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Simulations of Routing Protocols of Wireless Sensor Networks

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***Abstract*—**Wireless Sensor Network is widely used in electronics. Wireless sensor networks are now used in many applications including military, environmental, healthcare applications, home automation and traffic control. We will study one area of wireless sensor networks, which is the routing protocol. Routing protocols are needed to send data between sensor nodes and the base station.

In this paper, we will discuss two routing protocols, such as data-centric and hierarchical routing protocol. We will show the output of the protocols using the NS-2 simulator. This paper will compare the simulation output of the two routing protocol using Nam. We will simulate using Xgraph to find the throughput and delay of the protocol.

***Keywords*—**data-centric routing protocol, hierarchical routing protocol, Nam, NS-2, Routing Protocol, sensor nodes, SPIN, throughput, Xgraph

I. Introduction

A sensor network is composed of a large number of tiny autonomous devices, called sensor nodes [1, 7]. A sensor node has limited sensing and computational capabilities and can communicate only in short distances. Routing protocol is a set of rules defining the way router machines find the way that packets containing information have to follow to reach the intended destination [3].

The two routing protocols are the data-centric routing protocol and the hierarchical routing protocol. These two are the first and second category for routing protocol and mostly the data-centric routing protocol is the one mostly used.

Using the NS-2 Simulator [4], we can execute the routing protocols. Using Cygwin, we can see how the routing protocols work on each sensor nodes. After simulating the routing protocols, we will show how some protocols works in nam trace file and some does not. We will show a comparison of the two protocols. Lastly, we will see the xgraph of the input data that the data received and its delay.

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II. II. Routing Protocol Simulation

A. Data Centric Routing Protocol

The Data Centric Routing Protocol is the first category of routing protocols. For this category we choose to simulate the SPIN-1 (Sensor Protocols for Information via Negotiation) which is a source-initiated protocol [5]. It is the first data-centric routing protocol. It applies a 3 stage handshake interface for disseminating data (ADV-REQ-DATA). The source and destination might transmit alternately as follows: request to send, ready to receive, send message, message received [6]. SPIN nodes assign high-level names to their data, called meta-data. Meta-data is used to negotiate with each other before transmitting data to avoid transmitting redundant data in the network. By using NS-2 Simulator, we were able to simulate the SPIN-1.

Using NS-2 to run the program, we simulate the SPIN-1 and will give us figure 1. It is currently transmitting the data to other nodes simultaneously. This is the output from the nam trace.

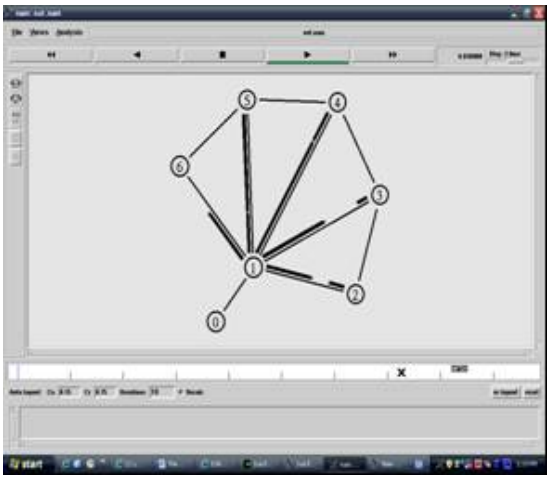

Fig. 1: Data-Centric Routing Protocol Simulation of SPIN-1.

B. Hierarchical Routing Protocol

Hierarchical Routing Protocol is the next category of routing protocols. Hierarchical routing is the procedure of arranging routers in a hierarchical manner [9]. The basic idea of hierarchical routing protocol is to organize sensor nodes

into cluster based on the received signal strength and use local cluster-heads as routers to base station [2]. It performs local data fusion and aggregation at cluster-heads to further reduce energy consumption. Sensor nodes elect themselves to be local cluster heads with a certain probability. The non-cluster head node will join a cluster-head that requires minimum communication energy [5]. In the hierarchical routing protocol, we assume that the base station is fixed and located far away from the sensors. Also, we assume that every sensor can reach the base station directly so it will limit the applicability of the protocol. We define the hierarchy of the topology as well as provide the nodes with hierarchical addressing in order to simulate the hierarchical routing protocol [10]. This routing protocol doesn't really apply in nam trace; therefore it just shows the number of nodes. This simulation shows the route to the base station.

