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Analysis of Energy Efficient Routing in Wireless Sensor Networks

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Abstract:

Recent technological advances in communications and computation have enabled the development of low-cost, low-power, small in size, and multifunctional sensor nodes in a wireless sensor network . The most important issue that must be solved in designing a data transmission algorithm for wireless sensor networks(WSNs) is to suggest an effective method for saving sensor node's energy while meeting the needs of applications. One of the important issues in wireless sensor network is the inherent limited battery power within network sensor nodes. In WSN, the sensors transmit the gathered data to the sink either in periodic manner or in event-trigger manner. This leads to unnecessary energy consumption that causes the termination of the node from the network. Some of the route discovery processes involve in redundant rebroadcasts of route-request packets, thus, leading to excess energy consumption. Several energy efficient routing protocols are suggested for WSNs to increase the lifespan of the nodes. In this paper we suggest a technique for energy saving in WSNs selects a node as cluster head that minimizes the total energy consumption in the cluster instead of the node with higher energy left, as in many other protocols. Hence, maximizing the lifetime of the network through minimizing the energy in WSNs.

Key words:

Routing, Tracking, Clustering Quality of Service(QoS), WSN, NS-2.

I.INTRODUCTION:

Wireless sensor networks have recently come into prominence because they hold the potential to revolutionize many segments of our economy and life, from environmental monitoring and conservation, to manufacturing and business asset management, to automation in the transportation and health-care industries.

The design, implementation, and operation of a sensor network requires the confluence of many disciplines, including signal processing, networking and protocols, embedded systems, information management. Unlike a centralized system, a sensor network is subject to a unique set of resource constraints such as finite on-board battery power and limited network communication bandwidth. Issues involved in designing sensor network systems are 1). Limited hardware: each node has limited processing , storage and communication capabilities, and limited energy supply and bandwidth. 2).Limited support for networking: The network is peer-to-peer with a mesh topology and dynamic, mobile, and unreliable connectivity. There are no universal routing protocols or central registry services. Each node acts both as a router and as an application host. 3). Limited support for software development: The tasks are typically real time and massively distributed involve dynamic collaboration among nodes, and must handle multiple competing events. Global properties can be specified only via local instructions. Because of the coupling between applications and system layers, the software architecture must be code signed with the information processing architecture.

II.WIRELESSSENSOR NETWORKS:

A wireless sensor network (WSN) is composed of a large number of densely scattered sensor nodes. A single node is equipped with limited storage, computation and communication capabilities.[1]. A Wireless Sensor Network is a network that is consisting of several tiny sensor nodes which are densely deployed in adhoc fashion in an unattended environment and capable of collecting, analyzing, computing and transmitting real time information to a central processor node for further analysis and report generation. There is several different routing, data dissemination and power management protocols have been designed and introduced for Wireless Sensor Networks (WSNs), dependent on both the architecture of Wireless Sensor Networks (WSNs) and the applications that WSN is intended to support.[2].

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WSNs can be very large networks. For large-scale WSNs, a single sink model is not feasible for the transfer of data as well as for the energy consumption of the sensor nodes since most of the nodes are far from the sink. Even more so, communication spends a lot of energy while sensor nodes have limited battery [3] [4]. As a result, the lifetime of WSNs becomes shorter and a difficult replacement of batteries if sensor nodes are deployed, for example in the forest or in the ocean has to be performed. Although energy is the most critical resource in WSNs, performance characteristics such as message transfer delay play a critical role in some applications for instance earthquake detection system. [5].

The sensor network is fault tolerant because many nodes are sensing the same events. Further, the nodes cooperate and collaborate on their data, which leads to accurate sensing of events in the environment. Sensor networks consists of different types of sensors such as seismic, thermal, visual, and infrared, and they monitor a variety of ambient conditions such as temperature, humidity, pressure, and characteristics of objects and their motion. Sensor nodes are more prone to failure and energy drain, and their battery sources are usually not replaceable and rechargeable. Sensor nodes may not have unique global identifiers, so unique addressing is not always feasible in sensor networks.

III. QUALITY OF SERVICE OF A WSN:

The purpose of a sensor network is to monitor and report events taking place in a particular area. So sensor network faces the problems, coverage and exposure in a given area. Coverage is a measure of how well the network can observe or cover an event. Coverage depends upon the range and sensitivity of the sensing nodes, and the location and density of the sensing nodes in the given region. Exposure is defined as the expected ability of observing a target in the sensor field. It is formally defined as the integral of the sensing function on path from source node to destination node. Localizing and tracking moving stimuli or objects is an essential capability for a sensor network in many practical applications. Tracking exposes the most important issues surrounding collaborative processing, information sharing, and group management including which nodes should sense, which have useful information and should communicate, which should receive the information and how often, all in a dynamically evolving environment.

