***Wireless Technology: ZigBee***

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**ABSTRACT:**

ZigBee? What is it?

Well! ZigBee is developed for providing low data rates , greater range and more importantly low power consumption communicating through small data packets and also enables us to have WWPAN’s, that’s Wireless Wide Personal Area Networks

Today, PAN is established using Bluetooth, although it provides high data rates but the high power consumption, short range are the major drawbacks. This network is much simpler than widely used Bluetooth which are some of the points of an upper edge for it.

The architecture is in the form of layers consisting of Physical, Media Access and Network and Application Support layer. This enables ZigBee to operate in variety of topologies, application and environment.

The Security services provided, is one of the features provided by ZigBee. Security is provided on every layer. There is specific frame format for each layer. Key Establishment service provides trust provisioning step using master key that establishes the link between devices. Many other services are provided such as transport key, update device, request key and Switch key.

The above mentioned points are covered in the paper in detail.

Due to so many features, many companies have invested millions of dollars in this technology. Major players are Innovative Wireless Technologies, Crossbow Technology, and Luxsoft Labs.

Looking at the tremendous growth that takes place day-by-day, we can think the near future could be dominated by ZigBee as it is by Bluetooth currently since some time in Personal Area Networking, but no one can guarantee for how long?

## INTRODUCTION:

## What is Wireless Communication?

A Communication from one point to another point without any wire or cable is known as Wireless Communication.

There are different techniques available in Wireless Communication such as: IR, BlueTooth, WI-Fi, WI-Max and different topologies but one which many do not know is “ZigBee”.

**What is ZigBee?**

The name "ZigBee" is derived from the erratic zigging patterns many bees make between flowers when collecting pollen. This is evocative of the invisible webs of connections existing in a fully wireless environment. ZigBee is designed to provide highly efficient connectivity between small packet devices. ZigBee is built on top of the IEEE 802.15.4 low power networking standard. The 802.15.4 standard is a simple packet data protocol for light weight wireless networks. The fourth in the series, WPAN Low Rate/ZigBee is the newest and provides specifications for devices that have low data rates, consume very low power and are thus characterized by long battery life. Other standards like Bluetooth and IRDA address high data rate applications such as voice, video and LAN communications. The goal is “to provide the consumer with ultimate flexibility, mobility, and ease of use by building wireless intelligence and capabilities into every day devices.

**Why ZigBee?**

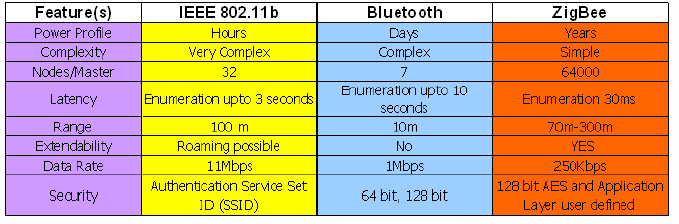
ZigBee looks rather like Bluetooth but is simpler, has a lower data rate and spends most of its time snoozing. This characteristic means that a node on a ZigBee network should be able to run for six months to two years on just two AA batteries.

The operational range of ZigBee is 10-75m compared to 10m for Bluetooth (without a power amplifier).

ZigBee sits below Bluetooth in terms of data rate. The data rate of ZigBee is 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz whereas that of Bluetooth is 1Mbps.

ZigBee uses a basic master-slave configuration suited to static star networks of many infrequently used devices that talk via small data packets. It allows up to 254 nodes. Bluetooth’s protocol is more complex since it is geared towards handling voice, images and file transfers in ad hoc networks. Bluetooth devices can support scatternets

**Comparison over current Technologies:**

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Yellow Color Represents ZigBee Application while Blue Color of Bluetooth



of multiple smaller non-synchronized networks (piconets). It only allows up to 8 slave nodes in a basic master-slave piconets set-up.

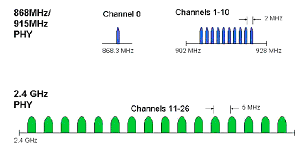
When ZigBee node is powered down, it can wake up and get a packet in around 15 msec whereas a Bluetooth device would take around 3sec to wake up and respond.

## ARCHITECTURE:

The ZigBee Standard has evolved standardized sets of solutions, called ‘layers'. These layers facilitate the features that make ZigBee very attractive, low cost, easy implementation, reliable data transfer, short-range operations, very low power consumption and adequate security features

1. **Physical (PHY) layer :**

The IEEE802.15.4 PHY physical layer accommodates high levels of integration by using direct sequence to permit simplicity in the analog circuitry and enable cheaper implementations. The data rate is 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz, which means as number of channels increases data rate also increases. The higher data rate at 2.4GHz is attributed to a higher-order modulation scheme. Lower frequency provide longer range due to lower propagation losses. Low rate can be translated into better sensitivity and larger coverage area. Higher rate means higher throughput, lower latency or lower duty cycle. Several channels in different frequency bands enable the ability to relocate within spectrum



Operating Frequency Bands

1. **Media access control (MAC) layer :**

The IEEE802.15.4 MAC media access control layer permits use of several topologies without introducing complexity and is meant to work with large numbers of devices. The features of MAC sublayer are channel access, frame validation, acknowledged frame delivery, association and disassociation.

1. **Network and Application Support layer :**

The network layer permit growth of network sans high power transmitters. This layer can handle huge numbers of nodes. This level in the ZigBee architecture includes the ZigBee Device Object (ZDO), user-defined application profile(s) and the Application Support (APS) sub-layer.

