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Energy Efficient Geographical Routing Protocol with Location Awareness in Mobile AdHoc Network

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ABSTRACT

A Mobile Ad hoc Network (MANET) is a kind of wireless ad-hoc network, and is a self configuring network of mobile routers (and associated hosts) connected by wireless links the union of which forms an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily, thus the network's wireless topology may change rapidly and unpredictably. Energy is a vital resource for MANET. The amount of work one can perform while mobile node is fundamentally constrained by the limited energy supplied by one's battery. Dynamic Source Routing (DSR) protocol is one of the most well known routing algorithms for ad hoc wireless networks. DSR uses source routing, which allows packet routing to be loop free. DSR increases its efficiency by allowing nodes that are either forwarding route discovery requests or overhearing packets through having frequent listening mode to cache the routing information. This paper suggests an approach to utilize location awareness information using Geographical Routing Protocol (GRP) to improve performance of Dynamic Source routing protocols for mobile ad hoc networks. By using location awareness information, the proposed GRP maintain table after every transmission of data update its routing table for that node to sending data with smallest path in mobile ad hoc network. Our experimental results show the effectiveness of performance on sending data from updated table to conserve power and time and obtain minimum time delay, maximum throughput and minimum data drop and retransmission attempts.

Keywords- MANET, DSR, GRP for Location Awareness, Energy Consumption

1. INTRODUCTION

Mobile ad hoc networks consist of wireless mobile hosts that communicate with each other, in the absence of a fixed infrastructure.1 Routes between two hosts in a Mobile Ad hoc Network (MANET) may consist of hops through other hosts in the network. Host mobility can cause frequent unpredictable topology changes. Therefore, the task of finding and maintaining routes in MANET is nontrivial. Many protocols have been proposed for mobile ad hoc networks, with the goal of achieving efficient routing. Geographic routing (also called geo-routing or position-based routing) is a routing principle that relies on geographic position information. It is mainly proposed for wireless networks and based on the idea that the source sends a message to the geographic location of the destination instead of using the network address. The idea of using position information for routing was first proposed in the 1980s in the area of packet radio networks and interconnection networks. Geographic routing requires that each node can determine its own location and that the source is aware of the location of the destination. With this information a message can be routed to the destination without knowledge of the network topology or a prior route discovery [1-2].

There are various approaches, such as single-path, multi-path and flooding-based strategies. Most single-path strategies rely on two techniques: greedy forwarding and face routing. Greedy forwarding tries to bring the message closer to the destination in each step using only local information. Thus, each node forwards the message to the neighbor that is most suitable from a local point of view. The most suitable neighbor can be the one who minimizes the distance to the destination in each step (Greedy). Alternatively, one can consider another notion of progress, namely the projected distance on the source-destination-line, or the minimum angle between neighbor and destination (Compass Routing). Not all of these strategies are loop-free, i.e. a message can circulate among nodes in a certain constellation. It is known that the basic greedy strategy and MFR are loop free, while NFP and Compass Routing are not. Greedy forwarding can lead into a dead end, where there is no neighbor closer to the destination. Then, face routing helps to recover from that situation and find a path to another node, where greedy forwarding can be resumed. A recovery strategy such as face routing is necessary to assure that a message can be delivered to the destination. The combination of greedy forwarding and face routing was first proposed in 1999 under the name GFG (Greedy-Face-Greedy). It guarantees delivery in the so-called unit disk graph network model. Various variants, which were proposed later, also for non-unit disk graphs, are based on the principles of GFG [4-6]. This paper proposed an approach to utilize location information using Geographical Routing Protocol (GRP) to improve performance of Dynamic Source routing protocols for mobile ad hoc networks. By using location information, the proposed GRP with Location Aware Routing (LAR) protocols limit the search for a new route to a smaller request zone of the mobile ad hoc network.

