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A LOW COST AND FLEXIBLE ZIGBEE SYSTEM FOR LOGISTICS USING WIRELESS SENSOR NETWORKS

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Abstract- A network consisting of sensors such as temperature, pressure and sound are densely distributed to monitor physical or environmental conditions such a network is known as WIRELESS SENSOR NETWORK (WSN). The sensor data is transmitted to network coordinator which is the heart of the wireless personal area network. In the modern scenario wireless networks contains sensors as well as actuators. ZigBee is newly developed technology that works on IEEE standard 802.15.4. The low data rates, low power consumption and low cost are the main features of ZigBee. WSN is composed of ZigBee coordinator (network coordinator), ZigBee router and ZigBee end device. The sensor node's information in the network is sent to the coordinator, the coordinator collects the sensor's data, stores the data in memory, processes the data, and routes the data to the appropriate node.
Keywords: Wireless Sensor Network; ZigBee, Routing; Protocols; Coordinator;

I. INTRODUCTION

Wireless sensor network is a technology for wide range of wireless environments. This works on low power, low data rate, low cost personal area network. The importance and application has been increased by the recent delivery of the IEEE 802.15.4 standard and the forthcoming ZigBee standard. The ZigBee Alliance has developed very low-cost, very low-power consumption, wireless communications standard for network and application layer to fulfill the demand of automation and remote control applications.[1,2]

A wireless sensor network is a collection of nodes. Each node consists of processing capability (one or more MCUs or DSP, chips), multiple types of memory (program, data and flash memories), a RF transceiver, a power source (batteries), and accommodates various sensors and actuators. Wireless sensor networks, the systems are wireless, have scarce power, are real-time, utilize sensors and actuators as interfaces, have dynamically changing sets of resources, aggregate behaviour. Many wireless sensor networks also utilize minimal capacity devices. Many wireless sensor networks also utilize minimal capacity devices.

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Usually these devices are small and inexpensive, so that they can be produced and deployed in large numbers, and so their resources in terms of energy, memory, computational speed and bandwidth are several constrained. [3] ZigBee is expected to provide low cost and low power connectivity for equipment that needs very long battery life as several months to several years but does not require data transfer rates as high as those enabled by Bluetooth. Also ZigBee can be implemented larger networks than is possible with Bluetooth. ZigBee compliant wireless devices are operate in the unlicensed RF worldwide (2.4GHz global, 915MHz Americas or 868 MHz Europe). The data rate is 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz [4].

II. TEHNOLOGY USED AND ZIGBEE PROTOCOL

ZigBee is a wireless network which has been developed recently to work on low power, low data rate, low cost personal area network. Hence because of this its importance and application has increased immensely in recent years. This network is based on the IEEE 802.15.4 standard. This IEEE 802.15.4 works on low data rate standard for MAC layer and physical sub layers. ZigBee is hence used to provide low cost and low power connectivity for certain equipment which requires very long battery life for about several months to years and which of those not requiring data transfer rates as high as those enabled by Bluetooth. Larger networks can also be implemented using ZigBee on comparison with Bluetooth's network [5, 6].

ZigBee is a standard developed for wireless radio networks in monitoring and control fields. To meet the following principal needs this standard was developed by ZigBee alliance:

- Low cost
- Ultra-low power consumption
- Use of unlicensed radio bands
- Cheap and easy installation
- Flexible and extendable networks
- Integrated intelligence for network set-up and message routing

The characteristics of physical and MAC layers are defined by ZigBee standard 802.15.4 for low rate wireless personal area networks (LR-PWAN). The node architecture is divided into a number of structural blocks called layers. Each layer offers services to its upper layers and gets services from its lower layers. Each network node's architecture is comprised Physical (PHY) layer and Medium Access Control (MAC) sub layer. There exists a layer called Service Specific Convergence Sub layer (SSCS) on top of all these layers which interfaces the MAC sub layer to the logical link control sub layer and other upper layers such as the networking layer which provides network configuration, manipulation and message routing, and application layer, which provides intended function of device. These LR-PWAN standards are undefined for other layers but defined only for PHY and MAC layer [7, 8].

