COMPARATIVE ANALYSIS OF MANET PROTOCOLS THROUGH SIMULATION USING PERFORMANCE EVALUATION METRICS

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ABSTRACT

Mobile Adhoc Network (MANET) is a form of wireless communication network that has received high attention in scientific research in the past decade. It contains mobile routers/hosts which communicate with each other through wireless links. The network topology is dynamic in nature. Collaborative computing in smaller areas can be set up using MANET. It covers wide application areas viz. military communications, emergency rescue operations, virtual classrooms, conferences, seminars and communication at airport terminals etc. MANET has brought hi-tech opportunities besides certain challenges. During communication over MANET, various routing protocols are needed. Since MANET supports mobile devices, the wireless links go down frequently. Hence stable routing is very critical to achieve due to highly dynamic environment. In this research paper, efforts have been made to carry out simulation modeling of two prime on-demand routing protocols i.e. DSR and AODV. The comparative analysis of these two protocols has been done using performance evaluation metrics through a self-created network scenario. It has been observed that AODV protocol performs better in dense environment in terms of stable routing and hence it can be chosen as a base protocol for further research in the field of MANET.

Keywords*: Adhoc, AODV, DSR, MANET, Networks, Routing, Simulation, Wireless*

I. Introduction

In MANET, routers/hosts are mobile devices and hence free to move randomly/arbitrarily. Network topology changes unpredictably and very rapidly. In nutshell, MANET is composed of wireless mobile devices/nodes that forms a temporary network with no fixed infrastructure. The mobile devices can be Laptop, Personal Digital Assistant (PDA) and Smartphone etc. These are often limited in resources such as CPU capacity, storage capacity, battery power and bandwidth. With the evolution of technology, stable and robust routing strategy in MANET has received high attention in scientific research in the past decade. MANET imposes certain routing constraints due to limited resources and dynamic nature of nodes.

The mobile wireless network is further classified into categories. One is Infrastructured network and other is Infrastructure-less network. In Infrastructured wireless network, base stations are fixed and nodes keep on moving. Due to mobility of nodes, whenever one node is beyond the range of its own base station, it gets into the range of another base station. In contrast, Infrastructureless wireless network does not require any fixed base stations and all the nodes behave as routers. Moreover, the nodes keep on moving during communication. This type of dynamic network is known as known as an adhoc network. Devi, M. et al. [1] in their paper entitled "Novel Algorithm for Enhancing Bitrate in MANET for Topology Based Routing Protocol" displays Infrastructured & Infrastructureless wireless networks as given in figure 1.

MANET has brought hi-tech opportunities besides certain challenges. The following list itemizes some of the key challenges in the area of MANET:

- Dynamic topology
- Frequent path breaks
- Stable routing
- Routing overhead
- Packet loss
- Scalability
- Secure routing
- Energy efficient routing

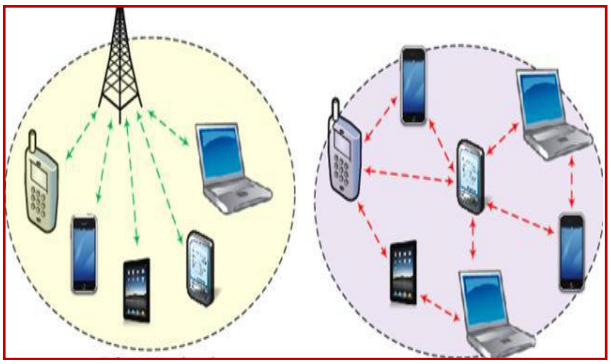

Figure 1: Infrastructured & Infrastructureless Wireless Networks

II. Objectives of Study

The objectives of this study are as follows:-

1. To do thorough literature review on MANET
2. To study prominent MANET protocols viz. DSR and AODV
3. To study various performance evaluation metrics
4. To simulate DSR and AODV protocols through self-created network scenarios
5. To do comparative analysis using performance evaluation metrics