The Dynamic Source Routing protocol is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR, the network is completely self-organizing and self-configuring, requiring no existing network infrastructure or administration. Network nodes cooperate to forward packets for each other to allow communication over multiple "hops" between nodes not directly within wireless transmission range of one another. As nodes in the network move about or join or leave the network, and as wireless transmission conditions such as sources of interference change, all routing is automatically determined and maintained by the DSR routing protocol. Since the number or sequence of intermediate hops needed to reach any destination may change at any time, the resulting network topology may be quite rich and rapidly changing.

In designing DSR, we sought to create a routing protocol that had very low overhead yet was able to react very quickly to changes in the network. The DSR protocol provides highly reactive service in order to help ensure successful delivery of data packets in spite of node movement or other changes in network conditions.

The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source routes in the ad hoc network:

- Route Discovery is the mechanism by which a node S wishing to send a packet to a destination node D obtains a source route to D. Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D.

- Route Maintenance is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When Route Maintenance indicates a source route is broken, S can attempt to use any other route it happens to know to D, or it can invoke Route Discovery again to find a new route for subsequent packets to D. Route Maintenance for this route is used only when S is actually sending packets to D.

GRP (Geographical routing protocol) is other position based based routing protocol.GRP assume the aid of street map in a city or campus environment. The street map is used to know the city or campus topology.GRP uses something called reactive location services (RLS) to get destination position. This protocol was designed for city or campus environment.

Location-Aided Routing (LAR) protocol is an approach that decreases overhead of route discovery by utilizing location information of mobile hosts. Such location information may be obtained using the global positioning system (GPS). LAR uses two flooding regions, the forwarded region and the expected region. LAR protocol uses location information to reduce the search space for a desired route. Limiting the search space results in fewer route discovery messages. When a source node wants to send data packets to a destination, the source node first should get the position of the destination mobile node by contacting a location service which is responsible of mobile nodes positions. This causes a connection and tracking problems.

Two different LAR algorithms have been presented in: LAR scheme 1 and LAR scheme 2. LAR scheme 1 uses expected location of the destination (so-called expected zone) at the time of route discovery in order to determine the request zone. The request zone used in LAR scheme 1 is the smallest rectangle including current location of the source and the expected zone for the destination. The sides of the rectangular request zone are parallel to the X and Y axes. When a source needs a route discovery phase for a destination, it includes the four corners of the request zone with the route request message transmitted. Any intermediate nodes receiving the route request then make a decision whether to forward it or not, by using this explicitly specified request zone.

Note that the request zone in the basic LAR scheme 1 is not modified by any intermediate nodes. On the other hand, LAR scheme 2 uses distance from the previous location of the destination as a parameter for defining the request zone. Thus, any intermediate node J receiving the route request forwards it if J is closer to or not much farther from the destination's previous location than node I transmitting the request packet to J. Therefore, the implicit request zone of LAR scheme 2 becomes adapted as the route request packet is propagated to various nodes

Background Techniques

Power Management in MANET

The mobile nodes in an ad hoc network are limited battery powered; power management is an important issue in such networks. Battery power is a precious resource that should be used effectively in order to avoid the early termination of nodes. Power management deals with the process of managing resources by means of controlling the battery discharge, adjusting the transmission power, and scheduling of power sources so as to increase the life time of nodes in the ad hoc networks. Battery management, transmission power management and system power management are three major methods to increase the life time of nodes.

Mechanisms for Energy Consumption

There are two mechanisms affect energy consumption, these are power control and power management. If these mechanisms are not used wisely, the overall effect could be an increase in energy consumption or reduced communication in the network.

- **Power Control**

The aim of communication-time power conservation is to reduce the amount of power used by individual nodes and by the aggregation of all nodes to transmit data through the ad hoc network. Two components determine the cost of communication in the network. First one is direct node to node communication or transmission. The transmission rate can be adapted by the sender. Second is forwarding of data through the networks. In the first case it can use the power control techniques to conserve the power. Whereas in the second case we can use the energy efficient routing schemes.

