Power Efficient GPS Aided DSR in MANET's

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***Abstract* - Aim of this paper is to improve routing performance of dynamic Source Routing (DSR) protocol in Mobile Ad-hoc network's (MANET's) by means of GPS aid. MANET's are multi-hop wireless communication networks formed dynamically on ad-hoc basis without fixed infrastructure and centralized administration. Intermediate nodes form multi-hop link between source and destination during data communication. These nodes are battery powered and have random mobility. Routing protocol of MANET must consider node mobility and power limitation of intermediate nodes during the process of forming end to end routs. Basic idea of DSR protocol proposed for MANET is inherited from fixed networks. Traditional DSR does not account power limitation of node and is not designed to adopt rapid changes in network topology due to node mobility. We have proposed customized DSR called GPS aided DSR which doesn't require source routing if GPS location of the destination node is available with source node. GPS aided DSR uses three transmission power levels depending upon transmission range to save battery power of a node. We have also modified route discovery process of traditional DSR protocol to find GPS location of destination node by means of controlled flooding. Using NS3.25 as simulation tool we demonstrate that GPS aided DSR is able to find the shortest end to end route (with minimum number of hops) with improved control overhead and battery power consumption.**

Keywords— GPS, DSR, MANET's, end to end delay, Jitter, packet delivery fraction, battery power, Haversine formula.

I. INTRODUCTION

Wireless Local Area Networks (WLAN's) can be extended to mobile WLAN's where participating mobile nodes form temporary LAN. Mobile WLAN is multi-hop wireless network formed temporary without any centralized administration and fixed infrastructure. MANET's are such networks which are very useful in situations where existing network collapsed due to the natural disaster or in remote military operations. The major difference between MANET's and WLAN is that MANET's are BSS (basic service set) without AP (Access Point) whereas WLAN's are BSS with an AP as defined by IEEE 802.11 standards. Design and deployment of MANET's are challenging due to issues like routing, energy consumption, scalability, quality of services, available bandwidth, security etc.

Routing is an important and challenging issue in MANET among others. The process of route formation is called routing and is highly depends on mobility, density and power limitations of nodes in a network. There are two broad categories of routing protocols for MANET's wise reactive and proactive. Reactive routing protocols are those routing protocols which find end to end routs when there is data to be sent to the particular destination and are also called on-demand routing protocols. Examples of important reactive routing protocols are AODV (Ad-hoc On-Demand distance Vector Routing), DSR (Dynamic Source Routing), TORA (Temporary Ordered Routing Algorithm) etc. Proactive routing protocols are those routing protocols which find routes from source to destination in advance. Each node in a network maintains a routing table having fixed routes to all possible destinations in a network. Examples of important proactive routing protocols are DSDV (Destination Sequenced Distance Vector Routing), WRP (Wireless Routing Protocol), OLSR (Optimized Link State Routing) etc. Most of these routing protocols are inherited from fixed networks wherein the network topologies are fixed [14][15].

Important issues related to routing in MANET's are node mobility, energy consumption, bandwidth, control overhead, node co-operation etc [15]. The limited battery power of the node is one of the important issues in MANET's. Routing protocol should consider available battery power while selecting a particular node as a hop while route formations. As on date, many optimizations are proposed to improve routing in MANET's (discussed in next section), very few of them considers limitations of battery power while route formations. The battery power of node can be saved if we reduce extra transmissions done by node like the transmission of control packets. Therefore reducing control overhead indirectly saves the battery of node.

In this paper, we have proposed GPS aided Dynamic Source Routing protocol. This is location aided reactive routing protocol which forms routes on demand using GPS location information. GPS aided DSR intends to reduce average power consumption by selecting shortest end to end routes. Selection of shortest end to end route (in terms of distance) contributes to reduce end to end delay, control overhead and average transmission power (since minimum intermediate hops involves). Two important differences between traditional DSR and proposed GPS aided DSR are as follows. First, if the location of the destination node is known to the source, DSR uses source routing, whereas GPS aided DSR doesn't need to form complete route in data packet header. Second, if the location of the destination node is not known to the source, Traditional DSR uses global flooding to find the route to destination, whereas in GPS aided DSR controlled flooding is used. Both DSR and GPS aided GPS stop route discovery if any of neighbor has a route to destination. Whenever a node (source or intermediate) has a packet to send, it checks packet header and follows two simple steps. First, finds the neighbor node which has the minimum distance to the destination node and second, selects appropriate transmission power level by calculating transmission range. When there is route break, local node (where a route is broken) sends RERR to source node if it doesn't have alternate route to the destination. In GPS aided DSR local node forwards packet to next neighbor node which has a minimum distance to destination node.

