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## **ZigBee and DataNet A Fusion of Technology**

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## **Table of Contents**

What is ZigBee Technology? .....	3
Why is ZigBee Technology Key for Data Logging? .....	4
The Requirements for ZigBee Data Monitoring .....	5
The Fusion of DataNet and ZigBee Technology .....	6
Multiple Channel Data Transmission .....	7
Controlling Option .....	7
System Wide Monitoring .....	7
128-bit Network Security Encryption .....	8
Signal Path Mapping .....	8
Amplifying Unit .....	8
What is the Future of ZigBee Technology .....	9

## What is ZigBee Technology?

ZigBee and IEEE 802.15.4 are standards-based protocols providing a network infrastructure comprised of coordinators, routers and end units.

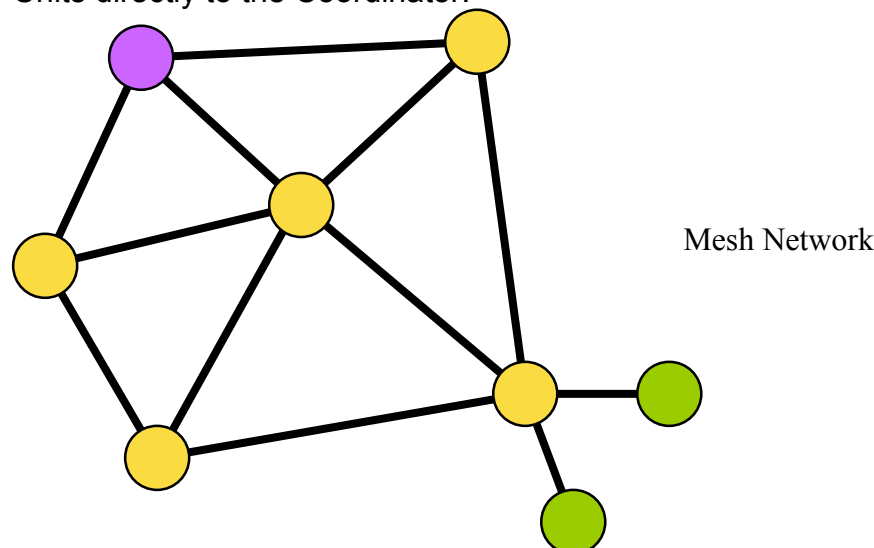
**ZigBee Coordinator:** There is only one Coordinator in a ZigBee network. Its job is to form and maintain the network.

**ZigBee Router:** a router can relay messages between units and by that increase the distance between units in the network. A router can also perform as an End unit.

**ZigBee End Unit:** a simple sensor unit, usually, battery operated. A ZigBee End unit can not relay messages.

ZigBee is the product of the ZigBee Alliance, and as recently as 2004 the first products supporting the ZigBee standard enter the market for use in the Internet and telecommunications. ZigBee is the key protocol for sensor network applications because of the long battery life, low costs for installation, maintenance and small footprint. ZigBee enables mesh networking which supports a wireless, yet integrated environment with communication between many coordinators, routers and receivers in environments where multiple applications are being monitored. The mesh network is ideal for can self configure and automatically self correct and is typically used in the Internet and by Telephone network companies.

There are multiple possible modes of network operation with ZigBee including the Star Network where the movement of data is in one direction from the End Units directly to the Coordinator.



However, for the purposes of this document we will consider the Mesh Network where every Unit can act as a router: Responsive to it's environment and communicating and reacting with its neighbors. Data then moves through the network, finding the best possible route until reaching its final destination.

The key issue about the Mesh Network is the ability to recover from unit failure. When one router malfunctions the network as a whole automatically finds an alternative route to the final destination.

## **Why is ZigBee Technology Key for Data Logging?**

The ZigBee network infrastructure and particularly the Mesh Network operation prove ideal for wireless sensor network applications. Such data acquisition networks require meter reading, parametric display of data such as temperature or humidity and responsive action when parameters are crossed. ZigBee protocol can provide this due to the fully automated, flexible and reliable nature. With the Mesh Network system, the ZigBee standard redresses misbalances in any data logging system, responding to weaknesses, inefficiencies, new network structure (with the additional or removal of devices) through self correct.

Within a Mesh network are a series of routers and receivers which all transmit the data eventually to an end-point. Data is usually sent through via dual channels and relayed to neighbor devices in the network. Essentially the data jumps through the network from one device to the next establishing automatically the most cost effective, efficient and secured path

When a new device it is recognized in terms of it's position and function. As mentioned each device consumes limited power and since the system relies on positioning near a neighboring device then interference from other radio signals is automatically limited. Since agent devices can be continuously added to increase the range of the network, there is always the potential for network growth. This allows for a flexible and trustworthy intelligent monitoring system. Many data monitoring environments require this level of intelligent automation and flexibility as applications become larger and more complex.