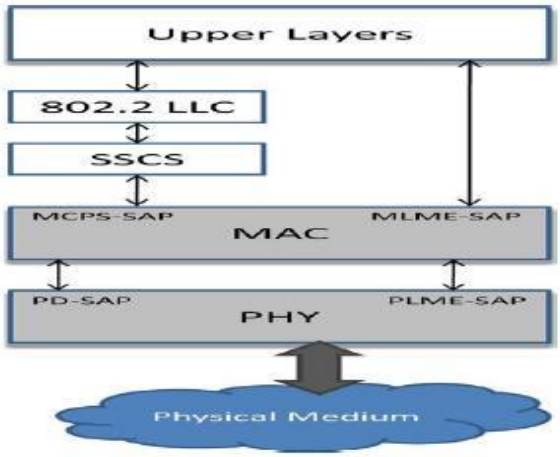

Fig 1: Layers of IEEE 802.15.4

Two services are provided by the physical layer, they are:

1. PHY data service and
2. PHY management service interfacing to the Physical Layer Management Entity (PLME).

The transmission and reception of PHY Protocol Data Units (PPDU) across the physical radio channel is enabled by this PHY data service. Some of the tasks performed by physical layer of IEEE 802.15.4 are as follows:

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- Activation and deactivation of the radio transceiver
- Energy Detection (ED)
- Link Quality Indication (LQI)
- Clear Channel Assessment (CCA)
- Channel Frequency Selection

Functions performed by the protocol is that it allows dynamic channel selection, a channel scan function in search of a beacon, receiver energy detection, link quality indication and channel switching as well.

Two services provided by the MAC sub layer, are

1. The MAC data service. This enables the transmission and reception of MAC Protocol Data Units (MPDU) across the PHY data service.

2. The MAC management service interfacing to the MAC sub layer Management Entity (MLME) Service Access Point (SAP) (MLME-SAP).

Beacon management, channel access control through the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) scheme, collision-free time slots management, frame validation, acknowledged frame delivery and node association and disassociation are some of the features of MAC sub layer.

III. LITERATURE SURVEY

[9] Nidhi Patel et al proposed a technique which is extremely flexible in nature. It also offers excellent features such as low cost, fault tolerance, high sensing fidelity. These are mainly used for developing remote sensing applications. Sensor network introduces certain constraints like fault tolerance, scalability, cost, hardware, topology change, environment and power consumption which we should aim to overcome.

[10] Sandeep Kaushik and Charanjeet Singh proposed a monitoring and controlling platform system based on ZigBee and Bluetooth. Both wireless standards have their own advantage and applications and drawbacks based on certain parameters but ZigBee seems to be more economical and effective network on comparison with Bluetooth. ZigBee offers lower power consumption and high range. Hence for food storage system network based on ZigBee is more suitable than Bluetooth network

[11] Geetha A et al proposed a wireless sensor system making use of extremely low powers have been designed at a reduced cost. Most reliable system which is very quick. Installation is also quite fast. It can be used to improve the system scalability and can be used to extend accurate position of underground miners in future by making use of ZigBee wireless positioning devices.

[12] Action Nechibvute & Courage Mudzingwa Proposed to achieve a seamless transition from wired to wireless communication, there is need for efficient integration of the WSNs into existing automation. This is also required for achieving simple deployment, commissioning, and maintenance's-enable automation systems will get more popular mainly due to lower cost increased flexibility and scalability which cannot be obtained from traditional all-wired automation systems.

IV. SYSTEM ARCHITECTURE

Low cost and low data rate networks using zigbee are growing in demand. The wireless sensor networks are used all spheres of the technical world now. In logistics, the technology has helped in the management of large warehouses. The e-commerce industry is also looking towards WSNs. The various configurations such as mesh, star and distributed are used in many useful purposes.

A. Proposed System

The main objective is to eliminate the manual checking of free spaces for storage of new items. The system also takes care of the size of items. The doors are enabled with a 20x4lcd display to how the status of the racks. This data is communicated by the ZigBee Xbee pro s2 from the co-ordinator to the entrance node. The data at the co-ordinator is updated for every 5seconds. The system proposes a design that does not use the extra microcontrollers at the sensor nodes. Hence the system is low cost, less complex and less power. The systems use the IR sensors for the detection of empty or occupied racks .The systems used in this system are ARM7 LPC2148 controller,20x4 LCD display,DS1307 Real Time Clock, IR sensors and PIR sensors. For communication we use the ZigBee Xbee pro s2.

