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Smart Home Energy Management Based on Zigbee

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ABSTRACT

Today organizations use IEEE 802.15&Zigbee to effectively deliver solutions for a variety of areas including consumer electronic device control, energy management and efficiency home and commercial building automation as well as industrial plant management. The smart home energy network has gained widespread attentions due to its flexible integrati- ion into everyday life. This next generation green home system transparently unifies various home appliances smart sensors &wireless communication technologies .The green home energy network gradually forms a complex system to process various tasks. Developing this tend, we suggest a new smart home energy management system (SHEMS) based on an IEEE802.15.14&Zigbee (we call it as a "Zigbee sensor network").The proposed smart home energy management system divides and assigns various home network tasks to appropriate components. It can integrate diversified physical sensing information and control various consumer home devices , with the support of active sensor networks having both sensor and actuator components. We develop a new routing protocol DMPR(disjoint Multi path based Routing) to improve the performance of our zigbee sensor networks. This paper introduces the proposed home energy control system design that provides intelligent services for users. We demonstrate its implantation using a real environment.

Keyword: DMPR,SHEMS,IEEE802.15.14&Zigbee.

INTRODUCTION

The*Real-time Embedded Software Group* concentrates on research on real-time embedded software systems at the intersection of software technology, embedded networking, and applied formal methods.The *Real-time Embedded Software Group* concentrates on research on real-time embedded software systems at the intersection of software technology, embedded networking, and applied formal methods. Real-time embedded systems are characterized by their interaction with the environment through sensors and actuators, their resource constraint platforms, and non-functional properties. Successful research in this area focusses on providing concepts, methods, and tools to build better systems more easily as well as on development of precise analytical methods for characterizing non-functional system properties and timing.Embedded system having a wide range of application in our day to day life such as house hold appliances, security systems automotive industry, tele communication industry, computer networking ,medicine measurement and instrumentation banking and retail, card readers,aircraft electronics ,militaryrobotics etc.As an emerging technology WSN(wireless sensor network) have lot of applications like health ,security, military and several other in various domains. Object tracking ,which is also called target tracking, is a major field of research in WSNs and has many real life applications such as wild life monitoring , security applications for buildings and compounds to prevent intrusion or trespassing ,and international border monitoring for illegal crossings.furthermore , object.ZigBee devices are designed for low power consumption. Devices put themselves to sleep when not in use, thereby conserving power. This makes these devices ideal for battery-operated applications because they can last for several years before needing new batteries.Designers of home automation systems are looking to wireless networks to provide the control and monitoring that they need with low cost and lower power consumption. There are a number of different technologies aiming to provide this capability, from the 802.15.4 ZigBee wireless mesh, through 802.11b/g WiFi to proprietary protocols such as Sigma Designs' Z-Wave.

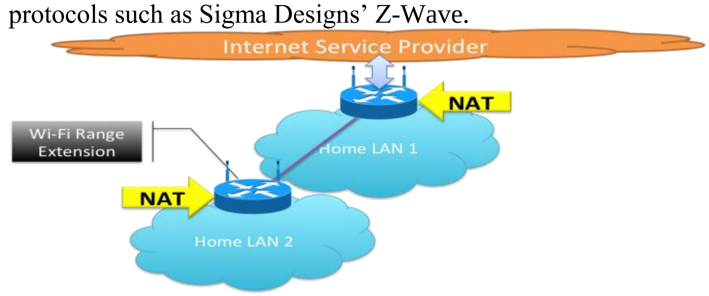

Fig1: The Future of Home Networking: A Problem Statement

Recent developments in process technology have allowed much higher levels of integration, allowing high performance microcontrollers to sit alongside RF transceivers in single chip devices that dramatically simplify the design process. Additionally, low power design techniques have reduced the power consumption of devices to the level where they can be powered by low cost single button cells or even by harvesting energy from the environment. All of thisprovides designers with a wide variety of options for developing the next generation of smart, connected home automation systems that can be accessed and controlled in many different ways.

