International Journal of Engineering Research (ISSN : 2319-6890)
Volume No.2, Issue No.2, pp : 167-171 01 April 2013

Evaluation of Communication Overheads in Wireless Sensor Networks

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Abstract

Wireless sensor network are collection of small sensing self powered nodes organized into a cooperative network which have certain processing capabilities and the nodes communicate wirelessly. Sensing, processing and communication are three key elements whose combination in one node gives rise to a vast number of applications of wireless sensor networks in areas such as environmental monitoring, warfare, education, agriculture to name a few. In the present work, the comparative evaluation of communication overhead due to sink mobility with speed variations, the effect of update time variation, the effect of number of nodes used in the wireless sensor networks is carried out. It has been observed that communication overheads increase significantly when sink mobility is high. The communication overheads can be reduced by increasing update time.

Keywords-component; Wireless sensor network(WSN); communication Overheads; BBM, ; update time

I. INTRODUCTION

A wireless sensor network (WSN) is a wireless network using sensors to cooperatively monitor physical or environmental conditions. The development of wireless sensor networks was originally motivated by military applications. Wireless sensor networks are now used in many wide-range application areas. The increasing interest in wireless sensor networks is due to vast number of applications which these sensor networks provide. A wireless sensor network of the type investigated here refers to a group of sensors, or nodes that are linked by a wireless medium to perform distributed sensing tasks. Connections between nodes may be formed using such media as infrared devices or radios. Wireless sensor networks will be used for such tasks as surveillance, widespread environmental sampling, security and health monitoring. They can be used in virtually any environment, even those where wired connections are not possible, where the terrain is inhospitable, or where physical placement is difficult. They may also be used as enabling infrastructure for new sensing/computational paradigms [2].

Wireless sensor networks are quite challenging networks as resources are limited and different network topologies is possible. The typical application for WSNs is the sensor nodes gathering data and reporting to sink. All data traffics are from sources to a sink or multiple sink nodes. Mostly sink nodes are assumed to be stationary and the sink mobility is hardly an issue. However in many real applications, the sinks are expected to be mobile when they are integrated with other mobile devices such as cell phones. In these cases sink mobility overhead Optimization of communication cost and overhead in the handling wireless sensor networks is a critical issue and thus efforts are being made to optimize or minimize the communications overheads. Due to dynamic nature of wireless sensor networks e,g in environment monitoring application and in military surveillance, resource optimization is very important. Establishing a secure communication link is a wireless sensor network is a challenging task due to resource limitation and wireless nature of transmission. As the sink moves the topology of a sensor network is changed which requires the reconstruction of routing path. In broadcast communication techniques the entire network management depends upon nodes which forward the data to desired destination creating a challenging problem of communication overhead reduction. If overheads are significant the communication stability, security, energy consumption and most importantly quality of services affected.

Communication establishment between source and sink become difficult when sink makes movement in fixed network length due to shortest path routing enforces overheads for maintaining consistent pathway and communication. If the network length increases simultaneously with sink mobility the communication overhead increases since sink has to broadcast every time it changes its states to whole of the network as it uses Broadcast based Method (BBM) techniques for communication. Similarly the frequent updates from the sink can lead to both rapid energy consumption of the sensor nodes and increased collisions in wireless transmission and in turn increases the communication overhead.

The overhead in wireless sensor network depends upon different network protocols like multi-path based routing, negotiation based routing, query based routing, quality of service based routing etc. Among these multi-path routing protocol is widely used for reliable data transfer. An energy efficient multi-path routing protocol has been proposed in [3]. The aim of this protocol is efficiently find the multiple paths from a source to a destination costing of minimum energy. But these techniques only provide the reliable paths but do not provide the techniques for reducing traffic overhead for packet data transfer. To overcome the traffic overhead another technique was proposed called data splitting technique [4]. This technique split the data packet and sends them using redundant paths. However it reduces the traffic but does not ensure the reliable multi-paths to transmit the split packets into the networks. Now the problem is energy efficient multi-path routing protocol [3] ensure only the reliable multiple paths and data splitting technique proposed in [4] reduces the traffic overhead. First one needs a better technique for reducing traffic and second one requires a better technique for reliable multi-paths. Therefore both the technique requires the other to ensure both reliability and reduced traffic overhead.

In wireless sensor network reliability and traffic overhead is an important issue. To improve the reliability we must, transmit the data in multiple paths from source node to sink node. Source node is a node which collects data through its sensing devices, finds neighbor nodes and sends message to them; all intermediate nodes, which relay the data through multi-hop communication, have the same configuration as the source nodes. Sink node is a special, single node serving as the target, the message receiver. If we transmit the same data in different path then the network become over loaded. So it is necessary to use data splitting technique in multipath routing protocol. Again if we transmit the data in those paths which are unable to reach to the destination successfully then it is necessary to retransmit the data increasing overhead. Similarly the energy optimization, in the case of sensor networks, is a complex task, since it involves not only reducing the energy consumption of a single sensor node, but also maximizing the lifetime of an entire network. To maximize network lifetime of the WSN structure, a dynamic tradeoff among various factors, viz. energy consumption, system performance, and operation fidelity is needed [5]. While designing the physical layer for sensor networks, energy minimization assumes significant importance, over and above the propagation and fading effects.

In this paper we have studied the variation of communication overhead with respect to various parameter e.g sink mobility with varying speed ,variation of no of network nodes i .e . Increment in no of nodes, increment in network length and update time. Matlab software has been used to carry out simulation.

