Energy Management in Wireless Sensor Network

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Abstract: - **In recent years, the number of wireless sensor network deployments for real life applications has rapidly increased. Still, the energy problem remains one of the major barriers somehow preventing the complete exploitation of this technology. Sensor nodes are typically powered by batteries with a limited lifetime and, even when additional energy can be harvested from the external environment (e.g., through solar cells or piezo-electric mechanisms), it remains a limited resource to be consumed judiciously. Efficient energy management is thus a key requirement for a credible design of a wireless sensor network. Wireless sensor networks find great applications in radiation levels control, noise pollution control, atmospheric pollution control, structural health monitoring and smart vehicle parking. All sensors present in wireless sensor network are battery operated devices which have limited battery power. After the deployment of sensor devices it is impossible to replace each and every battery present in the network. So energy conservation must be taken. In this paper we proposed an energy efficient dynamic power management technique which can reduce power consumed by each sensor node by shutting down some components of sensors according to our algorithm which yields better savings and enhanced life time.**

Keywords- WSN, Node, Power, Sensor

I. INTRODUCTION

A wireless sensor network (WSN) consists of a large number of tiny sensor nodes deployed over a geographical area also referred as sensing field; each node is a low-power device that integrates computing, wireless communication and sensing abilities . Nodes organize themselves in clusters and networks and cooperate to perform an assigned monitoring (and/or control) task without any human intervention at scales (both spatial and temporal) and resolutions that are difficult, if not impossible, to achieve with traditional techniques. Sensor nodes are thus able to sense physical environmental information (e.g., temperature, humidity, vibration, acceleration or whatever required), process locally the acquired data both at unit and cluster level, and send the outcome –or aggregated features- to the cluster and/or one or more collection points, named sinks or base stations Nodes organize themselves in clusters and networks and cooperate to perform an assigned monitoring (and/or control) task without any human intervention at scales (both spatial and temporal) and resolutions that are difficult, if not impossible, to achieve with traditional techniques.[1,2,3]

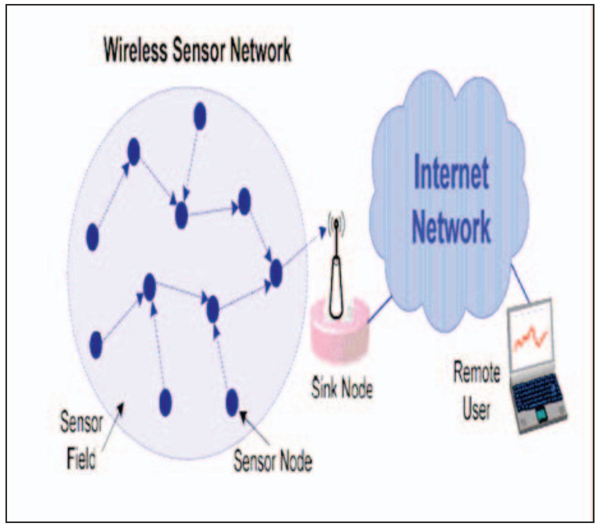

Figure 1.1 Basic Wireless Sensor Network

However, energy consumption still remains one of the main obstacles to the diffusion of this technology, especially in application scenarios where a long network lifetime and a high quality of service are required. In fact, nodes are generally powered by batteries which have limited capacity and, often, can neither be replaced nor recharged due to environmental constraints. Despite the fact that energy scavenging mechanisms can be adopted to recharge batteries, e.g., through solar panels, piezoelectric or acoustic transducers (the interested reader can refer to energy is a limited resource and must be used judiciously. Hence, efficient energy management strategies must be devised at sensor nodes (and then at cluster and network level) to prolong the network lifetime as much as possible. Wireless sensor network made-up of a large no. of low-power sensors. Now days, wireless sensor networks find wide-range of applications such as radiation level control, battlefield, noise pollution control, machine failure diagnosis, atmospheric pollution control, biological detection, structural health monitoring, home security, smart vehicle parking, inventory tracking, etc. A wireless sensor network consists of small sensing devices, deployed in an interested region. Each device has processor and wireless communication devices like

