



Web Based Remote Lighting System Using ZigBee Technology and SoC Solution

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Abstract: This paper presents the design and implementation of a web based Light Automation System built on wireless communication protocols IEEE 802.15.4 Zigbee. Wireless Xbee modules Series I or Series II, which are capable to be configured to work in a network under some different topologies like star, cluster tree and mesh[1]. With these module implementations of the Zigbee Wireless Networks with geographic coverage increasing rang are possible. Xbee module is a low cost and powerful tool for implementation of web base light automation systems. Because the basic standalone XBee radio does not allow access to any kind of logic, the incorporation of external microcontroller to each subsystem node will be necessary to allow some form of local logic that requires knowledge of the C-like language. i.e up till now Xbee Module by itself is not intelligent. The Application Software for operator interface will be networked over the Internet to accomplish remote monitoring and controlling over the plant Ethernet using Python programming the interface will be displayed as a secured HTML page in a website. The above idea will be verified via a representative example using the technologies presented in this paper.

Index Terms: Zigbee, Mesh Network, Xbee, IEEE 802.15.4, Microcontrollers.

I. INTRODUCTION

Recently, along with the development of computer, automation and communication, the everyday life of people has changed a lot. People now pay more and more attention to the safety, health and comfort of the living environment. As there are so many kinds of lighting products, how to effectively make them become an integer and solve the inconvenience caused by distributed control and provide people with better living environment, the answer is Smart Home Lighting System (SHLS). In the SHLS, it is a trend to apply wireless network technology to home automation network. Not only that wireless network can provide flexibility and reduce the cost of cabling, but also it accords with the feature of home network. In these days, people have explored so many kinds of wireless technology, ZigBee technology is one of them. ZigBee is a bi-direction wireless communication standard, it focuses on low power consumption and low cost and it fits for e case of wireless automatic control and measurement.

II. ZIGBEE TECHNOLOGY

ZigBee is a wireless network standard defined by ZigBee Alliance and based on the IEEE 802.15.4. The standard focuses on low rate, low cost, low power consumption, robustness, reliability and self-healing. Solutions adopting the ZigBee standard will be embedded in consumer electronics, home and building automation, industrial controls, PC peripherals, medical sensor applications, toys and games. The ZigBee stack architecture, which is depicted in Figure 1, is based on the standard Open Systems Interconnection (OSI) seven-layer model. The IEEE 802.15.4 standard defines the lower two layers: the physical (PHY) layer and the medium access control (MAC) sub-layer[6]. The ZigBee Alliance builds on this foundation by providing the network (NWK) layer and the framework for the application layer, which includes the application support sub-layer (APS), the ZigBee device objects (ZDO) and the manufacturer defined application objects. Each layer performs a specific set of services for the layer above.

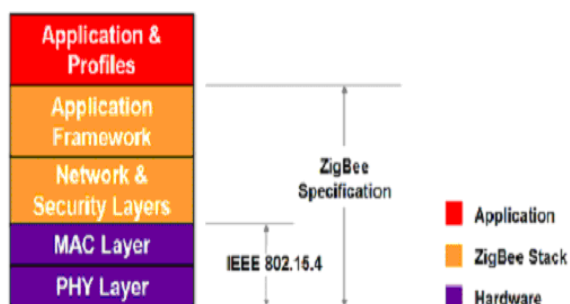


Fig. 1: ZigBee stack architecture

The ZigBee network layer (NWK) supports star, tree and mesh topologies. In a star topology, the network is controlled by one single device called the ZigBee coordinator. The ZigBee coordinator is responsible for initiating and maintaining the devices on the network, and all other devices, known as end devices, directly communicate with the ZigBee coordinator. In mesh and tree topologies, the ZigBee coordinator is responsible for starting the network and for choosing certain key network parameters but the network may be extended through the use of ZigBee routers. In tree networks, routers move data and control messages through the network using a hierarchical routing strategy. Mesh networks shall allow full peer- to-peer communication.

