Mobility impact, timing analysis and repeatability issues of DYMO protocol in a precise mobile ad hoc network

A. Boomarani Malany[†] and RM. Chandrasekaran[††],

[†]Department of Computer Science and Engineering, Anna University Tiruchirappalli, Tiruchirappalli -620 024, India
[††] Department of Computer Science and Engineering, Anna University Tiruchirappalli, Tiruchirappalli -620 024, India

Summary

In recent days, Mobile ad hoc network is an emerging trend and it has to face many challenges and issues. QOS (Quality of service) is a challenging requirement in mobile ad hoc networks. QOS metrics such as bandwidth, delay, delay jitter, packet delivery fraction are some of the requirements in this field. The design of a topology is a difficult task in mobile ad hoc network. This paper presents a new approach of designing a topology and to perform QOS requirements. These processes divulge the overall network efficiency as 94.7%. The performance may vary depending upon the topology design, flow patterns and mobility speed of the system. The repeatability issues and timing analysis also considered for run time variations, which is used for determining the scalability of mobile ad hoc networks. This paper performs various, quality of service metrics of mobile ad hoc network.

Key words: Manet, QOS, repeatability, scalability, DYMO

1. Introduction

A Mobile ad hoc network is a collection of wireless mobile nodes dynamically forming an ephemeral network without the use of any existing network infrastructure or centralized administration [1]. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change hurriedly and unpredictably. Such a network may operate in a stand-alone fashion, or may be connected to the Internet. The field of wireless networking emerges from the integration of personal computing, cellular technology, and the Internet. This is due to the increasing interactions between communication and computing, which are changing information access from "anytime anywhere" into "all the time, everywhere." At present, a large variety of networks exist, ranging from the well-known infrastructure of cellular networks to non-infrastructure wireless ad hoc networks. Vulnerability of channels and nodes, absence of infrastructure, and dynamically changing topology make ad hoc networks a difficult task. Many analysis and performance study were focused because of wide use of mobile ad hoc network. MANET (mobile ad hoc network) has been an energetic research field in recent years. The mobile nodes should spontaneously connect to the network and the nodes within its transmitting range. MANET is to establish a self-configuring, self-organizing and self-healing network of mobile routers and associated hosts that are connected by a series of wireless links. The devices are theoretically power-up-n-play with the help of the battery and automatically configure them selves and connect to other devices in an environment where there is no predefined infrastructure. Since it unpredictable network, it has to face many challenges and issues. Still quality of service [9] is a challenging network in mobile ad hoc network., hence Many protocols like AODV (Ad hoc On-Demand Vector Routing), DSR (Dynamic source routing), LAR (Location Aided routing), OLSR (Optimized Link state routing) have been analyzed their performances [8,14] in mobile ad hoc network.

This paper proposes a new topology approach, which is a precise topology in mobile ad hoc network with wide use of the random mobility model. Another important task is the impact of node mobility. There are different kinds of mobility models are available [3, 7]. Many analyses were made in different kinds of topology like star, mesh. A new topology was designed and the performances were calculated with different mobility speed [6]. The new emerging protocol DYMO protocol was applied which is defined by IETF [2,4,5]. We validate the scheme by simulating under different speed utilizations with IEEE 802.11 Distributed Coordination Function (DCF) ad hoc mode. During the simulation the numbers of events are noted and the repeatability of the simulation also considered. The simulation time Vs real time is also be calculated. The various metrics like throughput, end-to-end delay, average jitter and packet delivery fraction are evaluated.

Manuscript received June 5 , 2009
Manuscript revised June 20, 2009

2. Protocols:

There are different types of routing protocols are available, that is proactive, reactive and hybrid protocols. Reactive routing protocols for mobile ad hoc networks are also called "on-demand" routing protocols. In a reactive routing protocol, routing paths are searched only when needed. A route discovery operation invokes a route-determination procedure. The discovery procedure terminates when either a route has been found or no route is available after examination for all route permutations. In a mobile ad hoc network, active routes may be disconnected due to node mobility. Therefore, route maintenance is an important operation of reactive routing protocols. Compared to the proactive routing protocols for mobile ad hoc networks, less control overhead is a distinct advantage of the reactive routing protocols. The DYMO protocol was analyzed in their performance [4,5]. Hence a new emerging protocol DYMO (The DYnamic MANET On-demand) defined by IETF, which was derived from AODV protocol, which is a reactive protocol, applied in the networks

