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Abstract: This paper aims to compare performance of some routing protocols for Wireless Sensor Networks (WSNs). A Wireless Sensor Networks (WSN) is a set of hundreds or thousands of micro sensor nodes that have capabilities of sensing, establishing wireless communication between each other and doing computational and processing operations. The efficiency of sensor networks strongly depends on the routing protocol used. Routing protocols are needed to send data between sensor nodes and the base station. In this project, we will analyze three different types of routing protocols: Fisheye, LANMAR, LAR1. Sensor networks are simulated using Qualnet simulator. Several simulations are conducted to analyze the performance of these protocols on the basis of performance metrics such as hop count, throughput, end-to-end delay.

Keywords: WSNs, LANMAR, Fisheye, LAR1

1 Introduction

Routing is a function in the network layer which determines the path from a source to destination for the traffic flow. A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network, the choice of the router. Each
router has a priori knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, routers gain knowledge of the topology of the network. WSNs routing protocols are broadly divided into two categories [2] i.e reactive(on-demand) and proactive(table-driven). In Table-driven routing protocols, each node maintains one or more tables containing routing information to every other node in the network. All the nodes update these tables so that a consistent and up-to-date network is maintained. In contrast to table-driven routing protocols, all up-to-date routes are not maintained at every node; instead the routes are created as and when required. Various reactive protocols are DSR, AODV, ABR, TORA etc. LSR, OLSR, DSDV, LAR, Fisheye, LANMAR, are proactive protocols. In this paper we are using Fisheye, LANMAR and LAR i.e. unicast routing protocols for their performance comparison. We have taken these protocols as these are not evaluated earlier for such comparison.

An earlier protocol performance comparison was carried out by Guangyu Pei et all in [10], who conducted experiments with Ad hoc On-Demand Vector routing (AODV), Fisheye, Dynamic MANET On-demand (DYMO), Source Tree Adaptive Routing (STAR) protocol, Routing Information Protocol (RIP), Bellman Ford, LandMark Ad hoc Routing protocol (LANMAR) and Location Aided Routing protocol (LAR). The Bellman-Ford routing protocol shows highest throughput and RIP, STAR, Fisheye and LANMAR protocols showed a dip at a node density of 50. This simulation experiment showed that AODV, Dymo and Bellman ford protocols are having higher end to end delays than others, indicating that the speed of simulation in large scale networks will be affected, whereas LANMAR and RIP shows the considerable amount of delay in scaled up environment.

Performance comparison of AODV, DSR, FSR and LANMAR is presented by M. Gerla et all in [11]. According to their simulation results LANMAR outperforms FSR under all delay and throughput measures. Moreover, LANMAR provides a dramatic reduction in route table storage overhead with respect to FSR. Their results shows when the number of communication pairs increases, AODV and DSR will generate considerable routing overhead. Because of this increase in routing O/H, the performance of both AODV and DSR is worse than LANMAR for medium to high traffic loads.

In the last few years, there are several researches have evaluated the performance of routing protocols for mobile Ad- Hoc network as a function of mobility rate and pause time using ns2(network simulator 2)[9]. There are lesser evaluations available using Qualnet simulator [1] which is commercially available and faster than ns2 [3]. We are using Qualnet simulator for comparison evaluation of LANMAR, LAR1 and Fisheye.

The rest of the paper is organized as follows: Section 2 describes three concerned protocols in detail i.e. Fisheye, LANMAR and LAR1. Section 3 describes the simulation environment, parameters evaluated and simulation results. Lastly work is concluded in section 4.
2 Preliminaries

2.1 Fisheye

Fisheye technique proposed by Kleinrock and Stevens [4] to reduce the size of information required to represent graphical data. The eye of a fish captures with high detail the pixels near the focal point. The detail decreases as the distance from the focal point increases. Fisheye State Routing (FSR) [4] generates accurate routing decisions by taking advantage of the global network information. Fisheye Routing determines routing decisions using a table-driven routing mechanism similar to link state. The table-driven ad hoc routing approach uses a connectionless approach of forwarding packets, with no regard to when and how frequently such routes are desired. It relies on an underlying routing table update mechanism that involves the constant propagation of routing information.

