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QOS Based Power Management in ZIGBEE Wireless Sensor Network

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Abstract

The world presently is going through electrical energy crises. Energy saving becomes the first and foremost priority for engineers. Also the production of power from the utility point is less than the demand power of consumer side. In many countries the increase in demand is growing at an alarming rate than transmission capacity and also the cost of generation is also increasing due to the higher fuel prices. Increasing population is another issue to be addressed which adds to the crises. In WSN the one of the main challenges is to implement various routing protocols with QOS as well as energy efficiency**.** To overcome the problem of power management this paper provides an overview of wireless sensor network by managing the balanced power distribution using zigbee sensor network.

Keywords: qoc, arm7 microcontroller, mobile net. zigbee, power measurement.

1. INTRODUCTION

The world today is facing the most critical problem of scarcity in power. In nearly every country, researchers expect existing energy production capabilities will fail to meet future demand without non conventional energy sources and captive generations. Further, these supply side solutions do not achieve the said goals.

Wireless Sensor Network gives the wide range of opportunities and solutions to achieve this and a network can be created which has number of nodes to 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. In this way the available power can be managed using wireless sensor network working on ZigBee protocol. Each node is measures the power, being consumed by the appliance. The appliance is controlled by the end device i.e. a node. An overall operation of the system controlled by the control device. This paper focuses on is the wireless sensor network that will differentiate and control the devices in the network on the basis of power consumed by appliances to make the efficient use of power.

2. DESIGN ISSUES AND ROUTING CHALLENGES IN WSN

Wireless Sensor Networks (WSNs) are provides energy efficiency and different level of Quality of Service (QoS) which depends on the kind of applications. The energy efficient routing and QoS support becomes an important issue in WSNs due to resource constraints like memory, power sources, bandwidth and processing power in etc. [4]

Recent studies are provided with the facts that Quality of Service (QoS) routing is more efficient than routing that do not support or are not responsive to QoS requirements of traffic as by escalating the utilization of the network the network performance can be boosted by it. So the primary focus here is on evaluating and comparing the network performance in the WSN having QoS routing. QoS routing is the process of the mixture of the path to be used by the flow of packets, based on its QoS requirements, e.g., delay, throughput, bandwidth etc[5]

Following are the various routing challenges are faced by WSN:

(i) *Bandwidth*
(ii) *Fault –tolerance*
(iii) *Scalability network*
(iv) *Coverage*
(v) *Delay, Jitter and Loss*
(vi) *Responsiveness*
(vii) *Media Transmission*
(viii) *Distance Management*

QOS Protocols allow sensor nodes to balance between the energy consumption and certain pre-determined QoS parameter**s** such as delay, fault tolerance, energy, reliability, bandwidth, etc., before they deliver the data to the sink node.

QOS parameters are characterized by:

(i) *Delay*
(ii) *Reliability*
(iii) *Fault tolerance*
(iv) *Bandwidth*
(v) *Energy*

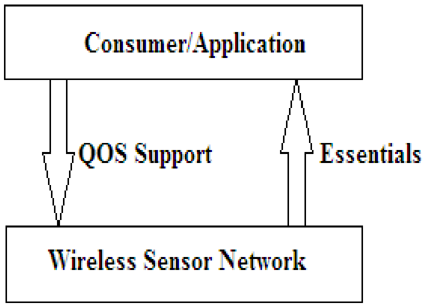

Fig. 1 Quality of Service Strategy

3. CONCEPT

The basic parts of the system include a Control Unit, End Device Unit having ZigBee interface. Power Measurement IC.ARM7 and GSM modem.

