Performance Evalution of MANET Routing Protocols using Reference Point Group Mobility and Random WayPoint Models

[1]M.Sreerama Murty and [2]M.Venkat Das

[1]Department of Computer Science and Engineering
Sai Spurthi Institute of Technology,Khammam,Andhra Pradesh,India
sreerammaturi@yahoo.com
[2]Department of Computer Science and Engineering
University College of Engineering,Osmania University,Hyderabad,Andhra Pradesh,India
vmaredu@gmail.com

Abstract

An ad hoc network is often defined as an "infrastructureless" network, meaning a network without the usual routing infrastructure like fixed routers and routing backbones. Typically, the ad hoc nodes are mobile and the underlying communication medium is wireless. Each ad hoc node may be capable of acting as a router.it's charactrizied by multihop wireless connection and frequently changing networks.we compare the performance of on-demand routing protocols for mobile ad-hoc networks are distributed cache updating for the dynamic source routing protocol(DSR) and ad hoc on-demand distance vector routing (AODV).the simulation model of the medium access control(MAC) layer is evaluting the performance of MANET protocols.DSR and AODV protocols share similar behavours.we evalute the both on demand protocols DSR and AODV based on packet delivery ratio , packet delivery latency,mobility variation with total number of errors, packet and normalized routing overhead,end-to-end delay by varying in node density.the performance and characterictics are explained by the graph models.

Keywords

Mobile ad-hoc network ,On-demand routing protocols,Mobility,Medium Acess Control,latency.

1.Introduction

Ad hoc is a decentralized wireless network which forms spontaneously.ad hoc networks are self organizing,self healing, distributed networks which most often employ wireless transimmissiion. Computer network ,tradionally viewed as infrastructure of a fixed evolved into of wired and wireless networks to suit today's need f mobile communication.

In mobile ad hoc network, nodes do not rely of any existing infrastructure.instead, the nodes themselves form the network and communicate through means of wireless communications. Mobility causes frequent topology changes and may break existing paths. routing protocols for ad hoc networks can be classified into two major types: proactive and on-demand**.** Proactive protocols attempt to maintain up-to-date routing information to all nodes by periodically disseminating topology updates throughout the network.on demand protocols attempt to discover a route only when a route is needed.

The general problem of modeling the behavior of the nodes belonging to a mobile network has not a unique and straightforward solution. Mobility and disconnection of mobile hosts pose a

DOI : 10.5121/ijasuc.2011.2104

number of problems in designing proper routing schemes for effective communication between any source and destination.

The mobile ad hoc networks are envisioned to support dynamic and rapidly changing the multihop topologies which are likely to becomposed of relatively bandwidth constrined wireless links.a generic framework to systematically analuze the impact of mobility on the performance of routing protocols for MANET has become important.As many studies have used refernce point(RP) and random waypoint(RWP) as reference model

In refernec point(RP) model an intermediate node can simultineosly serve as relay for more than one source.hence the resources are shared in an on-demand fashion.this is typical for most of the routing protocols for wireless ad hoc networks.

In the random waypoint(RWP) model,the nodes, that is,mobile users,move along a zigzag path consisting of straight legs from one waypoint to the next. In tthis model,a source reserves a multi-hop route to its destination.

2.Literature Survey

The routig protocols for MANET cn be broadly classified as on-demand/reactive and periodic/proactive protocols.

2.1 Distributed cache updating for the dynamic source routing protocol

DSR consists of two on-demand mechanisms: Route Discovery and Route Maintenance. When a source node wants to send packets to a destination to which it does not have a route, it initiates a Route Discovery by broadcasting a route request. The node receiving a route request checks whether it has a route to the destination in its cache. If it has, it sends a route reply to the source including a source route, which is the concatenation of the source route in the route request and the cached route. If the node does not have a cached route to the destination, it adds its address to the source route and rebroadcasts the route request. When the destination receives the route request, it sends a route reply containing the source route to the source. Each node forwarding a route reply stores the route starting from itself to the destination. When the source receives the route reply, it caches the source route.

