PERFORMANCE EVALUATION OF GEOGRAPHIC MULTICAST ROUTING PROTOCOL WITH BECON LESS GEOGRAPHIC MULTICAST ROUTING PROTOCOL IN WIRELESS SENSOR NETWORKS

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Abstract

This paper proposes the performance evaluation and comparison of the Geographic Multicast Routing (GMR) with and Beacon less Geographical multicast routing. Performance analysis is shown. The performance comparison is done with regard to the Packet delivery ratio. This comparison is an overview of available solutions based on detailed simulation study.

KEYWORDS: *Wireless Sensor Network; Multicasting; Protocols.*

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1. INTRODUCTION

A wireless sensor network is a multi-hop wireless network with a large number of low-cost and low-power sensor nodes. These sensor nodes are generally energy-constrained devices equipped with small memory, limited computation capability and short range radio. Another key requirement for WSN is a self-configuring capability, the importance of this increase with the size of the network. In any bigger network at least some of the nodes must also be capable of multi-hop data transmission despite low memory and computational capacity. : In most sensor network scenarios, devices acquire data from the environment, and send it to other nodes for further processing and analysis. Routing protocols for wireless sensor networks are used to transmit messages from sources to destinations. They can be classified as unicast, broadcast or multicast. Multicasting protocols try to minimize the consumption of network resources in comparison of unicast and broadcast protocols. The main advantages of Wireless Sensor Networks (WSNs) are their self-configuration and self-organization capabilities that allow the deployment of a monitoring system in an easy and economic way. However, the low cost together with the dimension of these small nodes causes some limitations at a level of the processor capability, storage, communication and power. Because of these limitations, it is necessary to use a lot of nodes to obtain an efficient and reliable system. The use of a Sink Node as a central point with larger capabilities that collects the information from sensors, is the common solution of these type of networks. Moreover, this sink node is usually the interface between the sensor nodes and the Internet. To prolong the life time of WSN net with limited energy resources, Multicast can better meet the requirements of network resources .With the character of high bandwidth utilization and effective mechanisms to save energy, Multicast packets can be transmitted efficiently to reduce energy consumption effectively. However, the widely used of multicast technology in traditional wireless networks have too much difference with Wireless sensor network

Geographic Multicast Routing (GMR) is a multicast routing protocol for wireless sensor networks. GMR manages to preserve the good properties of previous geographic unicast routing schemes while being able to efficiently deliver multicast data messages to multiple destinations. Each node propagating a multicast data message needs to select a subset of its neighbors as relay nodes towards destinations. GMR optimizes cost over progress ratio. The cost is equal to the number of selected neighbors, while progress is the overall reduction of the remaining distances to destinations.

Most geographic unicast routing protocols and all of the geographic multicast ones assume that nodes know their neighbor's positions using beacons messages. Beacons are short messages periodically broadcast by sensor nodes to advertise their position and identifier to neighboring nodes.

However, the use of beacons can introduce a number of severe problems when protocols are deployed in real test beds: collisions, imprecision in neighborhood tables, unnecessary waste of resources, etc. Beacon less Geographic protocol discovers reactively the set of candidate relays for multicast packets using data packets themselves. By doing that, Beacon less Geographic protocol is able to perform very well in realistic scenarios with interferences, collisions, etc.[3]

The remainder of the paper is organized as follows: section 2 presents an overview of GMR and Beacon less Geographical routing. In Section 3 we evaluate the performance of both multicast routing protocols using simulation. Finally, section 4 provides some conclusions.

2. OVERVIEW OF MULTICAST ROUTING PROTOCOLS

2.1 Geographic Multicast Routing (GMR)

Geographic Multicast Routing (GMR), a multicast routing protocol for wireless sensor networks. The general operation of geographic unicast routing is very simple. A node currently holding a message, selects one of its neighbors as next relay to reach the destination. This selection is done solely based on the positions of the current node, its neighbors and the position of the estimation. Whenever possible, geographic routing chooses neighbors which are closer to the destination than the current node. This is called greedy mode. When a node does not have any neighbor being closer to the destination than itself, perimeter mode (also called face routing) is used to escape from the local minimum until greedy mode can be resumed. There are two kinds of resources to take care of, network bandwidth and sensor internal resources. We must minimize the number of messages sent, which means using a limited bandwidth and using as few sensors as possible to route the message to the destinations. This algorithm is design with a low computational cost, and constrained memory consumption as the number of nodes increase [6].