III. Literature Review

During communication over MANET, various routing protocols are needed. Basically, whenever a node wants to transmit some information from source to destination in the form of packets, routing protocol is required. An exhaustive study on various parameters pertaining to routing protocols has been one of the active areas of interest. In this research paper, continuous efforts have been made to do comparative study of MANET routing protocols. Primarily, routing protocols are divided into two categories:

a) Table Driven (Proactive) Protocols
b) On-Demand (Reactive) Protocols

In table driven (proactive) protocols, each node is maintaining one or more tables. These tables contain routing information pertaining to every other node in the wireless network. All nodes make continuous updates in the concerned routing tables in order to maintain the current status of the network. Prominent protocols in this category include Destination-Sequenced Distance Vector Protocol (DSDV), Global State Routing (GSR) and Wireless Routing Protocol (WRP). In on-demand (reactive) protocols, routes are not pre-defined. They are created dynamically on need basis. Whenever a node transmits information from source to destination, route discovery procedure is executed. Current route is valid till destination is achieved or until the route is no longer required. Prominent protocols in this category include Dynamic Source routing (DSR) and Adhoc On-Demand Distance Vector (AODV).

Perkins, C. E. [2] discussed about adhoc networking, Department of Defense (DoD) perspective on mobile adhoc networks, DSDV - Routing over a multihop wireless network of mobile computers, DSR for multihop wireless adhoc networks, AODV protocol etc. in a book entitled "Adhoc Networking".

Rohal, P. et al. [3] presented study and analysis of throughput, delay and packet delivery ratio in MANET for topology based routing protocols: AODV, DSR and DSDV. The performance of the routing protocols was evaluated in mobile network environment. The applicability of protocols was assessed in different mobile traffic scenarios.

Nayak, P. et al. [4] presented analysis of random way point and random walk mobility model for reactive routing protocols for MANET using NetSim Simulator. The performance of DSR and AODV routing protocol with different mobility model was evaluated using NetSim Simulator to extend the applicability of these protocols.

Xiang, S. et al. [5] discussed the evaluation method regarding performance reliability of mobile ad hoc networks. The impact of interference on the transmission reliability was considered. The topology optimization of the MANET was studied based on the transmission reliability.

Ilanchezhiapandian G. et al. **[6]** presented the mechanism to handle frequent path breakage because of mobility of nodes and stable route selection through development of a path break prediction QoS routing protocol for MANET.

A brief review of prominent on-demand routing protocols i.e. DSR and AODV is given here in this paper.

IV. DSR Protocol

DSR [7, 9] protocol is source-initiated rather than hop-by-hop. This protocol is based on the concept of source-based routing rather than

table-based routing. This protocol does not require any existing network infrastructure. It allows the wireless network to be completely self-organizing. Two essential phases of this protocol are route discovery and route maintenance. In this routing protocol, each node is maintaining a cache to store recently discovered paths. Every time a node sends packet to some other node, it first checks cache entry. If it is found in the cache, it uses that path only to transmit the packet. It also attached its source address on the packet. If it is not found in the cache, the sender sends a route request packet to all of its neighbors requesting for a path to the destination. The sender keeps on waiting till the route is discovered. During the waiting tenure, the sender performs other tasks also and keeps on transmitting other packets. When route request packet comes to any of the nodes, it checks from neighbor or from cache whether the destination is known or not known. If route information is known, it sends back a route reply packet to the destination otherwise it broadcasts the same route request packet. When the route is discovered, the required packets will be transmitted on the discovered route. Also an entry will be made in cache for future use. Aging information is also recorded in the entry to know whether the cache is fresh or not. Whenever a data packet is received by any intermediate node, it first checks whether the packet is meant for itself or not. If it is meant for itself, the packet is received otherwise the same is forwarded using the path attached on the data packet. Since in MANET, any link might fail anytime on account of dynamic topology. Therefore, route maintenance process keeps on monitoring constantly and notifies the nodes if there is any failure in the path. Accordingly, the nodes will change the entries of their route cache.

