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A Survey on Various Routing Protocols for MANET in Different Node Mobility Models With Respect To Performance Aspects

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Abstract: MANET stands for Mobile Ad hoc Network. An ad hoc network is often referred to as an "infrastructure less" network, because the network does not need fixed routers [1]. These nodes are mobile communicating through wireless medium. Each ad hoc node may be capable of acting as a router. It's characterized by multi-hop wireless connection and frequently changing networks. Due to frequent topology changes and routing overhead, selection of routing protocol in Mobile Ad-hoc Network (MANET) is a great challenge. A design issue for an efficient and effective routing protocol is to achieve optimum values of performance parameters under network scenarios. There are various routing protocols available for MANET. This paper involves study of four routing protocols (Bellman Ford Routing, FSR, CGSR and SHARP), and performance comparisons between these routing protocols on the basis of performance metrics (throughput, packet delivery ratio, and end to end delay measured after simulation of network) with the help of QualNeT Simulator. In this study we have considered three mobility scenarios: Random Waypoint, Group Mobility and Freeway Models. These three Mobility Models are selected to represent possibility of practical application in future.

Keywords: MANET, Bellman Ford, FSR, CGSR, SHARP, Random waypoint Mobility, Group Mobility, Freeway Mobility Models

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) is a collection of wireless mobile nodes and connected in dynamic manner. Nodes forming a temporary/short-lived network without any fixed infrastructure where all nodes are free to move about arbitrarily. Nodes must behave as routers, take part in discovery and maintenance of routes to other nodes in the network.Wireless links in MANET are highly error prone and can go down frequently due to mobility of nodes. Stable routing is a very critical task due to highly dynamic environment in Mobile Ad-hoc Network Recent advances in wireless communication technology have generated a great interest in building and using ad hoc mobile networks in many diverse applications. A mobile ad hoc network constitutes multiple wireless stations called nodes which are mobile, capable of moving randomly and communicating with each other in the absence of any centralized administration and fixed infrastructure. MANET has several potential applications including emergency rescue operations during natural calamities, event meetings, conferences, and battlefield communication between moving vehicles and/or soldiers.

To thoroughly and systematically study a new Mobile Ad hoc Network protocol, it is important to simulate this protocol and evaluate its protocol performance. Protocol simulation has several key parameters, including mobility model and communicating traffic pattern, among others. In this chapter and the next chapter we focus on the analysis and modeling of mobility models. We are also interested in studying the impact of mobility on the performance of MANET routing protocols. We present a survey of the status, limitations and research challenges of mobility modeling in this chapter. Two variations of mobile wireless network are: infrastructure network and infrastructure less network.

a. Infrastructure networks: An Access Point (AP) represents a central coordinator for all nodes. Any node can be joining the network through AP. In addition, AP organizes the connection between the Basic Set Services (BSSs) so that the route is ready when it is needed. However, one drawback of using an infrastructure network is the large overhead of maintaining the routing tables. Infrastructure network as shown in Figure 1(a).

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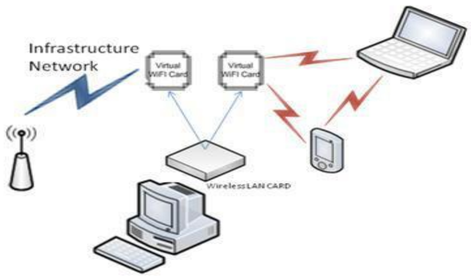

Figure 1 (a): Infrastructure Network.

Figure 1 (b): Ad Hoc network.

b. Ad Hoc networks: A wireless ad hoc network is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks [1]. Ad Hoc networks do not have a certain topology or a central coordination point. Therefore, sending and receiving packets are more complicated than infrastructure networks. Figure 1(b) illustrates an Ad Hoc network.

