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Performance Analysis of Self Adaptive Geographic Routing Protocols for MANETs

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Abstract - The Mobile ad hoc network commonly known as MANET, is a collection of mobile wireless nodes that has the capacity to self-organize dynamically without any preexisting infrastructure. Scalability and network performance are the two distinctive feature found in all MANET routing protocols .The simulation compares AODV with Self Adaptive on Demand Geographic Routing Protocol(SOGR) implemented through NS2.With the help of performance metrics such as throughput ,Packet drop rate ,Control Overhead , Average delay ,Cost factor , latency it is shown that SOGR-HR and SOGR-VR gives better performance than AODV. The simulation results demonstrate that SOGR-HR and SOGR-VR deliver high robustness in MANETs. These protocols can efficiently handle different dynamic scenarios and they offer high performance when compared to their existing geographic routing protocols under various environments. This paper presents an overall performance comparison on the basis of throughput ,Packet Delivery Ratio, Cost Factor and Average end-to-end delay considering different number of nodes and their mobility.

Index Terms—MANETs, Geographic routing , Self adaptive on demand ,Cost Factor , Packet Delivery Ratio.

1. INTRODUCTION

Evolution of wireless systems started in late 80s and has now become the buzzword for communication . The first wireless network called A-Netz was commissioned in Germany in 1958. The demand for wireless services is growing exponentially every year. This transition from the early wired to the wireless networks was made in a remarkably short time The first three Wireless Generation's Systems evolved dramatically with quest for data at higher speeds .The surge of interest and demand for mobility has created a new opportunity for wireless networking providing every user with truly "mobile" experience. This shift towards mobility has been a very welcoming change. Mobility has now become the keyword for all networks and the paradigm shift from wired to wireless networks has become the ultimate goal of any network. Apart from providing wireless connectivity secured connectivity along with wireless connectivity is yet another goal.

The Mobile Ad hoc networks are a quantum shift from the very old wired networks where people are bound to be static. Rapid advancements in wireless networking has evolved a new paradigm for mobile ad hoc networks . Mobile Ad hoc networks play a wide spread role in the evolution of future wireless technologies. A mobile ad hoc network (MANET) is having a dynamic infrastructure which configures automatically mobile devices which are connected by wireless link. In MANET the wireless mobile nodes communicate with each other using wireless connection without the aid of any network infrastructure. Here topology changes rapidly and unpredictably. Earliest MANETs were developed by DARPA during 1970 called "packet radio" networks.

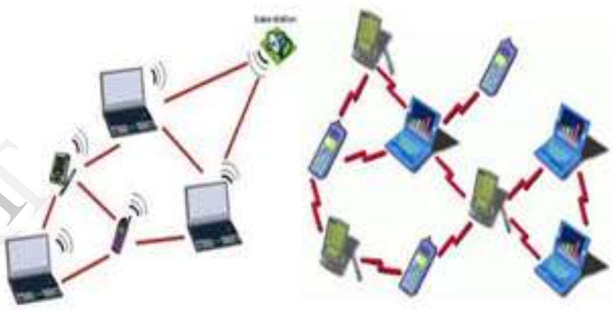

Fig 1 An example of a MANET

The main challenge in designing a routing protocol in wireless network is to consider the property of a Mobile Ad Hoc Network (MANET) to change its topology and infrastructure dynamically .Lack of infrastructure with no fixed routers and no centralized administration is yet another challenge. All the nodes in the network may move randomly and the nodes connect dynamically to each other. Mobile ad-hoc networks may be used in areas where establishing a communication infrastructure is not practical.

Features	Benefits
Robust Routing & Mobility Management Algorithms	High reliability and increased Network availability
Adaptive algorithms and protocols	Efficient self adaptive traffic Conditions
Low-overhead algorithms	Preserve the radio communication resource.
Robust network architecture	Avoid network failure and congestion

Table 1 Benefits of Manet

.II. ROUTING PROTOCOLS FOR MANET

Routing protocols for MANETs, can be categorized mainly into two categories: topology-based and position-based routing [3].

