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Performance Analysis of Wireless Sensor Networks in Different Terrain Areas Using DSR Routing Protocol in NS2 Simulator

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ABSTRACT: Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. Wireless sensor networks have many applications in everyday life, ranging from monitoring and detection to space exploration. The main task of a wireless sensor node is to sense and collect data from a definite domain, process them and convey it to the sink where the application lies. DSR has been implemented by numerous groups, and deployed on several test beds.
The main focus of this thesis is to discuss and evaluate the performance of different metrics in different scenarios and different terrain areas which may be small, and large in wireless sensor network using Dynamic Source routing protocols and for monitoring of critical conditions with the help of important metrics like throughput, PDF, NRL, Jitter, Packet loss% and end-to-end delay in different scenarios. In study of this thesis, simulation is based on varying Pause time in small, large and very large terrain areas and find out the performance evaluation of DSR routing protocol on behalf of Performance Metrics using NS-2.

KEYWORDS: Dynamic source Routing, Packet delivery fraction, Average Throughput, Packet Loss, Dynamic source routing, Wireless Sensor Networks

I. INTRODUCTION

Wireless ad hoc network is a collection of autonomous mobile nodes that communicate with each other over wireless links. Wireless Sensor Networks (WSNs) is a wireless network that consists of dispersed autonomous devices using sensors to monitor the conditions such as temperature, sound, vibration, pressure and motion at different locations. A wireless sensor network is a collection of nodes organized into a cooperative network.

In general the two types of wireless sensor networks are: unstructured and structured. The structured wireless sensor networks are those in which the sensor nodes deployment is in a planned manner whereas unstructured wireless sensor networks are the one in which sensor nodes deployment is in an ad-hoc manner. As there is no fixed infrastructure between wireless sensor networks for communication, routing becomes an issue in large number of sensor nodes deployed along with other challenges of manufacturing, design and management of these networks. There are different protocols that have been proposed for these issues. The critical condition monitoring application is studied in this thesis by evaluation of two routing protocols with the help of some performance metrics considering applications demand as well.

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II. ROUTING PROTOCOLS

Routing protocols in conventional wired networks generally use either distance vector or link state routing algorithms, AODV routing protocols. In distance vector routing, each router broadcasts to each of its neighbour routers its view of the distance to all hosts, and each router computes the shortest path to each host based on the information advertised by each of its neighbours. The Dynamic Source Routing protocol is a simple and efficient routing protocol intended exclusively for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR, the network is totally self-organizing and self-configuring, requiring no existing network communications. Network nodes control to onward packets for each other to allow communication over multiple hops between nodes not directly within wireless transmission range of one another. Route Discovery is used whenever a source node SN desires a route to a destination node DN in order to send the data packets. First, the source node SN looks up its route cache to determine if it already contains a route to the destination node DN. If the source node SN finds a valid route to the destination node DN, it uses this route to send its data packets. If the source node SN does not have a valid route to the destination node DN, it starts the route discovery process by broadcasting a Route Request Message RREQ. This route request message RREQ contains the address of the source and the destination, and a unique identification number. An intermediate node that receives a Route Request Message RREQ searches its route cache for a route to the destination node DN. If no route is found, it appends its address to the route record of the message and forwards the message to its neighbors. The message propagates through the network until it reaches either the destination or an intermediate node with a route to the destination. Then a route reply message, containing the proper hop sequence for reaching the destination, is generated and uni-cast back to the source node. Hence, Route Discovery is used only when source node SN attempts to send a packet to DN and does not already know a route to DN. Route Maintenance is the means by which node S is able to sense, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a linkage along the route no longer works. When Route continuation indicates a source route is broken, S can attempt to use any other route it happens to know to D, or it can invoke Route Discovery again to find a new route for subsequent packets to D. When a node requires a route to a destination, which it doesn't have in its route cache, it broadcasts a Route Request (RREQ) message, which is flooded throughout the network. The first RREQ message is a broadcast query on neighbours without flooding. Each RREQ packet is uniquely identified by the initiator's address and the request id. A node processes a route request packet only if it has not already seen the packet and its address is not present in the route record of the packet.

The routing protocol AODV creates no extra traffic for communication along existing links obeying IEEE 802.15.4 standard for low data rate wireless connectivity among relatively simple devices that consume minimal power. AODV is a packet routing protocol designed for use in mobile ad hoc networks (MANET), intended for networks that contain thousands of nodes.