Infrastructure network has bridges, known as base stations [3].These networks communicate with the nearest base station which lies within the range. The other variation is infrastructures less network, which are also called as Mobile ad hoc network (MANET). An ad hoc network [1] is a collection of mobile nodes forming a temporary network without the aid of any centralized administration or standard support services regularly available on conventional networks. Mobile Ad hoc networks (MANETs) are of much interest to both the research community and the military because of the potential to establish a communication network in any situation that involves emergencies. Examples are military deployment in hostile environment, search-and-rescue operations and several types of police and military operations. The advantages of such network are flexibility, rapid deployment, robustness, and inherent support for mobility. 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.

In the previous studies on mobility patterns in wireless cellular networks[3][4], researchers mainly focus on the movement of users relative to a particular area (i.e., a cell) at a macroscopic level, such as cell change rate, handover traffic and blocking probability. However, to model and analyse the mobility models in MANET, we are more interested in the movement of individual nodes at the microscopic-level, including node location and velocity relative to other nodes Over the last few years, a number of routing protocols have been anticipated and enhanced to well route data packets among two nodes in MANETs [3]. It is not clear how those different protocols perform under different environments like that a protocol may be the best in one network configuration but the worst in another.

The main aim of this paper is:

• Describing the detailed understanding of ad hoc routing protocols.
• Implementing the Mobility models
• Analyse and compare the performance of routing protocols under different mobility models. The purpose of this research is to provide understanding of how mobility affects routing in ad hoc networks and how to quantize those effects.

The rest of the paper is organized as follows. In following section, we first present an entity model named Random Way Point mobility model [4] and Freeway mobility model, called Reference Point Group Mobility model(RPGM)[5]. And further briefly discusses the MANET routing protocols description and the functionality of the two familiar reactive routing protocols AODV and DSR. Further it shows the simulation results and performance comparison of the two above said routing protocols. Finally, it concludes with the comparisons of the overall performance of two reactive routing protocols AODV and DSR based on metrics like packet delivery ratio (PDR), the average end-to-end delay and Throughput.

In Fig.2 we provide a categorization for various mobility models into several classes based on their specific mobility characteristics. For some mobility models, the movement of a mobile node is likely to be affected by its movement history. We refer to this type of mobility model as mobility model with temporal dependency. In some mobility scenarios, the mobile nodes tend to travel in a correlated manner. We refer to such models as mobility models with spatial dependency. Another class is the mobility model with geographic restriction, where the movement of nodes is bounded by streets, freeways or obstacles.

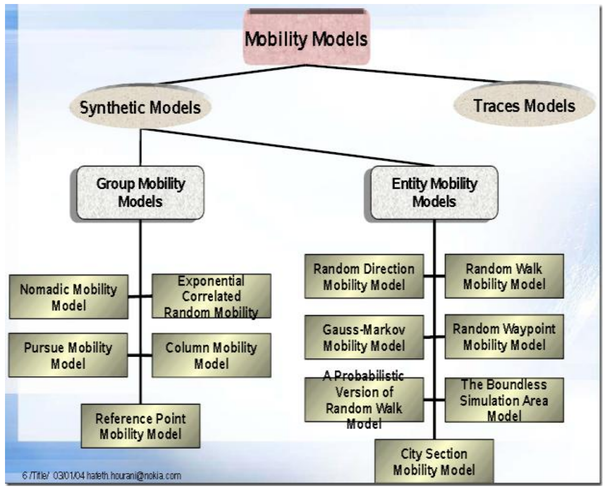

Figure 2: The categories of mobility models in Mobile Ad hoc Network

II. MOBILITY MODELS

Different mobility models can be differentiated according to their spatial and temporal dependencies.
Spatial dependency: It is a measure of how two nodes are dependent in their motion. If two nodes are moving in same direction then they have high spatial dependency.
Temporal dependency: It is a measure of how current velocity (magnitude and direction) are related to previous velocity. Nodes having same velocity have high temporal dependency.