In Route Maintenance, the node forwarding a packet is responsible for confirming that the packet has been successfully received by the next hop. If no acknowledgement is received after the maximum number of retransmissions, the forwarding node sends a route error to the source, indicating the broken link. Each node forwarding the route error removes from its cache the routes containing the broken link.

2.2 Ad Hoc On-Demand Vector Routing

Ad Hoc On-Demand Vector Routing (AODV) protocol is a reactive routing protocol for ad hoc and mobile networks that maintains routes only between nodes which need to communicate. The routing messages do not contain information about the whole route path, but only about the source and the destination. Therefore, routing messages do not have an increasing size. It uses destination sequence numbers to specify how fresh a route is (in relation to another), which is used to grant loop freedom.

Whenever a node needs to send a packet to a destination for which it has no ‘fresh enough’ route (i.e., a valid route entry for the destination whose associated sequence number is at least as great as the ones contained in any RREQ that the node has received for that destination) it broadcasts a route request (RREQ) message to its neighbors. Each node that receives the broadcast sets up a reverse route towards the originator of the RREQ, unless it has a 'fresher' one .

When the intended destination (or an intermediate node that has a 'fresh enough' route to the destination) receives the RREQ, it replies by sending a Route Reply (RREP). It is important to note that the only mutable information in a RREQ and in a RREP is the hop count (which is being monotonically increased at each hop). The RREP is uncast back to the originator of the RREQ . At each intermediate node, a route tothe destination is set (again, unless the node has a 'fresher' route than the one specified in the RREP). In the case that the RREQ is replied to by an intermediate node (and if the RREQ had set this option), the intermediate node also sends a RREP to the destination. In this way, it can be granted that the route path is being set up bidirectionally. In the case that a node receives a new route (by a RREQ or by a RREP) and the node already has a route 'as fresh' as the received one, the shortest one will be updated.

If there is a subnet (a collection of nodes that are identified by a common network prefix) that does not use AODV as its routing protocol and wants to be able to exchange information with an AODV network, one of the nodes of the subnet can be selected as their 'network leader'. The network leader is the only node of the subnet that sends, forwards and processes AODV routing messages. In every RREP that the leader issues, it sets the prefix size of the subnet

Optionally, a Route Reply Acknowledgment (RREP-ACK) message may be sent by the originator of the RREQ to acknowledge the receipt of the RREP. RREP-ACK message has no mutable information.

In addition to these routing messages, Route Error (RERR) message are used to notify the other nodes that certain nodes are not anymore reachable due to a link breakage. When a node rebroadcasts a RERR,it only adds the unreachable destinations to which the node might forward messages. Therefore, the mutable information in a RERR are the list of un-
reachable destinations and the counter of unreachable destinations included in the message. Anyway, it is predictable that, at each hop, the unreachable destination list may not change or become a subset of the original one.

3 Moblity Models of MANET

The mobility model is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time. Since mobility patterns may play a significant role in determining the protocol performance, it is desirable for mobility models to emulate the movement pattern of targeted real life applications in a reasonable way.

The mobility can be classified according to the different kinds of dependencies and restriction that are considered as:

(1) Random Models:-There are neither dependencies nor any other restrictions modeled which are similar to RWP model.

(2) Model with Temporal Dependency:- The mobile nodes tend to travel in a correlated manner..

(3) Model with Spatial Depandency:-The actual movement of a node is influnced by the nodes around it.

(4) Models with Geographic Restriction:- The area in which the node is allowed to move is restricted.