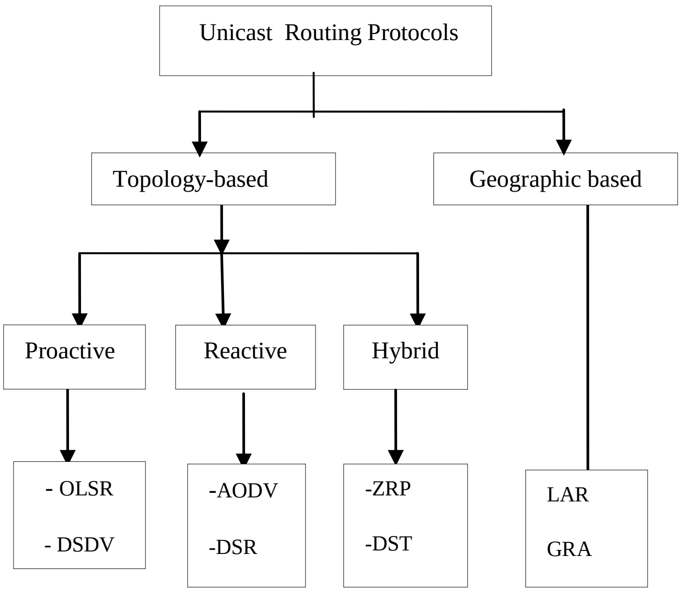

Fig 2: Categorization of MANET protocol

Topology-based routing protocols considers the path from source to destination as well as the route taken by a packet when it travels from source to destination[16].

Topology-based routing protocols are classified as:

1. Proactive Routing protocol or Table driven
2. Reactive Routing protocol or On – demand
3. Hybrid Routing protocol

Position-based or geographic routing approaches eliminate the limitations of the topology-based protocols in MANETs. These routing protocols rely on location service such as GPS or other types of positioning services [11, 12].Scalability, performance and robustness are the key highlights of Position-based routing protocols .These protocols rely on the use of geographical position of nodes to make routing decisions .This results in improved efficiency and performance. Every node should be able to obtain its own position and the source node is aware of geographical position of the destination[13], [14]. The mobile nodes in geographic unicast [18], [19], and multicast routing protocols are aware of their own positions through GPS .Certain Geographic protocols identify position using localization techniques [1] and a source node can obtain the position of all nodes through location service [4].

Properties	**Proactive routing protocols**	**Reactive routing protocols**	**Hybrid routing protocol**
Latency	Low latency	High latency	Medium
Routing	Destination initiated	Source initiaited	Combination
Network Organization	Flat / Hierarchical	Flat	Flat Hierarchical
Topology	Depends on an underlying routing table	Network topology are made dynamically on demand	Maintain an optimal balance between both protocols.
No of updates	Periodic update mechanism	Lower no of updates	Maintain an optimal balance between both protocols.
Delay	Little or no delay	Significant delay	Small delay
Overhead	High routing overhead	Low overhead	Low overhead
Routes Maintained	Routing cache	Routing table	Routing table
Communication overhead	High	Low	Medium
Energy efficiency	low	Medium	Medium
Bandwidth	Larger Bandwidth	Limited Bandwidth	LargerBandwidth
Security	Low	Low	Low

Fig 3: Analysis of Topology based Routing Protocols

Location Aided Routing Protocol (LAR) and Geographical Routing Algorithms (GAR) are unicast routing protocol in MANETs. Location-Aided Routing (LAR) reduce the routing overhead by the use of location information. Position information is also used by LAR for restricting the flooding to a limited area . The route request and route reply packets in the LAR routing technique is similar to DSR and AODV

III.POSITION DETERMINATION IN SELF ADAPTIVE GEOGRAPHIC ON DEMAND ROUTING PROTOCOL.

The main issues related with Geographic Routing protocol is

- non-optimal routing
- forwarding failure

A proactive fixed-interval beaconing scheme results in a high signaling cost and outdated local topology information at the forwarding node. This leads to non-optimal routing in existing geographic routing protocols. In geographic routing protocol a neighbor's information will be removed if not updated within the timeout interval, which is often set to be multiple beacon intervals[19]. Whenever any timeout neighbor information is kept in a node then the forwarding information obtained will be a wrong value. This reduces the efficiency of routing path and timeout information about locations results in higher data packet forwarding and control overhead in the high mobility scenarios[1]. To address these issues we propose two novel geographic routing protocols which maintain topology information based on the need of traffic transmissions[1] .Self-adaptive On-demand Geo-graphic Routing (SOGR) schemes assume nodes to be position aware through GPS or some localization technique), In SOGR a source can also obtain the destination's position through some kind of location service.

The two protocols adopt different schemes to obtain topology information. One protocol purely relies on single hop topology information, and the other one assumes a hybrid scheme which combines geographic and topology-based mechanisms for more efficient routing

To calculate the next node in a set of nodes SOGR-HR,uses both geographic based routing algorithms along with the topology based routing algorithms[23]. The details of topology involved in a network are incorporated and the topology-based path searching derives a more efficient routing path between the sender and receiver. SOGR-GR depends only on one-hop neighbors' positions to make greedy and perimeter forwarding like other geographic routing protocols[1].A neighboring node is triggered whenever it receives a request message. In order to trigger neighbouring node the nodes may broadcast these request messages. The neighboring node undergoes a random backoff before broadcasting request messages in order to avoid collision. With the neighbor topology information, SOGR-GR takes the same local void recovery method as existing geometric routing protocols to avoid the need of extra searching as in SOGR-HR.