This paper is organized as follows: section II discuss related work in the area of GPS based routing in MANETS. Section III and IV focuses on working of conventional DSR and GPS aided DSR respectively. Section V explains performance metrics used to measure the suitability of proposed technique. Section VI and VII focuses on result analysis, comments, and conclusion.

II. Related Work

Stefano Basagni et al. [2] proposed dynamic source routing technique for ad hoc networks combined with network location awareness. Whenever node has a packet to transmit it computes graph *'G'* representing the "current" network topology from its location table. Then it locally applies a centralized algorithm for the determination of a minimum cost path to the destination. Total cost represents the total number of hops a packet must take to reach the destination. Azzedine Bourkerche and Sheetal Vaidya [3] proposed a dynamic source routing discovery optimization protocol using GPS system. In this work, they proposed a technique based on GPS screening angle where the nodes take the forwarding decision based on the angle between the previous node, itself and the next node. This work shows GPS screening angle has the profound impact on reducing the number of route queries.

Y. Ko, N. H. Vaidya [4] proposed LAR (Location-Aided Routing) protocol that is developed from DSR which uses geographical location information like GPS in order to predict the location of node. The LAR protocols use location information to reduce the search space for the desired route. LAR divides network area into expected and request zones during the process of route formation. Limiting search space results in fewer route discovery messages. S. Begani et al. [5] proposed new routing protocol called DREAM (Distance Routing Effect Algorithm for Mobility) based on the principle of distance effect in which the location tables update frequency is determined by the distance of the mobile nodes. Nodes maintain location table by flooding control packets consisting position and speed information of all neighbor nodes in the network. Whenever a node has data to send it computes the expected zone and forwarding zone in a circular shape similar to LAR. Thananop Thongthavorn et al. [6] proposed GPS assisted overhead reduction technique in which LAR is modified. In this work author focused on the forwarding zone modification to overcome the misdirection flooding problem inspired by DREAM protocol. Rozita Aboki et al.[7] proposed routing protocol called PLAR for mobility models in which target motion is known. In this work LAR (Location-Aided Routing) is modified to use GPS information to predict the probable location of the destination node. It uses the concept of request zone to find destination node if it's GPS location known to the source.

Jan Blumenthal et al. [10] proposed method to measure a distance using the minimum transmission power between a transmitting node and a receiving node. Algorithms work based on the fact that all nodes are aware of their own positions. These algorithms assume that known neighboring nodes are located close to the local node and determine the local position by estimating out Algorithms working with neighboring information use the knowledge of the existence of remote nodes being aware their own positions.

III. Basic Operation of DSR

DSR uses source routing to send data packet from source to destination [13]. In the source routing sender has complete end to end routes to all possible destinations in a network. These routes are stored in route cache of a node. Node updates route cache information during data exchanges and route discovery process. Whenever source has a data packet to send, it puts complete end to end route to be followed into header of the packet. Route information in packet header consists next to next hop (to whom data packet to be forwarded) information. Intermediate nodes forwards data packet to the destination as per route available in a packet header. If there is no route to the destination in route cache of source node then source node initiates route discovery process using globally flooding route request (RREQ) packet. Upon receiving RREQ, receiving node sends route reply (RREP) to source node if it is the destination or has a route to the destination. In the case of route break, the source node is notified by sending route error (RERR) packet by the intermediate node beyond which route is broken. Source node updates its route cache and avoids this route for further communications. Fresh route discovery process is initiated for a new route to the destination if required.