METHODOLOGY

ZigBee stack architecture:

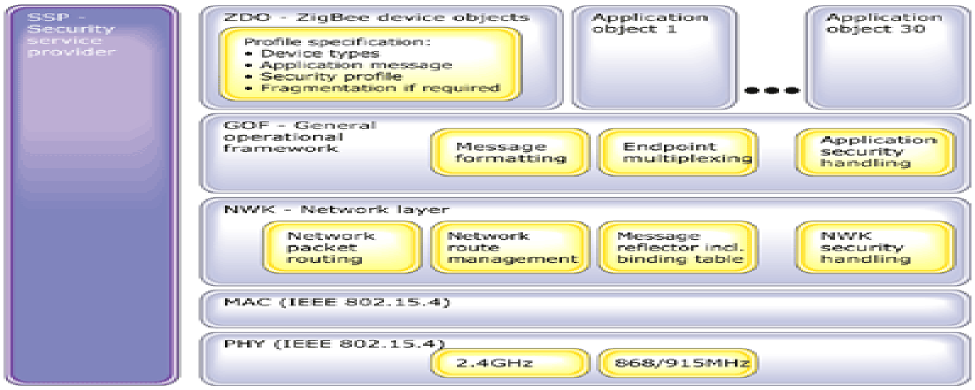

Fig 2: Architecture of the stack

It may be helpful to think of IEEE 802.15.4 as the physical radio and ZigBee as the logical network and application software, as Figure 1 illustrates. Following the standard Open Systems Interconnection (OSI) reference model, ZigBee's protocol stack is structured in layers. The first two layers, physical (PHY) and media access (MAC), are defined by the IEEE 802.15.4 standard. The layers above them are defined by the ZigBee Alliance. The IEEE working group passed the first draft of PHY and MAC in 2003. A final version of the network (NWK) layer is expected sometime this year. ZigBee-compliant products operate in unlicensed bands worldwide, including 2.4GHz (global), 902 to 928MHz (Americas), and 868MHz (Europe). Raw data throughput rates of 250Kbps can be achieved at 2.4GHz (16 channels), 40Kbps at 915MHz (10 channels), and 20Kbps at 868MHz (1 channel). The transmission distance is expected to range from 10 to 75m, depending on power output and environmental characteristics. Like Wi-Fi, Zigbee uses direct-sequence spread spectrum in the 2.4GHz band, with offset-quadrature phase-shift keying modulation. Channel width is 2MHz with 5MHz channel spacing .

Framestructure:

The four basic frame types defined in 802.15.4: data, ACK, MAC command, and beacon.

