Wireless Effective Energy Management by Using Zigbee

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"Abstract"

The world passing the biggest problem of Electric power. Because the production of power is less than the demand power of consumer side. In many countries the increase in demand is growing at a faster rate than transmission capacity and the cost of providing power is also increasing due to the higher coal prices and deficiency of fuel etc. Most important reason is that not getting regular and sufficient power to consumers because the growing population of countries. To overcome the problem of power distribution this paper provides an overview of wireless sensor network by managing the equal power distribution by using zigbee network sensor.

"1. Introduction"

The world today's facing the most critical Problem of not getting the regular power. In many countries .peoples had not getting at least the primary needs of. Lights, fans, TV. Etc. In nearly every country, researchers expect existing energy production capabilities will fail to meet future demand without new sources of energy, including new power plant construction. However, these supply side solutions ignore another attractive alternative which is to slow down or decrease energy consumption through the use of technology to dramatically increase energy efficiency.

To manage the available power more often the power is cut for particular area, and that area goes in dark i.e. not even a single bulb can work. Instead, we can use available power in such a way that only low power devices like Tubes, Fans, and Desktops TV. Which are primary needs should be allowed and high power devices like heater, pump-set, A.C. etc should not be allowed for that particular period. To achieve this, system can be created which will differentiate between high power and low power devices at every node and allow only low power devices to be ON.

To achieve this system we create a wireless sensor network having number of nodes which communicate with each other in full duplex mode. The communication will consist of data transfer, controlling node operation. We are using zigbee protocol for the wireless communication. The main advantage of using ZigBee protocol is that the nodes require very less amount of power so it can be operated from battery. And in this way we have managing the available power by using wireless sensor network working on zigbee protocol. Each node is measuring the power, which is being consumed by the appliance. The appliance is controlled by the end device i.e. node. An overall operation of the system controlled by the control device. Main purpose of the project is that the wireless sensor network will differentiate and

Control the devices in the network on the basis of power consumed by appliances to make the efficient use of power. [18] The basic parts of the project include a Control Unit, End Device Unit having ZigBee interface. Power Measurement IC.ARM7 and GSM modem.

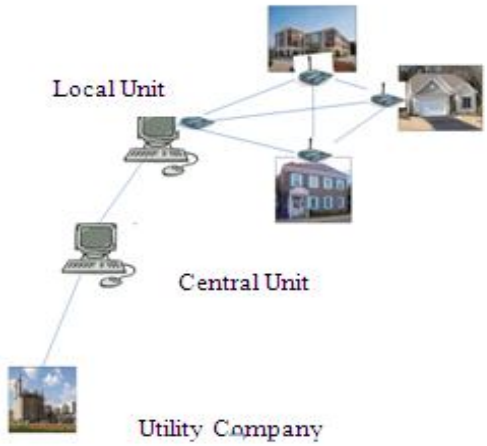

Figure 1. Concept diagram

"2. Implementation"

The block diagram of the system is shown below. Here controller will wirelessly communicate with end devices to control them. The power threshold will be set by the controller. The end device will compare this threshold with the power being consumed by the device connected through it and will take the appropriate action. Where n=1, 2, 3… [18]

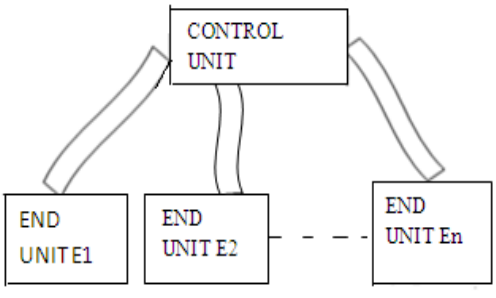

Figure 2:.System block diagram

2.1 End device

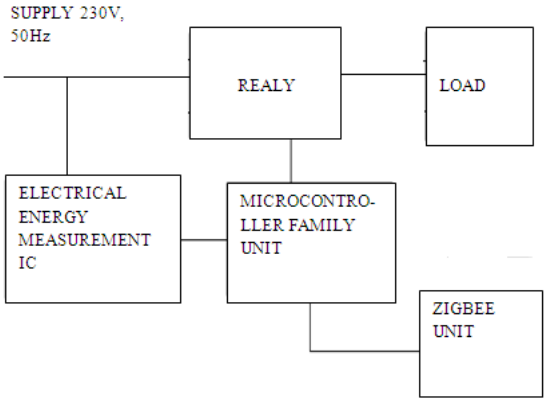

Figure 3.End Device block diagram

1] Power/Energy measurement IC- IC calculates the power used by the device which is to be controlled. IC also calculates power factor which can be maintained closer to unity by switching capacitive bank for power saving.

