

A Zigbee Technology for Lighting Control Application

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Abstract:- Zigbee is wireless communication technology and IEEE 802.15.4 standards for data communication. There are zigbee standards provides network security and application support services operating on top of the IEEE 802.15.4 medium access control and physical layer wireless standards and it employs a group of technologies to enable scalable, self-organizations, self-healing networks that can manage various data traffic patterns. The Zigbee is low-cost, low-power consumption, wireless mesh networking standards and It is designed around low power consumption allowing batteries to essentially last forever. Zigbee is use for monitoring and control applications. This paper presents a zigbee device types, its traffic varieties, structure and use in home automation and the lighting control applications.

Keywords:- Zigbee, IEEE 802.15.4, wireless mesh networking.

1. INTRODUCTION

Zigbee is the only standards based wireless technology designed to address the unique needs of low-cost, low-power wireless and control networks in just about any market. Zigbee also connects the widest variety of devices into easy-to-use networks. ZigBee is a longtime set of specifications for wireless personal space networking (WPAN), i.e. digital radio connections between computers and related devices. WPAN Low Rate or ZigBee provides specifications for devices that have low data rates, consume terribly low power and area unit so characterized by long battery life. ZigBee makes possible fully networked homes wherever all devices area unit ready to communicate and be controlled by one unit [1].

The relationship between IEEE 802.15.4 and zigbee is comparable to it between 802.11 and wifi alliance. The names refers to the waggle dance of honey bees after their return to the beehive zigbee is wireless mesh networking Provides high reliability and more expensive range and Zigbee chip vendors are sell integrated radio and microcontrollers with between 60KB and 256KB flash memory.

2. NEED OF ZIGBEE FOR LIGHT CONTROL

There are multitude of standards that address mid to high data rates for voice, PC LANS, video etc. However, until

now there hasn't been a wireless network standards and control devices. Sensor and control don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large devices arrays [2].

A lighting control system could in it is simplest form just be one manual switch for turning the lights on and off. There is lighting control systems: "smart lighting control system" or "Robust Lighting system". The objective such as a system is to;

Provide visual comforts; Minimize the energy consumption; Presence the quality of the work environment. The lighting control system is very dependent on the installation regarding location, operation, complexity, etc.

Converting to high efficiency lamp and combining it with energy efficient lighting control system has proven to be a very efficient way to reducing energy consumption. The ideal lighting control systems have some properties:-

- Handle the most efficient lamps, such as fluorescent, compact fluorescent and LED;
- Turn lights on/off and dim;
- Connect to different kinds of sensors, such as occupancy and photocell;
- Handle time scheduling;
- Interact with other system, Such as HVAC and building systems.

- Moreover, the system should be; user friendly for operation and programming, flexible with respect to complexity and price.

3. ZIGBEE DEVICES TYPES:-

I Zigbee devices are of three types:

- 1) *Zigbee coordinator (ZC):* the most capable devices the coordinator forms the root of the network tree and might bridge to other networks. There is a exactly one Zigbee coordinator in each network since it is the device that started the network originally it stores information about the network, including acting as the trust center & repository for security keys.
- 2) *Zigbee Router (ZR):* As well as running an *application function, a router can act as an intermediate router, passing on data from other devices.*
- 3) *Zigbee End device:* contain just enough functionality to talk to the parent node; it

Cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than ZR or ZC [2].

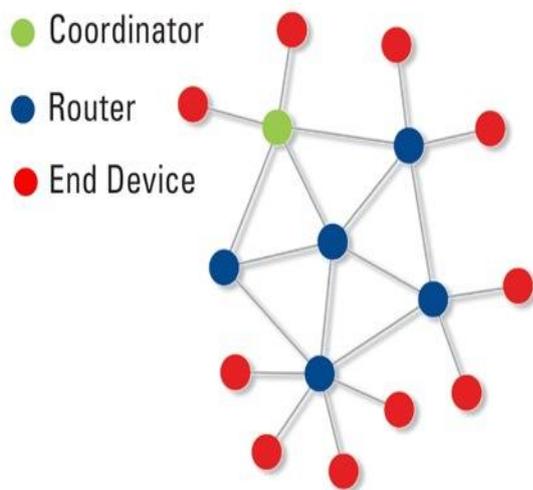


Figure1 Zigbee Devices

II Zigbee Topologies:-

Zigbee network have three topologies:-Star, tree and Mesh. They are illustrated.

- 1) *Star topology:* In this topology the central PAN coordinator node starts & maintain the network. Every other device can only communicate with and through the PAN coordinator.

- 2) *Tree topology:* In this topology has a top node with a branch/leaf structure below to reach its. Destination, a message travels up the tree and then down the tree.
- 3) *Mesh topology:* In this topology has a tree like's structure in which some leaves are directly linked. Messages can travel across the tree when a suitable route is available.

