

Wireless Communication Systems- ZigBee-based modules

Keywords: ZigBee, wireless, mesh networks, industrial applications, embedded technology

KEY BENEFITS OF ZIGBEE

- **Low Power Consumption**

ZigBee protocols require low data rates and low power consumption, which are significant for any organisation.

- **Reduced Cabling Requirement**

ZigBee wireless technology eliminates the need for cables and thus reducing complication and installation cost by more than 30%.

- **Enhanced Design and Installation Time**

ZigBee's wireless networks are easier to design and install.

- **Flexibility**

ZigBee systems enable flexibility in modifying and relocating equipments without having to rewire any of the devices.

- **Interoperability**

The adoption of IEEE standard makes it easier to communicate across devices, thus making it completely interoperable and automated.

The World is going WIRELESS. As engineers develop faster, more robust technologies to liberate us from wires, enable greater simplicity, convenience, and efficiency, the adaptability and acceptability of wireless devices is growing. From short range to long range, the wireless landscape has taken shape in our lives. A host of WPAN (Wireless Personal Area Network) technologies are available and among those, ZigBee, which is the next big leap in Wireless technology, promises to be a definite bet for monitoring and control of industrial equipment.

ZigBee is a suite of high-level communication protocols using small, low-power digital radios based on the Institute of Electrical and Electronics Engineers (or IEEE) 802.15.4 standard. ZigBee protocols are intended for use in embedded applications requiring low data rates and low power consumption. The technology is intended to be simpler and cheaper than other WPANs such as Bluetooth, Wi-Fi etc. One of ZigBee's key features is its ability to cover large areas with routers. This feature helps differentiate ZigBee from other WPAN technologies. Mesh networking extends the range of the network through routing, while *self-healing increases the reliability of the network*, especially in case of a node failure.

ZigBee has been developed to meet the growing demand for effective wireless networking between various low-power devices. The ZigBee protocol is designed to communicate data through hostile RF environments that are common in commercial and industrial applications.

ZigBee is being used for next generation automated manufacturing, with small transmitters in every device on the floor, allowing for communication between devices to a central computer. This new level of communication permits finely-tuned remote monitoring and manipulation.

The ZigBee Protocol

The ZigBee protocol, which has been created and ratified by member companies of the ZigBee Alliance comprising of over 300 leading semiconductor manufacturers, technology firms, OEMs and service companies, is designed to provide an easy-to-use wireless data solution characterised by secure, reliable wireless network architectures.

**ZIGBEE
PROTOCOL
FEATURES**

- **Multiple Network Topologies**

Supports point-to-point, point-to-multipoint and mesh networks

- **Low latency**

Compared to Wi-Fi and Bluetooth technologies

- **Direct Sequence Spread Spectrum (DSSS)**

Lessens the probability of data lost during transmission

- **Low Duty Cycle**

- **Up to 65,000 Nodes per Network**

- **128-bit AES Encryption**

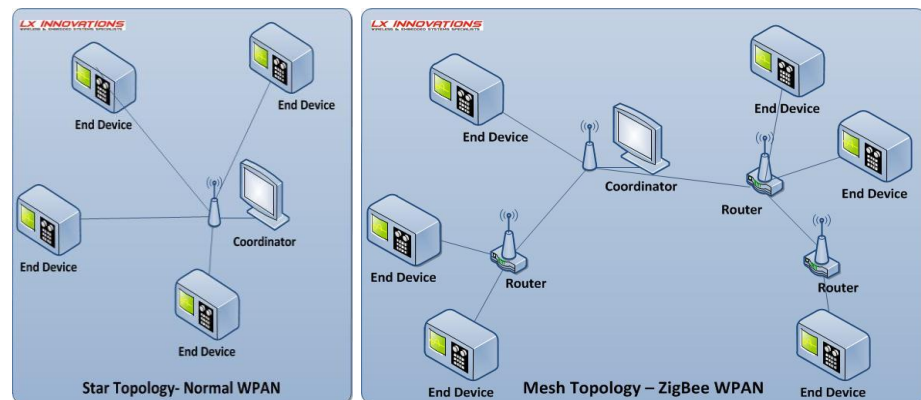
For secure data connections

- **Transmission check**

Mechanism to perform data retries and receipt of acknowledgements ensures proper transmission of data: a mandate for comprehensive automation

Mesh Networks

The core differentiation of ZigBee protocol with other WPANs is the ability to support *Mesh networks*. Mesh, or peer-to-peer, networks enable *high levels of reliability and scalability* by providing more than one path through the network. In a ZigBee network, a node also functions as a router and can relay messages for its neighbours. Through this relaying process, a packet of wireless data will find its way to its ultimate destination, passing through intermediate nodes with reliable communication links.