Further key concerns in monitoring large environments are the cost of installation, maintenance and power consumption and the ease with which a network can be expanded. With the ZigBee protocol, not only is implementation, maintenance, battery and support costs substantially lower, but additional devices can be added, existing devices removed or moved without setting up or surveying the network from scratch. The system simply self configures automatically bringing huge manual savings.

## The Requirements for ZigBee Data Monitoring

Alone ZigBee is essentially just a radio frequency technology. To become a data monitoring system it must be incorporated into a professional data acquisition system, with everything monitored under a single umbrella. Until now this was difficult to achieve when many different data loggers were working across numerous micro-environments. To combine these separate entities within one environment ZigBee technology must be leveraged to a wireless mesh network. Once the appropriate data logging technology can be developed an entire system and analysis software can fully monitor multiple environments, such as:

**Energy Management** – Here the strict and dynamic measurement of output and inputs is the key to ensuring efficient, safe management and minimized environmental impact via better controlled energy utilization. The breadth and type of data a mesh network provides brings customers and end users more information.

**Home Automation** – Total control and monitoring of your home environment, providing flexibility for home owners as they can manage from anywhere within the home temperature, light, security and entertainment systems

**Building Automation** – Integrated centralized management of temperature, security and light

**Industrial Automation** – integrating many complex elements of management across the various environments of the manufacturing and process control within a single, secured system.

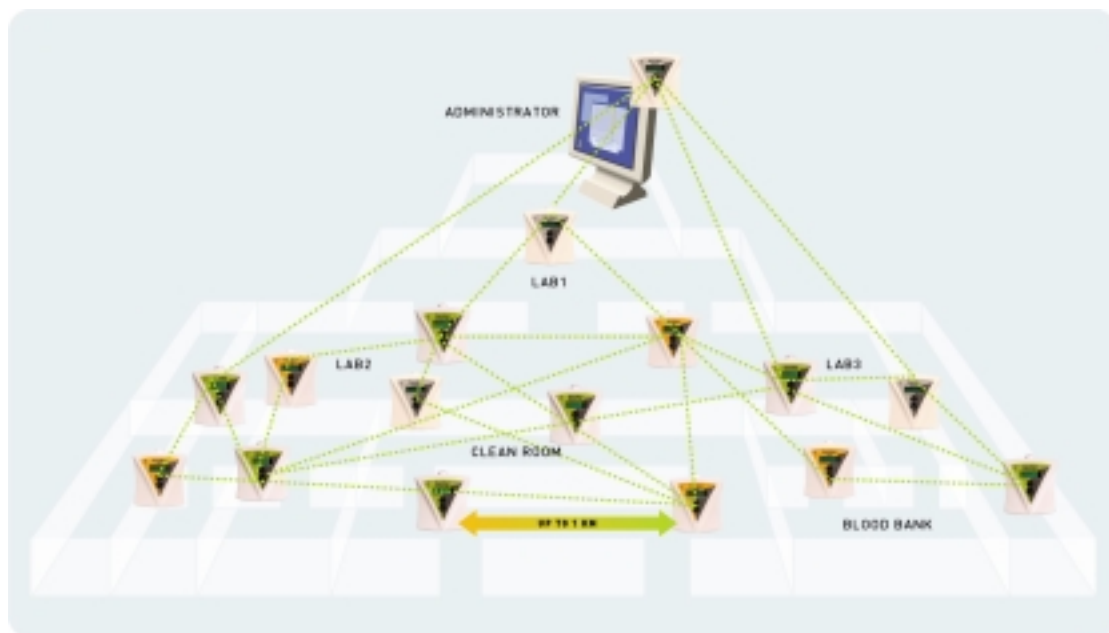
**Transportation** – every individual item in a shipment, as well as multiple containers can be monitored, the conditions and direction of the journey taken closely tracked.

**Laboratories** – monitoring all elements of the Lab equipment whether refrigerators, incubators, ovens or blood banks. This example would enable all extremes of temperature to be monitored, whether by a PT100 or thermocouple sensor, as well as CO<sup>2</sup> or Pressure all from within the same system.

A truly professional wireless mesh network intelligent monitoring system must have the following features:

- Expandable transmission range
- Ability to monitor almost any type of sensor
- Option to power from an external source when working with Transducer
- To ensure successful installations display the power signal of each data logger
- Ability to work with many units in the network, as well as creating many parallel networks in the same location

## The Fusion of DataNet and ZigBee Technology



With the DataNet system the traditional elements of the ZigBee Technology: Router, Coordinator and End Unit have been transferred to DataNet Repeater, Receiver and data logger. The Receiver now becomes the coordinator of the system – retrieving data from the various End Units and transmitting to the PC. In addition to this the Receiver also transmits data and commands to the End Units (in this case the DataNet data loggers). The Repeater acts as the Router – boosting the transmission ability and maintaining routing tables.