V. AODV Protocol

ADOV [8, 10] protocol is mainly based on DSDV and DSR protocols. This protocol does not maintain routes from every node to every other node. Routes are discovered on need basis and maintained till they are needed. In this routing protocol, whenever a node wants to transmit a data packet to destination, the entries in route table are checked. It is ensured whether there is a current route to the destination or not. If route exists, data packet is forwarded to the next relevant node towards destination. If route do not exists, then route discovery process is executed. AODV routing protocol executes route discovery process using Route Request (RREQ) and Route Reply (RREP) packets. The source node creates a RREQ packet. This packet contains its IP address, the destination's IP address, sequence numbers and broadcast ID. Whenever source node initiates RREQ, broadcast ID is incremented. The requests are sent using RREQ packets and the information regarding creation of a route is sent using RREP packets. RREQ is broadcasted by the source node to its neighbors and subsequently reply is awaited. To process the RREQ, the node sets up a reverse route entry in route table in order to forward a RREP to the source. Mostly a life-time is associated with the reverse route entry. If reverse route entry is not used within lifetime, the route information is permanently deleted. However, if RREQ packet is lost during transmission, the source node is permitted for broadcasting again using route discovery process. Maintenance of routes in AODV routing protocol is carried out through local route repair scheme.

VI. Performance Evaluation Metrics

There are number of quantitative metrics that can be used for evaluating the performance of a routing protocol for MANET viz.

- Packet Delivery Fraction (PDF)
- Average End-to-End Delay
- Throughput
- Packet Loss
- Normalized Routing Load
- Energy Consumed by Node
- Energy Left in Node

Out of these metrics, the prominent ones are Packet Delivery Fraction (PDF) and Average End-to-End Delay. The same has been used in this research paper during comparative analysis of MANET protocols through simulation.

VII. Simulation Model

In this research work, the efforts has been made to simulate the MANET routing protocols using network simulator by

developing a self created network scenario and using random waypoint mobility model. The study will help in comparative analysis of prominent MANET Protocols (DSR & AODV) to choose the base protocol for further research. Self-created denser medium as well as sparse medium scenarios have been developed using TCL scripts. The numbers of mobile devices/nodes considered in self-created scenarios are 30 (sparse medium) and 60 (denser medium) respectively. Software used for simulation modeling is network simulator. The packet size for transmission is taken as 512 bytes. Same TCL script/self-created network scenario is executed first for DSR protocol and then for AODV protocol in order to perform their comparative analysis. Varying parameters are number of nodes, speed, pause time, UDP/CBR traffic and TCP/FTP traffic with area as 800 meter x 800 meter. The performance metrics considered during comparative analysis are Packet Delivery Fraction (PDF) and Average End-to-End Delay.

VIII. Comparative Analysis of DSR and AODV

In figure 2, X-axis represents varying speed and Y-axis represents PDF. The results given below corresponds to UDP/CBR traffic with 30 mobile devices/nodes over 8 UDP connections.

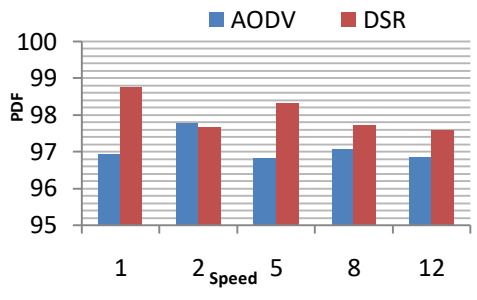

Figure 2: PDF analysis using 30 Nodes with varying speed (UDP)

In figure 3, X-axis represents varying pause time and Y-axis represents PDF. The results given below corresponds to UDP/CBR traffic with 30 mobile devices/nodes over 8 UDP connections.