A. Random Waypoint Mobility Model

The random way point model [4] is the simplest model but still the most widely used model to evaluate the performance of MANETs. The random way point model includes pause time between changes in direction and/or speed[7]. As a Mobile Node begins to move, it stays in one location for a certain period of time i.e. pause time. Once the pause time is elapsed, the Mobile node randomly chooses the next destination in the simulation area and selects a random speed uniformly distributed between [minspeed, maxspeed] and travels with a speed *v* which is uniformly chosen between the interval (0, *Vmax)*. Then, the Mobile Node continues its journey toward the newly selected destination at the chosen speed. As the mobile node arrives at the destination, it stays again for the specified pause time before continuing the process. The Random Waypoint Mobility Model is very widely used in simulation studies of MANET. As described in the performance measures in mobile ad hoc networks are affected by the mobility model used. Figures 3-5 illustrate examples of a topography showing the movement of nodes for Random Mobility Model.

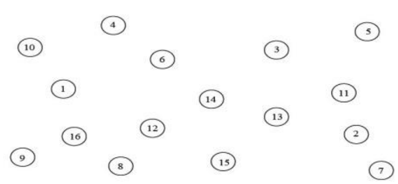

Figure 3: Topography showing the movement of nodes for Random mobility model.

B. Random Point Group Mobility Model

Random Point Group Mobility (RPGM) [5] Model described as another way to simulate group behaviour, The RPGM Group mobility may be used in rescue operations and military battlefield applications, where the commander and soldiers form a logical group. In reference point group mobility model, simulate group behaviour, where each node belongs to a group where every node follows a logical centre (group leader) that determines the group's motion behaviour. The nodes in a group are randomly distributed around a reference point. Each node uses their own mobility model and is then combined to the reference point, which directs them in the direction of group. The movement of a group leader determines the movement of the members of that group. This generic description of group mobility can be used to create diversity of models for different types of mobility applications. Given below is example topography showing the movement of nodes for Random Point Group Mobility Model. The scenario contains sixteen nodes with Node 1 and Node 9 as group leaders.

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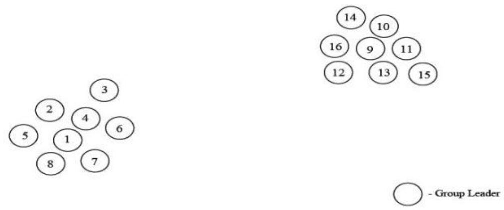

Figure 4: Topography showing the movement of nodes Random point group mobility

C. Freeway Mobility Model

This model emulates the motion behaviour of mobile nodes on a freeway. It can be used in exchanging traffic status or tracking a vehicle on a freeway. Each mobile node is restricted to its lane on the freeway. The velocity of mobile node is temporally dependent on its previous velocity. Given below is example topography showing the movement of nodes for Freeway Mobility Model with twelve nodes.

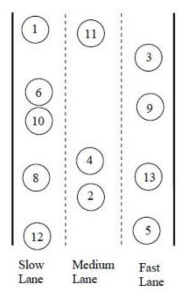

Figure 5: Topography showing the movement of nodes for Freeway mobility model.

III. DESCRIPTION OF ROUTING PROTOCOLS

A. Bellman Ford Routing

Bellman-Ford Routing Algorithm, also known as Ford-Fulkerson Algorithm, is used as an algorithm by distance vector routing protocols such as RIP, BGP, ISO IDRP, and NOVELL IPX. Routers that use this algorithm will maintain the distance tables, which tell the distances and shortest path to sending packets to each node in the network. The information in the distance table is always updated by exchanging information with the neighboring nodes. The number of data in the table equals to that of all nodes in networks (excluded itself). The columns of table represent the directly attached neighbors whereas the rows represent all destinations in the network. Each data contains the path for sending packets to each destination in the network and distance/or time to transmit on that path. The Measurements in this algorithm are the number of hops, latency, the number of outgoing packets, etc.

B. FSR

Fisheye Source Routing (FSR) is based on a method to divide each node's neighborhood to blurred zones so that the information details and accuracy is better for nodes to be near. The name's basis is on the phenomenon of fish eye's ability to see objects the better the nearer they are. In FSR zones are classified according to the distance, measured by hops, from the node. In figure 6 there can be seen three differed zones.