The fig. 2 describes the general block diagram of the entire system. Here we have taken one co-ordinator and three routers. The two routers are placed at the racks and update the status of the racks to the coordinator. The third node at the entrance is used to show the information through a LCD. The communication is set up by using the ZigBee. The LPC2148 is used at the co-ordinator to process and store the data. The controller at the gate is attached with the level sensors to detect the size of the item.

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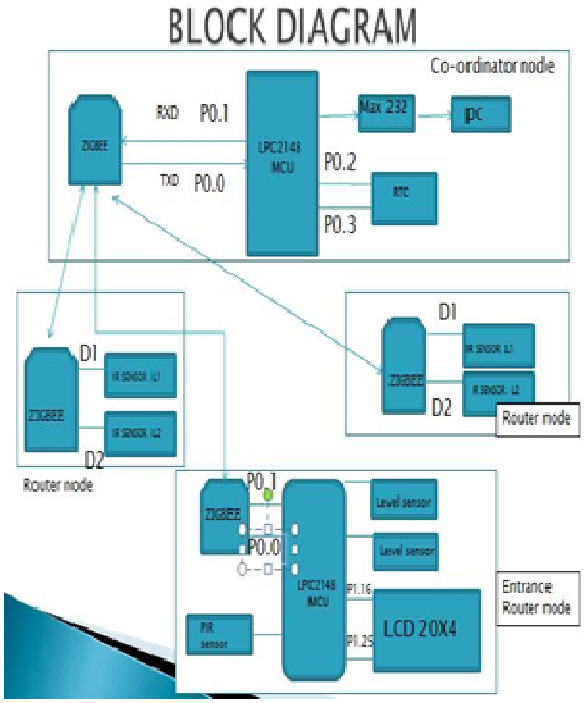

Fig 2: System Bock Diagram

V. SOFTWARE IMPLEMENTATION

We are using embedded C for programming in Kiel software and Flash Magic for dumping the code into LPC2148. Digi XCTU is used for ZigBee network formation. Hercules software is used for user displaying the router information at the coordinator.

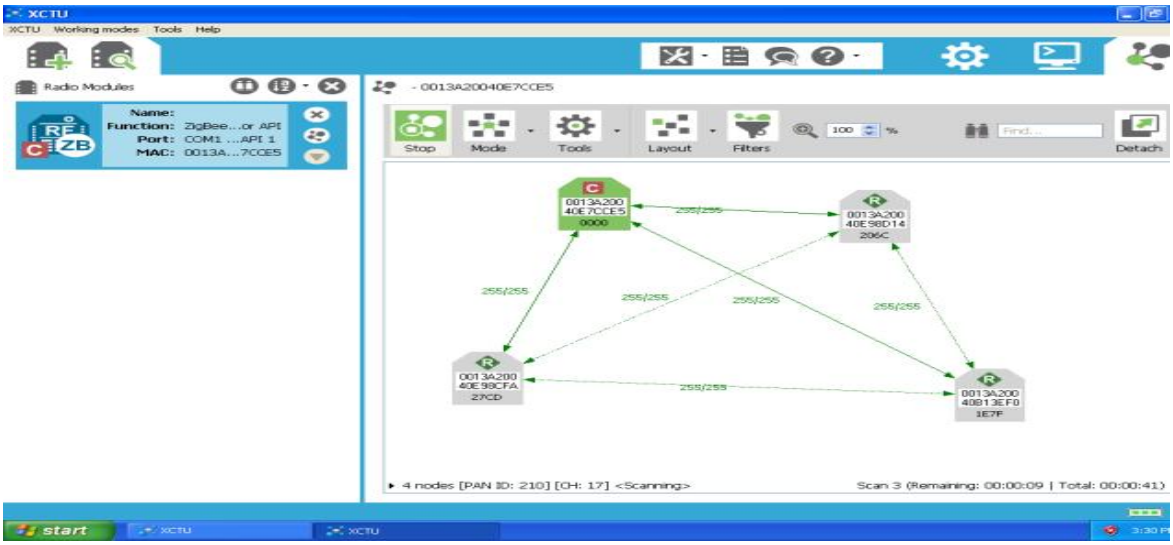

Fig 3: possible ways of communication

The network is formed by using the same PAN number at all nodes. The coordinator node operates in API mode and routers operate in AT mode. This is done by using Digi XCTU software. Identical sampling rate is set to send the information from the routers. Here we were updating the status for every 5seconds.The received data at coordinator is in packet form which is of 17bytes.