IV. GPS aided DSR

As mentioned earlier, GPS aided DSR is basically optimized DSR. We have modified DSR to include following additional features,

- All nodes exchanges GPS information using hello packets during network initialization phase.
- Route cache of all nodes in a network is modified to store GPS information of all active nodes in a network along with other information like node address.
- GPS information is updated during data exchange, route discovery process and special beacon transmitted by the node if it moves by certain GPS units.
- There is no need to construct complete end to end route in data packet header at the source node.
- Instead of a complete end to end route, packet header has GPS locations of destination node.
- Controlled flooding is used during route discovery process.
- In the case when route discovery requires, upon receiving RREQ, receiving node sends route reply

(RREP) consisting destination GPS to the source if it is the destination or has a route to the destination.

- Variable transmission power is used depending upon transmission range between two nodes.

If node has data to transmit, it searches route cache for GPS location of the destination. If GPS location of the destination node is not available in its route cache, source node initiates route discovery process. In case GPS location of destination is available, the end to end communication follows process explained in the following section. Haversine formula is used to find the minimum distance between two nodes along with variable power transmission is explained in the following section.

A. Haversine formula

Haversine formula [9] is used to calculate the distance between two nodes. It is an important equation in navigation to calculate distance on earth [9]. Ignoring ellipsoidal effects, if GPS locations of two points (location of nodes) on earth are available then shortest distance between these two points on surface of earth is calculated as,

$$d = R.c \qquad (1)$$

Where,

$$\mathbf{a} = \sin^2\left(\frac{\nabla\emptyset}{2}\right) + \cos\emptyset_1.\cos\emptyset_2.\sin^2\left(\frac{\nabla\lambda}{2}\right)$$
$$\mathbf{c} = 2.\mathrm{atan2}\left(\sqrt{\mathbf{a}}, \sqrt{1-\mathbf{a}}\right)$$
$$\phi = \text{Latitude},$$
$$\lambda = \text{Longitude},$$
$$\mathbf{R} = \text{Radius of earth (mean radius 6,371km)}$$

B. Power consumption model for proposed technique

While relaying information between two nodes, total transmission power must be greater than total sum of path loss and transceiver power loss (power consumed in transmission, reception and processing). Transceiver power depends on node circuitry and is same for all the pair of communicating nodes. Generally radio channel variations are characterized statistically by large-scale and small-scale variations. Large-scale propagation models are used to predict the mean signal power for any transmitter-receiver separation. Small-scale signal models characterize the rapid fluctuations of the received signal strength over very short travel distances [11].

Using experimental model proposed in [12], we have calculated minimum transmission power (P_t) need to transmit so that received power (P_r) maintained above threshold power (P_{thr}) required for signal detection. In this model it is assumed that all nodes (in receiver mode) in a network are designed to combat small scale variations at physical layer. Therefore P_{thr} at upper layer is determined by path loss and large scale variations. If there is single transmitter to transmit the signal, it can adjust its transmission power to handle large scale variations. It is also stated that the increase in transmit power to handle large-scale variations is fundamentally same as a design that considers only the path loss.

Let *'α'* denotes the target probability that received power (P_r) remains above threshold power (P_{thr}) for detection, *'d'* is distance between transmitter and receiver (calculated using (1)), '*n*' is exponent in the path loss model and receiver nodes and *'σ'* the standard deviation of the Gaussian random variable underlying the lognormal distribution. If *Q(.)* denotes the q function. Then,

$$Q\left(\frac{P_{thr} - P_t - 10log_{10}(d)}{\sigma}\right) = \alpha \qquad (2)$$

Taking P_t in left side we can write,

$$P_t = \left(10^{\sigma.\frac{argQ(-\alpha)}{10}} P_{thr}\right) d^n \qquad (3)$$

Where P_t and P_{thr} are measured in watt. Clearly, by defining the effective pre-detection threshold to be the coefficient of d^n in (2), we arrive at an expression for transmit power identical in form to the one obtained using only path loss.

C. Transmission power level and transmission distance

Based on GPS position of two nodes, the transmission distance is calculated and appropriate transmission power level is selected to transmit the data packet. The selected value of power is large enough to send data packet up to receiver node.