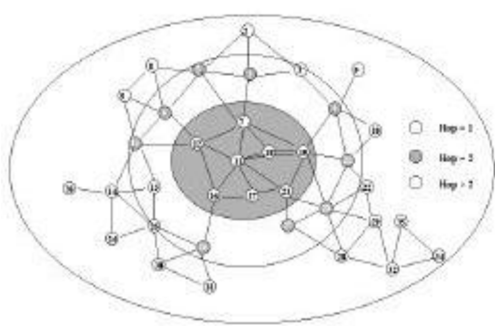

Figure 6: Scope of fisheye

FSR is a protocol to be built on top of another protocol. It can be applied to work together with some link-state protocols as GSR. In GSR link state packets are not flooded but nodes maintain a link state table based on the up-to-date information received from neighboring nodes and periodically exchange it with their local neighbors.The drawbacks of GSR are the large size update messages and the latency of the link state change propagation. FSR is applied to alleviate that situation by reducing the size of update messages without seriously affecting routing accuracy.The reduction of update message size is obtained by using different exchange periods for different entries in the table. The entries corresponding to nodes within the smaller scope are propagated to the neighbors with the highest frequency. As a result, a considerable fraction of link state entries are suppressed, thus reducing the message size. The imprecise knowledge of best path to a distant destination is compensated by the fact that the route becomes progressively more accurate as the packet gets closer to its destination.

C. Cluster Gateway Switch Routing

Clusterhead Gateway Switch Routing protocol is a multichannel operation capable protocol. It enables code separation among clusters. The clusters are formed by cluster head election procedure, which is quite intensive process. CGSR is not an autonomous protocol. This protocol modifies DSDV by using a hierarchical cluster-head-to-gateway routing approach to route traffic from source to destination. Gateway nodes are nodes that are within the communication ranges of two or more cluster heads. A packet sent by a node is first sent to its cluster head, and then the packet is sent from the cluster head to a gateway to another cluster head, and so on until the cluster head of the destination node is reached. The packet is then transmitted to the destination from its own cluster head. By forming several clusters; this protocol achieves a distributed processing mechanism in the network. However, one drawback of this protocol is that, frequent change or selection of cluster heads might be resource hungry and it might affect the routing performance.

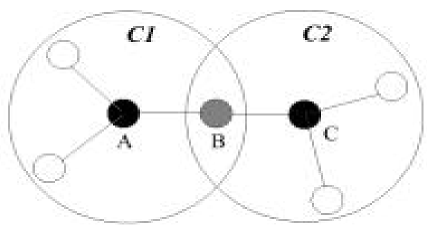

Figure 7: CGSR routing example

In above figure there is a example how the protocols manages to transmit a packet from node A to node C in CMDA network:

1. Node A (cluster head of C1) must get the permission to transmit (receives a token) in cluster C1.
2. Node B (gateway) must select the same code as node A to receive the packet from node A.
3. Node B must select the same code as node C (cluster head of C2) and get the permission to transmit in cluster C2 (receives a token from node C).

D. Sharp Hybrid Adaptive Routing

Sharp Hybrid Adaptive Routing Protocol (SHARP) adapts between reactive and proactive routing by dynamically varying the amount of routing information shared proactively. This protocol defines the proactive zones around some nodes. The number of nodes in a particular proactive zone is determined by the node-specific zone radius. All nodes within the zone radius of a particular node become the member of that particular proactive zone for that node. If for a given destination a node is not present within a particular proactive zone, reactive routing mechanism (query-reply) is used to establish the route to that node. Proactive routing mechanism is used within the proactive zone. Nodes within the proactive zone maintain routes proactively only with respect to the central node. In this protocol, proactive zones are created automatically if some destinations are frequently addressed or sought within the network. The proactive zones act as collectors of packets, which forward the packets efficiently to the destination, once the packets reach any node at the zone vicinity.