2] ARM7-It takes the power value from the power measurement IC and compares it with the threshold value set by the control unit and accordingly takes the controlling action like whether to keep device ON or switch it OFF.

3] Device driver- It is series pass element to switch on/off the device. It is nothing but relay to have make and break contact. It is driven by ARM7.

4] ZigBee module-It uses the ZigBee protocol to communicate with the control unit. It consists of transceiver, ARM7 and ZigBee stack implemented in it. This very small battery operated which provides full duplex communication with mesh networking.

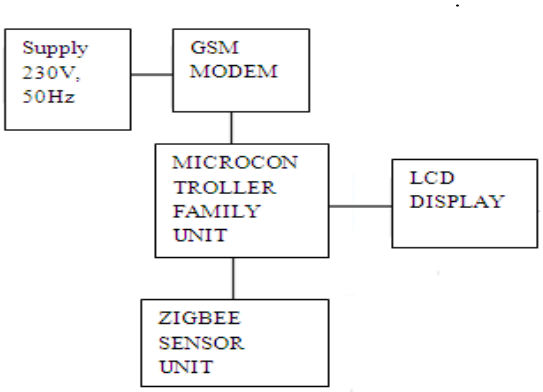

Figure 4. Block diagram of Control unit

2.2. Control Unit

It includes the ARM7 family microcontroller board, ZigBee, GSM modem interface. ARM7 sets the threshold for the end devices through the wireless communication using ZigBee module interface or simply it distributes power within the home. This control unit can be remotely programmable through GSM. GSM can also be used to send data to utility. Utility sets threshold for the control unit that is power for particular house. This threshold will be set to smaller value during peak period and vice versa. [18]

"3. Why ZigBee?"

a) ZigBee was developed by the ZigBee Alliance, a world-wide industry working group that developed standardized application software on top of the IEEE 802.15.4 wireless standard. So it is an open standard. [3]

b) The power measurement application encompasses many services and appliances within the home and workplace, all of which need to be able to communicate with one another. Therefore, open standards architecture is essential. Open standards provide true interoperability between systems. Open standards also help to future-proof investment made by both utilities and consumers. [6]

c) Using an open protocol typically reduces costs in implementing: there are no interoperability problems to solve, and manufacture costs tend to be lower.

d) ZigBee also provides strong security capabilities to prevent mischief, and is extremely tolerant of interference from other radio devices, including Wi-Fi and Bluetooth.

e) ZigBee- enabled meters form a complete mesh network so they can communicate with each other and route data reliably.

3.1. IEEE 802.15.4 STANDARD

The IEEE standard brings with it the ability to uniquely identify every radio in a network as well as the method and format of communications between these radios, but does not specify beyond a peer-to-peer communications link a network topology, routing schemes or network growth and repair mechanisms.

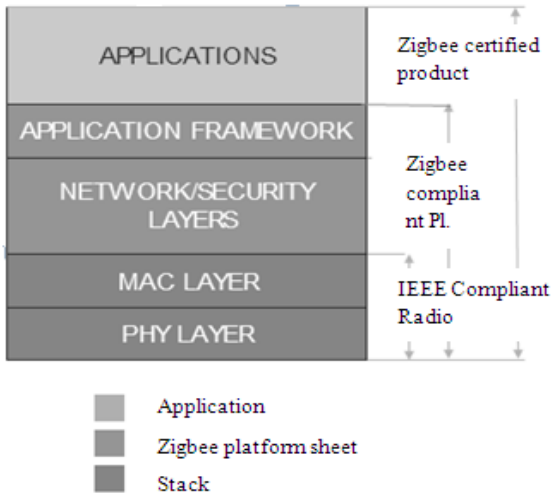

Figure 5. ZigBee Device Construction

The IEEE 802.15.4 standard, released in May 2003, was selected by the ZigBee Alliance as its "wheels and chassis", upon which ZigBee networking and applications are constructed. This is not without its challenges, as the Alliance does not control the IEEE specification. However, many of the same people who sit in the IEEE 802.15 Working Group are deeply involved in the ZigBee standard; this relationship has meant that both the IEEE and the ZigBee specifications track one another fairly well. Figure 3.4 shows the relative organization of the IEEE radio with respect to the ZigBee functionality. [19]