As shown in Fig. 1, we have different values of transmission power *(TP3>TP2>TP1)* for different transmission range *(R3>R2>R1)*. If *D* (calculated distance) between *N0* (transmitting node) and N1 (next node in a route) is less than *R1 (D<R1),* then the value of transmitted power is *TP1*. Similarly, if the calculated distance is in the range of *R1<D<R2* then the value of power transmitted is *TP2* and for *R2<D< R3* value of power transmitted is *TP3*. Using (3) we have calculated and fixed values as *TP1 = 3dBm, TP2 = 5dBm* and *TP3 = 8dBm* for transmission range *R1 = 50 m, R2 = 100 m and R3 = 140* m respectively. We have used values of constants and other parameters given in [12].

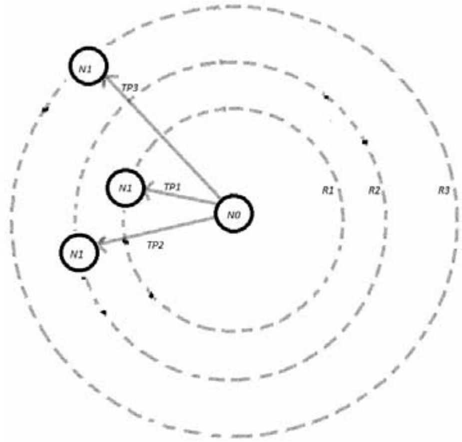

Figure 1. Selection of transmission range

D. If GPS location of destination node is available

Fig. 2, shows example network of area 300X300 m^2. In given network, let N0 and N9 are source and destination nodes respectively. Whenever N0 has data packet for N9, it looks into route cache to find GPS location of N9. Assuming that GPS location is available, N0 will follow two steps. First, it calculates the distance to N9 from its neighbors N1, N3 and N4 (nodes within transmission range) to find neighbor node nearest to the destination. Second N0 finds its distance to the node selected in the first step to select an appropriate level of transmission power. Nodes along green line (Fig. 2) are selected to form the route from N0 to N9. Red lines show nodes within transmission range of the particular node.

In this example (Fig. 2), N0 finds that N4 has minimum or shortest distance to N9 compared to N1 and N3. Therefore N0 will transmit the data packet with appropriate transmission power to N4. N4 follows the same process and transmit the data packet to N6. N6 will transmit the data packet to N9 using following the same process. In this process, intermediate nodes check the destination address in a packet header to know whether it itself is destination node or not. If an intermediate node is not destination node then it compares its neighbors with GPS location in a packet header to find next node in a route.

E. Route Discovery process if GPS location of destination node is not available

As long as GPS location of destination node available to the source, there is no need to initiate route discovery process. But if GPS location of the destination node is not available to the source node, it initiates route discovery process. The flowchart in Fig. 3, explains route discovery process if GPS location of the destination node is not available in route cache of the source node. In this case, the source node sends RREQ (consists location information of all its neighbors) to all neighbors with one hop count and waits for a reply. Upon receiving RREQ, node searches own route cache to find GPS information related to destination listed in RREQ packet. If GPS information of intended node is available, then it replies to the source node if note then remains idle.

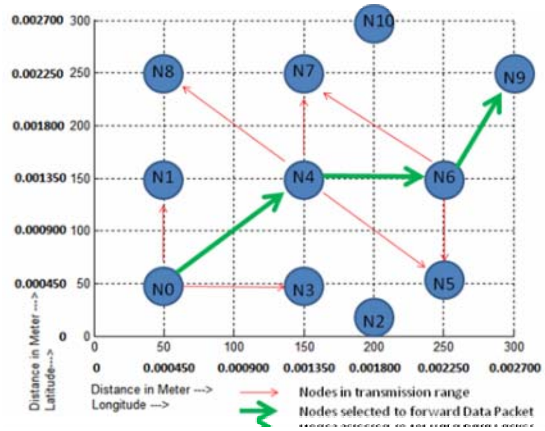

Figure 2. Forwarding data packet

Source node waits for acknowledgment up to one hop time and forwards the same RREQ again to same neighbors and increases hop count by two. At this time (for increased node counter) neighbors check hop counts and forwards it to next neighbors (that are not listed in RREQ packet (listed nodes are known and no need to check again), this limits duplicate transmission of RREQ packet) since hop count is still alive. This process continues until GPS information of destination node is available to a source node. This results in limited flooding into the limited area around source node. It is noted that whenever node forwards RREQ to next node it attaches location information it has in to RREQ so that next receiving nodes may update the route cache.