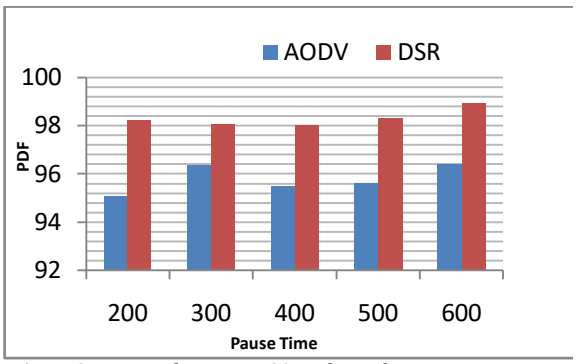

Figure 3: PDF analysis using 30 Nodes with varying pause time (UDP)

In figure 4, X-axis represents varying speed and Y-axis represents PDF. The results given below corresponds to TCP/FTP traffic with 30 mobile devices/nodes over 8 TCP connections.

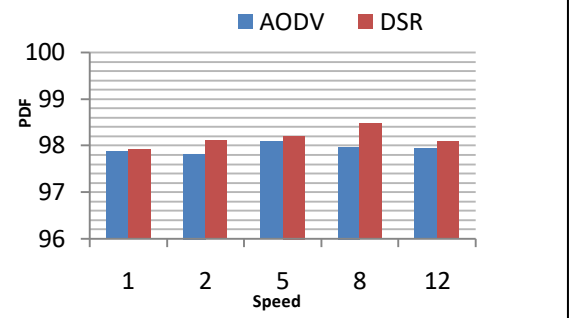

Figure 4: PDF analysis using 30 Nodes with varying speed (TCP)

In figure 5, X-axis represents varying pause time and Y-axis represents PDF. The results given below corresponds to TCP/FTP traffic with 30 mobile devices/nodes over 8 TCP connections.

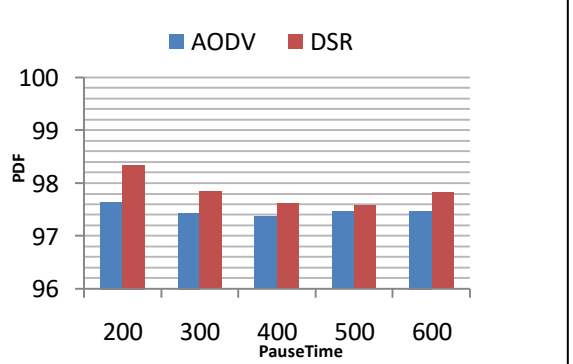

Figure 5: PDF analysis using 30 Nodes with varying pause time (TCP)

The graphical analysis on the basis of packet delivery fraction shown in figure 2 to figure 5 depicts that DSR protocol is better than AODV protocols in sparse medium

irrespective of varying speed or pause time. In figure 6, X-axis represents varying speed and Y-axis represents PDF. The results given below corresponds to UDP/CBR traffic with 60 mobile devices/nodes over 12 UDP connections.

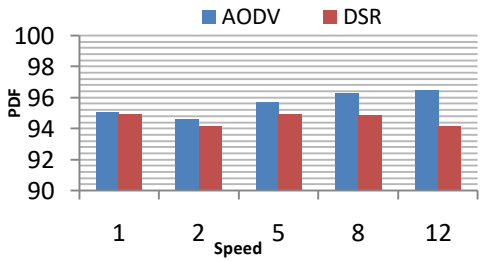

Figure 6: PDF analysis using 60 Nodes with varying speed (UDP)

In figure 7, X-axis represents varying pause time and Y-axis represents PDF. The results given below corresponds to UDP/CBR traffic with 60 mobile devices/nodes over 12 UDP connections.