3. Simulation Environment:

3.1 Design of the simulation:

The network was designed carefully which is facilitate to appraise and vary the impact of mobility, with static DYMO (Dynamic Manet On-demand protocol) which delivers data successfully because it is derived from AODV (Ad hoc On-Demand Vector Routing). The network designed as randomly a square topology where the mobile nodes placed starting from the centre point and the links were made by wireless link. The Qualnet Simulator was used which has a scalable network libraries and gives accurate and efficient execution [11, 12]. The simulations were performed with different node mobility speed and CBR (Constant bit rate) traffic flow. By this proposed topology the failure of node can be easily detected and it gives the way for the accuracy in their performance. CBR traffic flows with 512 bytes were applied. The workload assigned, as four sessions were each session delivers the result differently. A two-ray path loss model was applied to avoid random path loss component. Simulations were made in different speed utilization with IEEE 802.11 Distributed Coordination Function (DCF) ad hoc mode and the channel frequency is 2.4 GHz and the data rate 2mbps. The network protocol here applied was Internet Protocol version four (IPv4). The radio type 802.11b was applied and the transmission range is 50m. Table 1 shows the parameter management.

Table 1: managing parameters

Node density	***mobility***	Application traffic	Simulation time
Fixed	Varies	Fixed	varies

The simulation ran for four times to perceive the repeatability issues and the number of events occurred for each simulation with varying the node mobility speed from 10 mps to 50 mps. The timing analysis also noted how the deviation takes between the simulation time and the real time. The simulation parameters are listed in table.

Table 2: Simulation parameters:

Terrain size	1500m x 1500m
Number of nodes	20
Traffic	CBR
Packet size	512 bytes
Mobility	Random way point mobility
Speed	10-50 mps
Pause time	5s
Simulation time	100s
Mac protocol	IEEE 802.11 DCF
Bit rate	2 Mbps
Wireless propagation model	Two ray
Transmission range	50m
Routing protocol	DYMO

The workload assigned as three sessions and the performance evaluated for these sessions with varying speed of mobility 10, 20,30,40,50 with constant pause time 5s. The wireless link was placed at the centre of the network. The quality of service parameter are calculated for throughput, average end-to-end delay, average jitter and packet delivery fraction.

3.2 Performance metrics:

Several performance metrics are evaluated under various mobility speed based on the following calculations.

Throughput:

The amount of data that received through the network per unit time, i.e. data bytes delivered to their destinations per second

$$\text{Throughput} = \frac{\text{Total bytes received}}{\text{Total time}}$$

End-to-end delay:

End-to-end delay indicates how long it took for a packet to travel from the CBR source to the application layer of the destination. It represents the average data delay of an application or a user experiences when transmitting data.

Average Jitter:

Jitter is the time variation of a characteristic of the latency packets at the destination

Packet delivery fraction:
Packet delivery fraction=(total received packets/total sent packets)*100

4. Performance analysis:

The Analysis made for two sections; the First section the mobility speed varies while data rate and simulation time remains the same. The simulation time and the real time are noted which are not the same time. The four Constant bit rate sessions were taken and the data byte assigned as 512 bytes and data send was 100. The mobility random waypoint mobility applied to the destinations and the source nodes remain static. The simulation time assigned for the first session is 100S. The protocol DYMO [4,5] was applied for routing. In the first session packet delivery fraction, throughput, average delay and average jitter were considered as performance metrics. As per investigation, while the speed increases the packet delivery fraction and throughput were decreased gradually. This leads to scalability issues. While the speed decreased the throughput and packet delivery fraction are high (figures: 1&2), whereas average delay and jitter were reduced (figures: 3&4) at low and high-speed mobility. The figures illustrated below were shows the results of performance analysis of throughput, packet delivery fraction, end-to-end delay, and jitter.