IV. SIMULATION ENVIORMENT

Qualnet: Graphical Scenario and visual SIMULATION TOOL

Qualnet is a graphical scenario design and visualization tool. In Design mode, you can set up terrain, network connections, subnets, mobility patterns of wireless users, and other functional parameters of network nodes. You can create network models by using intuitive, click and drag operations. You can also customize the protocol stack of any of the

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nodes. You can also specify the application layer traffic and services that run on the network. In Visualize mode, you can perform in-depth visualization and analysis of a network scenario designed in Design mode. As simulations are running, users can watch packets at various layers flow through the network and view dynamic graphs of critical performance metrics. Real-time statistics are also an option, where you can view dynamic graphs while a network scenario simulation is running.

QualNet Analyzer: A statistical graphing tool that displays hundreds of metrics collected during simulation of a network scenario. You can choose to see pre-designed reports or customize graphs with their own statistics. Multi-experiment reports are also available. All statistics are exportable to spreadsheets in CSV format.

QualNet Packet Tracer: A graphical tool that provides a visual representation of packet trace files generated during the simulation of a network scenario. Trace files are text files in XML format that contain information about packets as they move up and down the protocol stack.

QualNet File Editor: A text editing tool

QualNet Command Line Interface: Command line access to the simulator

LANGUAGE USED AND COMPONENT DIAGRAM OF QUALNET:

C++: For implementing new protocols, Qualnet uses C/C++ and follows a procedural paradigm. Uses the parallel simulation environment for complex systems (PARSEC) for basic operations, hence can run on distributed machines [15]. The component diagram of QUALNET is given in Figure 8.

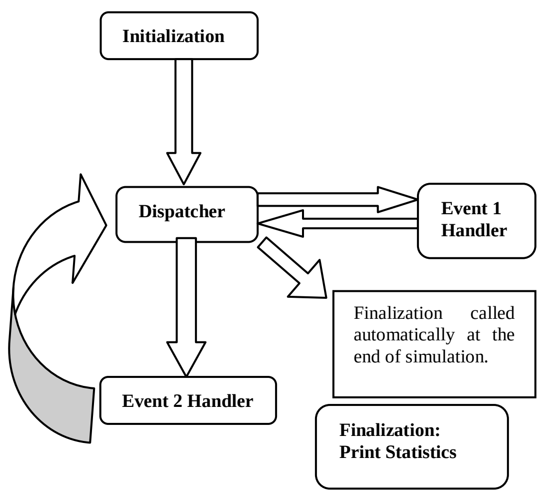

Figure 8: Architecture of QualNeT

V. RESULTS

Three performance metrics are used for measuring the performance of Bellman Ford, DSR, OLSR and DREAM Routing Protocols. The simulation results are shown in the form of graph that represents (i) Packet Delivery Ratio, (ii) Average End to End Delay and (iii) Throughput.

A. Packet Delivery Ratio:

Number of Data Packets Delivered over Number of Data Packets Generated. “Number of Data Packets Delivered” is the total number of received data packets by destinations; “Number of Data Packets Generated” is the total number of generated data packets by sources. Figure 9 (a), (b) and (c) shows the graph of Bellman Ford, FSR, CGSR and SHARP routing protocol for packet delivery ratio [9] between three mobility scenarios: Random Waypoint, Group Mobility and Freeway Models respectively.

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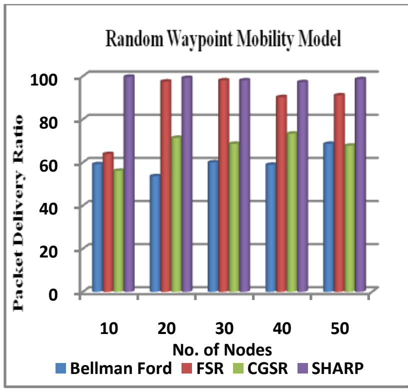