III. SIMULATION TOOLS

Ns-2 is a packet-level simulator and essentially a centric discrete event scheduler to schedule the events such as packet and timer expiration. NS2 is simply an event driven simulation tool that has proved useful in studying the dynamic nature of communication networks. Simulation of wired as well as wireless network functions and protocols (e.g., routing algorithms, TCP, UDP) can be done using NS2. NS2 provides users with executable command ns which take on input argument, the name of a Tcl simulation scripting file. Users are feeding the name of a Tcl simulation script (which sets up a simulation) as an input argument of an NS2 executable command ns. NS-2 provides the Network components like Node, Link, Queue, etc. they are created from the corresponding C++ classes; The other are compound components, that is, they are composed multiple simple C++ classes like Link are composed of Delay (emulating propagation delay) and Queue. We can say that in ns-2, all network components are created, plugged and configured from TCL.

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NS-2 provides the Event Scheduling that is associated with time. NS-2 has four main components: NS itself, Network animator (NAM), Pre-processing and post-processing. The primary component is ns, the actual simulator. This provides the software backup for programming network models. The programming environment provides an interactive mode because the front-end OTcl interpreter allows for the direct programming of the simulator.

IV.SIMULATION PARAMETERS

The following three important performance metrics are considered for evaluation of the DSR routing protocols: 1. Packet delivery fraction [%] (PDF): PDF is defined as the ratio of the number of data packets successfully delivered to the destination nodes and number of data packets produced by source nodes. 2. Average Throughput: Throughput is refers to the amount of data transfer from source node to destination in a specified amount of time. 3. End-to-End Delay: The average time interval between the generation of a packet in a source node and the successfully delivery of the packet at the destination node. 4. Routing Load: The ratio of the number of routing messages propagated by every node in the network and the number of data packets successfully delivered to all destination nodes. 5. Packet Loss [%]: It is the number of dropped packet to the total packets. Packet Loss [%] = (dropped Packets/ (total packets)) *100)

V. SIMULATION SETUP

In this study investigators use a scenario where a total of 100 nodes are used with the maximum connection number 10; seed for the one, and a hope that have 10 CBR; 4 packets per second transfer rate and the pause time is varying of 0.00 sec, 20sec, 40sec, 60sec, 80sec, and 100sec implemented respectively in a 500m x 500m, 800m x 800m, 1500m x 1500m terrain areas scope.
Finding Metrics are PDF, Average End-to-End Delay, average Throughput, Normalized Routing Load, and Packet Loss%.

VI. RESULT AND ANALYSIS

A)The investigations were performed on Packet delivery fraction using DSR routing protocol. When Nodes - 100, Pause Time - 00.0-100secs, Maximum Speed- 10m/s, Routing protocol-DSR, and Finding Metrics: Packet Delivery Fraction.

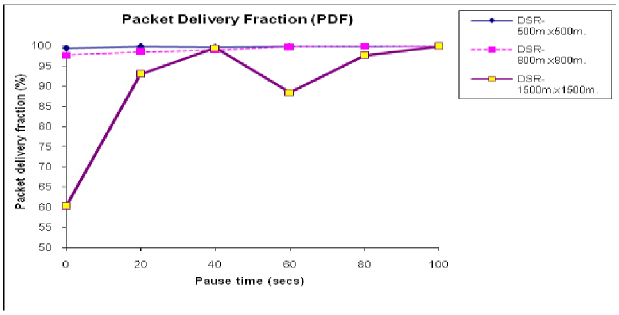

Figure 1.1: Pause Time versus Packet Delivery Fraction When Terrain Areas is 500m x 500m, 800m x 800m, 1500m x 1500m.

If we implement wireless sensors in biggest terrain areas, the packet delivery fraction is decreased on varying pause time.
B)The investigations were performed on Average Throughput using DSR routing protocol. When Nodes-100, Pause Time - 00.0-100secs, Maximum Speed- 10m/s, Routing protocol- DSR, and Finding Metrics: Average End-to-End Delay.

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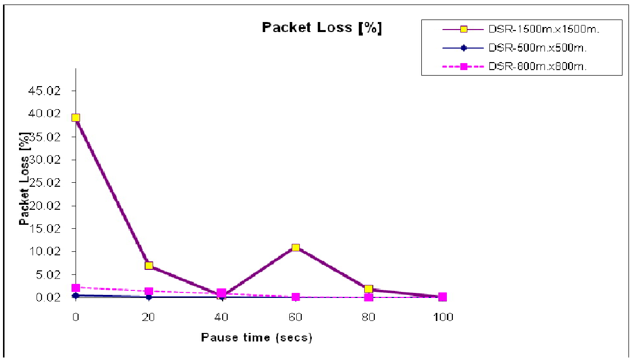

Figure 1.2: Pause Time vs Average End -to-End Delay When Terrain Areas is 500m x 500m, 800m x 800m, 1500m x 1500m.