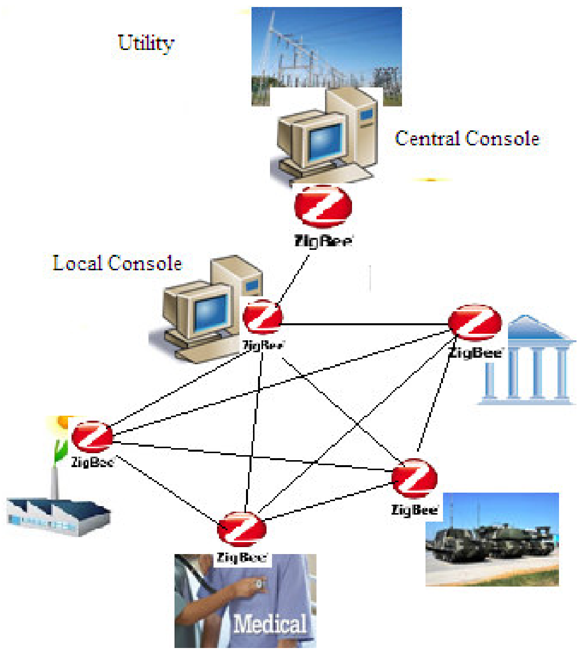

Fig. 2 Concept

For ARM7TDMI-S users in the embedded market, the Cortex-M3 processors offer a much superior alternative, enabling tomorrow's embedded applications by delivering more features at a lower cost, increasing connectivity, better code reuse, and improved energy efficiency.

The ARM Cortex-M3 processor is the industry-leading 32-bit processor for highly deterministic real-time applications, specifically developed to enable partners to develop high-performance low-cost platforms for a broad range of devices including microcontrollers, automotive body systems, industrial control systems and wireless networking and sensors. The processor delivers outstanding computational performance and exceptional system response to events while meeting the challenges of low dynamic and static power constraints. The processor is highly configurable enabling a wide range of implementations from those requiring memory protection and powerful trace technology to cost sensitive devices requiring minimal area.

Here is the comparison of ARM Cortex-M3 LPC1769 microcontroller and ARM7TDMI LPC2148 microcontroller.

Entities	LPC 1769	LPC 2148
	The LPC17xx is an ARM Cortex-M3 based microcontroller for embedded applications requiring a high level of integration and low power dissipation. The ARM Cortex-M3 is a next generation core that offers system enhancements such as modernized debug features and a higher level of support block integration.	The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

Features	• ARM Cortex-M3 processor, running at frequencies of up to 120 MHz on high speed versions, up to 100 MHz on other versions. • ARM Cortex-M3 built-in Nested Vectored Interrupt Controller (NVIC) • Up to 512 kB on-chip flash program memory with In-System Programming (ISP) and In-Application Programming (IAP) capabilities. • Data Memory – 64KB	• ARM7TDMI processor, running at frequencies of up to 60MHz on high speed versions. NO • Up to 512 kB on-chip flash program memory with In-Systupt Programming (ISP) and In-Application Programming (IAP) capabilities. • Data Memory – 32KB
Peripheral Compliment	• Ethernet MAC • USB interface that can be configured as either • Host, Device, or OTG. • 8 channel general purpose DMA controller • 4 UARTs • 2 CAN channels • 2 SSP controllers, SPI interface • 3 I2C interfaces, 2-input plus 2-output I2S interface • 8 channel 12-bit ADC • 10-bit DAC • Motor control PWM • Quadrature Encoder interface • 4 general purpose timers • 6 output general purpose PWM • Ultra-low power RTC with separate battery supply. • Up to 70 general purpose I/O pins.	• USB interface that can be configured as either • 8 channel general purpose DMA controller • 2 UARTs • SPI interface • 2 I2C interfaces • 6 channel 10-bit ADC • 10-bit DAC • Motor control PWM • 2 general purpose timers • 6-output general purpose PWM • Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input. • Up to 45 general purpose I/O pins.
Power Consumption	• 3.15V-3.3V external powering, or from USB via JTAG probe (LPC-LINK)	• +3.3V available for external circuits, up to 300 mA • Power supply: 9-15 VDC, from 2.1 mm power connector, or directly from USB.

Table 1 Comparison of Controllers

4. IMPLEMENTATION

The block diagram of the system is shown below. Here controller will wirelessly communicate with end devices to control. A power threshold is set by the controller and the end device will compare the threshold with the power being consumed by the device connected and will take the appropriate action.

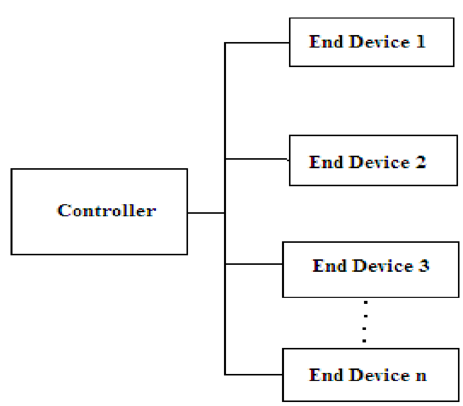

Fig.3 Block Diagram

4.1 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. The control unit can be programmed through GSM. GSM can also be used to send data to utility. Utility sets threshold for the control unit. The threshold can be set to smaller value during peak period and vice versa for optimum utilization.