The REQ and REPLY messages hold many information including the location of the sender sending messages which is used for calculating many performance metrics. Data packet in these protocols holds the position of nodes forwarding the packets. These details are used for path discovery and packet forwarding[1]. An Optimal balance has to be kept for these values to prevent frequent path discovery and routing failure. The design of SOGR has three main phases namely route discovery, data forwarding, and route maintenance.

In SOGR-HR, there is a path discovery phase for searching the route.A linear estimation method is used for position determination and can be used for a better estimation to further improve performance

$$x = x_2 + (x_2 - x_1)(t_1 - t_2)/(t_2 - t_0)$$

$$y = y_2 + (y_2 - y_1)(t_1 - t_2)/(t_2 - t_0)$$

where x_2 is x coordinate of new node, x_1 is x coordinate of old node, y_2 is y coordinate of new node, y_1 is y coordinate of old node, t_1 is time of current node – t_2 is time of of new node and t_0 is time of old node.

IV. SIMULATION ENVIRONMENT

Simulations are done using Simulator ns-2 to compare these routing protocols. Ns-2 ,the network simulator developed by the VINT research group at University of California at Berkeley in 1995[22] . NS2 is a discrete event network simulation and is a standard experiment environment in research community. NS2 is used to simulate the proposed algorithm. In simulation we put together simulation model, performance metrics and environment (topology) using network simulator input scripts and run the results[22].The implementation of the protocol has been done using TCL language in the frontend. TCL(Tool Command Language) is compatible with C++ programming language. When the program is run in ns2 two files trace files and nam files will be generated. Network Animator file, records provides a visualization of all events that happened during the simulation. Trace files (.tr), holds the complete list of events that occur during the simulation .The performance will be obtained only after analyzing the trace file. This can be done with the help of of perl scripts[22]and awk scripts. In this paper we have used Perl script along with NS2 for evaluation.

V. PERFORMANCE EVALUATION & RESULTS

Performance Evaluation is done to compare a number of alternative designs and finds the best design.Here, we evaluate the performance of SOGR-HR and SOGR-GR with a number of qualitative and quantitative metrics[1].

Fig 4:Route discovery in SOGR Protocol

There are various parameters like mobility , node densities, varying traffic loads and position inaccuracies at destination[1] that can be used to compare these protocols. Following parameters are considered in this paper.

Average end to end delay: This metric , measured in seconds calculates the time between a packet to generate at the source node and time for the packet to reach the destination. This is the average end to end delay counts only successfully transmitted packets. Average end to end delay is calculated by reducing the time taken for route discovery from the total time.

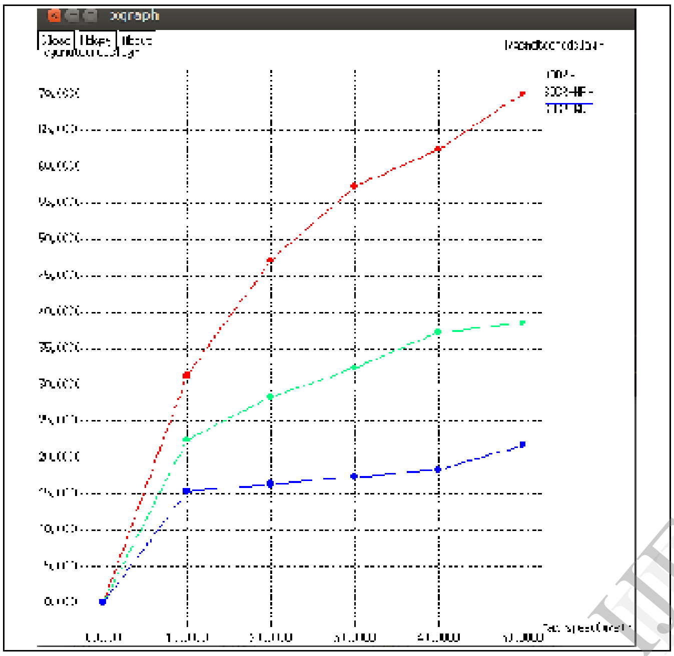

Fig 5:Comparison of Average end to end delay of AODV with SOGR Protocols

Control overhead: Control overhead is the ratio of the total no of control packets and routing packets to the total number of data packets[20].

Control overhead =The total control message transmissions

The total number of data packets received.

