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Design of Low Power Wireless Sensor Network Node with Component Activity Profile

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Abstract

A multi hop wireless sensor network is composed of large number of nodes and consecutive link between them. Wireless sensor network normally consist of large number of distributed nodes. In WSN one of the main problems is related to power issue because every node is operated by external battery. To have a large network life time all nodes need to minimize their power consumption. Node is composed of small battery so energy associated with this is very less so replacing or refilling of battery is not possible which is very costly. Hence some technique are applied through which power associated with each node can be conserved. In this paper we proposed design for implementation of wireless sensor network protocol for low power consumption by using power gating signal.

Keywords: *Wireless sensor network, power consumption, node, battery, life time of network, protocol, inactive state.*

1. Introduction

The term "wireless" has become a generic and all-encompassing word used to describe communications in which electromagnetic waves to carry a signal over part or the entire communication path. Wireless technology can able to reach virtually every location on the surface of the earth. Due to tremendous success of wireless voice and messaging services, it is hardly surprising that wireless communication is beginning to be applied to the domain of personal and business computing. [2].Ad- hoc and Sensor Networks are one of the parts of the wireless communication. In ad-hoc network each and every nodes are allow to communicate with each other without any fixed infrastructure. This is actually one of the features that differentiate between ad-hoc and other wireless technology like cellular networks and wireless LAN which actually required infrastructure based communication like through some base station. [3].

Wireless sensor network are one of the category belongs to ad-hoc networks. Sensor network are also composed of nodes. Here actually the node has a specific name that is “Sensor” because these nodes are equipped with smart sensors [3]. A sensor node is a device that converts a sensed characteristic like temperature, vibrations, pressure into a form recognize by the users. Wireless sensor networks nodes are less mobile than ad-hoc networks. So mobility in case of ad-hoc is more. In wireless sensor network data are requested depending upon certain physical quantity. So wireless sensor network is data centric. A sensor consists of a transducer, an embedded processor, small memory unit and a wireless transceiver and all these devices run on the power supplied by an attached battery [2].

. Battery Issues

The battery supplies power to the complete sensor node and hence plays a vital role in determining sensor node lifetime. Batteries are complex devices whose operation depends on many factors including battery dimensions, type of electrode material used, and diffusion rate of the active materials in the electrolyte. In addition, there can be several non idealities that can creep in during battery operation, which adversely affect system lifetime. We describe the various battery non idealities and discuss system level design approaches that can be used to prolong battery lifetime.[1]

Rated Capacity Effect

The most important factor that affects battery lifetime is the discharge rate or the amount of current drawn from the battery. Every battery has a rated current capacity, specified by the manufacturer. Drawing higher current than the rated value leads to a significant reduction

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in battery life. This is because, if a high current is drawn from the battery, the rate at which active ingredients diffuse through the electrolyte falls behind the rate at which they are consumed at the electrodes. If the high discharge rate is maintained for a long time, the electrodes run out of active materials, resulting in battery death even though active ingredients are still present in the electrolyte. Hence, to avoid battery life degradation, the amount of current drawn from the battery should be kept under tight check. Unfortunately, depending on the battery type (lithium ion, NiMH, NiCd, alkaline, etc.), the minimum required current consumption of sensor nodes often exceeds the rated current capacity, leading to suboptimal battery lifetime. [4]

Relaxation Effect

The effect of high discharge rates can be mitigated to a certain extent through battery relaxation. If the discharge current from the battery is cut off or reduced, the diffusion and transport rate of active materials catches up with the depletion caused by the discharge. This phenomenon is called the relaxation effect and enables the battery to recover a portion of its lost capacity. Battery lifetime can be significantly increased if the system is operated such that the current drawn from the battery is frequently reduced to very low values or is completely shut off [5].

2. Proposed Method for Implementation of Low power WSN Node

The sensor node's radio enables wireless communication with neighboring nodes and the outside world. In general, radios can operate in four distinct modes of operation: Transmit, Receive, Idle, and Sleep. An important observation in the case of most radios is that operating in Idle mode results in significantly high power consumption, almost equal to the power consumed in the Receive mode [6]. Thus, it is important to completely shut down the radio rather than transitioning to Idle mode when it is not transmitting or receiving data. Another influencing factor is that as the radio's operating mode changes, the transient activity in the radio electronics causes a significant amount of power dissipation. For example, when the radio switches from sleep mode to transmit mode to send a packet, a significant amount of power is consumed for starting up the transmitter itself [7].

Therefore our idea to keep wireless sensor network node in inactive (shut down) mode until it get power gating signal. For implementing this idea we first consider the transmitter and receiver section design consideration and then develop node (i.e. transmitter plus receiver) by using power gating signal.