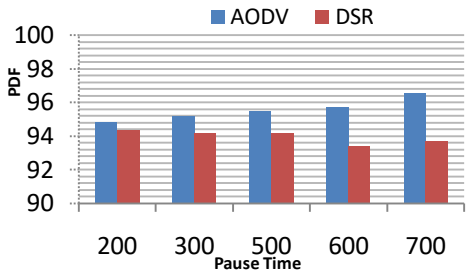

Figure 7: PDF analysis using 60 Nodes with varying pause time (UDP)

In figure 8, X-axis represents varying speed and Y-axis represents PDF. The results given below corresponds to TCP/FTP traffic with 60 mobile devices/nodes over 12 TCP connections.

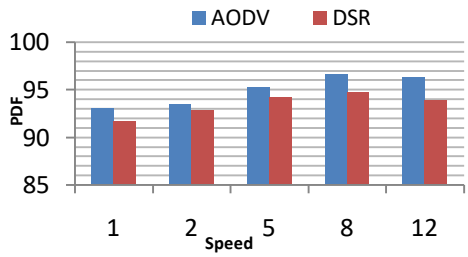

Figure 8: PDF analysis using 60 Nodes with varying speed (TCP)

In figure 9, X-axis represents varying pause time and Y-axis represents PDF. The results given below corresponds to TCP/FTP traffic with 60 mobile devices/nodes over 12 TCP connections.

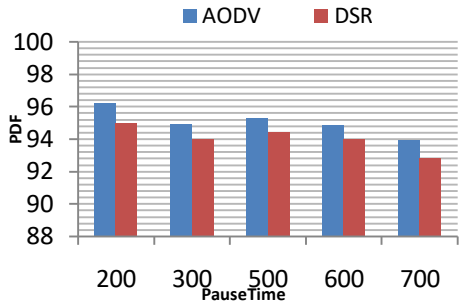

Figure 9: PDF analysis using 60 Nodes with varying pause time (TCP)

The graphical analysis on the basis of packet delivery fraction shown in figure 6 to figure 9 depicts that AODV protocol is better than DSR protocols in denser medium irrespective of varying speed or pause time. In figure 10, X-axis represents varying pause time and Y-axis represents average end to end delay. The results given below corresponds to UDP/CBR traffic with 30 mobile devices/nodes over 8 UDP connections.

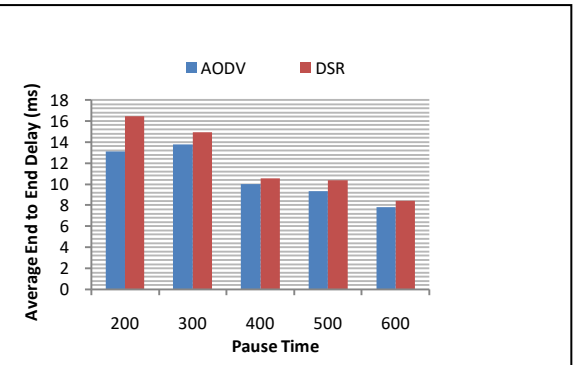

Figure 10: Average End to End Delay analysis using 30 Nodes with varying pause time (UDP)

In figure 11, X-axis represents varying pause time and Y-axis represents average end to end delay. The results given below corresponds to TCP/FTP traffic with 30 mobile devices/nodes over 8 TCP connections.

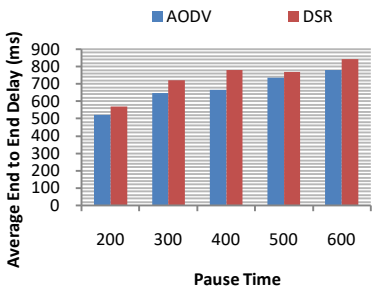

Figure 11: Average End to End Delay analysis using 30 Nodes with varying pause time (TCP)

In figure 12, X-axis represents varying pause time and Y-axis represents average end to end delay. The results given below corresponds to UDP/CBR traffic with 60 mobile devices/nodes over 12 UDP connections.