IV. TRACKING IN WSNs:

The tracking scenario in WSN to bring out key CSIP issues includes 1). Discovery 2). Query Processing 3). Collaborative processing 4).Communication 5). Reporting. This tracking scenario raises a number of fundamental information processing issues in distributed information discovery, representation, communication, storage and querying. In collaborative processing, the issues of target detection, localization, tracking, and sensor tasking and control. In networking, the issues of data naming, aggregation, and routing. In databases, the issues of data abstraction and query optimization. In infrastructure services, the issues of network initialization and discovery, time and location services, fault management, and security. To address the data association problem, a number of approaches have been developed by the multi sensor multi target tracking research community. These include multiple hypothesis tracking(MHT) and joint probabilistic data association(JPDA). MHT and JPDA were specifically designed for managing association hypothesis in multiple target tracking. Replicated information is another serious problem in distributed tracking, whether the tracking is about a single target or multiple targets.

One source of information double counting is due to loopy propagation of evidence in a network. A single piece of evidence may be used in a Bayesian estimation multiple times, resulting in an overly confident estimate. This is similar to the loopy problem in Bayesian networks, and may be addressed by approximation algorithms developed in the Bayesian network research community. Another source of information double counting is due to multiple sensor nodes observing a single target and reporting multiple directions. An aggregation module will be necessary to combine and consolidate multiple local detections before reporting the overall detection to a user. Since network delays can cause local detections to arrive at different, unpredictable times, the aggregation module may need to compare detections over an extended time period assuming the detections are all time stamped. Energy Aware routing to a region. Instead of broadcasting to all nodes in the network, a more common situation is the wish to reach all nodes in a certain geographic region to improve the Quality of Service(QoS). For example, we may be concerned only about seismic vibrations near a downtown area with high buildings. The problem of routing a message to a region combines two of the problems 1. Unicast geographic routing

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2. Energy minimizing broadcast, first we have to get the message to the region of interest, and then we have to distribute it to all the nodes in the region. Energy considerations matter in the first phase as well.

V. ENERGY EFFICIENT DESIGN OF WSN:

Sensor nodes are battery driven, and hence operate on an extremely frugal energy budget. They must have a life time on the order of months to years, because battery replacement is not an option for networks with thousands of physically embedded nodes. In some cases these networks may be required to operate solely on energy scavenged from the environment through seismic, photo voltaic or thermal conversion. This transforms energy consumption into the most important factor that determines sensor node lifetime. Energy optimization, in the case of sensor networks is far more complex, since it involves not only reducing the energy consumption of a single sensor node, but also maximizing the life time of an entire network. The network life time can be maximized only by incorporating energy awareness into every stage of wireless sensor network design and operation, thus empowering the system with the ability to make dynamic tradeoffs between energy consumption system performance, and operational fidelity.

Event tracking involves a significant amount of collaboration between individual sensors to perform complex signal processing algorithms such as Kalmn filtering, Bayesian data fusion, and coherent beam forming. This collaborative signal processing nature of sensor networks offers significant opportunities for energy management. For example, just the decision of heater to do the collaborative signal processing at the user end point or somewhere inside the network has significant implication on energy and lifetime. The micro controller unit in a sensor node usually support various operating modes including, Active, Idle and Sleep modes, for power management purposes. Each mode is characterized by a different amount of power consumption. For example, the strong ARM consumes 50mW of power in the Idle mode, and just 0.16mW in the sleep mode. However transition between operating modes involves a power and latency over head. Thus the power consumption levels of the various modes the transition costs, and the amount of time spent by the MCU in each mode, all have a significant bearing on the total energy consumption(battery life time) of the sensor node.

There are several sources of power consumption in a sensor, including 1). Signal sampling and conversion of physical signals to electrical ones 2). Signal conditioning 3). Analog to digital conversion. In general however, passive sensors such as temperature, seismic etc, consume negligible power relative to other components of the sensor node. However, active sensors such as sonar rangers, array sensors such as imagers, and narrow field of view sensors that require repositioning such as cameras with pan-zoom-tilt can be large consumers of power. The power consumption of ADCs is significant and is related to the data conversion speed and the resolution of the ADC. A high speed resolution product, ADC, high power consumption. Using low power components and trading off unnecessary performance for power savings during node design, can have a significant impact, upto a few orders of magnitude. The node power consumption is strongly dependent on the operating modes of the components. Due to extremely small transmission distances, the power consumed while receiving data can often be greater than the power consumed while transmitting packets. The conventional network protocols which usually assume the receiver power to be negligible, are no longer efficient for sensor networks, and customized protocols that explicitly account for receive power have to be developed.