2.2 LANMAR

The Landmark Ad-hoc Routing Protocol (LANMAR) [5] combines the features of FSR and landmark routing. LANMAR is an efficient routing protocol in a “flat” ad hoc wireless network. LANMAR assumes that the large scale ad hoc network is grouped into logical subnets in which the members have a commonality of interests and are likely to move as a “group”. LANMAR uses the notion of landmarks to keep track of such logical subnets [6]. Each logical group has one node serving as landmark. The route to a landmark is propagated throughout the network using a Distance Vector mechanism [11]. The routing update exchange of LANMAR routing can be explained as follows. Each node periodically exchanges topology information with its immediate neighbours. In each update, the node sends entries within its Fisheye scope [4]. Updates from each source are sequentially numbered. To the update, the source also piggybacks a distance vector of all landmarks. Through this exchange process, the table entries with larger sequence numbers replace the ones with smaller sequence numbers. As a result, each node has detailed topology information about nodes within its Fisheye scope and has a distance and routing vector to all landmarks.

2.3 LAR

The goal of Location-Aided Routing (LAR) [7] is to reduce the routing overhead by the use of location information. LAR protocol uses the GPS (Global Positioning System) to get location information of mobile hosts. In the LAR routing technique, [8] route request and route reply packets similar to DSR and AODV are being proposed.
3 Performance Evaluation

We carried out simulations on Qualnet simulator. The simulation parameters are summarized in the table 1. We designed the network using Random waypoint model with different number of nodes. We are compiling the results using 5 simulations and the application traffic between the randomly chosen source and destination is CBR traffic[7]. The metrics used to measure the performance of protocols are average end to end delay, average TTL based hop count and throughput.

Table 1: Parameters for simulation evaluation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of nodes</td>
<td>25,50,100</td>
</tr>
<tr>
<td>Dimension of space</td>
<td>1500x1500</td>
</tr>
<tr>
<td>Simulation time</td>
<td>900s</td>
</tr>
<tr>
<td>Item size</td>
<td>512 bytes</td>
</tr>
</tbody>
</table>

3.1 Simulation Results

3.1.1 Average End to End Delay

End-to-end delay indicates duration for a packet to travel from the CBR source to the application layer of the destination. According to results obtained in figure 1 LANMAR shows minimum end to end delay of 0.015 s and almost remains constant irrespective of increase in no. of nodes. Similar is the case with LAR1 protocol which shows a slight higher delay in comparison with LANMAR. FSR shows worst performance with highest end to delay of 0.023.

3.1.2 TTL Based Average hop Count

Hop count is the number of hops a packet took to reach its destination. The results for TTL based hop count in figure 2 shows three protocols have a constant hop count irrespective of the no. of nodes. With the increase of no. of nodes it remains constant. LANMAR have highest hop count of 64 hops while FSR and LAR1 require less number
Fig 1  Simulation Result of End-to-End Delay

Fig 2  Simulation Result of TTL Based Average Hop Count

Fig 3  Simulation Result of Throughput
of hops of 19 hops and 1 hop respectively. The plotted graph shows that hop count is independent of no. of nodes.

### 3.1.3 Throughput

Throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. It is usually measured in bits per second. The results of throughput in figure shows that LAR performs the best.

### 4 Conclusion

In this paper, a performance comparison of three different routing protocols i.e. FSR, LANMAR, and LAR1 for wireless sensor network is presented. Three performance metrics used to compare protocols are average end to end delay; average TTL based hop count and throughput. LANMAR performs best in measuring end to end delay and FSR performs best in TTL based hop count. LAR1 performs best in case of throughput. In future, this work may be extended for analyzing the behavior of these protocols in heterogeneous networks with many more metrics for evaluation.

### References

3. Performance comparison of MANET routing Protocols in different network sizes by David Oliver Jorg, institute of computer Science and applied mathematics computer Networks and distributed systems University of Berne, switzerland.


10. “Landmark Routing for Large Scale Wireless Ad Hoc Networks with Group Mobility” by Guangyu Pei, Mario Gerla and Xiaoyan Hong Computer Science Department University of California.