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transceiver and sensors, which enable it to gather information from the environment and to generate and deliver report messages to the remote base station i.e.., remote user. After gathering information, the base station analyzes the report messages decides whether there is an unusual event or normal event occurrence in that particular deployed area. In order to gather accurate information a large no. of wireless sensors deployed in a high density and which improves system reliability. In WSN, the main source of energy is usually battery power. Sensors are often intended to be deployed in areas such as a battlefield or radiation plants; once deployment of sensor network it is impossible to recharge or replace the batteries of all the sensors. But, long system lifetime is needed for any monitoring application. The system lifetime, which is measured as the time until all nodes have been drained out of their energy (battery power).Important challenge to the design of a large wireless sensor network is energy efficient problem. So the proposed design should extend the system lifetime without sacrificing system reliability.[2,3]

II. POWER MANAGEMENT

The lifetime of a sensor network depends highly on the power consumed at each sensor node. A more efficient power management will provide a longer network lifetime. Several methodologies have been proposed at many levels. Mainly at hardware and system levels, to design energy efficient communication process, sensor node operating system and sensor node circuits. In addition, a variety of DPM techniques have been Proposed to reduce the power consumption in sensor nodes and in general battery-powered embedded systems by selectively shutting down the components. Much work has been done exploiting sleep state and active power management , Dynamic Voltage Scaling (DVS) and Dynamic Voltage and Frequency scaling [10], sentry-based power management , an application-driven approach , software and operating system power management and battery state awareness power management. The main goal of power management is to prolong the lifetime of WSN and preventing connectivity degradation through aggressive power management as the most of the devices have limited battery life. Once the sensor network has been deployed It is impossible to replace each and every battery present in WSN if the battery is emptied. So we should follow power conservation technique in order to save the energy. If blindly turn the radio OFF during each idle slot, over a period of time to save the energy, we might end up expending more energy than if radio has been left on continuously .So, Power saving is energy-efficient only if the energy conserved is greater than energy expended in order to transit to sleep state The main goal of power management is to prolong the lifetime of WSN and preventing connectivity degradation through aggressive power management as the most of the devices have limited battery life. Once the sensor network has been deployed It is impossible to replace each and every battery present in WSN if the battery is emptied. So we should follow power conservation technique in order to save the energy. If blindly turn the radio OFF during each idle slot, over a period of time to save the energy, we might end up expending more energy than if radio has been left on continuously .So, Power saving is energy-efficient only if the energy conserved is greater than energy expended in order to transit to sleep state[2,3,4]

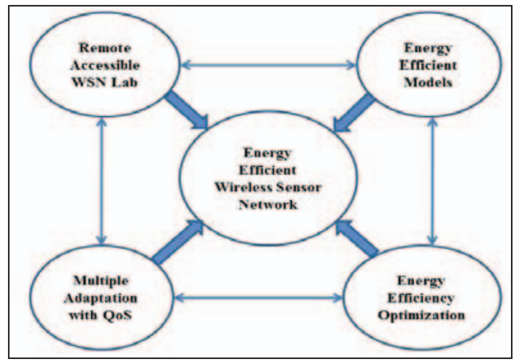

Figure 2.0 Energy Management Model

III. METHODS OF ENERGY MANAGEMENT

Communication is the primary consumer of energy in wireless networks. It has been observed that a node requires almost as much energy to listen as it does to transmit data in short-range RF communications. Energy management techniques include those that reduce communication and increase computation, power down certain components of the node or the entire node, nodes that cover smaller areas, and renewable sources of energy. The desire to save energy has also affected routing algorithms, scheduling, data collection and aggregation and MAC (Medium Access Control) protocol research. The tradeoff between energy savings and latency are of major concern. Some time critical applications cannot tolerate delay in packet delivery.

A. *Data reduction techniques*

It is desirable to reduce the amount of data that needs to be transmitted between nodes because the cost of transmission is high. Data aggregation methods are used to minimize the amount of redundancy in the data that needs to be transmitted. Although the processor consumes power during this process, it is much less than that consumed by the transmitting and receiving tasks. LEACH (Low-Energy Adaptive Clustering Hierarchy) is a cluster based protocol that uses hierarchy to reduce the data collected by the sensors before sending it on to a central base node. The energy load is evenly distributed among the sensors in the network. Simulations show energy dissipation can be reduced by much as a factor of 8 compared to conventional routing protocols. The lifetime of the individual sensors is also increased because the energy is dissipated evenly among the sensors in the network.