4. Analysis of Mobility Models

4.1 The Random Waypoint Model

It became a 'benchmark' mobility model to evaluate the MANET routing protocols, because of its simplicity and wide availability. The Random waypoint model is a random-based mobility model used in mobility management schemes for mobile communication systems. The mobility model is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time. Mobility models are used for simulation purposes when new network protocols are evaluated. In random-based mobility simulation models, the mobile nodes move randomly and freely without restrictions. To be more specific, the destination, speed and direction are all chosen randomly and independently of other nodes. This kind of model has been used in many simulation studies. Two variants, the Random walk model and the Random direction model are variants of the Random waypoint model

The implementation of this mobility model is as follows: as the simulation starts, each mobile node randomly selects one location in the simulation field as the destination. It then travels towards this destination with constant velocity chosen uniformly and randomly from [0,V], where the parameter V is the maximum allowable velocity for every mobile node. The velocity and direction of a node are chosen independently of other nodes. Upon reaching the destination, the node stops for a duration defined by the 'pause time' parameter . If T=0, this leads to continuous mobility. After this duration, it again chooses another random destination in the simulation field and moves towards it. The whole process is repeated again and again until the simulation ends

In the Random Waypoint model, V and T are the two key parameters that determine the mobility behavior of nodes. If the V is small and the pause time T is long, the topology of Ad Hoc network becomes relatively stable. On the other hand, if the node moves fast (i.e., is large) and the pause time T is small, the topology is expected to be highly dynamic. Varying these two parameters, especially the V parameter, the Random Waypoint model can generate various mobility scenarios with different levels of nodal speed. Therefore, it seems necessary to quantify the nodal speed.

4.2 Reference Point Group Mobilty Model

In line with the observation that the mobile nodes in MANET tend to coordinate their movement, the Reference Point Group Mobility (RPGM) Model . One example of such mobility is that a number of soldiers may move together in a group or platoon. Another example is during disaster relief where various rescue crews (e.g., firemen, policemen and medical assistants) form different groups and work cooperatively.

In the RPGM model, each group has a center, which is either a logical center or a group leader node. For the sake of simplicity, we assume that the center is the group leader. Thus, each group is composed of one leader and a number of members. The movement of the group leader determines the mobility behavior of the entire group. The respective functions of group leaders and group members are described as follows.

4.2.1.The Group Leader

The movement of group leader at time t can be represented by motion vector V_{group}^{t} . Not only does it define the motion of group leader itself, but also it provides the general motion trend of the whole group. Each member of this group deviates from this general motion vector V^t_{group} by some degree. The motion vector V^t_{group} can be randomly chosen or carefully designed based on certain predefined paths.

4.2.2. The Group Members

The movement of group members is significantly affected by the movement of its group leader. For each node, mobility is assigned with a reference point that follows the group movement. Upon this predefined reference point, each mobile node could be randomly placed in the neighborhood.
Formally , the motion vector of group member i at time t,V^t_i , can be described as

$$V^t_i = V^t_{group} + RM^t_i \quad (1)$$

Where the motion vector RM^t_i is random vector deviated by group member i from its own referenc point. The vector RM^t_i is an independent identically distributed (i.i.d) random process whose length is uniformly distributed in the interval $[0,r_{max}]$ (where is r_{max} allowed distance deviation) and whose direction is uniformly distributed in the interval $[0,2\pi)$.

With appropriate selection of predefined paths for group leader and other parameters, the RPGM model is able to emulate a variety of mobility behaviors. the RPGM model is able to represent various mobility scenarios including

(i) In-Place Mobility Model**:** The entire field is divided into several adjacent regions. Each region is exclusively occupied by a single group. One such example is battlefield communication.
(ii) Overlap Mobility Model**:** Different groups with different tasks travel on the same field in an overlapping manner. Disaster relief is a good example.
(iii) Convention Mobility Model**:** This scenario is to emulate the mobility behavior in the conference. The area is also divided into several regions while some groups are allowed to travel between regions.

In RPGM model, the vector MRi indirectly determines how much the motion of group members deviate from their leader. So, we are not able to generate the various mobility scenarios with different levels of spatial dependency, by simple adjustment of model parameters. RPGM model is proposed. The movement can be characterized as follows:

$$|V_{member}^{(t)}| = |V_{leader}^{(t)}| + random()*SDR*max\_speed$$

$$\theta_{member}^{(t)} = \theta_{leader}^{(t)} + random() + SDR*max\_angle \quad .... \quad (2)$$

where 0<SDR,ADR<1.. SDR is the Speed Deviation Ratio and ADR is the Angle Deviation Ratio. SDR and ADR are used to control the deviation of the velocity (magnitude and direction) of group members from that of the leader. By simply adjusting these two parameters, different mobility scenarios can be generated.