III. Xgraph of Data Centric protocol.

Xgraph is an open file format used to describe a graph object [8]. Xgraph is a general purpose x-y data plotter that can plot multiple data.

A. Throughput vs. Time

Throughput is the data that is sent from one sensor node to the other sensor node in a given period of time. In the figure below, we xgraph the throughput by getting the bytes that the node receives the data using xgraph and every node is shown in one plot.

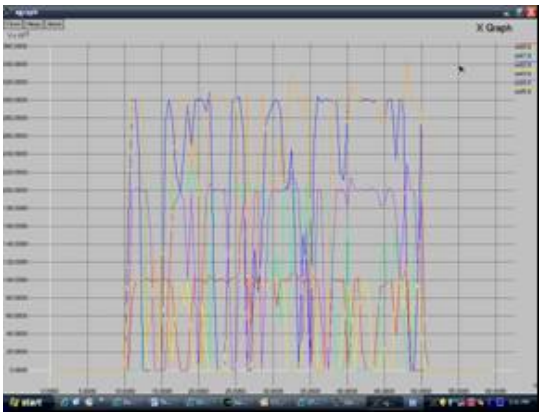

Fig. 2: Throughput vs. Time xgraph

Based from the xgraph, node 1 and node4 got the lowest data and node 6 got the highest data. This reason is due to the simulation of spin.tcl. It shows that the last data received was by node 6 that is the reason why it has the highest data. The spin.tcl gives random amount of data because we didn't specify the amount that the nodes will receive. It only shows how the data centric routing protocol SPIN-1 works. We can change timeline to distinguish the xgraph in different time to observe what the xgraph would look like.

B. Delay vs. time

Delay is the time it takes for the data to go from the sender node to the receiver node. In terms of delay, they almost have the same bandwidth because they are all running in the same time and the simulation code to receive data is the same. We just have to create the configuration parameter of the idle time so it will xgraph the delay of the protocol.

The xgraph below shows the delay of the SPIN-1 routing protocol. As you can see from the xgraph, the delay on this protocol is the same as all because it sends the data and does the handshake at same time. It also depends on how we call the logging of the bandwidth or how we place the simulation time for the sensor nodes. If we put the simulation time of the sensor nodes to flow smooth, there will be no delays.

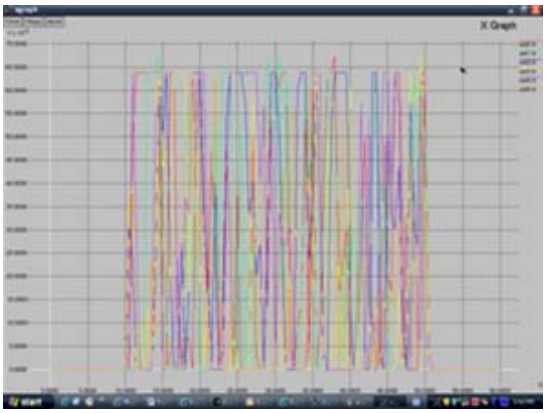

Fig. 3: Delay vs. Time xgraph

IV. Conclusion

In conclusion, we have introduced about two routing protocols which are data-centric routing protocol and the hierarchical routing protocol. We show how it works and (SPIN-1) Data centric routing protocol creates a handshake interface for disseminating data. The first node sends an ADV message for a new message to disseminate. REQ sends a message back to the first node. When the first node receives the REQ, it will respond back by sending the DATA back t the second node. If the nodes are connected to other nodes, it will send the message simultaneously. We explain that hierarchical routing protocol is not supported by nam trace file it just gave us the connection with the sensor nodes and the base station.

The xgraph shows the throughput, the data the receiver node receives. According to the nam trace file, node 6 receives the last data randomly. This paper xgraph the delay on the routing protocol to show the different delays on the different nodes but it turns out they are almost the same. We assume that SPIN-1 is like a tree where it sends the data to its branches one by one until it reach the last node. Routing protocol is an important element for wireless sensor networks to operate.

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