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Scalable and Cost Effective Solution to Minimum Cost Forwarding in WSN

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Abstract: *This paper introduces an improved routing protocol for wireless sensor networks (WSN), built on the basis of fundamental concepts in source based minimum cost forwarding protocol. Neither routing tables nor network topology information is maintained at the sensor level, which makes the proposed protocol part of the reactive routing protocol class. Despite the lack of routing information at the sensor, the packets from the sink node to sensors, and vice versa, always accompany the optimal communication path with minimal cost. Simulation results have proven that the proposed protocol performs better than existing protocol, and nodes always route the packets through the optimal path up to destination. In fact, according to the energy consumption, packet delivery ratio, normalized routing protocol, end to end delay and throughput found by simulation, proposed protocol improves on the existing protocol for applications where the sink node, acting as a server or base station (BS), generates significant amounts of mesh traffic. All results are based on simulations and data treatment performed with Network Simulator (NS2).*

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Keywords:: *Wireless Sensor Networks; Minimum Cost Forwarding; Source Based Routing.*

I. INTRODUCTION

Recent progress in wireless communication has enabled the development of low-cost, low-power, multifunctional sensor nodes, which furnish the solution to a variety of real-world problems. Sensors are low-cost tiny devices with limited memory, computational capability, and ability. Devices in sensor networks have a much smaller memory, constrained energy supply, less operation and communication bandwidth. Topologies of the sensor networks are constantly changing due to a high node failure rate, periodically shutdown, and abrupt communication interferences. Wireless Sensor Network differs from other types of the network because they bridge the gap between the physical and the virtual world. Due to the nature of the applications supported, sensor networks need to be densely deployed. In addition, energy conservation becomes the essence of focus due to the limited battery capacity and the impossibility of recharge in the hostile environment. Wireless sensor networks allow flexible, powerful, automated data collection and monitoring schemes to be created.

Routing protocols are classified on the basis of whether they are proactive and reactive protocols [1]. Proactive routing protocols keep track of paths to all destinations in routing tables. LEACH and PEGASIS are two examples of proactive routing protocols. Unlike proactive protocols, reactive protocols assume routes on demand and avoid saving information about the mesh topology. Flooding, Gossiping and Minimum Cost Forwarding [2] [3] are examples of reactive protocols. Traffic in sensor network displays, a heterogeneous nature. In fact, in most cases, the communication rules in sensor networks are characterized by:
a. Traffic between the BS node and sensor nodes.
b. Traffic between adjacent nodes.
This paper offers a reactive routing protocol where sensors have no information about the mesh topology, but packets from sensors to BS or vice-versa, always communicate over optimum paths with minimum cost.

Since the proposed concept is the improvement in Source Routing for Minimum Cost Forwarding Protocol [4].

II. RELATED WORK

The Minimum Cost Forwarding protocol is a secure method for routing packets that have been proposed by Ye et al. [2] as an efficient protocol appropriate for simple WSN with limited resources and does not necessitate the storage of routing tables at the sensor nodes establishing optimal routing paths with few message exchanges and is scalable and simple to enforce. The Minimum Cost Forwarding is a cost field based approach and exploits the fact that the routing direction of data, flowing from sensors to sink, is always recognized and that cost is always minimized. So a sensor need not have a unique ID for maintaining a routing table. In fact, the cost of sending a message to the sink is the sole information required by a node to only implement the protocol. The simplicity of the Minimum Cost Forwarding is an advantage for sensor nodes with limited processing capability and/or memory. The link cost can be of any form such as hop count, consumed energy or delay.

In this method, sink node starts to frame-up the network with broadcasting its cost value and all nodes get minimum cost value to arrive at the sink node. With this method, sensor nodes have neither routing tables nor information about the mesh topology.It is evident that this approach applies only to data sent from the sensor nodes to sink. If the sink node wants to transmit data to a specific node, other methods like flooding must be utilized. In situations where the BS node simultaneously behaves as a sink and server and brings forth a significant amount of data, then implosion, overlapping and resource blindness problems, ensuring from the flooding method, will contract the network performance. Therefore, Minimum Cost Forwarding is set aside only for those diligences where the sink node has an almost exclusive use of the data collected.

For the BS to send information to a dedicated sensor, destination and routing path must be specified in the BS node like in source based routing (SBR) [5]. To implement source routing, the packet contains the address of each node along the routing path. Source routing requires decoding the address of all nodes and routing paths from source to destination, as is done with protocols like Dynamic Source Routing (DSR) [5] [6] for wireless ad hoc network and Link Quality Source Routing (LQSR) developed by Microsoft for wireless mesh networks. DSR and LQSR protocols are reactive approaches and do not call for routing tables. These protocols define a route on-demand, when the source node wants to transmit data to the destination node and hold on the routing information while transmitting.
The source node establishes a route between source and destination nodes by transmitting a RouteRequest packet. When the destination node gets the RouteRequest packet, it responds with RouteReply packet to the source node. This packet transmits the routing path from the source node to the destination node. During the communication between the nodes, the intermediate nodes route the packets by using the routing information which is conveyed in the packet headers. A higher connection frame-up delay in comparison with table-driven protocols, and the absence of a mechanism for local repair of failed connections are some of the disadvantages of the DSR and LQR protocols. Our work is closely related to this work. The major difference between proposed protocol and other protocols is that proposed protocol is more scalable and cost effective.