Because of the inherent characteristic of spatial dependency between nodes, the RPGM model is expected to behave different from the Random Waypoint model. Hong, Gerla, Pei and Chiang report that RPGM incurs less link breakage and achieves a better performance for various routing protocols than Random Waypoint model. In the next chapter, a detailed investigation on the characteristics of RPGM model is conducted.

5. Methodology

There are three techniques to evaluate the performance; analytical modeling, simulation and measurement. In this model simulation technique had being chosen because it is the most suitable technique to get more details that can be incorporate and less assumption is required compared to analytical modeling. Accuracy, times available for evaluation and cost allocated for the thesis are also another reason why simulation is choosing. By using simulation, researchers should be allowed to study a system in well-known conditions, repeatability if necessary in order to understand events.

5.1 MANET Framework

The purpose of AODV routing protocol in Ad hoc network is to send a data successful to the destination node. This operation encompasses other nodes and packet prior to the data being generated by the source node. From the perspective of network simulation, Ad hoc network consists of three types of nodes: source node, intermediate node (as neighbor node) and destination node.

The signal propagation between source nodes and destination nodes are the same using the wireless channel. The purpose of wireless propagation channel among the nodes s to send a packet and a data to the other neighbor nodes over the wireless channel. In order to enable the simulation of mobile nodes, a mobility model is included.

The operation of the simulation framework can be illustrated by considering a simple event: A source node is periodically generated a packet in the application layer to the destination node before send a data. A source node can only send a data packets over the neighbor nodes over the physical layer and mobility model. The neighboring nodes which are in the radius of source node will receive the packets through the MAC layer.

5.2 Performance Metrics

Mobile ad hoc networks have several inherent characteristics (e.g. dynamic topology, time-varying and bandwidth constrained wireless channels, multi-hop routing, and distributed control and management). Design and performance analysis of routing protocols used for mobile ad hoc network (MANET) is currently an active area of research. To judge the merit of a routing protocol, one needs metrics—both qualitative and quantitative--with which to measure its suitability and performance.Specifically, this paper evaluates the performance comparison of AODV, DSR and DSDV protocols on the following performance metrics: Average routing overhead, Packet delivery ratio and end-to-end delay,Throughput.

a) Packet Delivery Ratio(PDR): The number of data packets sent from the source to the number of received at the destination.

   PDR = (control packets sent-delivery packet sent) / control packets sent ....(3)

b) Avarge routing head(ARH): Average routing overhead is the total number of routing packets divided by total number of delivered data packets.

   ARH=Total no of routing packets/Total no of delivered data packets ....(4)

c) Avarage End-to-End Delay(AEED): Average End-to-End delay (seconds) is the average time it takes a data packet to reach the destination.

$$\text{AEED}=\sum_{I=0}^{N} \frac{(\text{time packet received} - \text{time packet sent})}{\text{total no of packets recevied}} \quad \ldots\ldots \qquad (5)$$

d) Throughput: The rate of successfully transmitted data per second in the network during the simulation.

5.3. Simulation Setup

This simulation are using three mobility models that will be tested on AODV routing protocol scheme.The simulation period for each scenario are conduct in 900 seconds and the simulated mobilitynetwork area is 800 m x 500 m rectangle with 250m transmission range. The simulation will conducted in two different scenario to gain a good result and shows the differences of the performance for each mobility model.

- The first scenario is to compared the mobility models in various number of nodes; 5, 10, 15, 20 and 25 nodes with fixed speed 15 m/s.
- The second scenario is to evaluated the mobility models in different node speed; 5, 10, 15 and 20 m/s with fixed the number of node to 50 nodes.