3.2. ZigBee Vs Bluetooth

Bluetooth-

• targets medium data rate continuous duty
• 1 Mbps over the air, ~700 kbps best case data transfer
• Battery life in days only
• File transfer, streaming telecom audio
• Point to multipoint networking
• Network latency (typical) New slave enumeration-20s Sleeping slave changing to active-3s
• Uses frequency hopping technique
• 8 devices per network
• Complexity is higher

ZigBee-

• targets low data rate, low duty cycle
• 250 kbps over the air, 60-115 kbps typical data transfer
• Long battery life (in years)
• More sophisticated networking best for mesh networking
• Network latency (typical) New slave enumeration Sleeping slave changing to active
• Mesh networking allows very reliable data transfer
• Uses direct spread spectrum technique
• 2 to 65535 devices per network
• Simple protocol.

"4.Result"

Utility companies sending the message of power available to the control device unit. Control device unit receive the message and display the available power on LCD Screen. The control unit will divided the available power to the end devices connected to the control device. If the load will be more than the available power then automatically cut of the high power consumption devices of the end devices and only to ON the low power consumption devices. In this way the system will be managing by availability of power as shown in following figure no.6

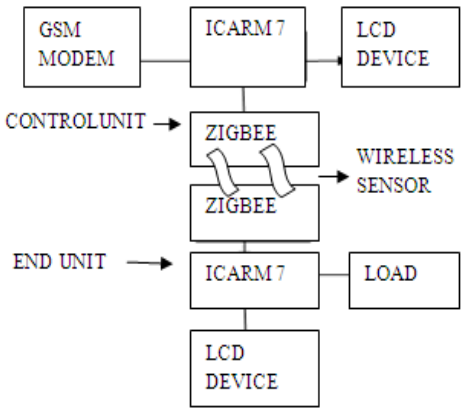

Fig 6. Wireless communication of system

In this power management paper, we have used the two major devices like Control unit and End unit as shown in figure.

"5. Future Scopes"

1) The system can be modified to monitor three phase supply. The three-phase supply can be monitored using 3 CT's and 3 PT's. So MUX will have 9 inputs including 3 power signals. Software also can be modified accordingly.

2) System also can be modified to monitor Power factor, maximum demand of power in the company.

3) System indication for crossing the upper and lower preset limit of power factor and maximum KVA demand can be made. So as to switch on or switch off necessary capacitor banks/inductive loads to correct power factor and to switch on or switch off some of the loads for load shedding.

4) Data logging to PC and printer can be made available, so that data tabulating and plotting can be done for analysis purpose.

5) System can be build to detect the tampering made by customer (wrong connections, wrong phase sequence etc.)

6) By modifying the VB programming at the receiver end and using another transmitting and receiving module the bill can be sent to the user to its PC. Then he can submit the bill amount through e- banking.

7) By making some changes in the RTC and the assembly language programming the consumed power can be sent to the mobile.

5.1Applications

1) To monitor power usage in different departments. The power usage in different departments can be monitored, so it can be observed that which department is using maximum power. So, if there is waste of power in any department, it can be limited.

2) It can also be used to monitor total power usage of a small scale company.

3) It can be used in such places where manpower is less or due to environment effects it is difficult to collect the data of power consumed.

4) In India it can be used in such areas where people manipulate the meter reading.

5) It can be used in houses for monitoring the consumption of the power. It is helpful for the user also because they do not have to wait for the person coming from the EB. Also it reduces the human error.

"6. Conclusion"

1) This wireless Network is a realistic approach to the Power measurement using the Zigbee communication.