V. PERFORMANCE METRICS

To measure the suitability of proposed routing protocol five important packet level metrics are evaluated [8]. First three metrics EED, PDF and Jitter evaluates best effort traffic. NRL evaluates efficiency of the routing protocol. Battery power is important issue in MANET's to maintain network lifetime. Amount of transmission power per transmitted packet is to be regularized to increase life of node battery.

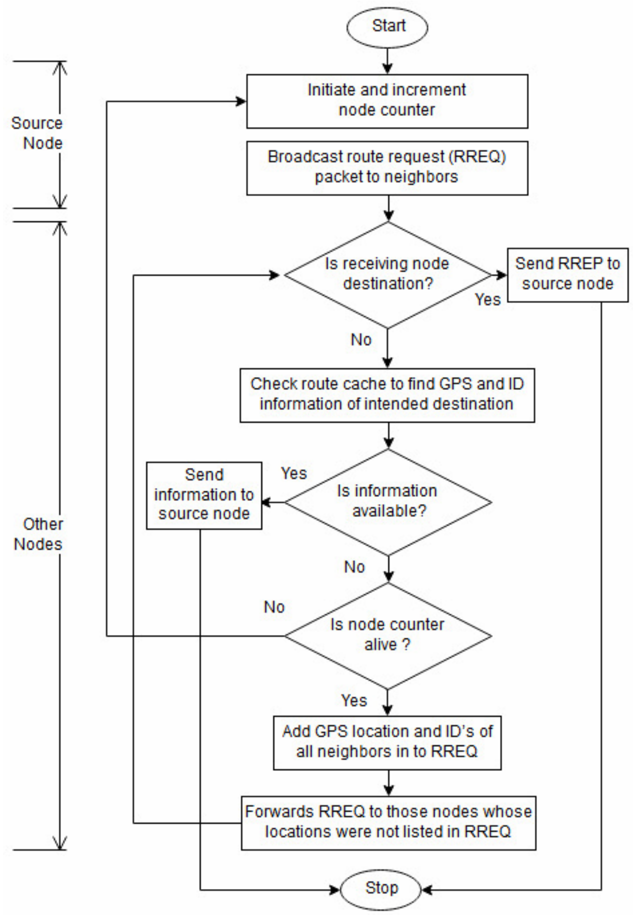

Figure 3. Route Discovery process- Flowchart

End to End Delay (EED) - It is average time taken by packets to reach the destination in seconds. EED is simulation time difference between transmission (tt) and reception (rt) of particular packet.

$$EED\ (sec.) = tt - rt \tag{3}$$

Packet Delivery Fraction (PDF) - It is the ratio of the data packets successfully delivered (*pr*) to destination nodes to those generated by source nodes (*pt*).

$$PDF = \frac{pr}{pt} \tag{4}$$

Jitter - It is the time variation in the arrival of consecutive packets at the receiver. It is also referred as packet delivery variation. Jitter is results of variable path lengths, traffic, and route availability, timing drift etc. To calculate jitter we have calculated the time difference between successive arrivals of packets at particular node. These time differences are then averaged over a number of packets successfully received over simulation time by all participating nodes. While calculating jitter lost packets are ignored.

Normalized Routing Load (NRL) - It is defined as the number of routing (control) packets (*rp*) transmitted per data packet delivered to the destination.

$$NRL = \frac{rp}{pr} \tag{5}$$

Average transmitted power (P_{av}) – Total transmitted power is the total sum of power transmitted per packets by all nodes in the network during simulation time. Transmitted packets (TP) include both data and control packets. For GPS aided DSR we have separated transmitted packets on the basis of transmission range. Depending upon transmission range and power values total transmitted power is calculated as,

$$P_{av}(dBm) = \frac{3 * PR_1 + 5 * PR_2 + 8 * PR_3}{TP} \tag{6}$$

Here PR_1, PR_1 and PR_1 are number of packets transmitted for range $R1, R2$ and $R3$ respectively.