6. Experimental Results

The simulation results are focusing in analyzing the performance on routing overhead, throughput and packet delivery ratio. The results also compared with different mobility model that we had chosen in the early chapter. The result are based on the two scenario that we will decided to shows the performance for every mobility model that had been selected.

6.1 Avarge routing head(ARH)

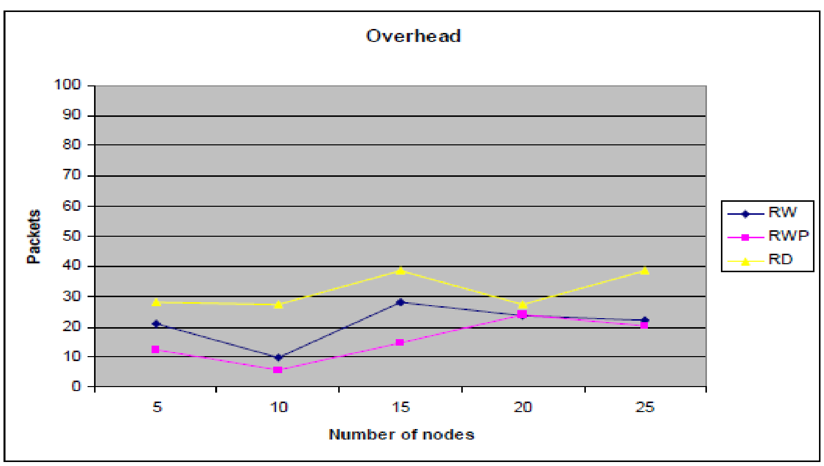

Figure 6.1: Routing Overhead versus Number of Nodes

it shows that the Random Direction Model is generated the highest routing overhead compared with the other mobility model due to the movement of the each MN are being forced to the border of the simulation area before changing direction. Random Waypoint Model performs lowest routing overhead and it's good for the routing communication. All the mobility models show that the routing overhead is increased when the number of number is increased.

6.2 Packet Delivery Ratio(PDR)

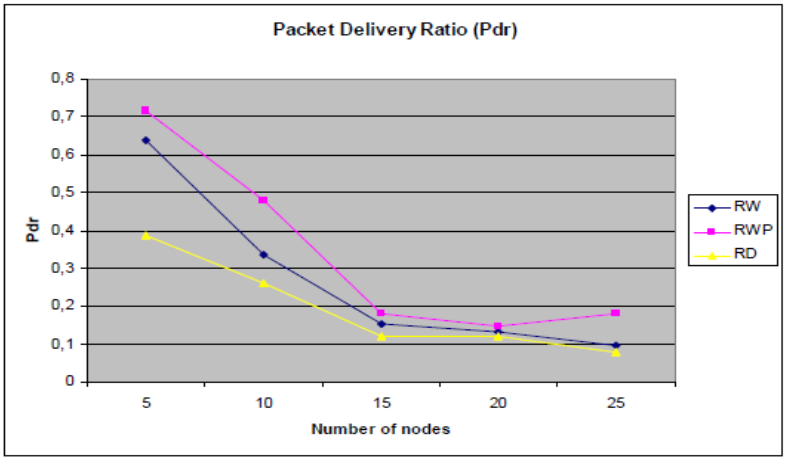

Figure 6.2: Packet Delivery Ratio versus Number of Nodes

Figure 6.2 shows Random Waypoint Model performed better in delivering packet data to destination by considering the pause time every time changing their directions. All mobility models are decreased significant with the increasing of the number of nodes because the number of load is small and the traffic is not heavy. Based on this result, it shows that at node 15 all models are become stable and consistent with packet delivery ratio until node 25.