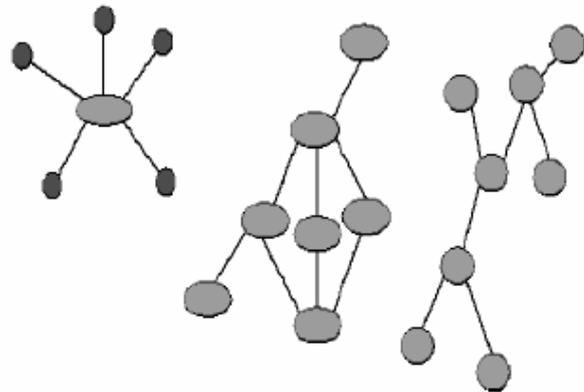


Figure2 Zigbee topologies

III TRAFFIC VARIETIES:-

ZigBee/IEEE 802.15.4 addresses three typical traffic varieties. IEEE 802.15.4 MAC can accommodate all the kinds.

1. Information is periodic. The appliance dictates the rate, and also the sensing element activates checks for information and deactivates.
2. Information is intermittent. The appliance, or other stimulus, determines the speed, as with in the case of say smoke detectors. The device has to connect with the network only communication is necessitated. This type allows optimum saving on energy.
3. Information is repetitive, and also the rate is fastened a priori. Depending on assigned time slots, called GTS (guaranteed time slot), devices operate for fastened durations.[2]

4. ZIGBEE STACK ARCHITECTURE

ZigBee builds upon the physical layer and media access control defined in IEEE standard 802.15.4 for low-rate WPANs. The specification goes on to complete the standard by adding four main components: network layer, application layer, ZigBee device objects (ZDOs) and manufacturer-defined application objects which allow for customization and favor total integration. Besides adding

two high-level network layers to the underlying structure, the most significant improvement is the introduction of ZDOs. These are responsible for a number of tasks, which include keeping of device roles, management of requests to join a network, device discovery and security.

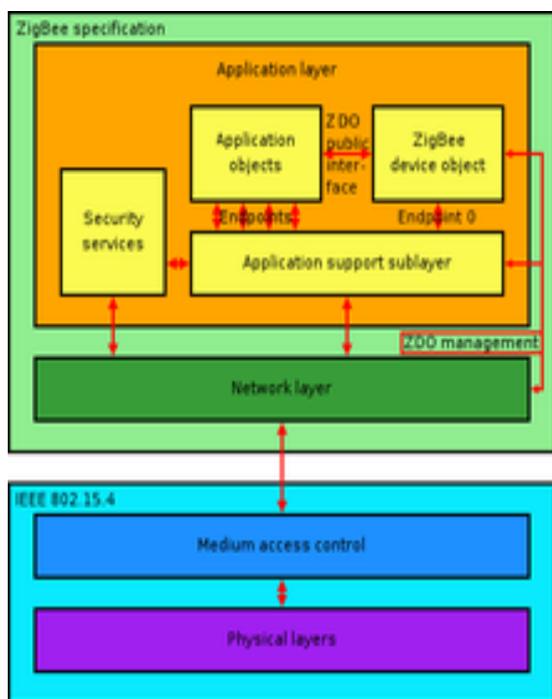


Figure 2 ZigBee protocol stack [3]

Because ZigBee nodes can go from sleep to active mode in 30 ms or less, the latency can be low and devices can be responsive, particularly compared to Bluetooth wake-up delays, which are typically around three seconds. Because ZigBee nodes can sleep most of the time, average power consumption can be low, resulting in long battery life.[3].

I Zigbee characteristics

1) 2.4GHz is use upper band. it is applicable worldwide, and 868/915 is use in lower band. This represents 3 license-. the lower band within the areas of North America, Europe, Australia and New-Zealand. free bands: a pair of 4.2-4.835 GHz, 868-870 megahertz and 902-928 megahertz. The number of channels assigned to every band is mounted at sixteen, one and 10 respectively.

2) Low power consumption, with battery life ranging from months to years. Considering the number of devices with remotes in use nowadays, it is easy to check that a lot of numbers of batteries want to be provisioned each therefore typically, entailing regular (as well as timely), revenant expenditure. In the ZigBee customary, longer battery life is accomplishable by either of two means: continuous network connection and slow however certain battery drain, or Most information rates allowed for every of those frequency bands square measure mounted as 250

kbps @ 2.4 GHz, 40 kbps @ 915 megahertz, and twenty kbps @ 868 megahertz.[2]

3) High turnout and low latency for low duty cycle applications.

4) Channel access victimization Carrier Sense Multiple Access with Collision turning away.

(CSMA - CA)

5) Addressing house of up to sixty four bit IEEE address devices, 65,535 networks-shaked" knowledge transfer protocol [1].

II Advantages of Zigbee for light control

1) *Easy of installation:* There is no need to run control wires and crawl about in wall and ceiling spaces. Zigbee wireless mesh networking was designed to handle many of the network formation task needed in smart lighting system and automated commissioning techniques can make it even quicker and easier to get the network up and running once it has formed.

2) *Scalability and Reliability:-* Lighting networks can be very large in scale, encompassing hundreds or even thousands of lighting devices located within communicating distance from one another. Mesh networks perform well in this kind of environment, with a high node count actually improving the health of the network since there are more potential communication paths.