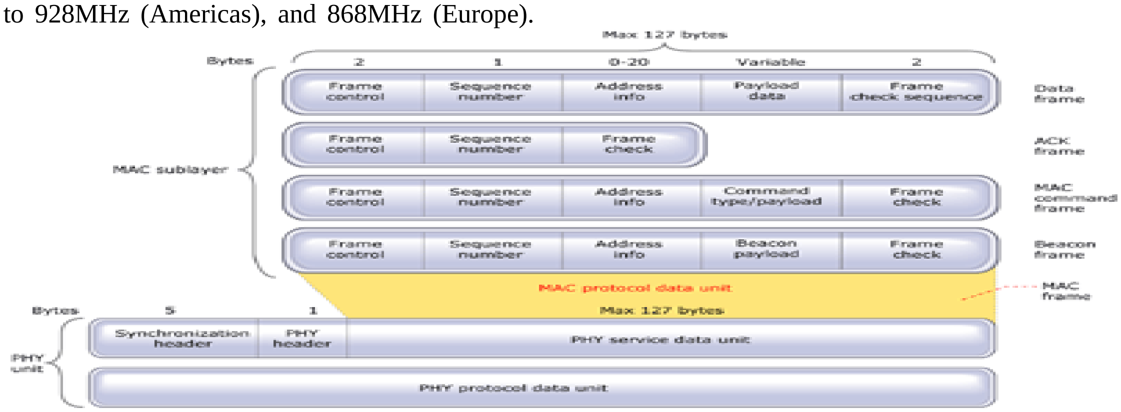

Fig3: Frame structure

The data frame provides a payload of up to 104 bytes. The frame is numbered to ensure that all packets are tracked. A frame-check sequence ensures that packets are received without error. This frame structure improves reliability in difficult conditions.Another important structure for 802.15.4 is the acknowledgment (ACK) frame. It provides feedback from the receiver to the sender confirming that the packet was received without error. The device takes advantage of specified "quiet time" between frames to send a short packet immediately after the data-packet transmission. A MAC command frame provides the mechanism for remote control and configuration of client nodes. A centralized network manager uses MAC to configure individual clients' command frames no matter how large the network. Finally, the beacon frame wakes up client devices, which listen for their address and go back to sleep if they don't receive it. Beacons are important for mesh and cluster-tree networks to keep all the nodes synchronized without requiring those nodes to consume precious battery energy by listening for long periods of time.

Networks:

A key component of the ZigBee protocol is the ability to support mesh networks. In a mesh network, nodes are interconnected with other nodes so that at least two pathways connect each node. Connections between nodes are dynamically updated and optimized in difficult conditions. In some cases, a partial mesh network is established with some of the nodes only connected to one other node. Mesh networks are decentralized in nature; each node is self-routing, self healing and able to connect to other nodes as needed. The characteristics of mesh topology and ad-hoc routing provide greater stability in changing conditions or failure at single nodes. The ZigBee specification identifies three kinds of devices that incorporate ZigBee radios, with all three found in a typical ZigBee network.

- A coordinator, which organizes the network and maintains routing tables.
- Routers, which can talk to the coordinator, to other routers and to reduced-function end devices.
- Reduced-function end devices, which can talk to routers and the coordinator, but not to each other.

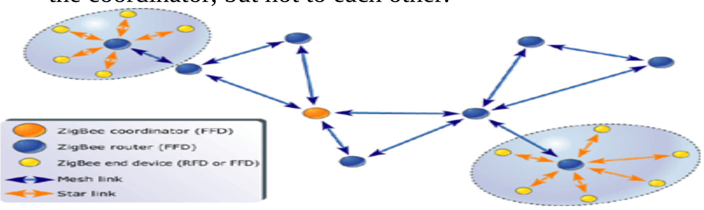

Fig4: Network communications

Zigbee network model:

In a star topology, one of the FFD/RFD-type devices assumes the role of network coordinator and is responsible for initiating and maintaining the devices on the network. All other devices, known as end devices, directly communicate with the coordinator. In a mesh topology, the ZigBee coordinator is responsible for starting the network and for choosing key network parameters, but the network may be extended through the use of ZigBee routers. The routing algorithm uses a request-response protocol to eliminate sub-optimal routing. Ultimate network size can reach 264 nodes (more than we'll probably need). Using local addressing, you can configure simple networks of more than 65,000 nodes, thereby reducing address overhead.

BLOCK DIAGRAM:

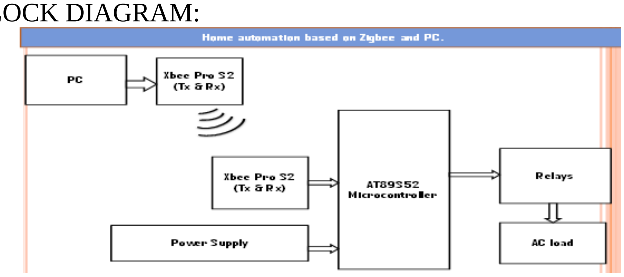

Fig 5:Block diagram of smart home energy management system

The proposed smart home energy management system divides and assigns various home network tasks to appropriate components.It can integrate diversified physical sensing information and control various consumer home devices , with the support of active sensor networks having both sensor and actuator components.we develop a new routing protocol DMPR(disjoint Multi path based Routing) to improve the performance of our zigbee sensor networks.This paper introduces the proposed home energy control system design that provides intelligent services for users.We demonstrate its implantation using a real environment.