If We implement wireless sensors in biggest terrain areas, the Average End-to-End Delay is increased on varying pause time.

(C) WHEN Nodes -100, Pause Time - 00.0-100secs, Maximum Speed- 10m\s, Routing protocol- DSR, and Finding Metrics: Average Throughput kbps)

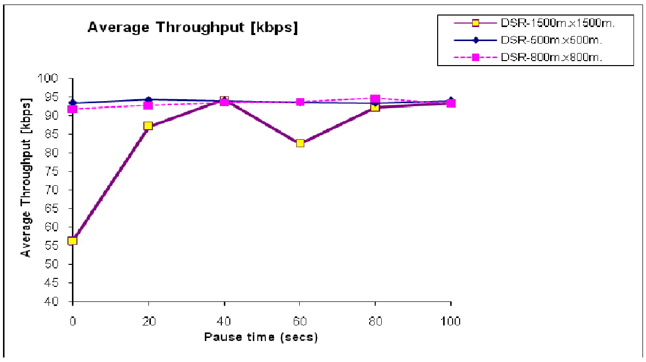

Figure 1.3: Pause time versus Average Throughput (kbps) when Terrain Areas is 500m x 500m, 800m x 800m, 1500m x 1500m.

If we implement wireless sensors in biggest terrain areas, the Average Throughput is decreased on varying pause time.

(D) WHEN Nodes-100, Pause Time - 00.0-100secs, Maximum Speed- 10m\s, Routing protocol- DSR, and Finding Metrics: Normalized Routing Load.

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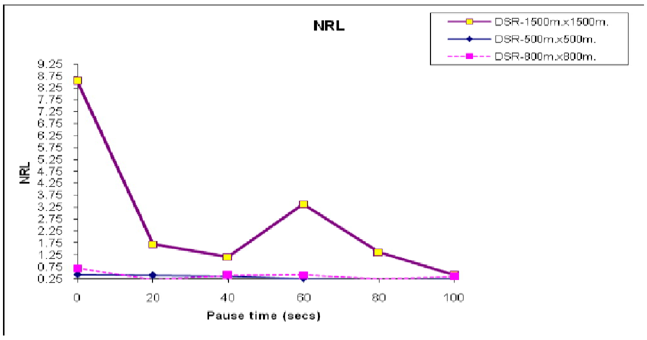
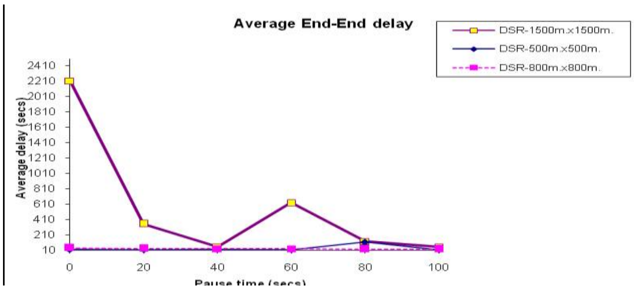


Figure 1.4: Pause Time versus Normalized Routing Load When a Terrain Area is 500m x 500m, 800m x 800m, 1500m x 1500m.

If we implement wireless sensors in biggest terrain areas, the Normalized routing Load is increased on varying pause time.

(E) WHEN Nodes-100, Pause Time - 00.0-100secs, Maximum Speed- 10m\s, Routing protocol- DSR, and Finding Metrics: Packet Loss%.If we implement wireless sensors in biggest terrain areas, the Packet Loss% is increased on varying pause time.



VII. CONCLUSION

The results are analyzed and discussed in different topology areas having networks of 100 mobile nodes on varying Pause time and Maximum speed for finding performance of different metrics like PDF, NRL, average throughput, packet loss% and average End-to-end Delay in small, large and very large terrain areas. In study of this thesis, simulation is divided based on varying Pause time in small and large terrain areas 500m x 500m, 800m x 800m, and 1500m x 1500m using NS-2. Our study provides an optimal result which is fully based on simulation and analysis. Every case consists five another cases for different metrics with the help of table and generated graph. Each case represents a special issue for metric and Terrain area ((500 * 500), (800 x 800) and (1500 x 1500)). According to the analysis we fully satisfy the contents and relationship between metrics and terrain areas which is 500m x 500m, 800m x 800m, and 1500m x 1500m. Packet loss occurs due to sink failure. We have to recover the sensor nodes which are connected with the failed sink. Our future plan includes providing failure recovery mechanism for sink failure and energy efficiency also performing analysis using AODV routing protocol because when we implement sensor nodes in small terrain areas AODV give better performance in Packet Delivery Fraction, and NRL rather than DSR.

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