TABLE I. SIMULATION PARAMETERS

Parameter	Value/Type
Number of Nodes	10, 20, 40, 60, 80, 100
Total Simulation Time	100 seconds
Data Packet Length	512 Bytes
Data Rate	2048 bps
Network Area	1000 x 1000 m
Propagation Loss Model	Friis Prop. Loss Model
Mobility Model	Random Waypoint
Physical Standard	IEEE 802.11b
Node Speed	20 ms
Pause Time	0 ms
Maximum Transmission Power	8 dBm

VI. RESULT ANALYSIS

Simulations are performed for a set of parameters given in Table I. Trace files (*.tr) of ns-3.25 are analyzed to calculate the values of performance metrics. Numbers of sink nodes are kept to half of total nodes in a network.

Fig. 4, shows a comparative graph for an average end to end delay verses increasing network load. End to end delay is time taken by a packet to reach a destination. End to end delay is mainly caused by length of route followed by packet from source to destination and processing delay at intermediate hops. It means end to end delay is directly proportional to length of route and number of intermediate hopes. If path followed by a packet is shorter in length then packet can reach destination through minimum intermediate hops. In GPS aided DSR packet follows shortest path to the destination in terms of distance and number of hopes and due to this we can see (Fig. 4) there is 35% reduced end to end delay compared to DSR. For 20 to 30 nodes end to end delay is large due to low node density in a network. Beyond 70 nodes average end to end delay increases sharply (by 39%) for DSR due to packet losses of approximately 5% whereas proposed technique has comparatively low end to end delay.

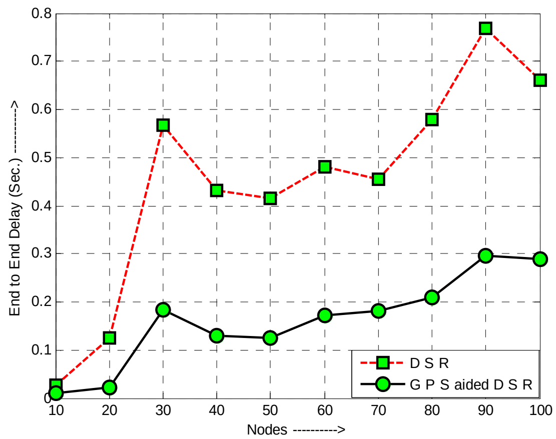

Figure 4. End to End delay v/s Increasing nodes

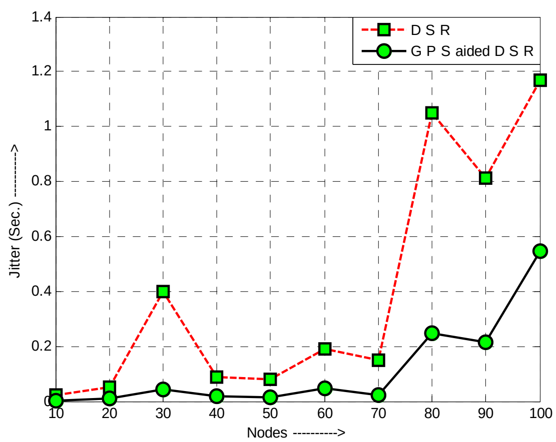

Figure 5. Jitter v/s Increasing nodes

Fig. 5, compares average value of jitter during simulation time. Jitter is time difference between successive arrivals of packets. It occurs because of paths followed by packet varies in length due to mobility, route breaks, congestion etc. Other than this, due to highest mobility (0 pause time) routes available in route cache become out of date frequently; this causes frequent route discoveries in traditional DSR. Due to this route cache information is updated and therefore fewer route discoveries processes initiated. GPS aided DSR able to perform better because it uses shortest paths, quickly amends broken paths at local level. On an average there is difference of 0.28 sec (29%) between successive arrivals of packets for DSR and GPS aided DSR.

Fig. 6, shows a fraction of packets delivered successfully to the packets generated from various data sources. It also indicates amount packets dropped during transmission because of different reasons like congestion, route breaks etc. Both DSR and GPS aided DSR are succeed to deliver most of the packets transmitted. On an average packet loss in GPS aided DSR is 3% less compared to DSR. Beyond 70 nodes approximately 3% packets got lost for GPS aided DSR and in DSR value is approximately 5%.

