMS IN ZIGBEE

There are some problems in zigbee technology like the coordinator carry too much nodes, especially in the large scale wireless sensor network, It will increase packet loss, and decrease stability. There are some places where it is difficult for humans to change the batteries of nodes, or there is a fairly large number of nodes which is troublesome to change present an improved design.

The coordinator only deal with the task on the Zigbee network, the rest tasks will be processed by another processor. Prolonging the lifetime of the Zigbee network is the important goal of designing the Zigbee routing protocol. An energy-aware routing mechanism EA-AODV is presented that can save energy and improve the performance of Zigbee network. ZigBee technology is a new standard in wireless personal area after Bluetooth. After learning this technology a new wireless meter reading system based on ZigBee protocol is possible. The system, which is comprised of ZigBee network and database management system, has many important advantages such as low cost, low power consumption, and low date rate [7].

VII. CONCLUSION

Zigbee technology is a replacement of wireless technology like Bluetooth and wifi due to the characteristics of low cost, high data rate, low power consumption which can help to scale in wide area. This paper will provide information of

zigbee architecture, protocol structure and different topologies we can develop our network. Also real time application of Zigbee protocol if would like to implement for real time environment. It is most widly used in the field of safety and automation in industry.

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