Current technology supports power control by enabling the adaptation of power levels at individual nodes in an ad hoc network. Since the power required transmitting between two nodes increases with the distance between the sender and the receiver, the power level directly affects the cost of communication. The power level defines the communication range of the node and the topology of the network. Due to the impact on network topology, artificially limiting the power level to a maximum transmit power level at individual nodes is called topology control.

MAC layer protocols coordinate all nodes within transmission range of both the sender and the receiver. In the MAC protocols, the channel is reserved through the transmission of RTS and CTS messages. Node other than the destination node that hears these messages backs off, allowing the reserving nodes to communicate undisturbed. The power level at which these control messages are sent defines the area in which other nodes are silenced, and so defines the spatial reuse in the network. Topology control determines the maximum power level for each node in the network. So topology control protocols minimize power levels increase spatial reuse, reducing contention in the network and reducing energy consumption due to interference and contention. The use of different power levels increases the potential capacity of the network.

Once the communication range of a node has been defined by the specific topology control protocol, the power level for data communication can be determined on a per-link or even per-packet basis. If the receiver is inside the communication range defined by the specific topology control protocol, energy can be saved by transmitting data at a lower power level determined by the distance between the sender and the receiver and the characteristics of the wireless communication channel.

Power aware routing reduces the power consumption by finding the power efficient routes. At the network layer, routing algorithms must select routes that minimize the total power needed to forward packets through the network, so-called minimum energy routing. Minimum energy routing is not optimal because it leads to energy depletion of nodes along frequently used routes and causing network partitions.

- **Power Management**

Idle-time power conservation spans across all layers of the communication protocol stack. Each layer has different mechanisms to support power conservation. MAC layer protocols can save the power by keeping the nodes in short term idle periods. Power management protocols integrate global information based on topology or traffic characteristics to determine transitions between active mode and power save mode. In ad hoc networks, the listening cost is only slightly lower than the receiving cost. Listening costs can be reduced by shutting off the device or placing the device in a low-power state when there is no active communication. The low-power state turns off the receiver inside the device, essentially placing the device in a suspended state from which it can be resumed relatively quickly. But the time taken to resume a node from completely off state is much more and may consume more energy.

The aim of any device suspension protocol is to remain awake the node when there is active communication and otherwise suspend. Since both the sender and receiver must be awake to transmit and receive, it is necessary to ensure an overlap between awake times for nodes with pending communication.

Different methods such as periodic resume and triggered resume can be used when to resume a node to listen the channel. In periodic resume, the node is suspend the nodes most of the time and periodically resumes checking if any packet destined to it. If a node has some packets destined for it, it remains awake until there are no more packets or until the end of the cycle [3-5].

The main reasons for power management in MANETs are the following:

➔**Limited Energy Reserve:** The main reason for the development of ad hoc networks is to provide a communication infrastructure in environments where the setting up of fixed infrastructure is impossible. Ad hoc networks have very limited power resources. The increasing gap between the power consumption requirements and power availability adds to the importance of energy management.

➔**Difficulties in Replacing Batteries:** In some situations, it is very difficult to replace or recharge batteries. Power conservation is essential in such situations.

➔**Lack of Central Coordination:** The lack of central coordination necessitates some of the intermediate node to act as relay nodes. If the proportion of relay traffic is more, it may lead to a faster depletion of power source.

➔**Constraints on the Battery Source:** Batteries will increase the size of the mobile nodes. If we reduce the size of the battery, it will results in less capacity. So in addition to reducing the size of the battery, energy management techniques are necessary.

➔**Selection of Optimal Transmission Power:** The transmission power determines the reach ability of the nodes. With an increase in transmission power, the battery charge also will increase. So it is necessary to select an optimum transmission power for effectively utilize the battery power.

➔**Channel Utilization:** The frequency reuse will increase with the reduction in transmission power. Power control is required to maintain the required SIR at receiver and to increase the channel reusability [5] and [6].