B. *Algorithms to choose the cluster that a node joins [4, 5]*

Some algorithms are designed to conserve energy by having a node join the most appropriate cluster.
Information is collected by the cluster leader and passed along in the network. Nodes switch between active (on) and sleeping (off) mode Many different studies have been done that involve nodes switching between an active and sleep mode. The variables include how to determine the active/sleep schedule, the duration of the active/sleep period, and whether or not the nodes are aware of the schedules of the other nodes in the network. In order for the network to be reliable, events must not be missed. The nodes need to be able to sleep, but still respond to the events of interest. TinyOS supports this capability. Nodes are independent In research the nodes switched between active and sleeping mode independently of each other. The sensors are distributed based on a Poisson process. Nodes are responsible for sensing a particular area and sending data to the sink node in multiple hops, using other nodes to relay the message. The sink node is always connected. The network is always disconnected because the number of nodes active at any given time is very low. Nodes spend more time sleeping than awake. Once a node senses an event, it stays active and sends the information to all of the nodes that are reachable in 1 hop. The node keeps transmitting the information until all of its immediate neighbors have received the information, since they can only receive the message if they are awake. Once all of the neighbors have gotten the message, the node can go back to its schedule of active and sleep time. All of the neighbor nodes repeat this process until all of their immediate neighbors get the message. The process continues until the message reaches the sink node. One obvious problem is the delay (latency) introduced by a message trying to reach a sleeping node. Latency is acceptable in some applications such as those that gather statistical information. Time critical applications such as those that send an alarm when an unexpected event occurs are much less tolerant of latency. Latency is affected by random placement of the nodes, random radio range, sensing distance and random sleeping and active periods of the nodes. Even applications that can tolerate latency would not tolerate a high degree of variability in the amount of latency. The latency will be larger as the node gets farther away from the sink node. The study showed that the latency was linearly proportional to the distance from the sink node. Some time critical applications can use this method by adjusting the dependent variables to make the latency in message delivery tolerable.

C. *Event based communication [6,9]*

In this event based communication model, nodes subscribe only to event types they are interested in. Each node is scheduled to receive data, transmit data and power its radio down to a low-power standby mode. An event scheduler dynamically schedules time slots for each type of event. There is a root node that acts as the base station with greater computational, transmission and storage capability. Nodes save power by powering down their radio during those time slots that do not match the events they are interested in. The Topology-Divided Dynamic Event Scheduling (TD-DES) protocol organizes the wireless network into a multi-hop network tree. The result of the study indicated that TD-DES was efficient for conserving power, but has the disadvantage of introducing latency in the form of more multi-hop events.

D. *Reduce the power consumed by the sensing task [5, 8]*

The less area a sensor covers, the lower the amount of energy it consumes. The application determines the frequency of the sensing activity, but there is still an opportunity to reduce power consumption by the sensing task by decreasing the coverage area of a particular sensor. In order to cover the area completely, the number of sensors used by the application needs to be increased. This method can greatly increase the life expectancy of a particular sensor.

E. *Shorter higher quality links vs. Longer lossy links [9, 10]*

Many network routing schemes try to send packets to the neighbor node that is closest to the sink node. This seems efficient because fewer hops are required to deliver the packet. The problem arises when the links to these nodes are lossy, meaning they have a high amount of data loss. Unreliability in wireless links can cause energy loss, because packets need to be retransmitted. Research involves a forwarding scheme that relies on shorter more reliable links for a packet to reach its destination. The scheme blacklists neighbors that have been shown to have weak links. If the geographic forwarding scheme attempts to minimize the number of hops by maximizing the geographic distance covered at each hop (as in greedy forwarding), it is likely to incur significant energy expenditure due to retransmission on the unreliable long weak links. On the other hand, if the forwarding mechanism attempts to maximize per-hop reliability by forwarding only to close neighbors with good links, it may cover only a small geographic distance at each hop, which would also result in greater energy expenditure due to the for more transmission hops for reach packet to reach the destination

IV. CONCLUSIONS

Energy sources are very limited in wireless sensor networks. In this paper we propose a feature selection and ranking approach to manage energy in wireless sensor network. Using lesser sensors that are most significant can increase the life time of the network. Further, the proposed feature ranking and selection scheme allows graceful management of sensor network in the event of sensor failures, by increasing the number of sensors to meet the specified accuracy requirements. Many factors can influence the energy consumption in wireless sensor networks. A lot of research is being done in this area. It is apparent that focusing on any one of these things and ignoring all others may result in consuming energy unnecessarily.

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