4.1 Mobility Speed Varies:

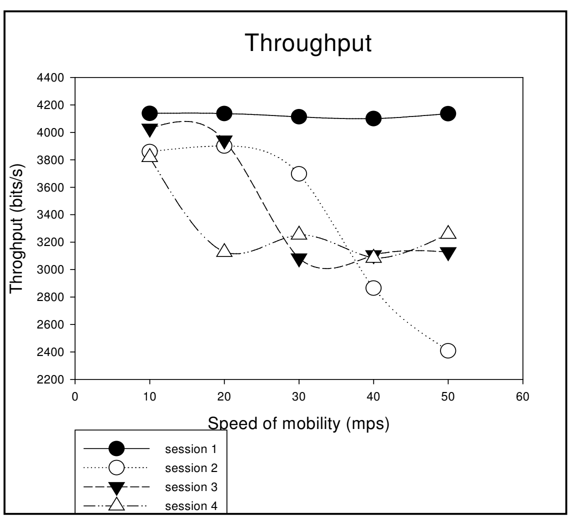

Figure 1: Throughput

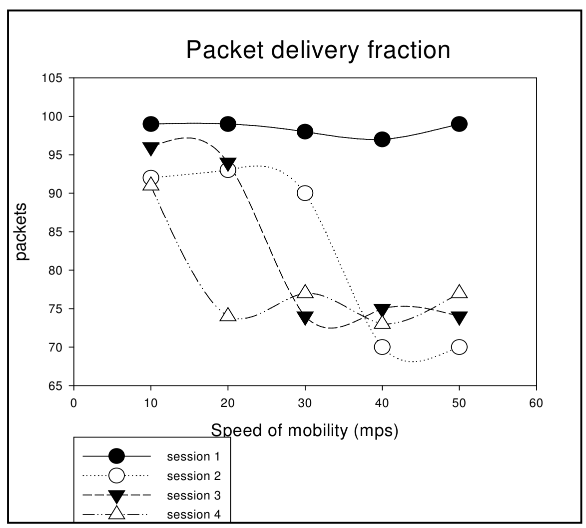

Figure 2: Packet delivery fraction

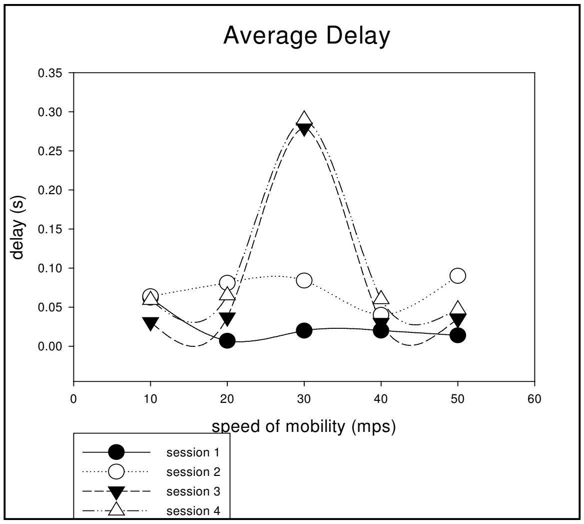

Figure 3: Average end-to-end delay

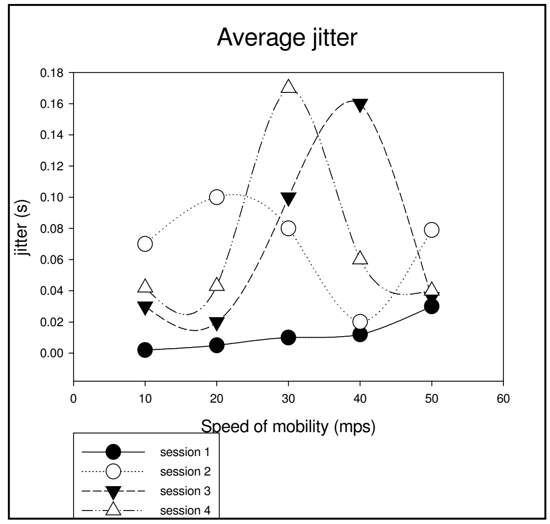

Figure 4: Average jitter

Each session delivers different output even though the same parameters are assigned to the precise mobile ad hoc network. The throughput and packet delivery fraction is high and low in delay and jitter. Using this investigation it is easy to find out faults analysis, where and how can be the faults were detected. The various parametric changes were deployed and can be investigated various metrics through these experiments.

Table 3: Real time variations with mobility speed

Mobility Speed	Real time	No. of events
10	**31**	**233880**
20	**42**	**217202**
30	**58**	**244120**
40	**91**	**231296**
50	**94**	**216343**

The table shows the various points were noted during the simulation. The mobility speed varies for each simulation in 10,20,30,50. Even though the simulation time is fixed as 100s seconds there is a variation in simulation time and the real time which is noted in the table and the number of events also varies if the network remains the same while mobility varies.

In the second section, the timing analysis [10] and repeatability issues, where evaluated in the different simulation time, as the mobility and data rate remains the same. The simulation parameters are also same as stated in the table. The repeatability made for each interactive run for four times which shows the real time varies and the simulation time set as 20,40,60,80 and 100 seconds and events remain same for the repeatability runs and varied for the real time.