Key advantages of ZigBee Mesh networks

Self-Configuring- ZigBee networks discover new nodes and automatically incorporate them into the network without the need for a system administrator or change in the central coordinator system.

Self-Healing- If a node in a ZigBee network fails, messages are sent via other devices thus human intervention is not necessary for re-routing of messages.

Redundant- A mesh network can support multiple nodes, so that each device has two or more paths for sending data, increasing redundancy.

Scalability- ZigBee standard supports up to 65,536 nodes. Adding multiple data collection points is also convenient since it is not centrally controlled.

ZigBee versus Other Wireless Networks

In the following table, ZigBee is depicted as faring better in the majority of aspects relating to connectivity in industrial applications. The benefits that it offers are enhanced transmission of data, fewer complication in networking, seamless device integration, reduced power usage, robust security, shorter boot-up time, reduced turnaround time in implementing additional applications and above all lower cost and better ROI.

WHY ZIGBEE DESIGN FROM LX INNOVATIONS?

A host of generic ZigBee-based applications are available, but it is always prudent to have a custom-built application. LX Innovations provides design and manufacture services of such equipment, Advantages include:

- ✓ Vast expertise in development and implementation of ZigBee based applications
- ✓ Immense knowledge in design and manufacture of custom-built applications
- ✓ Highly reliable design and delivery
- ✓ Enhanced usability and efficiency in the long run
- ✓ Optimal productivity and efficiency
- ✓ Lower Total Cost of Ownership (TCO) compared to generic applications

	ZigBee	802.11 (Wi-Fi)	Bluetooth	UWB (Ultra Wide Band)	Wireless USB	IR Wireless
Data Rate	20, 40, and 250 Kbps	11 & 54 Mbps	1 Mbps	100-500 Mbps	62.5 Kbps	20-40 Kbps 115 Kbps 4 & 16 Mbps
Range	10-100 m	50-100 m	10 m	<10m	10 m	<10 m
Networking Topology	Ad-hoc, peer to peer, star or mesh	Point to hub	Ad-hoc, small networks	Point to point	Point to point	Point to point
Operating Frequency	868 MHz(EU) 900-928 MHz (NA), 2.4 GHz (Global)	2.4 and 5 GHz	2.4 GHz	3.1-10.6 GHz	2.4 GHz	800-900 nm
Complexity	Low	High	High	Medium	Low	Low
Power Consumption	Very low (design goal)	High	Medium	Low	Low	Low
Security	128 AES + application layer security	-	64 and 128 bit encryption	-	-	-
A Device joins network in..	Under 30ms	3-5 secs	Up to 10 secs	-	-	-

ZigBee Applications

ZigBee’s unique blend of wireless connectivity and distributed deployment enables it to be used in host of environments. Some of the applications that can be supported using ZigBee networks are:

- **Large Industries and Manufacturing Companies**
 - HVAC Monitoring & Control
 - Structural Integrity Monitoring
 - Lighting Control
 - Hoists / Elevator control
- **In Cargo, Shipping and Parking Lots**
 - Cargo Tracking
 - Parking Automation
- **Across Verticals and Companies**
 - Automated Meter Reading/ Energy Efficiency
 - Remote Energy Management
- **Manufacturing Companies**
 - Fuel Tank Monitoring
 - Solar Energy

Conclusion

Reliability, adaptability and scalability are the most important attributes of a wireless network for industrial control and sensing applications. ZigBee technology is designed to address this and much more. The next generation in automated manufacturing can have distributed devices, interconnected wirelessly for seamless operation, yet controlled and monitored remotely from a central location. ZigBee technology has the potential to make this happen - a potential that can help the world stride closer to the FULLY WIRELESS era!

About LX Innovations

LX Innovations is an electronics design company in Australia (www.lx-innovations.com.au). They design electronics, firmware, and software for many industries including the mining. LX Innovations is a pioneer in customer product development using PLC and ZigBee-based applications. LX enables its clients to access embedded applications designed and custom-built to a client’s requirements. The client benefits by having an application that has a Lower TCO, smaller in size combined with reliability and good performance. LX Innovations’ expertise in building PLC-based applications enables quicker design and reduces the time in bringing a concept-to-reality.

Keywords: ZigBee, wireless, mesh networks, industrial applications, embedded applications