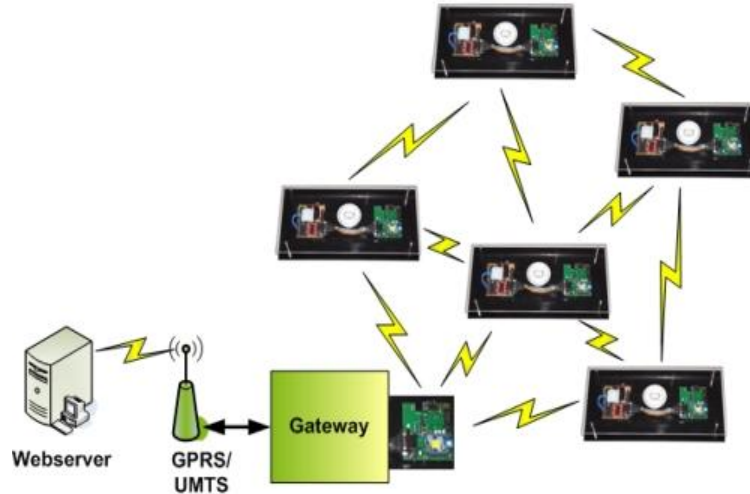


Fig. 2: Scheme of the proposed system

III. COMMUNICATION PROTOCOLS

ZIGBEE/ IEEE 802.15.4/ DIGIMESH In our papers each subsystem node is based on the wireless modules Xbee which support the IEEE 802.15.4 and Zigbee protocols respectively. IEEE 802.15.4: is a wireless standard protocol oriented to the implementation of wireless sensor network applications. This communication protocol drive the physical (PHY) and Media Access Control MAC layers of the device of radio frequency and as in the most of the wireless communication protocols the MAC layer coordinates the access to one channel of radio share for several wireless devices and modules. Zigbee: is a wireless communication protocol which work over IEEE 802.15.4

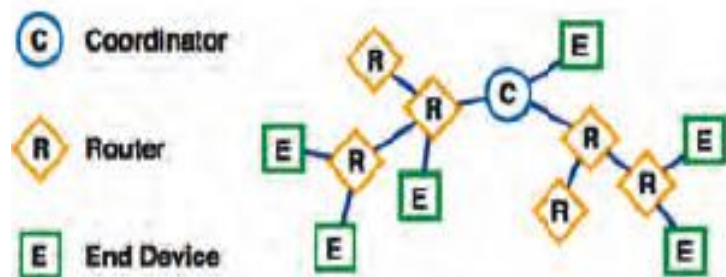


Fig. 3: ZigBee protocol nodes types

Zigbee define the top layers of applications, networking and security, and its architecture defines three different types of devices, Coordinator, Routers (repeaters) and final function end devices as in Fig. 3.

The Coordinator device manages the network and is the responsible administrating the network. Its main functions are to start the net and to add the possible nodes needed to be aggregate to the network. The Routers devices: are the means through which the messages are transmitted between the coordinator and final function devices to extend the range. These devices enable data packages or messages to arrive to those nodes out of coverage of the coordinator, i.e they repeat the messages to the next node in the router and facilitate the communication between the coordinator and remotes nodes. These devices have the capacity to acquired and transmit data through its digitals I/O's. The End devices: the final function devices just have the characteristics of acquired data and affect its digital I/O channels if is the case[2]. These values are sent to the coordinator or other node through the net. Apart from, this kind of devices can operate in different modes of low cost energy in the wanting of energy autonomy.

IV. COMPONENTS OF THE PROPOSED SYSTEM

As a kind of wireless communication technology, ZigBee has broad application prospects. This paper proposes a Web-Based DCS Built On Zigbee Mesh Network. In this system, Xbee Modules and microchip microcontrollers in addition to the Rabbit SBC BL4S100 Series Single-Board Computer (as an embedded web server) are used to realize the hardware platform and the like C- languages (MikroC, Dynamic C and C-Sharp) will be used to construct and realize the software function of the system. And to guarantee the reliability of the system operation, hierarchical networks topology based on mesh will be designed[3]. Fig. 7 shows a general overview of the considered system. The following are the system main components of the considered system. The main components are:

- The Xbee modules
- PIC Microcontrollers
- The application software

A. The Xbee module

The module comes in several versions but all have similar pin outs as shown in Fig. 4. Differences between Xbee versions include the power output, antenna style, operating frequency and networking abilities. The Xbee is a 20-pin DIP module with pin spacing of 2 mm (0.079 in) as opposed to typical pin spacing of 2.54 mm (0.1 in). The Xbee is available in two major versions and variants of those versions.



Fig.4: Different types of Xbee radios

The Xbee/Xbee-PRO OEM RF Modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART; or through a level translator to any serial device (For example: RS-232/485/422 or USB interface board).