Figure 9 (a). PDR with Random Way Point model

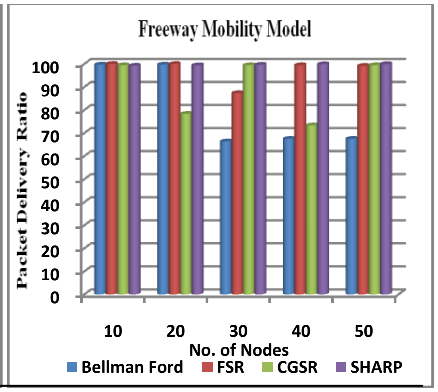

Figure 9 (b). PDR with Freeway mobility model

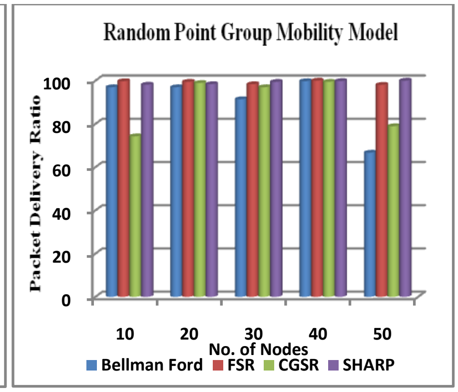

Figure 9 (c). PDR with Random point group mobility model

B. Average End to End Delay:

Average packet delivery time from a source to a destination. First for each source-destination pair, an average delay for packet delivery is computed. Then the whole average delay is computed from each pair average delay.Figure 10 (a), (b) and (c) shows the graph of Bellman Ford, FSR, CGSR and SHARP routing protocol for average end to end delay between three mobility scenarios: Random Waypoint, Group Mobility and Freeway Models respectively**.** End-to-end delay includes the delay in the send buffer, the delay in the interface queue, the bandwidth contention delay at the MAC, and the propagation delay.

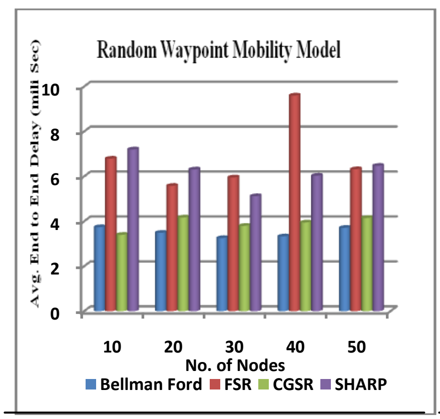

Figure 10 (a). End to End Delay with Random Way Point model

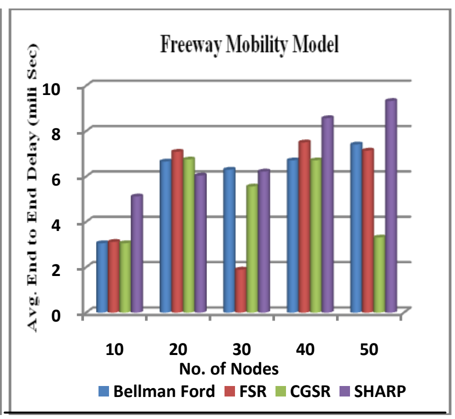

Figure 10 (b). End to End Delay with Freeway mobility model

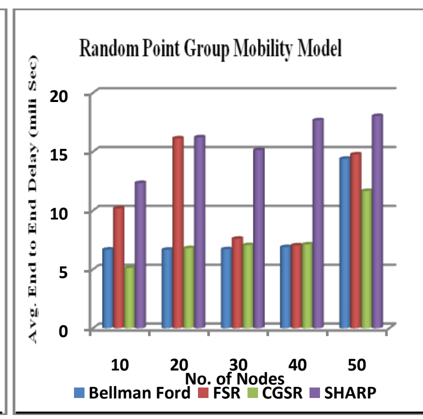

Figure 10 (c). End to End Delay with Random point group mobility model

C. Throughput:

Throughput is the number of packet that is passing through the channel in a particular unit of time. This performance metric show the total number of packets that have been successfully delivered from source node to destination node and it can be improved with increasing node density. Figure 11 (a), (b) and (c) shows the graph of Bellman Ford, FSR, CGSR and SHARP routing protocol for throughput between three mobility scenarios: Random Waypoint, Group Mobility and Freeway Models respectively.