2) This paper has a high degree of the accuracy for the measurement of the Power consumed.

3) This system efficiently combines the two branches as Electrical engineering Measurements with the high-tech Electronics communication

4) The basic principle of monitoring and transmitting of measured parameter can be applied to many other applications such as gas, flow, temperature measurement.

5) This system will not require the new communication system to be set up, since the mobile technology is already setup thus saving the cost of the final installation.

6) The most challenges and "green" legislation that utilities are facing today, combined with increased demand from consumers for more flexible offerings and cost savings, make a solution like smart meters both timely and inevitable.

7) ZigBee's wireless open standard technology is being selected around the world as the energy management and efficiency technology of choice. Implementing smart meters with an open standard such as ZigBee helps to keep costs down, ensure interoperability, and future-proof investments made by both utilities and consumers. [1]

8) Consumers and businesses will see changes they never dreamed possible. The information collected through smart energy meters provides unprecedented insight into energy demand and usage, allowing utilities and consumers alike to do their part to ensure continued and affordable supply of essential services into the future. The "tipping point" is indeed here and much bigger than ever imagined.

References

[1] "ZigBee: The Choice for Energy Management and Efficiency" presented by ZigBee Alliance, June 2007

[2] "New ZigBee smart energy profile delivers efficiency and savings" by ZigBee Alliance at Tampa, Florida January 22, 2008 atDistribuTECH

[3] Zigbee: "Wireless Control That Simply Works" William C. Craig, Program Manager Wireless Communications, ZMD America, Inc.

[4] "ZigBee Vision for the Home", ZigBee Wireless Home Automation, by ZigBee Alliance November 2006.

[5] [Online]: **www.zigbee.org**

[6]Going green with AMI and ZigBee smart energy" by Daintree Networks January 2008.

[7] A. K. Sawhney, "*A Course in Electrical and Electronic Measurements and Instrumentation*", Seventeenth Edition, Dhanpat Rai & Co., 2000, pp 329-338, 384-429, 430-494.

[8] Goldings, "*Electrical Measurements*", Third Edition, McGraw-Hill International Edition, 1997, pp 716-747, 764-805.

[9] Zahir j.paracha, "Load management: techniques and methods in electric power system"IEEE cataloge no.-98EX137, in 1998, page no. 213-217 vol.1.

[10] William C. Y. Lee, "*Mobile Cellular Telecommunication Analog and Digital Systems*", Second Edition, McGraw-Hill International Edition, 1995, pp1-53, 103-156, 257-306, 463-562.

[11] Lili Goleniewski, "*Telecommunication Fundamentals*", First Edition, Tata McGraw Hill Publication, 2001, pp 1-34, 56-87

12] Carl Weisman, "*Mobile Telephony: What makes it Mobile?*", First Reprint, Pacific Publications, 2002, pp 1-35, 55-73.

[13]Bhupendra Singh Chhabra, "*Microcontroller & Its Applications*", First Edition, Dhanpat Rai & Co (P) Ltd., 1999, pp 1-88.

[14]Radwan Tahboud, Vasile Lazarescu, "Novel approach for remote Energy Meter reading using mobile agent", IEEE proceedings of the Third International conference on Information technology,2006.

[15] P. A. V. Loss, M. M. Lamego, G. C. D. Sousa and J. L. F. Vieira, "A single phase Microcontroller based Energy Meter", IEEE Instrumentation & Measurement Technology conference, May 18-21, 1998**.**

[16] B. S. Koay, S. S. Cheah, "Design and Implementation of Blue Tooth Energy Meter", IEEE Instrumentation & Measurement Technology conference, 15-18 Dec. 2003.

[17] Pop Ovidiu, Chindris Gabrial, "DSP's based energy meter", and IEEE 26th International spring seminar on Electronics Technology, May 8-11, 2003

[18] Pritam shah, Tahir sheikh, Kuldeep ghan, "Power management using zigbee wireless sensor network", in, 2008 IEEE, page no.242-245.

[19] Zigbee wireless Technology and the IEEE 802.15.4 Radio enabling simple wireless, by Jon T. Adams, in Texas wireless symposium-2005, page no.76-80.

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