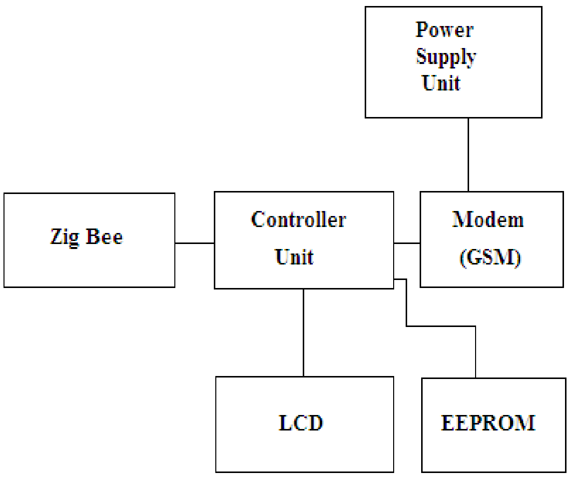

Fig.4 Control Unit

4.2 End Device

- Power/power factor measurement IC**:** It calculates the power used by the device wh to be controlled and also calculates power factor which can be maintained closer to unity by switching capacitive bank.
- 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. It also takes corrective action for power factor improvement.
- Device driver**:** It is series pass element to switch on/off the device which is actually a relay and driven by ARM7.
- ZigBee Module: Uses ZigBee protocol to communicate with control unit. Primarily consists of transceiver, ARM7 and ZigBee stack. This very small battery operated which provides full duplex communication with mesh networking.

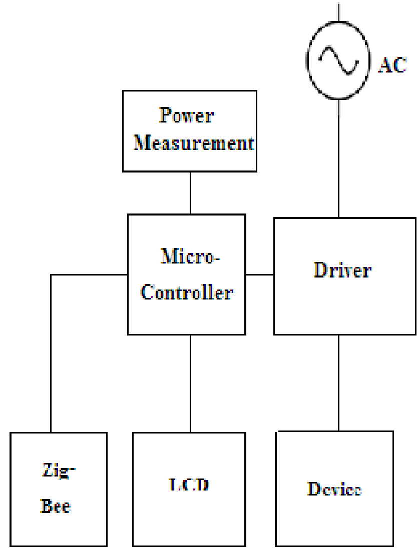

Fig.4 END Device

4.3 Outcome

Utilities will send message for available power to the control device. Control device will receive the message and display the available power on LCD which in turn divides the available power to the end devices. It will act when the load is more than the available power and balance it.

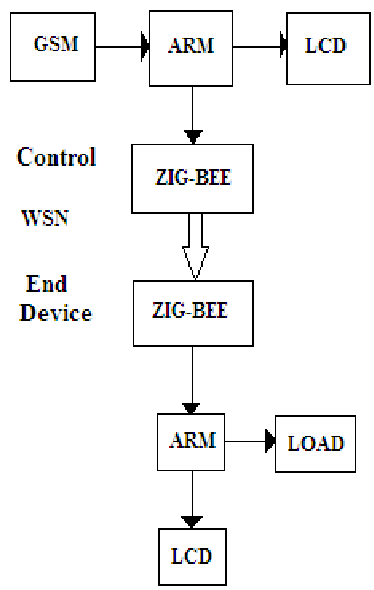

Fig.5 Network Communication

5. ZIGBEE

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. [7]. 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 helps in validation of the standards. [8] Using an open protocol typically reduces costs in implementations. Fyrther ZigBee provides strong security capabilities and is extremely tolerant to interference from other radio devices, including Wi-Fi and Bluetooth. ZigBee- enabled meters form a complete mesh network so they can communicate with each other and route data reliably. Also ZigBee network can be easily expanded.

6. Future Work

On-demand meter reading and remote troubleshooting allow utilities to provide better and timelier customer support. Utilities should have more knowledge about outages and restorations. During emergencies, utilities can create partial outage to ensure power availability. Also power factor improvement can result in a lot of power saving for industrial sectors.

7. Conclusion

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. ZigBee's wireless open standard technology is being selected around the world as the energy management and efficiency technology. Implementing smart meters with an open standard such as ZigBee helps to keep costs down and ensure interoperability. [10] 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 continuous and affordable supply. The "tipping point" is indeed here and much bigger than ever imagined.

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