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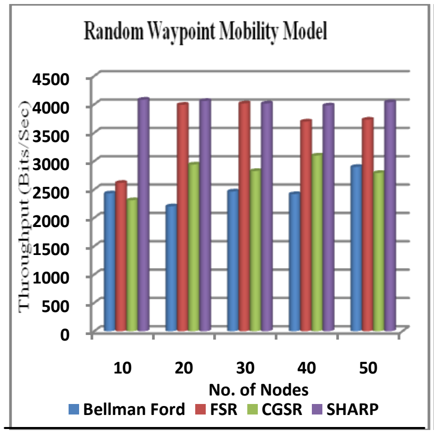

Figure 11 (a). Throuhput with Random Way Point model

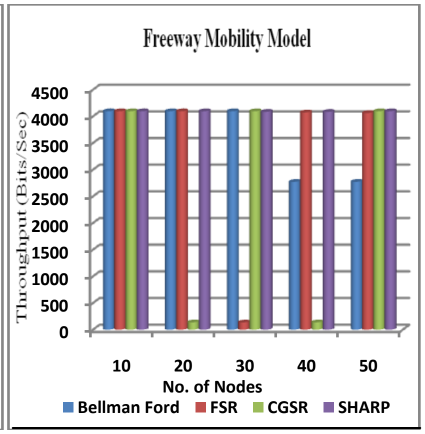

Figure 11 (b). Throuhput with Freeway mobility model

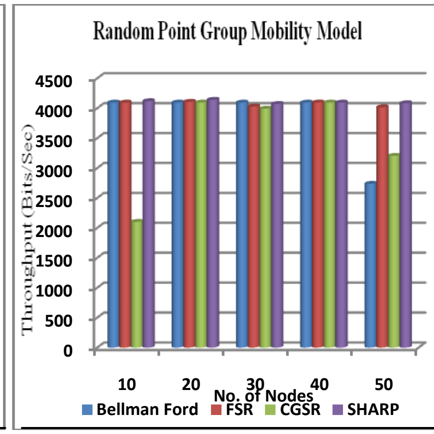

Figure 11 (c). Throuhput with Random point group mobility model

VI. CONCLUSION

In this paper we have simulated the Bellman Ford, FSR, CGSR and SHARP routing protocols on QualNet Simulator. The performance of the protocols was measured with respect to metrics like Packet delivery ratio, end to end delay and Throughput. Simulations were carried out with identical networks and running different protocols on the mobile node. The simulation is divided in three parts basis on the mobility model (random waypoint mobility, random point group mobility model and freeway mobility model). Here we conclude as:
1. SHARP performs well than FSR, Bellman Ford and CGSR (in reference to packet delivery ratio) if the node mobility is random waypoint and random point group mobility model.
2. Bellman Ford has performed well when the node mobility model is freeway mobility model.
3. Packet delivery ratio is increases as the number of nodes increases.
4. Freeway mobility model is better than the other two mobility models in terms of Packet Delivery Ratio.
5. Bellman Ford performs better than FSR, SHARP and CGSR in terms of average end to end delay and random waypoint mobility model is better than random point group mobility model and freeway mobility model.
5. FSR and SHARP both have better Throughput than Bellman Ford and CGSR.
6. Random point group mobility is better in compare to freeway mobility model and random way point mobility model in terms of throughput.

For the above discussion we can say that all the routing protocols and mobility models have their own significance they all have their own advantages and disadvantages its depends upon the situation where we have to use. In some situation SHARP Routing is better and in some situation FSR is better. In some cases Random Waypoint mobility model is better and in some cases Random Point Group mobility model is better.

VII. FUTURE SCOPE

Future work may include same experiments for SRMP, OSPF, DYMO and ZRP, measuring the average end to end delay, packet delivery rate and drop ratio and the same experiments for different node mobility speed of the simulation and other mobility models. Another Future work is to perform the experiments for various different node migration speeds.Further study should be assigned to the Boundless mobility model on the real implementation to be sure if it is suitable to be deployed in real-life implementation.Performance of other routing protocol can be evaluated over various mobility models taking in to consideration number of average connected paths to gain greater insights into the relationship between them. Designing scenarios which depict real world applications more accurately can be designed through in-depth study of the application.