II. OVERHEAD IN WIRELESS SENSOR NETWORKS

In wireless sensor networks (WSN) data produced by one or more sources usually has to be routed through several intermediate nodes to reach the destination. Problems arise when intermediate nodes fail to forward the incoming messages. The reliability of the system can be increased by providing several paths from source to destination and sending the same packet through each of them. Using this technique, the traffic increases significantly primary path and therefore expend significantly more energy than that on the primary path.

In the past few years, intensive research that addresses the potential of collaboration among sensors in data gathering and processing, and coordination and management of the sensing activity was conducted. In most applications, sensor nodes are constrained in energy supply and communication bandwidth. Thus, innovative techniques to eliminate energy inefficiencies that shorten the lifetime of the network and efficient many routing, power management, and data dissemination protocols have been specifically designed for WSNs, where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture. The overhead in wireless sensor networks is governed by following factors

Scalability and Reliability

In a wireless networks, reliability and scalability are always inversely coupled. In other words, it becomes more difficult to build a reliable network as the number of nodes increases. This is due to the network overhead that comes with the increased size of the network. In wireless networks, the network is formed without any predetermined topology or shape. Therefore, any node wishing to communicate with other nodes should generate more packets than its data packets. These extra packets are generally called "control packets" or "network overhead." Route discovery packets and route response packets in typical wireless network routing protocols are a few examples of the overhead. As the size of the network grows, more control packets will be needed to find and keep the routing paths. Moreover, as the network size increases, there is higher chance that communication links get broken in communication paths, which will end up with creating more control packets thereby increasing overhead. In summary, more overhead is unavoidable in a larger scale wireless sensor network to keep the communication paths intact.

Quick Responsiveness and Reliability

Responsiveness is the ability of the network to quickly adapt itself to changes in topology. To achieve high responsiveness, an ad hoc network

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should issue and exchange more control packets, which increases overhead.

Mobility and Reliability

Generally, a wireless sensor network that includes a number of mobile nodes should have high responsiveness to deal with the mobility. So, it is not easy to design a large scale and highly mobile wireless sensor network without significantly increasing overheads.

Power Efficiency and Reliability

Power efficiency also plays another important role in wireless network. A typical method for designing a low-power wireless sensor network is to reduce the duty cycle of each node. The drawback is that as the wireless sensor node stays longer in sleep mode to save power, there is less chance that the node can communicate with its neighbours. In addition to creating scalability challenges due to the need for a more complicated synchronization technique to keep more nodes in low duty cycle, this will decrease the network responsiveness and may also lower reliability due to the lack of the exchange of control packets and delays in packet delivery.

In this paper, we have evaluated the broadcasting with the sink mobility. The mobile sink would update the location information to whole network with the change in the position above a threshold distance and with the update time.

III SIMULATION RESULTS

Simulation was carried out in Matlab [6]. As seen from figure 1 communication overheads increases significantly when velocity of sinks nodes increases linearly. When number of nodes are 20 the communication overhead increases almost linearly. When nodes are taken nearly 100, rate of communication overhead becomes very fast.

Figure 2 shows the relationship of update time with communication overhead. As can be seen from figure 2, the decrease in communication overheads is not significant when number of nodes is small (nearly 20). When number of nodes is nearly 100, the communication overhead drops significantly with increasing update time.

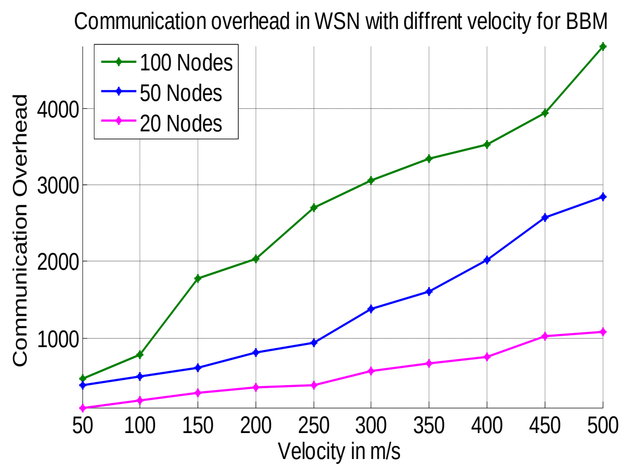

Figure 1: Communication overhead in WSN with different velocity for BBM

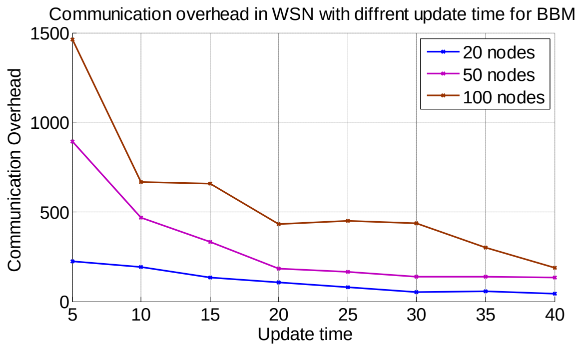

Figure 2: Effect on communication overhead with increase update time (in seconds).

ACKNOWLEDGMENT

Authors are thankful to the Head of JMGP Burhanpur, India for his kind support and useful technical discussion during the course of this work, Thanks are also due to friends and colleagues of our department for their cooperation, fruitful technical discussion and guidance.

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