GMR uses cost over progress metric ratio to select the next hopes towards destinations. In the multicasting problem, where a source node wishes to send a packet to a number of destinations (sinks) with known positions. Assume that a node X, after receiving a multicast message, is responsible for destinations A1, A2, A3, A4, and that it evaluates neighbors Y1, Y2 as possible candidates for forwarding. The whole task can be sent to a single neighbor (e.g. if there exist one that is closer to all destinations than X), or can be split to several neighbors, each with a subset of destinations to handle. Hop count is assumed to be proportional to distances. Let us consider the case in Fig. 1 as illustration of the general principle. The current total distance for multicasting is

$T1 = |XA1| + |XA2| + |XA3| + |XA4|$

If X considers Y1 and Y2 as forwarding nodes, covering A1, A2, A3, and A4. respectively, the new total distance is

$T2 = |Y1A1|+|Y1A2|+|Y1A3|+|Y2A4|$

And the progress made is T1−T2. The aim is also to minimize the consumption of bandwidth, which is proportional to the total number of forwarding nodes selected. Thus, the cost is the number of selected neighbors, which in the above example are 2. Thus the forwarding set {Y1, Y2} is evaluated as 2/T1−T2 .Among all candidate forwarding sets, the one with minimal value of this expression is selected. If there is no neighbor closer than X towards one or more of the destinations, then we have to enter into face mode [6].

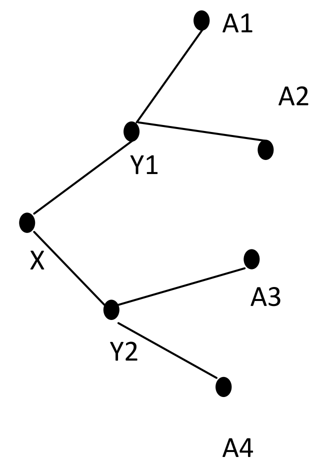

Fig-1 Evaluating the candidate forwarding from X to Y1 and Y2

2.2 Beacon less Geographical multicast Routing

Most geographic unicast routing protocols and all of the geographic multicast ones assume that nodes know their neighbor's positions using beacons messages. Beacons are short messages periodically broadcast by sensor nodes to advertise their position and identifier to neighboring nodes. However, the use of beacons can introduce a number of severe problems when protocols are deployed in real test beds collisions, imprecision in neighborhood tables, unnecessary waste of resources, etc. Beacon less Geographic protocol discovers reactively the set of candidate relays for multicast packets using data packets themselves. By doing that, Beacon less Geographic protocol is able to perform very well in realistic scenarios with interferences, collisions, etc.

As in most geographic routing protocols, it is assumed that nodes know their own position and the existence of a location service available to the source node for locating the destination's location. These locations are included in the header of the message issued by the source node, so that, every node forwarding the message knows its location and the one of the destination nodes. Additionally, neighbors' positions are reactively discovered by means of a 1-hop query-answer mechanism. Therefore, we can say that, in this protocol, nodes only use local information to forward messages. Concretely, each node forwarding a message follows these three steps[3]:

1) Decide whether to branch or not: The key for multicast routing protocols to produce efficient trees, is to appropriately select branching points. That is, nodes where the data packet must be replicated to reach different sets of destinations.It follows the approach used by LEMA [8] and MSTEAM [9] to determine when and how to branch. Concretely, we locally build a Minimum Spanning Tree (MST) of a complete graph containing only the receivers and the current node as vertices. In that graph edges are labeled with the euclidean distance between the two endpoints. That gives us an approximation of a very efficient multicasting backbone.

The resulting tree is then used to determine if receivers can still be reached through the current branch. If they can't then they must be split into different branches. In this case the partition of destination is also determined by the previously computed MST.