2. RELATED WORK

- **Minimum Energy Routing (MER) Protocol**

Minimum Energy Routing (MER) can be described as the routing of a data-packet on a route that consumes the minimum amount of energy to get the packet to the destination which requires the knowledge of the cost of a link in terms of the energy expanded to successfully transfer and receive data packet over the link, the energy to discover routes and the energy lost to maintain routes. MER incurs higher routing overhead, but lower total energy and can bring down the energy consumed of the simulated network within range of the theoretical minimum the case of static and low mobility networks. However as the mobility increases, the minimum energy routing protocol's performance degrades although it still yields impressive reductions in energy as compared performance of minimum hop routing protocol [6] and [8].

- **Lifetime-aware Tree (LMT) Protocol**

The Lifetime-aware tree routing algorithm maximizes the ad hoc network lifetime by finding routes that minimize the variance of the remaining energies of the nodes in the network. LMT maximizes the lifetime of a source based tree, assuming that the energy required to transmit a packet is directly proportional to the forwarding distance. Hence, LMT is said to be biased towards the bottleneck node. Extensive simulation results were provided to evaluate the performance of LMT with respect to a number of different metrics (i.e., two definitions of the network lifetime, the root mean square value of remaining energy, the packet delivery ratio, and the energy consumption per transmitted packet) in comparison to a variety of existing routing algorithms and Least-cost Path Tree (LPT). These results clearly demonstrate the effectiveness of LMT over a wide range of simulated scenarios [3] and [8].

- **Lifetime-aware Refining Energy Efficiency of Trees (L-REMIT)**

Lifetime of a tree in terms of energy is the duration of the existence of the service until a node dies due its lack of energy. L-REMIT is a distributed protocol and is part of a group of protocols called REMIT (Refining Energy efficiency of Trees). It uses a minimum-weight spanning tree (MST) as the initial tree and improves its lifetime by switching children of a bottleneck node to another node in the tree. A tree is obtained from the "refined" MST (after all possible refinements have been done) by pruning the tree to reach only group nodes. L-REMIT is a distributed algorithm in the sense that each node gets only a local view of the tree and each node can independently switch its parent as long as the tree remains connected that utilizes an energy consumption model for wireless communication. L-REMIT takes into account the energy losses due to radio transmission as well as transceiver electronics. L-REMIT adapts a given tree to a wide range of wireless networks irrespective of whether they use long-range radios or short-range radios [1] and [4].

- ***Localized Energy-aware Routing (LEAR) Protocol***

Local Energy-Aware Routing (LEAR) simultaneously optimizes trade-off between balanced energy consumption and minimum routing delay and also avoids the blocking and route cache problems. LEAR accomplishes balanced energy consumption based only on local information, thus removes the blocking property. Based on the simplicity of LEAR, it can be easily be integrated into existing ad hoc routing algorithms without affecting other layers of communication protocols. Simulation results show that energy usage is better distributed with the LEAR algorithm as much as 35% better compared to the DSR algorithm.

LEAR is the first protocol to explore balanced energy consumption in a pragmatic environment where routing algorithms, mobility and radio propagation models are all considered [3] and [4] and [8].

- **Conditional Max-Min Battery Capacity Routing (CMMBCR) Protocol**

The Conditional Max-Min battery capacity routing (CMMBCR) protocol utilizes the idea of a threshold to maximize the lifetime of each node and to fairly use the battery fairly. If all nodes in some possible routes between a source-destination pair have larger remaining battery energy than the threshold, the min-power route among those routes is chosen [3]. If all possible routes have nodes with lower battery capacity than the threshold, the max-min route is chosen. CMMBCR protocol selects the shortest path if all nodes in all possible routes have adequate battery capacity (i.e. the greater threshold). When the battery capacity for some nodes goes below a predefined threshold, routes going through these nodes will be avoided, and therefore the time until the first node failure, due to the exhaustion of battery capacity is extended. By adjusting the value of the threshold, we can maximize either the time when the first node powers down or the lifetime of most nodes in the network [10] and [11].