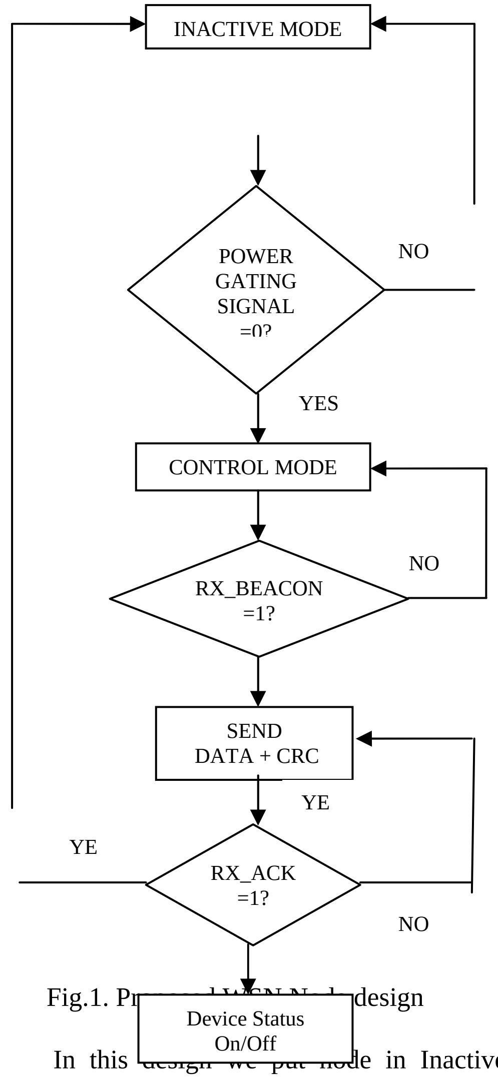

Fig.1. Proposed WSN Node design

In this design we put node in Inactive Mode (shut down mode) after gating active low POWER GATING signal it will enter in Control Mode where it will wait for RX_BEACON signal from receiver. If it get active high signal it will transmit with CRC until it get acknowledgement from receiver depending upon nature of data it will command the device and after getting acknowledgement from receiver it again enter in Inactive mode. The flow diagram for node is shown in fig.

3.Component Activity Profiles:

The efficiency of power gating depends on the activity profile of a component. Generally, the component's activity consists of subsequent active and

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idle periods. Figure 2 shows an example of the activity profile when only the clock gating is applied. The active and idle periods are initiated by the corresponding WAKE and SLEEP signals.

Figure 3 shows an example of the activity profile when the basic power gating is applied. There is a certain delay after the WAKE signal is applied and before the system enters the active state. The static power savings are not instantaneous but need some time until the target levels are reached (dotted lines).

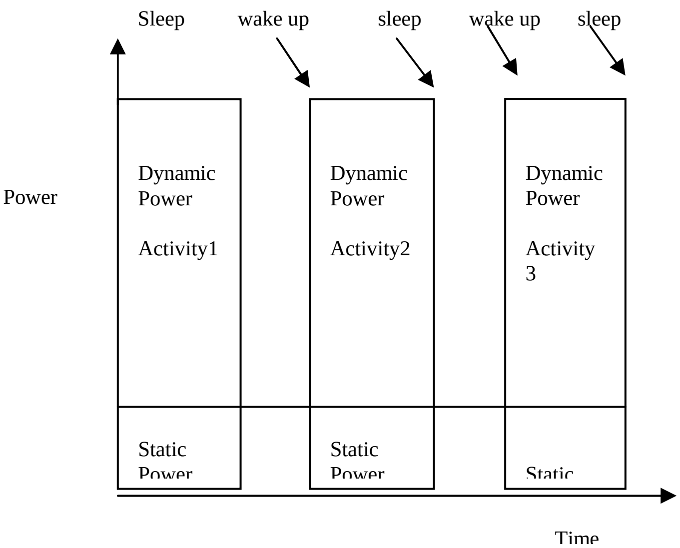
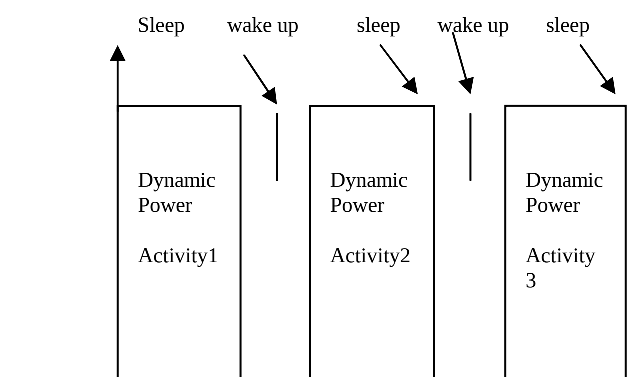


Fig.2 Activity profile with power gating



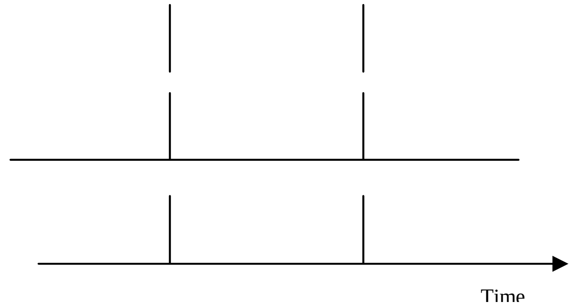


Fig.3 Activity profile with power gating

4. Conclusions

This paper describes challenges face by wireless sensor network and present design for low power node. Present techniques that are available are complicated and economically costly to implement .The design technique that we have used in our paper is robust, low cost and easy to implement. The use of Power Gating signal enables our system to meet the low power requirements of wireless sensor node. If we write VHDL code for our protocol implementation and find out it power after simulation then we get power as low as 20μW so such amount power saving can lead to significant enhancement in sensor network lifetime. Therefore our approach for implementation of wireless sensor network protocol is simple and cost effective.

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