Schematic circuit diagram:

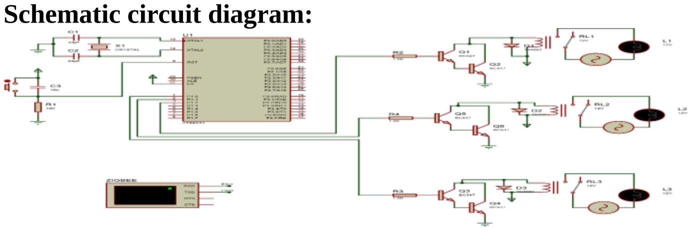

Fig 6:Circuit diagram

A **patch antenna** (also known as a rectangular microstrip antenna) is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. The assembly is usually contained inside a plastic radome, which protects the antenna structure from damage. Patch antennas are simple to fabricate and easy to modify and customize. They are the original type of microstrip antenna described by Howell in 1972; the two metal sheets together form a resonant piece of microstriptransmission line with a length of approximately one-half wavelength of the radio waves. The radiation mechanism arises from discontinuities at each truncated edge of the microstrip transmission line. The radiation at the edges causes the antenna to act slightly larger electrically than its physical dimensions, so in order for the antenna to be resonant, a length of microstrip transmission line slightly shorter than one-half a wavelength at the frequency is used. A patch antenna is usually constructed on a dielectric substrate, using the same materials and lithography processes used to make printed circuit boards.The simplest patch antenna uses a patch which is one-half wavelength long, mounted a precise distance above a larger ground plane, sometimes using a spacer made of a dielectric between them. Electrically large ground planes produce stable patterns and lower environmental sensitivity but of course make the antenna bigger. It isn't uncommon for the ground plane to be only modestly larger than the active patch. When a ground plane is close to the size of the radiator it can couple and produce currents along the edges of the ground plane which also radiate. The antenna pattern becomes the combination of the two sets of radiators.The current flow is along the direction of the feed wire, so the magnetic vector potential and thus the electric field follow the current, as shown by the arrow labeled "E" in the figure below. A simple patch antenna of this type radiates a linearly polarized wave. The radiation can be regarded as being produced by the ''radiating slots'' at top and bottom, or equivalently as a result of the current flowing on the patch and the ground plane.

radiation towards the back of the antenna (angles from 180 to 360°), but the real antenna has a fairly small ground plane, and the power in the backwards direction is only about 20 dB down from that in the main beam.

Impedance bandwidth: The impedance bandwidth of a patch antenna is strongly influenced by the spacing between the patch and the ground plane. As the patch is moved closer to the ground plane, less energy is radiated and more energy is stored in the patch capacitance and inductance: that is, the quality factor Q of the antenna increases. A very rough estimate of the bandwidth is

$$\frac{\delta f}{f_{res}} = \frac{Z_0}{2R_{rad}}\frac{d}{W}$$

where d is the height of the patch above the ground plane, W is the width (typically a half-wavelength), $Z_0$is the impedance of free space, and $R_{rad}$is the radiation resistance of the antenna. The fractional bandwidth of a patch antenna is linear in the height of the antenna. The impedance of free space is approximately 377 ohms, so for the typical radiation resistance of about 150 ohms, a simplified expression can be obtained.