3. PROPOSED MECHANISM

In the proposed system

Each host still has a unique ID (such as IP address or MAC address). To be location-aware, each mobile host is equipped with a positioning device such as a GPS receiver from which it can read its current location. Each node knows their maximum distance for communication, according to their transmitter power.

The algorithm

Let a node S has to transmit the packet to destination D.

Case1: The S knows the coordinates of D and all intermediate nodes coordinates. Then firstly the S will calculate the possible positions of all nodes belong to all routes from S to D, by following formula.

$$C_{new} = C_{old} + P_{max}*V_{avg}$$

Where the C represents the coordinates of nodes, C_{old} is coordinates when it is previously accessed & C_{new} is the possible estimation of current position depending upon the maximum probability of moving in one of the six directions (P_{max}) and average velocity (V_{avg}).Now the updated coordinates table is used for best route selection. The P_{dir} & V_{avg} is calculated by previously accessed data

Let the node is previously accessed M times & we have divided the surrounding area by hexagon hence it could be present in any of six areas of hexagon ($A_{1....}$to A_6).Let the node detected at each area from m_1….to m_6 times where $m_1 + m_2 ….. + m_6 = M$. Hence

$$P_{dir} = m_1/M$$

$$V_{avg} = (C_{old1} – C_{old2})/t_1$$

Case 2: The S doesn't know the coordinates of D and all intermediate nodes coordinates it will work normally as GRP.

Hence by using these algorithm the proposed GRP with location awareness routing protocol as been developed to get accurate position of mobile node to send data with minimum time delay, minimum retransmission and maximum throughput.

One possibility direction to assist routing in Mobile Ad Hoc Network (MANET) is to use geographical location information provided by positioning devices such as global positioning systems (GPS). Instead of searching the route in the entire network blindly, position-based routing protocol uses the location information of mobile nodes to confine the route searching space into a smaller estimated range. The smaller route searching space to be searched, the less routing overhead and broadcast storm problem will occur. In this paper, we proposed GRP based Location Aware Routing (LAR) protocols limit the search for a new route to a smaller request zone of the mobile ad hoc network.

Proposed GRP based Location Aware Routing (LAR) protocol

We now describe the GRP based Location Aware Routing (LAR) algorithm. As mentioned in the introduction, we are interested in routing queries to regions in proposed sensor-net applications. The process of forwarding a packet to all the nodes in the target region consists of two phases:

Forwarding the packets towards the target region:

GRP based Location Aware Routing uses a geographical and energy aware neighbor selection heuristic to route the packet towards the target region. There are two cases to consider:

(a) When a closer neighbor to the destination exists:

GRP based Location Aware Routing picks a next-hop node among all neighbors that are closer to the destination.

(b) When all neighbors are further away: In this case, there is a hole. GRP based Location Aware Routing picks a next-hop node that minimizes some cost value of this neighbor.

4. Results Analysis

(a) Simulation Model

In this paper we proposed location awareness information using Geographical Routing Protocol (GRP) to improve performance of protocols was successfully implemented using OPNET modeler 14.0, in which I have implemented the algorithm in existing techniques by making necessary changes in the existing system. The following choices are made for simulation considering accuracy of result and available resources. Then, we carry out quantitative and comprehensive evaluation of performance in terms of time, overall performance ratio, and traffic sensitivity. The simulation parameters of our paper work as follows:

Length of WMN (Area)	1km x 1km
No. of mobile nodes	09and 1818
Packet rate of normal connection	Poisson distribution
Movement Model	Linear hexagon
Maximum node speed	1 km/hr
Rate (packet per sec)	Passion distribution 1
Data payload (packet size)	1024 bytes

Table 1 Simulation parameters

In this we have taken an area of 1km x 1km and made 2 experiment for number of mobile node in group of 9 nodes and 18 nodes , packet of normal connection is Poisson distribution and move in linear hexagonal area, maximum node speed is 1 km/hr. Packet size is 1024bytes it start sending data after 100.0 sec.

