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Combining Power Management and Control (PMaC) for Wireless Sensor Networks

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***Abstract*—Power management and power control are two common techniques for saving energy in wireless sensor network. In this paper we propose a technique to combine both power management and power control simultaneously. Our goal is to save energy by combining both of these energy saving techniques. We have designed a testbed using microcontroller and wireless transceiver to run experiment of our approach. Using the results found from the experiment we will design a combined technique to achieve both power management and power control at the same time.**

I. Introduction

Wireless network is becoming much and much popular day by day than wired network. Also there are some cases when wired networking is not possible. Wireless network can work as an independent unit without any external connection from outside. For supplying power dc battery is a good option in that cases. However wireless chip consumes a good amount of power. As a result batteries of wireless chip have to be changed or recharged frequently. So many research have been done to minimize the power consumption of wireless transceivers. On the other hand as wireless networking is widely used in many communication purposes an efficient power saving scheme can save a significant amount of energy. Power management and power control are two good ways of saving power for wireless sensor network.

There are two power states of a station. One is the Awake state, in which a station is fully powered and can transmit, receive, and listen to the network. The other is the Doze state, in which a station demands very low power, but can not transmit, receive or listen to the network. A significant difference in power consumption between these two states. Awake states consumes much power than Doze state. Power management reduces the idle listening time by putting the stations into the Doze state as much as possible. In real wireless network the transceivers do not transmit or receive data all the time. So when the transceivers do not work i.e. they are "idle" then taking them to the idle state can save a significant amount of energy.

Wireless sensor nodes are not fixed in a position. Because of movement the distance between two communicating node will not fixed all the time. So it is not necessary to transmit data to a node when it is at s_1 distance with same power when it is at s_2 distance if s_1 is closer than s_2. Power control is the adjustment of transmitting and receiving power according to the distance between nodes. If transmission power is reduced then the range of the wireless device for interference also reduced. So power control reduces interference also. Received signal strength indicator (RSSI) indicates the signal strength of a node in a definite distance. By measuring the value of RSSI the necessary signal strength of transmitting power can be measured.

Both power management and power control are different and independent in implementation on wireless sensor network. So the combination of them would be a better solution for saving energy in wireless sensor network. Combined power management and control (PMaC) can save much energy than independently used power management or power scheme.

II. Our Approach

We want to combine PMaC for wireless sensor network and test our approach in a testbed for checking the effectiveness of it.

For transmitting and receiving data we used wireless transceiver Chipcon CC1100 EM. This is an ultra low power UHF wireless transceivers which can transmit and receive data in 868 MHz and 915 MHz. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 500 kbps. This chip has serial peripheral interface (SPI) to communicante with any intelligent devices. By these communications the status of the chip can be controlled. Using this SPI interface the transmission and reception of data and transmission power can be controlled easily.

To control this transceiver we used a microcontroller board from Olimex Limited. It is MSP430-PXX. In this board a microcontroller is connected with some supplementary devices. The microcontroller is MSP430f1611. There is a RS232 interface to communicate between between computer and microcontroller using Universal Synchronous/Asynchronous Receiver/Transmitter (USART). Also this microcontroller provides spi interface which can be used with the CC1100's spi interface to communicate between the microcontroller and transceiver.

We first interface the microcontroller with computer for controlling it from computer. Then we interface the microcontroller with the transceiver. According to the command sent from computer microcontroller communicates with the transceiver and the transceiver transmits or receives data.

By writing some definite data to the registers of the transceiver we can change the state of the device idle or active. Also writing values we can change the transmit power. By controlling these registers we can acheive our PMaC scheme.

III. Experimental Result

We have created a testbed to test the characteristics of the network in power management and power control scheme. We used the microcontroller MSP430f1611 in Olimex board to communicate with the wireless transceiver chipcon CC 1100. We used computer to send data and show the output. The microcontroller works as a bridge communicator between computer and wireless transceiver.

Our experimental setup has been successfully able to communicate between two computers via 868 MHz radio of chipcon CC 1100. Changing the transmission range we also transmit data at different transmission power. We have checked the viability of power control scheme for our testbed.

We have seen significant amount of power saving of transceiver in combined PMaC than individual power management & power control.

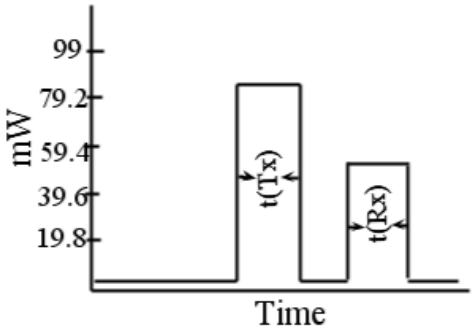

Fig. 1. Only Power Management

When only power management scheme is applied like figure 1 we can make the transceiver in sleep mode while there is no transmit or receive of data. However a default amount of power is transmitted regardless of position of receiving chip.

If we only apply power control scheme we can save power depending on the position of the receiver as shown in figure 2. However the transceiver does not go to the sleep state at the time of no transmission or reception of data.

Combining both of the techniques can give us both the advantages. Figure 3 shows the output in PMaC combination.

More experiments about power management and power control in detail is going on. After combining the results of these experiments we want to set a model of combined power management and power control technique for wireless sensor network.

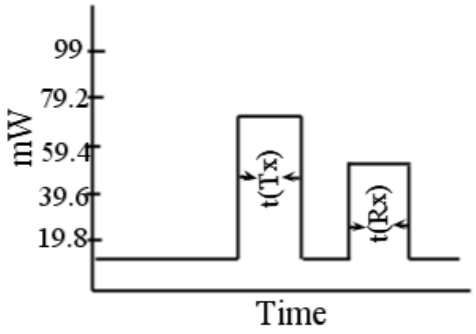

Fig. 2. Only Power Control

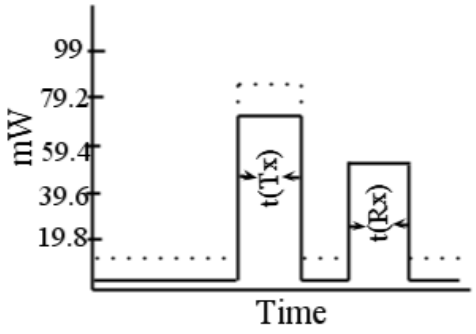

Fig. 3. Combined Power management & control

IV. Conclusion

PMaC can be a good approach for saving a significant amount of energy in wireless sensor network. We think much research is necessary in this field. Testing this technique in widely used IEEE 802.11 and 802.16 network can save huge amount of power of a country. Also the device drivers of wireless devices for different operating system can be studied for implementing PMaC in those devices.

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