Normalized Routing load comparison (Fig. 7) shows GPS aided DSR performs better compare to traditional DSR. It transmits 1.4 control packets per data packet, whereas traditional DSR transmits 11 control packets for 5 data packets. GPS aided DSR avoids global flooding during route discovery process and uses route maintenance at local. It is to be noted that as number of hopes increases in a route, control packets also increases. As mentioned earlier control packets consume battery of node, it is seen from Fig. 8 that P_{av} for GPS aided DSR is less because of controlled overload.

Fig. 8, compares total power consumed during simulation time. It is observed that due to variable transmission power in GPS aided DSR, it uses total 9 watt less power throughout simulation time. For node density above 70, battery power consumption of traditional DSR increases rapidly whereas proposed method well controls transmission power. It is also noted that during simulations most of transmissions are done using range $R1$.

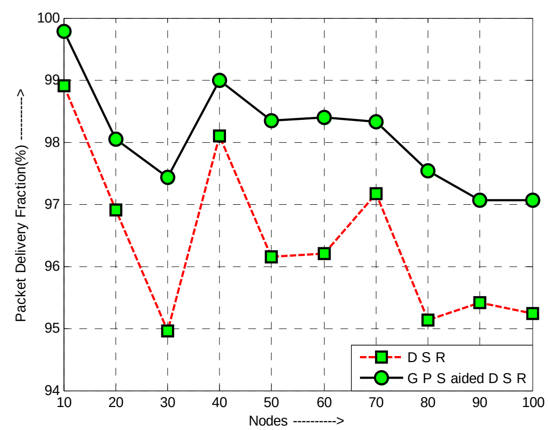

Figure 6. PDF v/s Increasing nodes.

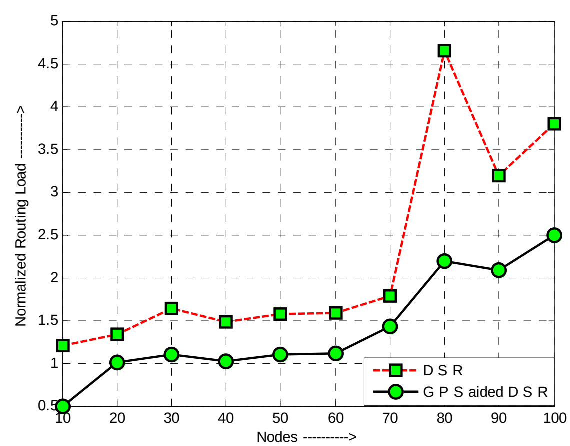

Figure 7. NRL v/s Increasing

nodes

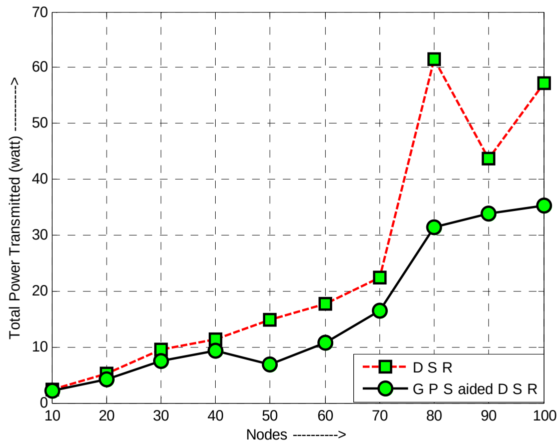

Figure 8. Power Transmitted v/s Increasing nodes

VII. Conclusion

DSR uses source routing which needs complete end to end routes in the route cache. It performs well when networks are steady or have low mobility. When the network has high mobility, there are multiple routes in the route cache; most of these routes are outdated since there are no periodic and time-based route updates in DSR. The route formed between source and destination at any time may not be shortest and strongest (in terms of link duration and battery life of intermediate nodes). Whereas, GPS aided DSR is made to transmit a beacon consisting location information if a node moves by predefined values of longitudes and latitudes. GPS aided DSR exploits use of position information to find the shortest end to end to end routes. It uses the relationship between transmission power and transmission range to reduce average transmission power during simulation time. If routs break due to mobility data packet automatically opt alternate route to the destination. If we can manage to exchange latest GPS information among nodes in a network with minimum control overhead, it is very easy to perform routing of data packets in MANET's. Due to these simulation results shows GPS aided DSR performs better than DSR in MANET's.