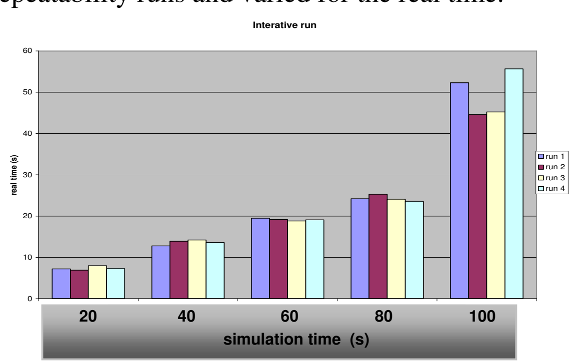

Figure 5: Simulation Vs real time with 4 interactive runs

Table 4: Number of events occurred

Simulation time	No. of Events
20	58819
40	107474
60	148726
80	194510
100	237421

The above table 4 shows, the number of events may vary while the simulation time varies event though the same network. The figure 5 shows the variability of real time for the same network simulated for four interactive runs. From these repeatability issues, that is assigned for same network the real time will vary. These issues were used for the scalability and designing the network according to the users.

4.2 Simulation time varies:

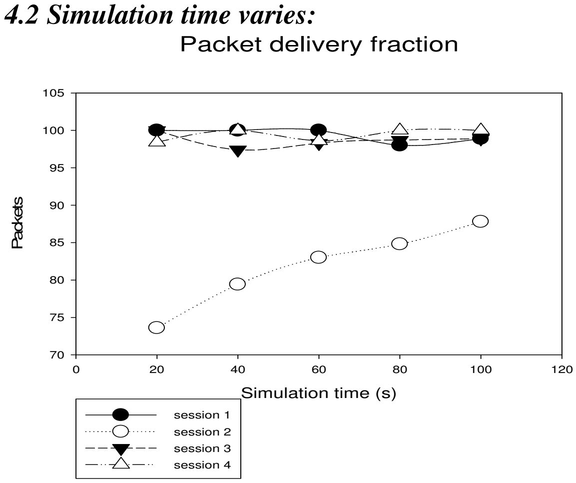

Figure 6: Packet delivery fraction

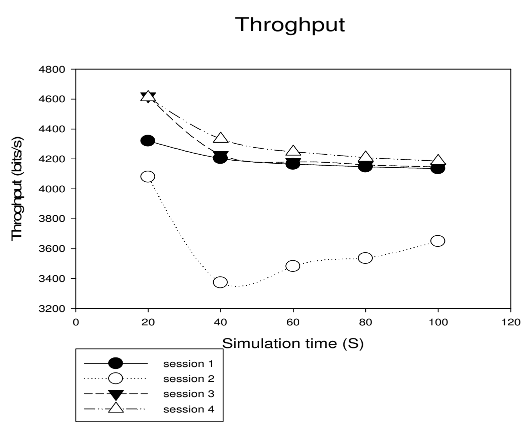

Figure 7: Throughput

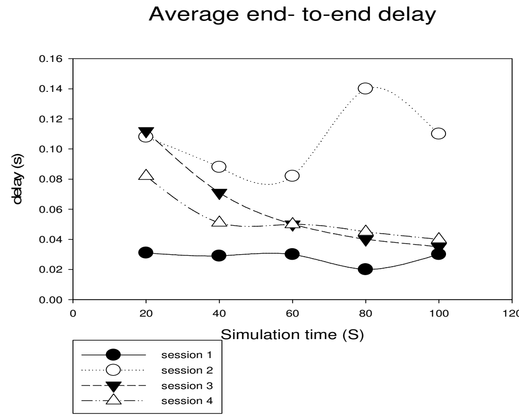

Figure 8: Average end to end delay

In this section, the experiment evaluated for the different simulation time varies. Here the Mobility speed, data byte and network parameters were remain same but the simulation time varies. The important point was noted that is without any changes in the network, there is a performance changes while the duration of the simulation time varies. The simulation time varies for 20,40,60,80 and 100 seconds. In the resultant figure 6 shows the packet delivery fraction has little difference for session 1, 3, and 4. The session 2 shows fully differ and produce low Packet delivery fraction and throughput. There is a reduction in throughput, hence average end-end- delay increased for session2. The other session shows increased throughput and Packet delivery fraction and less delay. For overall network efficiency tends to 94.7%, which is high in performance. Hence the scalability of the network also increased.