$$\frac{\delta f}{f_{res}} = 1.2\left(\frac{d}{W}\right)$$

For a square patch at 900 MHz, W will be around 16 cm. A height d of
1.6 cm will provide a fractional bandwidth of around 1.2(1.6/16) ≈ 12%, which gives a Bandwidth of 108 MHz at the center frequency.A patch printed onto a dielectric board is often more convenient to fabricate and is a bit smaller, but the volume of the antenna is decreased, so the bandwidth decreases because the Q increases, roughly in proportion to the dielectric constant of the substrate. Patch antennas utilized by industry often use ground planes which are only modestly larger than the patch, which also alters their performance. The details of the feed structure affect bandwidth as wellThe negative return loss for a pair of representative commercial patch antennas is shown below; both antennas are nominally designed to operate in the US Industrial, Scientific, and Medical (ISM) band from 902-928 MHz. Antenna B uses a 16-mm patch height above ground, and the measured bandwidth of about 150 MHz at 10 dB return loss is rather close to that estimated above. However, this antenna also uses a very large (30x30 cm) ground plane. Antenna A delivers similar bandwidth but at about 20x20 cm is considerably smaller and more convenient to mount and position. Commercial antennas vary widely in performance, often due to poor centering of the band even when theoretical bandwidth is achieved.Rectangular (non-square) patches can be used when it is desired to produce a fan beam: a radiated wave whose vertical and horizontal beamwidths are substantially different.

RESULT

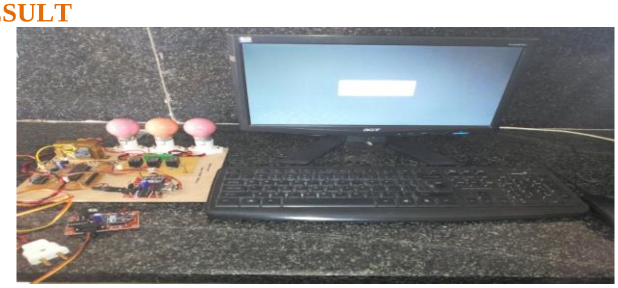

Fig 7: Input circuit diagram

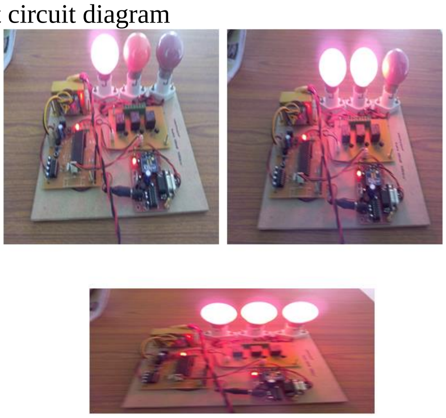

Fig8: Output circuit diagram

Advantages: ZigBee's main advantage is its ability to be configured in so-called mesh networks with wireless nodes that are capable of multi-year battery lives. In a mesh topology, each node is in direct communication with its immediate neighbor; if a node fails, messages are automatically rerouted a sort of miniature Internet.

- ❖ Low cost
- ❖ Range and obstruction issues avoidance
- ❖ Multi-source products.

Disadvantages:

- ❖ Cost still high
- ❖ Total solutions still lacking-slow to materialize
- ❖ Technology coverage communications short range

Applications:

- ❖ ZigBee enables broad-based deployment of wireless networks with low-cost.
- ❖ low-power solutions.
- ❖ It provides the ability to run for years on inexpensive batteries for a host of monitoring applications: Lighting controls, AMR (Automatic Meter Reading), smoke and CO detectors, wireless telemetry, HVAC control, heating control, home security, Environmental controls and shade controls, etc.

CONCLUSION

Today organizations use IEEE 802.15&Zigbee to effectively deliver solutions for a variety of areas including consumer electronic device control, energy management and efficiency home and commercial building automation as well as industrial plant management. The smart home energy network has gained widespread attentions due to its flexible integrati- ion into everyday life.The project “smart home energy management system based on zigbee”has been successfully designed and tested.integrating features of all the hardware components used have developed it.presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit.secondly,using highly advanced IC’s and with the help of growing technology the project has been successfully implemented.

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