3) *Reduced maintenance:* The network's self-configuring and self-healing capabilities help to reduce the manual maintenance required. Mesh networks can also automatically detect and troubleshoot problems that occur.

4) Up to 50% energy reduction.

5) Centralized control.

6) Significant reduction in installation cost and time.

7) Consumption monitoring.

5. APPLICATION OF ZIGBEE TECHNOLOGY

There are so many applications on light control. Some light control applications are there:

1) *Parking plot:* Beyond office lighting Zigbee is gaining in foothold in other key lighting applications. Both indoor and outdoor parking lots of energy. Depending on the size of lot, dozens or hundreds of lights are used, and for security reason these lights often stay on all night even when no one is there. To save on such unnecessary and

expensive energy use while still preserving security, Zigbee enabled motion control detectors can be installed automatically turn off or dim the lights 50% power when no one is there. But quickly turn them back on to 100% brightness if someone arrives in the lot. On site security necessary, dimming, turning on, or turning off, any light in any area of the parking plot or other outdoor illuminated areas from a central control node point.

2) Street and highway lighting: Municipal street and roadside light consume a lot of electricity and contribute significantly to a city’s overall operational expense. The setting can be overridden from a remote location by a city manager and Zones can be set up so that each zone can be set independent from the other Zones. Furthermore Zigbee can automatically detect when a street light has burnt out and needs to be replaced, sending and automatically email or sms text message to a city manager. This saves significant money when compared to sending a city employee periodically up and down every city block and down each highway to check and report on lights that needs to be replaced. This also yields safety benefits as the lights can be replaced very quickly, rather than waiting for the next periodic city wide inspection.

3) Residential: Though currently limited to use in high end homes only, Zigbee delivers some tangible benefits. Beyond saving energy, Zigbee makes it much easier to add, move and reconfigure residential lighting because only a local power source is required. Lights can be dimmed or adjusted to fit any mood, by room or by Zone and zone can be reprogrammed at any time.

4) City traffic lights: zigbee has several applications for city traffic light system. A Zigbee-enabled traffic light can automatically detect bulb failure, which aside from the savings of reduced periodic inspections, delivers a tremendous safety benefit by dramatically minimizing the amount of time a traffic light is out of order. An automatic notification email or SMS text message can be sent immediately to the city’s traffic department.

Zigbee-enabled traffic lights can detect traffic conditions and adjust the green light/red light durations accordingly.

This can be as simple as turning a light from red to green when there is no cross traffic or something more sophisticated such as adjusting the light durations based on the overall mix of traffic at any given intersection. Algorithms for traffic management can be programmed by urban planners and adjusted or overridden remotely at anytime. Traffic lights can also be dimmed or made brighter based on ambient lighting conditions, enabling the lights to be brighter on a sunny day while dimmer at night, increasing safety while saving energy.

5) In future Zigbee and LED lighting: LED lighting is essentially lighting by a tiny silicon chip. LED lighting delivers benefits in reduced size of the lighting element, increased brightness, and reduced brightness, reduced energy use, durability, lower total cost, lower heat and increased flexibility. New LED lighting applications include flashlights, accent lights in stores and restaurants, the internal illumination for new HDTV sets, and miniaturized projectors. LED lighting is also being phased in as a replacement for today’s everyday lighting, including incandescent and fluorescent lighting for homes and offices, and today’s mercury vapor and sodium vapor roadside and street lighting. Virtually any application where reduced size, reduced energy and better brightness are winning characteristics, LED lighting may stake a claim [6].

TABLE.1 COMPARISON BETWEEN LOW POWER WIRELESS TECHNOLOGIES

| Parameter | Zigbee | Bluetooth | Wi-Fi |
|---------------------------------|--------------------------|-------------------|-----------------------------------|
| Standard | 802.15.4 | 802.15.1 | 802.11.b |
| Application focus | Monitoring & control | Cable replacement | Web, email, video |
| Distance | 50-1600m | 10m | 50m |
| Extension | Automatic | None | Depending on the existing network |
| Frequency Range | 868MHz, 916 MHz, 2.4GHz | 2.4GHz | 2.4GHz |
| Security | 128bit AES | 64bit, 128bit | SSID |
| Success metrics | Reliability, power, cost | Cost conveniences | Flexibility |
| Power supply | Years | Days | Hours |
| Transmission speed | 250Kbps | 1Mbps | 1-54Mbps |
| Linking time | 30ms | Up to 10s | Up to 3s |
| Integration level & reliability | High | High | Normal |
| Easy of use | Easy | Normal | Hard |
| Cost | Low | Low | High |
| Channel | 16 | 19 | 3 |

CONCLUSION:

In this paper, zigbee technology is smart wireless technology in using many areas. It is high level, direct communication and also reduces the cost. Like home

automation, in industrial, commercial, etc. the new intelligent lighting system is available in new technologies on the market to offer higher efficiency and considerable savings. The system is easily design and developed. this system is flexible and extendable and save maximum energy. it is use in the parking lot, shopping mall, street lighting for control intensity and dimming. And In building lighting control is different locations use in different light designing in all types of building light control.

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