(b) Performance Metrics

We compare our DSR protocol, GRP and Proposed GRP with Location awareness protocols. And our proposed work give better result comparing to other two.

We evaluate mainly the performance according to the Following metrics-

Delay of time: The delay of time how much time taken to receive packet.

Retransmission attempts of packet: - It will count the retransmission of packet again after failure
.

Average end-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

Average Packet Delivery Ratio: It is the ratio of the number of packets received successfully and the total number of packets sent

Throughput: It is the number of packets received Successfully.

Data Drop: It is the number of packets dropped.

Average Energy: It is the average energy consumption of all nodes in sending, receiving and forward operations

(c) RESULT IN GRAPH

In below blue line shows DSR results, Red line shows GRP result and Green line shows GRP protocol with location aware using technique probability based predication results.

- **Average Delay (secs) in MANET**

In 1 figure we are compare DSR protocol, GRP protocol AND GRP protocol with location aware using technique probability based predication consisting 9 node. And obtain average delay of time in proposed protocol compare to other two routing protocols.

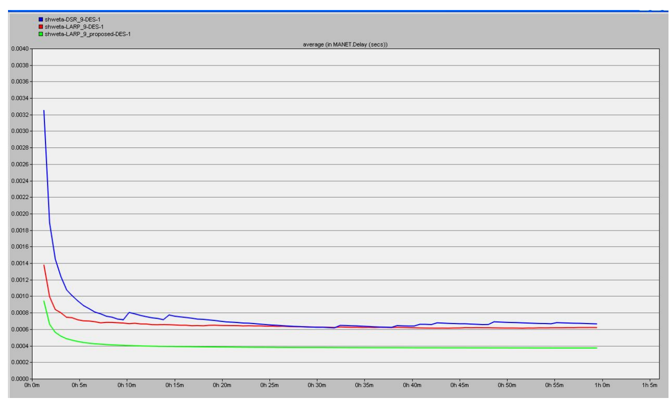

FIGURE 1. Average Delay (Sec) in MANET

- **Average Retransmission attempt (packets) in wireless LAN**

In 2 figure we are compare DSR protocol, GRP protocol AND GRP protocol with location aware using technique probability based predication consisting 9 node. And obtain average retransmission attempts of packets in proposed protocol compare to other two routing protocol.

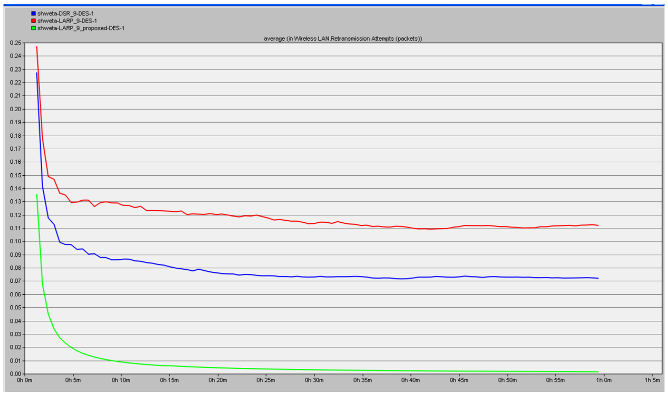

FIGURE 2. Average Retransmission attempt (packets) in wireless LAN

➢ **Average Throughput in wireless LAN**

In 3 figure we are compare DSR protocol, GRP protocol AND GRP protocol with location aware using technique probability based predication consisting 9 node. And obtain average Throughput (bit/sec) in proposed protocol compare to other two routing protocols.