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REFERENCES

[1]. Nancy Garg, "Network Simulators: A Case Study", IJARCSSE, 5(1), January - 2015, pp. 651-655.
[2]. Yassine MALEH, DR. Abdellah Ezzati "Comparative Analysis of Routing Protocols AODV DSDV and DSR in MANET", IJCSMC, Vol. 3, Issue. 3, March 2014, ISSN 2320–088X.
[3]. Danish Vasan, "A Consolidated Analysis of MANET Routing Protocols", IJWCNT, 3(2), February – March 2014, 30- 34.
[4]. Sanjeev Kumar, "Investigate and Improving Routing Mobility Based On Random Way Point Mobility Model Using FTP Traffic in MANET" ,IJARCSSE, 3(4), April - 2013, pp. 332-337.
[5]. Dr.S.S.Dhenakaran[1] , A. Parvathavarthini[2], "An Overview of Routing Protocols in Mobile Ad-Hoc Network", IJARCSSE, 3(2), February - 2013, pp. 251-259.
[6]. Preeti Gaharwar[1], Mr. Sunil R. Gupta[2] Performance Comparison of AODV, DSDV & DSR Routing Protocols in MANET IJARSSE, Volume 3, Issue 4, April 2013, ISSN: 2277 128X.
[7]. Preeti Gaharwar[1], Mr. Sunil R. Gupta[2] "Performance Comparison of Routing Protocols" IJARCCE Vol. 2, Issue 4, April 2013, ISSN (Print): 2319-5940.
[8]. Somya Jain[1], Deepak Aggarwal[2] "Performance Evaluation of Routing Protocols for MAC Layer Models", IOSR-JCE, Volume 10, and Issue-4 (Mar. - Apr. 2013), PP 71-77, ISSN: 2278-8727.
[9]. Robinpreet Kaur & Mritunjay Kumar Rai, A Novel Review on Routing Protocols in MANETs, Undergraduate Academic Research Journal (UARJ), ISSN : 2278 – 1129, Volume-1, Issue-1, 2012.
[10]. Dr. Kamaljit I. Lakhtaria, Analyzing Reactive Routing Protocols in Mobile Ad Hoc Networks, Int. J. Advanced Networking and Applications Volume:03 Issue:06 Pages:1416-1421 (2012) ISSN : 0975-0290.
[11]. C. Bettstetter, H. Hartenstein, and X. Perez-Costa, Stochastic Properties of the Random Waypoint Mobility Model, in ACM/Kluwer Wireless Networks, Special Issue on Modeling And Analysis of Mobile Networks, vol. 10, no. 5, Sept 2004.
[12]. F. Bai, A. Helmy, "A Survey of Mobility Modeling and Analysis in Wireless Adhoc Networks" in Wireless Ad Hoc and Sensor Networks, Kluwer Academic Publishers, 2004.
[13]. F. Bai, G. Bhaskara and A. Helmy," Building the Blocks of Protocol Design and Analysis Challenges and Lessons Learned from Case Studies on Mobile Adhoc Routing and Micro-Mobility Protocols", ACM Computer Communication Review, Vol.34, No.3, pp.57-70, 2004.
[14]. F. Bai, N. Sadagopan and A. Helmy, "IMPORTANT:A framework to systematically analyze the Impact of Mobility on Performance of Routing protocols for Adhoc Networks, IEEE INFOCOM, pp. 825-835, 2003.
[15]. David B. Johnson, David A. Maltz, Yih-Chun Hu, The Dynamic Source Routing (DSR) Protocol for Mobile Ad Hoc Networks.draft-ietf-manet-dsr-10.txt, July 2004.
[17]. Biao Zhou, Kaixin Xu and Mario Gerla, "Group and Swarm Mobility Models for Ad Hoc Network Scenarios Using Virtual Tracks, In Proceedings of MILCOM'2004, Volume 1, pp. 289- 294, 1994.
[18]. User Manual for IMPORTANT Mobility Tool Generator in NS-3 Simulator. Release Date February 2010.

BIOGRAPHY

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