B. The PIC Microcontroller

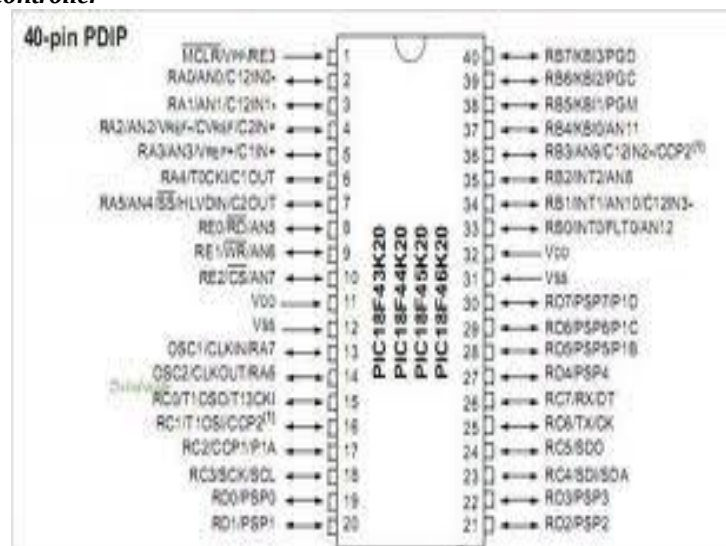


Fig. 5: PIC18F45k20 pin diagram [6]

The PIC18F45k20 microcontroller has 16K of code space, 34 I/O pins and many other features in a 40-pin DIP package. The PIC18F45k20 features a 'C' compiler friendly development environment, 256 bytes of EEPROM, Self-programming, an ICD, 2 capture/compare/PWM functions, 8 channels of 10-bit Analog-to-Digital (A/D) converter, the synchronous serial port can be configured as either 3-wire Serial Peripheral

Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and Addressable Universal Asynchronous Receiver Transmitter (AUSART). All of these features make it ideal for manufacturing equipment, instrumentation and monitoring, data acquisition, power conditioning, environmental monitoring, telecom and consumer audio/video applications.

C. Application Software

The following development tools are provided as standard:

- A graphics editor, with standard drawing facilities, including freehand, lines, squares circles, etc. It is possible to import pictures in many formats as well as using predefined symbols including e.g. trending charts, etc. A library of generic symbols is provided that can be linked dynamically to variables and animated as they change. It is also possible to create links between views so as to ease navigation at run-time.
- A data base configuration tool, usually through parameter templates. It is in general possible to export data in ASCII files so as to be edited through an ASCII editor or Excel.
- A scripting language.
- An application Program Interface (API) supporting C, C++, QT.

The development tools that will be used in this project are as follows:

1. MikroC will be used for PIC microcontroller programming, the mikroC for PIC compiler contains many libraries that will considerably simplify the process of writing a program for the PIC microcontroller. By using a few routines from these libraries, it is possible to create the program that will make it possible to control and monitor devices and process.
2. Django active server pages is used to create a website that will contain the overall system interface that enables the operator to control and interact with plant over the Internet by hosting the created website in the system server which has a public or real IP.
3. Python, WebPages will be programmed using django to handle the interaction operation with the plant.
4. SQL is used in this project to save the system variables, historical status in conjunction with MS Access. This helps and enables the operator to take the appropriate decisions.

V. APPLICATION EXAMPLE

A normal user can use this technology through a web browser. The lights in the user's registered area can be controlled through the login ID provided to the user. The user can control the basic functionalities like switching the lights ON/OFF, controlling the intensity of the LED and setting the RGB values of the LEDs. The user can also make groups for the available lights. The groups can be collectively turned On or OFF[5]. The intensity and RGB values can also be changed collectively for the grouped lights. The groups can be changed and reformed anytime by the user.

VI. CONCLUSIONS

ZigBee technology is a new wireless protocol that widely used in various areas for its excellent performance in reliability, power consumption, flexibility and cost. This paper introduced how to use ZigBee technology to realize wireless control in building lighting. The lamp node will turn to sleep mode when it is in off mode. Experiments proved that this system is low power consumption, low complexity and high reliable. It also meets the need of developing of data acquiring and control system in industrial automation. With the consequent develop of a series of products based on ZigBee protocol. more attention and development will be dedicated to the fields of application design and realization ,interoperability test and market promotion. We believe that more and more build-in ZigBee function equipments will be widely used in military and civil area in the near future.

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