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 life time. In addition to using low power hardware components during sensor node design, operating the various system resources in a power aware manner through the use of dynamic power management(DPM) can reduce energy consumption further, increasing battery lifetime. Even driven power management is extremely crucial in maximizing node lifetime. While shutdown techniques save energy by turning off idle components, additional energy savings are possible in active state through the use of Dynamic Voltage Scaling(DVS). DVS dynamically adapting the processor's supply voltage and operating frequency to just meet the instantaneous processing requirement, thus trading off unutilized performance for energy savings.

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VI. CLUSTERING IN WSNs:

The notion behind the clustering technique is to group the nodes in several overlapping clusters. Clustering enables the aggregation of the routing information, and hence, supports the scalability of routing algorithms. Cluster based routing tackles the problem of node heterogeneity, and routing overhead. In particular, the clustering enables the process of hierarchical routing in which routes are recorded between clusters resulting in increased route lifetime and decreased control overhead. Cluster head co-ordinates the cluster members and their activities. The cluster bottleneck problem arises as the cluster concentrates more on the traffic of its cluster and this can be avoided by adopting a fully distributed clustering approach. The communications in cluster can be inter-cluster or intra-cluster. The inter-cluster communication represents the communication of nodes within the cluster while the intra-cluster communication represents the communication between the clusters through the gateway nodes. The intra-cluster transmission processing can be divided into two categories generally, the first one is the one-hop communication mode. The ordinary nodes in the cluster transmit the collected data to the cluster-head directly. The second one is the intra-cluster chain transmission mode.

VII. PERFORMANCE RESULTS:

In this section we present the simulation results, with multiple node creation and communication model using UDP(User Datagram Protocol) and CBR(Constant Bit Rate). And configuring distinct energy for every node and energy consumption of the node and energy consumption of the entire network. Each node in the network is configured with the specific sensing range and communication range with twice the sensing range. Without having to establish the data transmission links and transmit the sensed data along such links in the cluster, the intra-cluster average hop-count and further the transmission delay of routing algorithm is less. Intra-cluster routing algorithm has better performance than the data transmission process by using the data relay link in Low Energy Adaptive Clustering Hierarchy(LEACH) in terms of energy consumption and throughput.

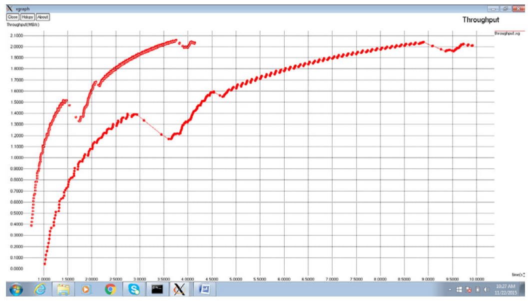

Fig 1.Throughput

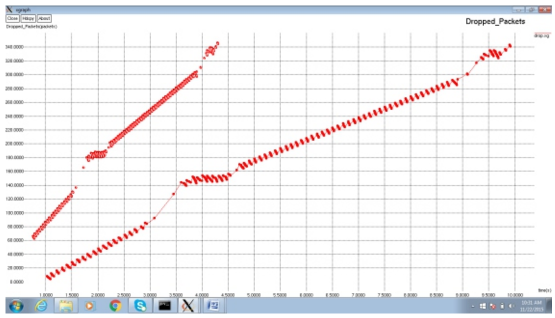

Fig 2. Packet delivery ratio

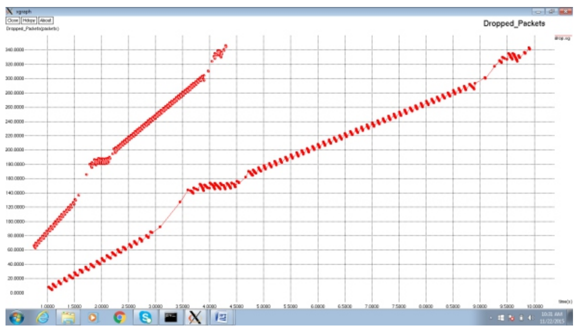

Fig 3. Delay

Fig 4. Dropped packets.

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VIII. CONCLUSION:

In this paper, we proposed a new scheme for the purpose of energy efficient routing in the Wireless Sensor Networks, in which a node is selected as cluster head based on the ability of the node to minimize the total energy consumption in the cluster as the network structure is based on the hierarchical structure and the relevant location information can be obtained by sensor nodes. This scheme mainly focuses on intra-routing. The general solution for energy efficient WSNs is suggested as the contention-based protocols are scalable and adaptable to node density or traffic load variations and schedule-based protocols are collision free and hence, limit the wastage of energy due to collision.

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