In future GPS can play a decisive role to enhance routing performance in MANET's. Exchange of latest GPS information among network nodes is to be refined in future. By considering precise transmission power levels, mobility parameters we can still improve the performance of routing in proposed technique. Proposed technique can be further improved by considering more direct mobility metrics like the degree of temporal, spatial dependence and relative speed.

References

[1] D. Johnson and D. A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks", in Mobile Computing (T. Imielinski and H. F. Korth, eds.), ch. 5, pp. 153-181, Dordrecht, The Netherlands: Kluwer Academic Publishers, February 1996.

[2] Stefano Basagni, Imrich Chlamtac and Violet R. Syrotiuk, "Dynamic Source Routing for Ad Hoc Networks Using the Global Positioning System", Wireless Communication and Networking Conference (WCNC 1999 IEEE), 21-24 Sept. 1999.

[3] Azzedine Boukerche and Sheetal Vaidya, "A Performance Evaluation of a Dynamic Source Routing Discovery Optimization Using GPS System", in Telecommunication Systems (Kluwer Academic Publishers.), Volume 22, Issue 1 pp. 337–354, January 2003.

[4] Y. Ko and N. H. Vaidya, "Location-Aided Routing (LAR) in mobile Ad Hoc Networks", Journal Wireless Networks, vol 6, pp 307-321, July 2000.

[5] S. Begani, I. Chalmatac and V. Syrotiuk, "A Distance Routing Effect Algorithm for Mobility (DREAM)", Proc. 4th Annual ACM IEEE Int. Conf. Mobile computing and Networking, MOBICOM'98, pp 76-84.

[6] Thananop Thongthavorn, Worrawat Narongkhachavana and Sumet Prabhavat, "A study on Overhead Reduction for GPS-Assisted Mobile Ad-Hoc Networks" IEEE 2014.

[7] Rozita Aboki et. al.,"Predictive Location Aided Routing in Mobile Ad Hoc networks", 2013 IEEE 11th Malaysia International Conference on Communications 26th - 28th November 2013, Kuala Lumpur, Malaysia.

[8] M. W. Subbarao, "Ad hoc networking critical features and performance metrics", In: Wireless Communications Technology Group, NIST October 7, 1999.

[9] Hagar Mahmoud and Nadine Akkari, "Shortest Path Calculation: A Comparative Study for Location-Based Recommender System", 2016 13th International Bhurban Conference on Applied Sciences and Technology (IBCAST), Islamabad, Pakistan, IEEE-2016.

[10] Jan Blumenthal, Frank Reichenbach and Dirk Timmermann," Minimal Transmission Power vs. Signal Strength as Distance Estimation for Localization in Wireless Sensor Networks", 3rd Annual IEEE Communications Society on Sensor and Ad Hoc Communications and Networks, 2006. SECON '06. 2006, Reston, VA, USA.

[11] T. S. Rappaport, Wireless Communications: Principles and Practice. Englewood Cliffs, NJ: Prentice-Hall, 1996, pp. 69–122, 139–196.

[12] Rodoplu, Volkan, and Teresa H. Meng. "Minimum energy mobile wireless networks." IEEE Journal on selected areas in communications 17.8 (1999): 1333-1344.

[13] Johnson, David B., and David A. Maltz. "Dynamic source routing in ad hoc wireless networks." *Mobile computing* (1996): 153-181.

[14] Bijendra Bansal et al.,"Improved routing protocol for MANET", 2015 Fifth International Conference on Advanced Computing & Communication Technologies, IEEE-2015.

[15] Yuandong Sun, Yongquan Chen and Yangsheng Xu, "A GPS Enhanced Routing Protocol for Vehicular Ad-hoc Network", Proceedings of the 2011 IEEE International Conference on Robotics and Biomimetics December 7-11, 2011, Phuket, Thailand.

[16] Jörg Ott et al., " On the sensitivity of geo-based content sharing to location errors", 13th Annual Conference on Wireless On-demand Network Systems and Services (WONS), Jackson, WY, USA, 21-24 Feb. 2017.

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