6.3 Throughput

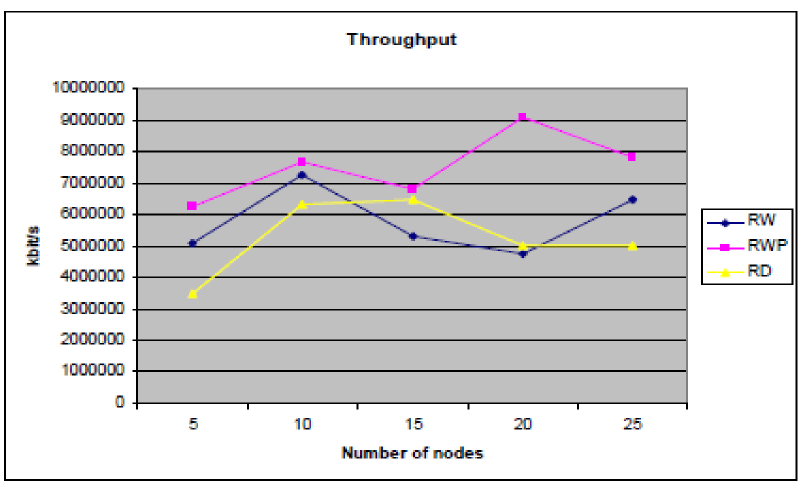

Figure 6.3: Throughput versus Number of Nodes

Fig 6.3 shows Random Waypoint Model outperforms both Random Walk Model and Random Direction Model in calculating the throughput which measured the hops performed by each packet. The higher throughput is contributed the lower delay because of the lower number of hop.

The result also shows, after node 10 the value of throughput are started to decreased and at certain number of nodes and they are not consistent for all model.

7. Conclusion and Future Work

Three mobility model from random-based model group have been evaluated theperformance comparing with AODVand DSR routing protocol. Since, the previous research has done a lot ondoing research with this mobility model.

The Random Waypoint Model is the best model whichoutperforms both Random Walk Model and Random Direction Model in both scenarios. The resultsindicate that Random Waypoint produces the highest throughput but the throughput of the RandomWalk Model and Random Direction drastically falls over a period of time.

Further study should be devoted to the Random-based Mobility Model. The detection of patterns and behaviors within this model would help identify whether scenarios exist in our world that inherently use the Random-based Mobility Model. This model might not accurately represent any scenario in our world, simply because real MNs must travel around obstacles and along pre-defined paths. So, the future research have to done to study on the real implementation of this model to suitewith current environment.

References

[1] C.E. Perkins, E.M. Royer & S. Das, Ad Hoc On Demand Distance Vector (AODV) Routing,IETFInternet draft, draft-ietf-manet-aodv-08.txt, March 2001

[2] Tracy Camp, Jeff Boleng and Vanessa Davies, " A survey of Mobility Models for Ad hocNetwork Research", Wireless Communications and Mobile computing: A special issue on Adhoc network Research, vol 2, No5, pp. 483-502, 2002

[3] Naski, S. 2004. 'Performance of Ad Hoc Routing Protocols: Characteristics and Comparison.'Seminar on Internetworking, Helsinki University of Technology, Finland.

[4] D. Johnson, D. Maltz. "Dynamic source routing in ad hoc wireless networks," In T. Imelinsky and H. Korth, editors, Mobile Computing, pages 153-181. Kluwer Academic Publishers, 1996.

[5] S. Lee, M. Gerla, and C. Chiang. "On-Demand Multicast Routing Protocol." IEEE WirelessCommunications and Networking Conference (WCNC'99), 1999.

[6] Ahmed S. and Ramani A. K., "Exploring the Requirements for QoS in Mobile Ad hoc Networks,"Journal of Information & Communication Technology Vol. 1, No. 2, (Fall 2007) 01-09

[7] Aziz S. R. A., Endut N. A., Abdullah S. and Daud M. N. M., "Performance evaluation of AODV, DSR and DYMO routing protocol in MANET", CSSR 08-09, 14 - 15 March 2009.

[8] Perkins C. E. and Royer E. M., "Ad-Hoc On-Demand Distance Vector Routing, Mobile Computing Systems and Applications," Proc. IEEE Workshop Mobile Computing Systems & Applications (WMCSA '99), pp. 90-100, 1999.

[9] J. Broch, D. Maltz, D. Johnson, Y.-C. Hu, and J. Jetcheva. A performance comparison of multi-hop wireless ad hoc network routing protocols. In Proc. 4th ACM MobiCom, pp. 85–97, 1998.