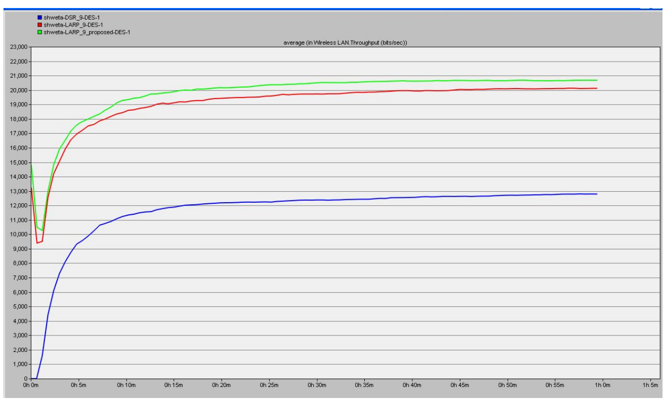

FIGURE 3. Average Throughput (bit/sec) in wireless LAN

➢ **Average Network Load (bit/sec) in wireless LAN**

In 4 figure we are compare DSR protocol, GRP protocol AND GRP protocol with location aware using technique probability based predication consisting 18 node. And obtain average network load of time in proposed protocol compare to other two routing protocol.

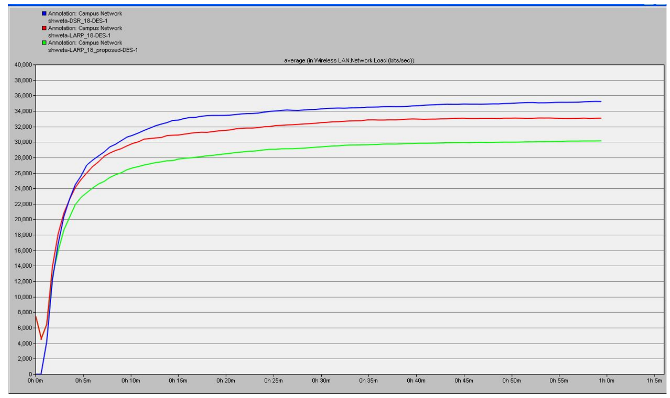

FIGURE 4 Average Network Load (bit/sec) in wireless LAN

➢ **Average Data Dropped in wireless LAN**

In 5 figure we are compare DSR protocol, GRP protocol AND GRP protocol with location aware using technique probability based predication consisting 18 node. And obtain average data dropped network in proposed protocol compare to other two routing protocol

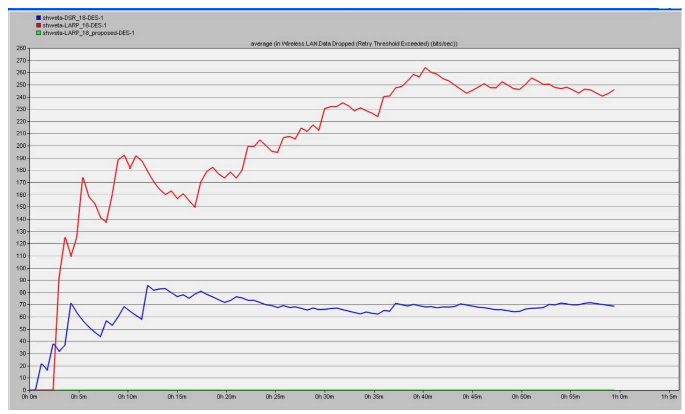

FIGURE 5 Average Data dropped (bit/sec) in wireless LAN

5. CONCLUSION

In this paper we compared the two protocols DSR (dynamic source routing) and GRP (Geographical routing protocol) and proposed new routing protocol that is GRP (geographical routing protocol) with Local Awareness using technique probability based predication. We create an hexagonal area nearer to every node which calculate the maximum possibility
of node move in which area which send data in minimum time with minimum retransmission attempts of packet and with maximum throughput(bit/sec). Our proposed work GRP with location awareness maintains update routing with every

single transmission from node to node. It help us to calculate minimum distance between node.

In future other topology such as circle, square, rectangle etc can be considered. And the acceleration can also be considered.

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