III. SYSTEM MODEL

Consider a wireless network composed of multiple sensor nodes and one BS node. The BS node maintains a table of minimum cost route from itself to every sensor node in the network. If the BS node needs to transmit a packet to a given sensor node, over a specific path defined in the table, the intermediate nodes must be aware of the path and route the packet to the correct links. As aforementioned, sensors in a reactive network do not have any information about the network topology. Moreover, it is impossible to route the packet over a predefined fixed path when nodes have no knowledge about network topology or routing information. However, if the packet carries the path information like it is done in Trajectory Based Forwarding (TBF) [7] and DSR, then the intermediate nodes can use this information to route the packets to the destination node.

Taking into account the heterogeneous traffic in a WSN and making use of minimum cost forwarding and source based routing concepts, a reactive protocol can be designed to have an optimum routing in both communication directions (from BS to nodes and nodes to BS).

It should be noted that in this method there is only one routing table at the BS node: the other nodes use the information in that table when the BS node issues a route packet. The routing of packets, originated from sensor nodes, is based on the minimum cost forwarding method, without resourcing to a routing table.

The following premises are made constructed the system model.

- A sensor network consists of sensor nodes and base stations.
- Sensor nodes are deployed in an ad-hoc basis for unattended operation and they are static (No mobility).
- Sensor nodes can appraisal and mastery the rates at which data packets are generated. All the data packets are of the same size.
- Sensor nodes can transmit with other sensor nodes and base stations within their wireless transmission range using a MAC protocol. The MAC protocol defines the average rate at which a sensor node can broadcast data to its neighbour over a wireless channel. This pace is the channel capacity.
- Before executing, it will ask user to enter Transmitter and Receiver node to transmit the data.
- Sensor Node - 0 calculate distance of all the nodes.
- Sensor Node selects the path by which transmission has minimum cost and more scalability. It is checked by the factor packet delivery ratio, normalized routing load, throughput, energy consumption and end to end delay.

IV. MINIMUM COST FORWARDING PROTOCOL

A. Problem formulation

Existing protocol is made by the combination of source based routing (SBR) for ad hoc networks and minimum cost forwarding (MCF) methods for heterogeneous WSNs. In this routing protocol packets are sentby different procedure in two ways which are followed:

- Packets from a Sensor Node to BS
- Packets Sent from BS to Sensor Node

But then also the end to end delay is very much and the value of packet delivery ratio, throughput is not much.

B. Solution

```
Set NN = M; //Number of mobile node
Set RP = MCF; //Routing protocol
Set rng = 250 m; //Radio range
Set Ideal =0.1 j;
Set Sender = S; // S ε M
Set Receiver = R; // R ε M //
 Generate test Traffic Compute route ();
RREQ_B (S, R, rng)
{// search route from source to destination
if ((next_hop == true) && (rng ≤250) && (eng ≥ 10j))
{
next_hop -> Rx_RREQ;
Call_MCF();
D_PATH = PATH(max);//maximum path
 rtable->insert(rtable->rt_nexthop); // nexthop to RREQ
source rtable1->insert(rtable1->rt_nexthop); // nexthop
to RREQ destination
if (destination == R)
{
If (more route live)
{
Check PATH of both routes;
Call_MCF();
 If (rt1_PATH > rt2-PATH) Accept RREQ_B; //from
rt1
D_PATH = PATH(mcf);
Send_ack through rtable1 to source node
}
 Else
{
 Accept RREQ_B; //from rt2
D_PATH = PATH(mcf);
 Send_ack through rtable2 to source node
 }
}
 Else
{
destination not found;
}
}
else
{
destination unreachable;
}
```

V. CONCLUSION

This paper identifies a routing protocol for wireless sensor networks based on the inclusion of routing information in the packets when the minimum cost forwarding method is practiced. With the proposed protocol, and except for the BS node, there is no need to maintain explicit forwarding path tables in the intermediate nodes. The routing table on BS is formed in the network setup phase and updated after any modification in network topology reported by sensor nodes. The intermediate nodes to acquire routing information from the packets originating from the BS without having to recognize the network topology. In comparison with the existing protocol, the simulation results indicate that not just the proposed protocol has very minor end to end delay, high throughput and high ratio of packet delivery than existing protocol, but also dissipates less energy.

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