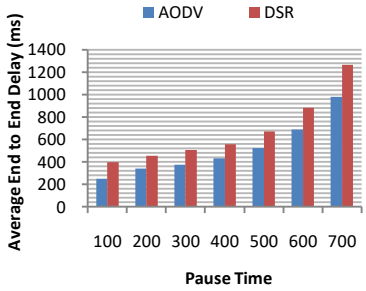

Figure 12: Average End to End Delay analysis using 60 Nodes with varying pause time (UDP)

In figure 13, X-axis represents varying pause time and Y-axis represents average end to end delay. The results given below corresponds to TCP/FTP traffic with 60 mobile devices/nodes over 12 TCP connections.

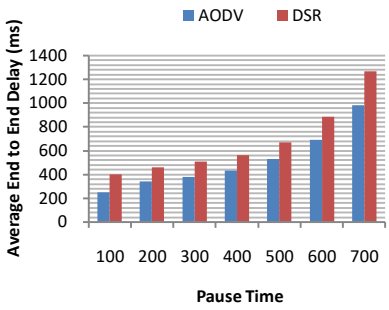

Figure 13: Average End to End Delay analysis using 60 Nodes with varying pause time (TCP)

The graphical analysis on the basis of average end to end delay shown in figure 10 to figure 13 depicts that AODV protocol is better than DSR protocols in sparse as well as in denser medium irrespective of varying pause time.

IX. Conclusion

In this paper, an attempt has been made to perform comparative analysis of two prominent MANET routing protocols viz. DSR and AODV. The simulation has been done over network simulator using self created network scenarios over random way point model. The performance evaluation metrics considered are packet delivery fraction and average end to end delay. On the basis of packet delivery fraction, it has been observed that DSR protocol outperforms AODV protocol in sparse medium but in denser medium, the performance of AODV protocol is better than DSR protocol. However, on the basis of average end to end delay, it has been found that AODV protocol outperforms DSR protocol in all situations i.e. both in sparse or denser mediums. As a conclusion, AODV routing protocol is better choice in the real time scenario to carry out further research work in the area of mobile Adhoc networks.

References

1. Devi, M. and Gill, N. S., "Novel Algorithm for Enhancing Bitrate in MANET for Topology Based Routing Protocol", International Journal of Engineering and Advanced Technology, Volume 9, Issue 1, pp. 2655-2662, October 2019.
2. Perkins, C. E., "Adhoc Networking", Addison-Wesley, 2008.
3. Rohal, P. and Dahiya, R., "Study and Analysis of Throughput, Delay and Packet Delivery Ratio in MANET for Topology Based Routing Protocols (AODV, DSR and DSDV)", International Journal for Advance Research in Engineering and

Technology (IJARET), Volume I, Issue II, March 2013.

4. Nayak, P. and Sinha, P., "Analysis of Random Way Point and Random Walk Mobility Model for Reactive Routing Protocols for MANET Using NetSim Simulator" 3rd International Conference on Artificial Intelligence, Modelling and Simulation (AIMS), Kota Kinabalu, pp. 427-432, 2015.
5. Xiang, S. and Yang, J., "Performance reliability evaluation for mobile ad hoc networks", Elsevier - Reliability Engineering & System Safety, Volume 169, Pages 32-39, 2018.
6. Ilanchezhiapandian G. and Khader P. Sheik Abdul, "A Path Break Prediction QoS Routing Protocol for MANET", Advances in Wireless and Mobile Communications, vol. 2, issue 2, 2009.
7. D. B. Johnson, D. A. Maltz AND Y.C. Hu, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", IETF Draft, 2003.
8. C. Perkins, E. B. Royer, S. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing", IETF Draft, 2003.
9. The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks, RFC 4728, Internet Engineering Task Force (IETF), https://datatracker.ietf.org/doc/rfc4728/ [Viewed on 25th November 2020]
10. Ad hoc On-Demand Distance Vector Routing, RFC 3561, Internet Engineering Task Force (IETF), https://datatracker.ietf.org/doc/rfc3561/ [Viewed on 17th December 2020]