Fourier first considered the Zigbee technology because it carried many of the benefits of Bluetooth technology in that it had 2.4Ghertz – Wi-Fi promise, but a different protocol which could manage the transmission of data and network running on low power consumption. Today ZigBee is purchased as a chip and that chip was inserted into the DataNet system products, leveraging the ZigBee technology in fusion with the DataNet technological innovations to create the ZigBee data logging machine.

### *Multiple Channel Data Transmission*

The ZigBee protocol allows for 65,000 units within a Mesh Network all transmitting in dual directions. Fourier integrated up to 6 channels into each unit so that in total a possible 360,000 channels of any sensor input can be monitored, bringing broader, simplified coverage with substantial cost savings. Fourier's experience in large networking fields led us to anticipate that working with 65,000 nodes could potentially be challenging in terms of congesting the network and causing delays. In response to this, the R&D team took the same single ZigBee unit and dressed it with 6 channels, ensuring fewer transmissions from fewer devices are necessary. In other words data can be sent from 6 channels in a single transmission. This feature is key for applications requiring more than one monitoring unit, for example a refrigerator that needs different cells to be monitored simultaneously, here the data can be streamed through 6 channels and through the ZigBee chip. With the current system 4 inputs bring direct measurement and recording of PT-100, thermocouple, voltage 4-20mA, frequency and pulse.

### *Controlling Option*

The DataNet system adds a controlling option with the Zigbee so each data logging unit can control any unit in the network. The controlling output can be connected to any alarming device or for example can control the light level in a building via the light level sensor. The system responds when the light level drops below a specific parameter by activating a predefined unit's number to adjust the light level. Here the DataNet is performing much more than data receipt, and is actually following/activating commands.

### *System Wide Monitoring*

With the ZigBee and DataNet technology a response and action are ensured and need not be local but system wide, across a number of control rooms, production rooms, transportation units or laboratories. The monitoring crosses the entire system as far as the user defines it, with the actions of units in one area causing a response from units somewhere else within the same system. The dual communication of the ZigBee protocol enables this intelligent mesh system and the DataNet software makes this process automated.

### *128-bit Network Security Encryption*

The DataNet system incorporates some key security elements which include 128-bit encryption, the concept of a trust center, links and network keys, authentication and encryption and keys can be hard wired into the application. The 128-bit Network Security Encryption allows the system to work with 128 networks in the same environment. The system has 128 channels – meaning that different ZigBee networks can be established in the same locality, all working in parallel without seeing one another. In other words, this feature means a separation can be made between different departments or functions in any environment whilst still maintaining the integrity of a complete system. Furthermore, every system is secured and safe from external penetration. One successful example of this has been the establishment of separate networks for maintenance and surgery rooms in a hospital.

### *Signal Path Mapping*

The DataNet transmits more than simply data. It provides a map of the signal path indicating through color-coding the signal strength. This allows the user much easier installation and deployment of the system. A visually map of the journey the data takes is indicated on the DataNet software. Normally ZigBee technology only provides the information reflected in the collected data, with the DataNet technology this information has been given a much greater breadth of meaning. It has been mapped to describe the strength and flow of data to the PC. With this data map users can see how the entire DataNet system is truly deployed in their facilities, enabling them to upload a diagram showing the exact position of each unit. The line drawn between the units brings a virtual structure indicating how the information moves.

### *Amplifying Unit*

To ensure that a group of multiple units can work with a single repeater and transmit data over a distance of up to 800m, we added the Amplifying Unit to the DataNet repeater. Here the standard ZigBee transmission of up to 100m was extended, whilst still maintaining the free worldwide license specs of the ZigBee protocol, and ensuring power consumption is still low. The Repeater receives and transmits data to the second link. Should a network require monitoring over a larger area then the repeater can be added to the system rather than an entire monitoring unit which contains a repeater unit built in without the Amplifying Unit.

## **What is the Future of ZigBee Technology**

The future at first glance indicates powerful, wireless mesh networks that promise reliability, affordability and accessibility. Their influence will extend well beyond the initial rigorous or dangerous environments envisioned for ZigBee technology requiring broad and difficult to access distribution of monitoring devices. The protocol will also spread beyond the automated home industry, ensuring a comfortable control over temperature, light, entertainment systems and security. As the list of devices that are becoming portable and wireless increases, the possible applications for mesh networks is infinite.

The future spells cohesion with ZigBee as one current system can have all future systems integrated with it. Every technology using the ZigBee protocol will make it easy to read and integrate all the systems from a single interface. Manufacturers are reported as saying that with new technologies now available, wide adoption of RF wireless controls in commercial applications will occur within five years. This will have a considerable impact on how we impact our environment, establish cultures of work, manufacture, ship and market - throwing open the doors to automation and cost reductions and decentralized sensing and control.

Such a powerful, affordable and flexible tool will find an intersection through many mass markets. The key for the automated data acquisition market is to find a way to join the charge without getting lost in the stampede – possible only by supplementing the technology.

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