Conclusion:

In the proposed topology various performance metrics, timing analysis and repeatability issues were calculated for the QOS (quality of service) metrics in mobile ad hoc networks. The Experiment delivers high throughput and packet delivery fraction with low average end-to-end delay and average jitter at low mobility speed. In Simulation time varies the performance also varies even though there is no change in the precise mobile ad hoc network. Since there is increased in throughput leads to better scalability and quality of service in DYMO protocol of mobile ad hoc network. The repeatability issues show the scalability of the mobile ad hoc network. The further work will be continued on different layer metrics in precise mobile ad hoc network.

Reference:

[1] Kavita Taneja , R.B.Patel ," An Overview of Mobile Ad hoc Networks:Challenges and Future", M.M. Instt. Of Computer Tech. & Business Management, Deptt. Of Computer Engg. , M. M. Engineering College Mullana, Haryana, India.

[2] I.D. Chakeres and C.E. Perkins. Dynamic MANET On-demand (DYMO) Routing.http://www.ietf.org/internet-drafts/draft-ietf-manet-dymo-10.txt, July 2007. Internet-Draft.

[3] T. Camp, J. Boleng, and V. Davies, "A survey of mobility models for ad hoc network Research," Wireless Communications and Mobile Computing (WCMC): on Mobile Ad Hoc Networking: Research, Trends and Applications, vol. 2, no. 5, pp. 483–502, 2002.

[4] A. Boomarani ,"Performance analysis of mobile adhoc network with mobility variations in pause time", National conference in march 2009

[5] A. Boomarani and RM. Chandrasekeran," SQMD model in mobile ad hoc network", Bangalore, ICIP 09

[6] Brent Ishibashi, Raouf Boutaba," Topology and mobility considerations in mobile ad hoc networks", School of Computer Science, University of Waterloo, April 2004

[7] Xavier P´erez-Costa Christian Bettstetter Hannes Hartenstein, "Towards a Common Mobility Metric for Comparative Studies of Mobile Ad Hoc Networks: Results and Challenges", ACM Sigcomm 2003

[8] S. R. Das, C. E. Perkins, E. M. Royer, and M. K. Marina, "Performance comparison of two on-demand routing protocols for ad hoc networks," IEEE Personal Communications Magazine, on Mobile Ad Hoc Networks, vol. 8, no. 1, pp. 16–29, February 2001.

[9] Rafael Guimar.aes, Juli´an Morillo, Llorenc¸ Cerd_a, Jos´e-M Barcel´o and Jorge Garc´_a ,"Quality of Service for Mobile Ad-hoc Networks: an Overview", Technical University of Catalonia, spain, July 2004

[10] Ferdinand C, "Worst-Case Execution Time Prediction by Static Program Analysis", IEEE International Symposium on Parallel and Distributed Processing, pages 125-, 26-30th April, 2004.

[11] Scalable Network Techologies, "Qualnet simulator," Software Package, 2003. [Online].Available: http://www.qualnet.com

[12] The software available fromhttp://www.scalable-networks.com

[13] Ilka Miloucheva Eberhard Müller Alessandro Anzaloni "A practical approach to forecast Quality of Service parameters considering outliers" Austria, 2003

[14] Jong-Mu Choi and Young-Bae Ko, "A Performance Evaluation for Ad hoc routing protocols in realistic military scenarios", Proc. of the 9th International Conference on Cellular and Intelligent Communications (CIC 2004): Oct. 2004

A.BoomaraniMalany received her B.E degree in electronics and communication engineering from Madras University, Chennai in 2000 and M.E degree in Computer science engineering from Annamalai University, Chidambaram in 2005. She worked as Lecturer in the Department of Computer science engineering during 2005 to 2007. Currently, she is pursuing her Ph. D in the Department of Computer Science engineering, Anna University Tiruchirappalli, Tamil Nadu, India. She is also a life member of ACEEE

Dr.RM. Chandraekaran is currently working as a Registrar of Anna University Tiruchirappalli and Professor at the Department of Computer Science and Engineering, Annamalai University, Annamalai Nagar, Tamil Nadu, India. From 1999 to 2001 he worked as a software consultant in Etiam, Inc, California, USA. He received his Ph. D Degree in 2006 from Annamalai University, Chidambaram. He has conducted Workshops and Conferences in the Areas of Multimedia, Business Intelligence and Analysis of algorithms, Data Mining. He has presented and published more than 32 papers in conferences and journals and is the co-author of the book Numerical Methods with C++ Program (PHI, 2005). His Research interests include Data Mining, Algorithms and Mobile computing. He is Life member of the Computer Society of India, Indian Society for Technical Education, Institute of Engineers, Indian Science Congress Association.