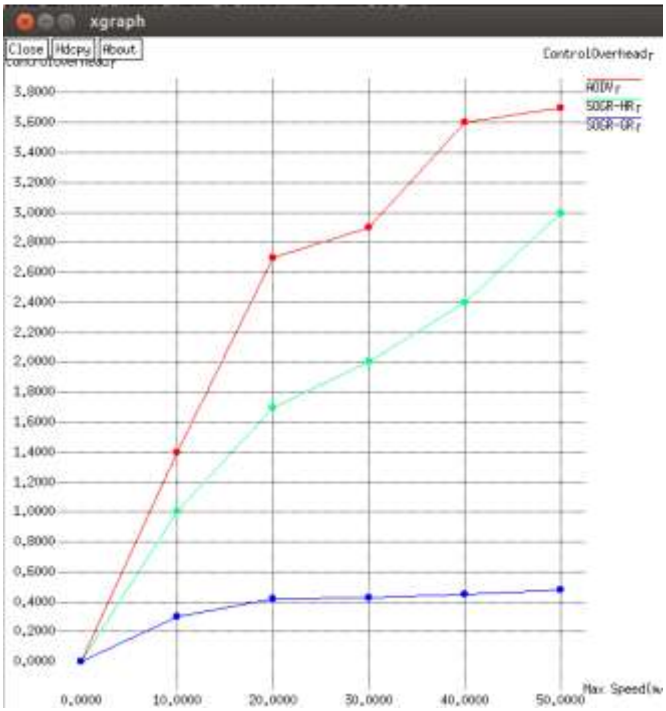

Fig 6:Comparison of Control overhead of AODV with SOGR Protocols

Packet Delivery Ratio: Packet delivery ratio calculates the total number of the packets delivered at destination divided by the total no of data packets send from the source. Packet Delivery Ratio (PDR) shows the ratio of successful packets reaching the destination.

Packet Delivery Ratio = Total number of packets received / Total number of packet send

Fig 7 .Comparison of Packet Delivery Ratio of AODV with SOGR Protocols

Throughput: Throughput is measured in bits per seconds. Throughput calculates the total amount of data reaching the destination [20].

$$\text{Throughput} = \frac{\text{Total no of bits received at destination}}{\text{Total time taken}}$$

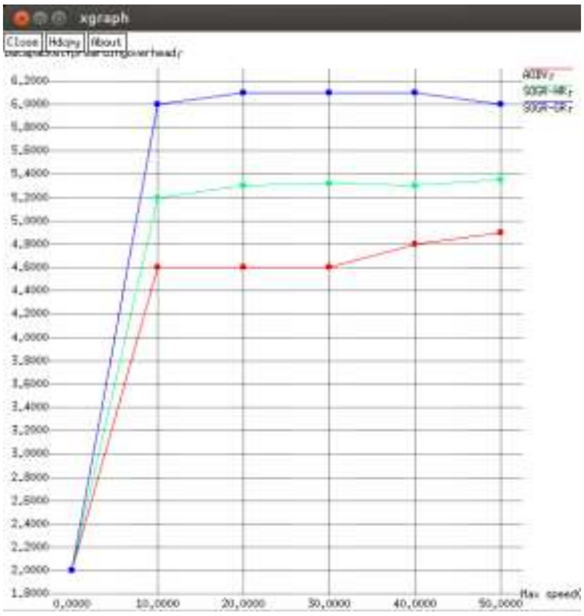

Fig 8 Comparison of Throughput of AODV with SOGR Protocols

Cost factor: Cost factor increases when total delay increases.
The graph obtained shows that the cost factor when computed for SOGR is relatively low when compared to AODV.

Fig 9 Comparison of Cost factor of AODV with SOGR Protocols

We have analysed results with nodes varying from 20 to 50 numbers while keeping network parameters as constant during the simulation.The performance metrics considered in this research are Average end to end delay, Control overhead , Packet delivery ratio, Throughput, Cost factor and are very important for any networking protocol.We can summarise our conclusion from the simulation experiment that SOGR shows greater performance than AODV with less End to End Delay and Energy Consumption.

VI. CONCLUSIONS

In this paper, a study on different performance evaluation metrics was done on AODV, and both SOGR protocols . The result after analysis reflect that our protocols have high robustness in a dynamic mobile ad hoc network, and both SOGR protocols offers good performance than existing geographic routing protocols and conventional on-demand protocols when tested under different mobility. Both SOGR protocols could reduce the end-to-end delay up to 80% in high mobility scenario. Both SOGR routing protocols have got high delivery ratios and have very low transmission delay in all test scenarios .This paper can be extended by incorporating other performance metrics.

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