The received packet consists of 1byte start delimiter whose value is 7E, 2bytes of length, one byte to indicate the frame type, 64bit source address, received data and a checksum value. The possible ways of communication is shown in Fig 3. Here we are using the star network for communication. The UART ports are used for user interface. These were initialized using UART register, an interrupt is raised the when there is a transmission and reception. The timer interrupt is used (using the timer registers) for RTC.

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MAX 232 is used for UART connection between ZigBee and LPC2148, MAX232 performs TTL logic conversion. The pins are selected for a particular operation using pin select register in LPC2148.At routers, pins DOI1 and DOI2 of Xbee are used for data transmission from the sensors. This operation is demonstrated by the help of a flowchart in figure 4

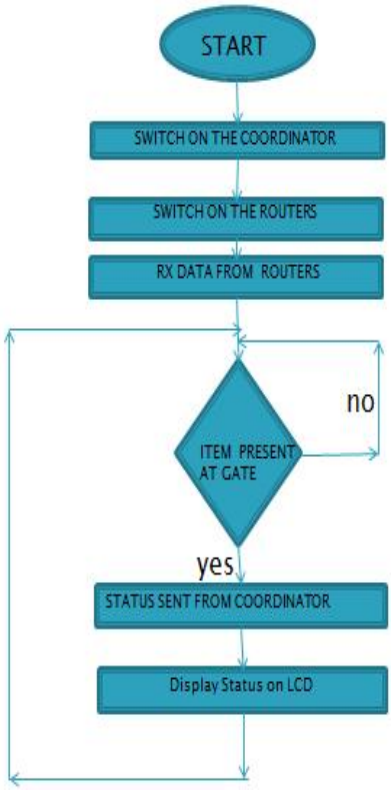

Fig 4: Flowchart of the System

VI. RESULTS

The figure 5 shows the result at the coordinator using Hercules software.

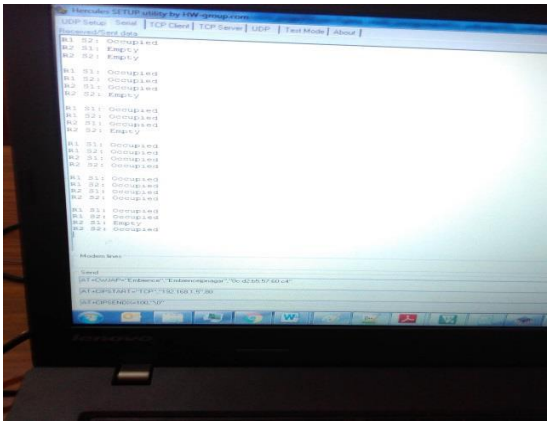

Fig 5: Router status at coordinator

Once the data is received it is converted into hex value, using the address the source is found and status is updated and the information is sent to entrance node which will be displayed in LCD as shown in the figure 6.

Fig 6: LCD display at entrance

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CONCLUSION

A wireless sensor network as we know has many excellent features such as fault tolerance, low cost, high sensing fidelity and is also greatly flexible in nature. All of these features can be wisely used for developing applications in remote sensing. This wireless system is used to establish monitoring and controlling platform using ZigBee. The central monitoring unit will receive the monitoring data from all the sensor units and stores them in the database. ZigBee is preferred because it is more economical and effective compared to Bluetooth. And offers low power consumption and high range network. But there are certain constraints when we consider sensor networks which should be overcome. Some of these may include constraints introduced by scalability, hardware, topology change, environment and power consumption. Some new wireless ad hoc networking techniques must be incorporated as we know all these constraints are highly stringent and specific for sensor networks

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