[10] IEEE Computer Society LAN MAN Standards Committee. Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std 802.11-1997. The IEEE, New York, New York, 1997.

[11] D. Johnson and D. Maltz. Dynamic Source Routing in ad hoc wireless networks. In Mobile Computing, T. Imielinski and H.Korth, Eds, Ch. 5, pp. 153–181, Kluwer, 1996

[12] C. Perkins, E. Royer, and S. Das. Ad hoc On-demand Distance Vector (AODV) Routing, RFC 3561. http://www.ietf.org/rfc/rfc3561.txt, July 2003.

[13] G. Lin, G. Noubir, and R. Rajaraman, "Mobility models for ad hoc network simulation," in Proceedings of the 23rd Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM '04), vol. 1, pp. 454–463, Hongkong, March 2004.

[14] T.Camp,J.Boleng, and V.Davies,A Survey of Mobility Models for Ad Hoc Network Research,in Wireless communication and mobile computing:Special issue on Mobnile Ad Hoc Networking:Research,Trends and Applications,vol.2no .5 pp,483-502,2002

[15] Y.-C. Hu and D. B. Johnson. Caching Strategies in On-Demand Routing Protocols for Wireless Ad Hoc Networks, in Proceedings of the Sixth Annual International Conference on Mobile Computing and Networking (MobiCom 2000), ACM, Boston, MA, August 2000.

[16] D. M. Blough, G. Resta and P. Santi, A statistical analysis of the long-run node spatial distribution in mobile ad hoc networks, in Procedding of ACM International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems(MSWiM), Atlanta, GA, Sep. 2002.

[17] P. Johansson, T. Larsson, N. Hedman, B. Mielczarek, and M. Degermark, Scenario-based performance analysis of routing protocols for mobile ad-hoc networks, in International Conference on Mobile Computing and Networking (MobiCom'99), 1999, pp. 195--206.

[18] R. Folio, J. B. Cain, and S. Kota, "Challenges in the verification of mobile ad hoc networking systems," International Journal of Wireless Information Networks, vol. 14, no. 2, pp. 107–120, 2007.

[19] E. Hyyti¨a and J. Virtamo, "Random waypoint mobility model in cellular networks,"WirelessNetworks, vol. 13, no. 2, pp. 177–188, 2007

[20] P. S. Mogre, M. Hollick, N. d'Heureuse, H. W. Heckel, T. Krop, and R. Steinmetz, "A graph-based simple mobility model," in Proceedings of the 4th Workshop on Mobile Ad-Hoc Networks (WMAN '07), pp. 421–432, Bern, Switzerland,February-March 2007.

[21] S. Gowrishankar, T. G. Basavaraju, and S. K. Sarkar, "Effect of random mobility models pattern in mobile ad hoc networks,"International Journal of Computer Science and Network Security, vol. 7, no. 6, pp. 160–164, 2007.

[22] N. Aschenbruck, E. Gerhards-Padilla, and P. Martini, "A survey on mobility models for performance analysis in tactical mobile networks," Journal of Telecommunications and Information Technology, vol. 2, pp. 54–61, 2008.

Acknowledgements

The authors would like to thank the anonymous reviwers for their careful reading and insightful comments that have helped in improving of this paper.

Authors

M.Sreerama Murthy Recived M.Tech in Computer Scince and Engineering from University College of Engineering ,JNTU,Kakinada.B.Tech in Information Technology from JNTU,Hyderabad. And now presently working as Assistant Professor Sai Spurthi Institute of Technology,Khammam.His research interests includes Mobile Computing,Image Processing,DataMining and Embedded Systems.

Prof .M.Venkat Das is working as Associate Professor in Department of Computer Science and Engineering,Osmania University,Hyderabad. His authored book titled, "Information revolution! Will It Lead To A New Social Revolution?".His achieved 1st rank in SLET (NET) .His research interest includes Automata Theory, Compilers, Embedded Systems.