2) Locate candidate neighbors to next relay: It is a beacon-less protocol. To gather information about available next hops the node currently holding the data message sends a query message which also includes the data payload. Only those neighbors that successfully receive the data message answer with a response message indicating that they can act as next relays. Then, a neighbor is assigned to every branch obtained in the previous step among the set of discovered neighbors. Obviously, the same candidate can be the next relay for different branches.

As this process can generate a big number of response messages we also include a sophisticated timer assignment protocol to priorize the answers from good candidates and to reduce the number of responses in order to minimize the bandwidth consumption as well as to reduce the collisions among responses which increases reliability.
3) Deliver the message: As the data payload is already transmitted in the query message used to locate candidate neighbors to next relay, this final step consists only in announcing the assignment of routing subtasks. This is done by means of a single selection message including a list of assignments. Each one contains the identifier of the neighbor selected as next relays and the subset of destinations it has been assigned to [3].

3. PERFORMANCE EVALUATION

In this section, we compare the Geographic Multicast Routing and Beacon Less Geographic Routing on packet delivery ratio. For simulations, we use the TOSSIM[7] simulator. In simulation there are nodes randomly placed in an area of 500x500 square meter. For simulation setup the maximum radio range is fixed to R = 100m. Simulation is done in 25 different scenarios for different mean densities of nodes of 5, 10, 15, 20, 25,30,35,40 and 45.
Fig[2] compares the packet delivery ratio for both protocols. We can see that Beacon Less Geographic Routing clearly outperforms GMR regardless of the density because Beacon Less Geographic Routing's opportunistic selection of next hops is able to choose those neighbors which have a very high probability of reception. GMR has a lower delivery ratio because in some cases a node receives beacons from neighboring nodes whose link quality is not very good. Thus, even though small beacon messages can be transmitted reliably on that link, data packets may not be able to traverse the link because their large size makes them more prone to errors. The best result for GMR is close to 85% whereas Beacon Less Geographic Routing achieves more than 90% for all the densities considered.

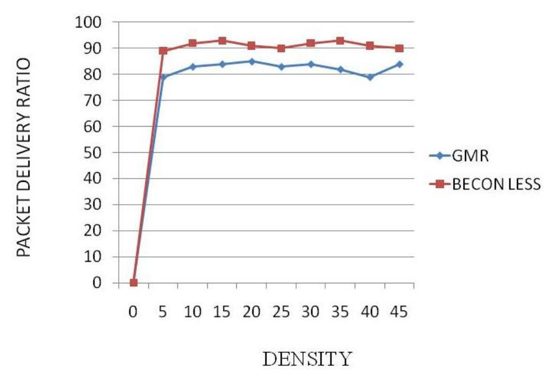

Fig2: Transmission for multicast destinations

To assess the performance of both protocols we considered Packet Delivery Ratio (PDR) metric. Details of the metric are : Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the source. This metric determines the efficiency of multicast path selection. Higher the percentage of packets received, higher is the efficiency of the protocol.

Fig[2] shows the details in which densities of node and percentage of packet delivery ratio is used to determine the performance of the protocol. With this graph we can determine the efficiency in delivery for each protocol tested.

If the percentage of packet delivery ratio is good then the efficiency of the protocol is good. From the graph it is clear that beacon less geographic protocol is efficient then GMR because beacon less geographic protocol performs greedy selection technique with which it is easy to determine next hops which are able to choose those neighbors which have a very high probability of reception. On the other side GMR has a lower delivery ratio because of few nodes which receive beacons from neighboring nodes where link quality is not very good. That's why even if short beacon messages can be transmitted reliably on that link it may not possible to data packets to get the link because of their large size which makes them more error prone.

4. CONCLUSION

This paper presents two multicast routing protocols: Geographic Multicast Routing (GMR) and , beacon less geographic multicast protocol proposed for Wireless Sensor Networks. In this study performance of these two protocols: GMR and beacon less geographic protocol have been evaluated with the help of TOSSIM Simulator and also performance analysis has been shown. To assess the performance of both protocols we considered the packet delivery ratio metric.

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