## TYPES OF ZIGBEE NETWORKS

# ZigBee networks can be configured to operate in a variety of different ways to suit the application and environment, supported topologies include;

**1. Peer to Peer (Ad-hoc):**

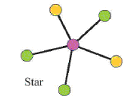
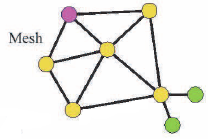
ZigBee nodes connect directly to each other for Peer to Peer communication.

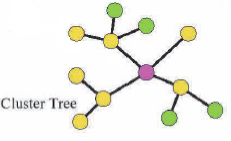
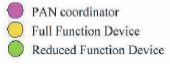
**2. Star configuration:**

Using a single PAN coordinator, each node connects directly to the central coordinator all inter-node communications are passed through the coordinator.

**3. Cluster Tree:**

A cluster tree network consists of number of star networks connected who’s central nodes are also in direct communications with the single PAN coordinator.

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* **Security services:**

Security services provided for ZigBee include methods for key establishment, key transport, frame protection, and device management which make it more secure than exiting system. These services form the building blocks for implementing security policies within a ZigBee device.

* **MAC Layer Security:**

A frame originating at the MAC layer needs to be secured, as per 802.15.4 specification .This layer has the ability to protect incoming and outgoing frames using encryption-only and integrity-only capabilities.

* **NWK Layer Security:**

Like the MAC layer, the NWK layer's frame protection mechanism make use of the Advanced Encryption Standard (AES); Upper layers manage NWK layer which is determining which security level to use.

One responsibility of the NWK layer is to route messages over multi-hop links.

* + **APL Layer Security:**

When a frame originating at the APL layer needs to be secured, the APS sublayer handles security. The APS layer's frame protection mechanism allows frame security to be based on Network key.

* **Key Establishment:**

Thes APS sublayer's key establishment services provide the mechanism by which a ZigBee device may derive a shared secret key, the so-called link key with another ZigBee device. Trust information (for example, a master key) provides a starting point for establishing a link key .A key-establishment protocol involves three conceptual steps:

1. The exchange of ephemeral data;
2. The use of this ephemeral data to derive the link key;
3. The confirmation that this link key was correctly computed.

* **Transport Key:**

The transport-key service provides secured means to transport a key to another device. The secured transport-key command provides a means to transport a master, link, or Network key from a key source to other devices.

* **Update Device:**

The update-device service provides a secure means for a device (for example, a router) to inform a other device (for example, a trust center)about the current status of other devices to minimize congestion .

* **Remove Device:**

The remove device service provides a secure means by which a device informs another device (for example, a router) that one of its children should be removed from the network which does not satisfy the terms.

* **Request Key:**

The request-key service provides a secure means for a device to request the current Network key, or an end-to-end application master key, from another device (for example, its trust center).

* **Switch Key:**

The switch-key service provides a secure means for a device (for example, a trust center) to inform another device that it should switch to a different active Network key.

## Basic Network Characteristics with ZigBee:

* 2.4 GHz and 868/915MHz dual PHY modes.
* 1 fully functional network coordinator (master)
* Optimized for timing-critical applications
* New slave enumeration: 30 ms (typical)
* Sleeping slave changing to active: 15 ms (typical)
* Active slave channel access time: 15ms (typical)

#### General Characteristics:

* 200m free space range approx.
* 2.4GHz IEEE 802.15.4 / ZigBee RF module.
* Addressing space upto 64 bit IEEE address devices.
* High throughput and low latency for low duty cycle applications.
* External antenna and screening can options.
* Output power 1mW / 0dBm.
* Consumes just 20mA (Rx), 18mA (TX)
* 2.1V - 3.6V supply
* Fully reliable hand-shaked data transfer protocol.
* Data rates of 250 kbps @ 2.4 GHz, 40 kbps @ 915 MHz.
* Low power consumption with battery life ranging from months to year.
* 255 devices per network
* Range: 10m nominal (1-100m based on settings)
* 1 fully functional network coordinator (master)
* .4GHz IEEE 802.15.4 / ZigBee RF module.
* Addressing space up to 64 bit IEEE address devices.
* High throughput and low latency for low duty cycle applications.
* 2.1V - 3.6V supply
* Fully reliable handshake data transfer protocol.
* Data rates of 250 kbps @ 2.4 GHz, 40 kbps @ 915 MHz.
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#### APPLICATIONS:

* Audio Video remote control
* Light switches, fire & smoke detectors
* Heating control
* Home security
* Landscaping
* Medical sensing and monitoring
* Universal Remote Control to a Set-Top Box which includes home control, industrial and building automation

Low Data Rate Radio Devices

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TV



VCR



DVD



CD



Remote



Mouse



Keyboard



Joystick



Game pad



Security



HVAC



Lighting



Closures



PETs



Gameboys



Educational



Monitors



Diagnostics



Sensors

Industrial & Commercial

Consumer Electronics

Personal Healthcare



Monitors



Sensors



Automation



Control

Toys & Games

PC Peripherals

**Overview of Application:**

Home Automation

* **CONCLUSION:**

ZigBee has the capability to quickly and inexpensively extend existing Bluetooth devices. Thus in this fast growing world, ZigBee will be one of the most important tool in fulfilling most of the current demands such as low power consumption, data sharing, sufficient speed, and data security at an reasonable cost.

## REFERENCES:

1. Wireless communications and networks by “William Stalling”.
2. www.ZIGBEE.org
3. www.IEEE.802.15.4.com