Comparative Study of AODV, DSR AND DSDV Routing Protocols in MANET

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Abstract—*Mobile Ad-hoc Network (MANET) is a self-configured network. MANET is an autonomous system in which mobile nodes are connected by wireless links. All nodes operate as end systems and as routers, to route packets. The nodes are freely movable and organize themselves into a network. The change in positions of these nodes is frequent. MANET comprises of numerous routing protocols such as: DSDV, DSR, OSLR, FLR, HRP, ZRP, AODV and much more. This paper attempts to compare the performance of MANET's three prominent routing protocols AODV, DSR, and DSDV by using three performance metrics, packet delivery ratio, average end to end delay and routing overhead. We made appropriate implementation and simulation using Network Simulator NS-2.35. This paper aims at providing insight on the performance of some prominent MANET routing protocols based on some important metrics and provide new researchers in the field some literatures and better understanding of MANET and its Security.*

Keywords—***MANETS, AODV, DSR, DSDV***

I. INTRODUCTION

MANET is a type of ad hoc network that can change locations and configure itself on the fly. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission. Some MANETs are restricted to a local area of wireless devices (such as a group of laptop computers), while others may be connected to the Internet. For example, VANET (Vehicular Ad Hoc Network), a type of MANET that allows vehicles to communicate with roadside equipment. While the vehicles may not have a direct Internet connection, the wireless roadside equipment may be connected to the Internet, allowing data from the vehicles to be sent over the Internet. The vehicle data may be used to measure traffic conditions or keep track of trucking fleets. Because of the dynamic nature of MANETs, they are typically not very secure. Therefore it is important to be cautious what data a number over a MANET. Due to increase in popularity of wireless mobile devices, researchers have proposed many routing protocol designs [2] to let the nodes connect with each other to communicate in an efficient and timely manner which are divided in many categories but three main categories are Proactive/Table driven [17], reactive and Hybrid routing protocol. Due to the dynamic nature of MANET, the network faces many challenges such as security, high latency by some routing protocols, high overhead, poor packet delivery ratio and High end-to-end delay; there is need for proper Study and comparison to reveal the strength and weaknesses of the most popular routing protocols in MANETs. This paper presents a comprehensive comparison of Adhoc on-Demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Destination Sequence Distance Vector (DSDV) routing protocols by simulating the routing protocols with Network Simulator 2 (NS2) with the same set of routing parameters.

A. Routing in MANET

According to [5], "Routing is the process of information exchange from one host to the other host in a network" Routing is the process of selecting the best route from source to destination for packets across the network. The efficiency of the path is measured in various metrics like Number of hops, traffic, security, etc. In Ad-hoc network each host node acts as the specialized router itself [18].

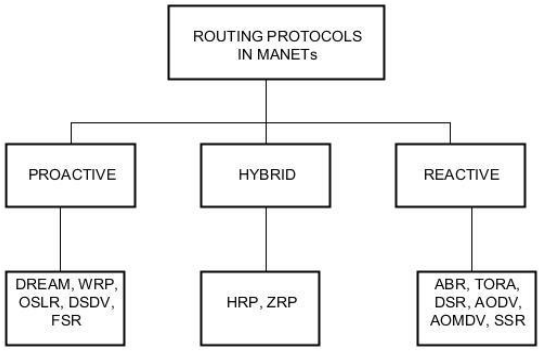

Figure 1: Routing Protocols in MANETs

B. Significance of the study

Physical security in MANET is very limited, the types of attacks can be categorized into passive and active [20]. The common security issues are Passive attacks which include eavesdropping and information disclosure. Active attacks include Denial of service, Data modification by viruses, Trojans, and worms. There are other more specific problems with mobile ad hoc network such as vulnerability of channels and nodes, black hole and wormhole attack [1]. The main purpose of this comparison is to provide an insight on the performance of some prominent MANET routing protocols for future and upcoming researchers in the field of MANET and its security.

C. Ad Hoc on-Demand Distance Vector (AODV) Routing Protocol.

AODV routing protocol is a reactive or on-demand routing protocol, which means that a route between two nodes will be determined only when there is data to be transmitted [13]. Each node's routing table only contains the next hop to a particular destination, so the information on the route to be traversed by a packet is distributed to all the nodes on the path. Neighbor connectivity is established with periodic Hello Messages. Routes are found by flooding of route request (RREQ) messages. As each node receives and retransmits the RREQ it records the previous hop in its routing table. In AODV, when a source node S wants to send a data packet to a destination node D and does not have a route to D, it initiates route discovery by broadcasting a route request (RREQ) to its neighbors. A timer call RREP_WAIT_TIME is started when the RREQ is sent. The immediate neighbors who receive this RREQ rebroadcast the same RREQ to their neighbors. This process is repeated until the RREQ reaches the destination node. Upon receiving the first arrived RREQ, the destination node sends a route reply (RREP), to the source node through the reverse path where the RREQ arrived. The destination node will ignore the same RREQ that arrives later. In addition, AODV enables intermediate nodes that have sufficiently fresh routes (with destination sequence number equal or greater than the one in the RREQ) to generate and send an RREP to the source node. Once the source receives the first RREP message, it starts the data transmission along the path traced by the RREP packet.

D. Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) is an on-demand source routing [11] that employs route discovery and route maintenance procedures same as that of AODV [9]. It performs source routing whenever it has a packet to transmit. In DSR, each node maintains a route cache with entries that are continuously updated as the node learns new routes. Similar to AODV, a node wishing to send a packet will first examine its route cache to see whether it already has a route to the destination. If there is no valid route in the cache, the sender initiates a route discovery procedure by broadcasting a route request packet, which contains the address of the destination, the address of the source, and a unique request ID [11]. When a node receives a request packet and finds its own address recorded in the packet, it discards this packet and does not rebroadcast it further. A node keeps a record of lately forwarded request packets, and maintains the cache of their sender addresses, request IDs, and rejects any duplicate request packets. The entire path from the source to the destination will have recorded once a request packet arrives at the destination.

E. *Destination Sequence Distance Vector (DSDV).*

DSDV is one of the earliest routing protocols which were designed for Ad Hoc wireless networks [2]. [17] proposed the proactive DSDV protocol and is based on the Bellman-Ford algorithm, it is a distance vector routing protocol in which nodes keep on informing the neighbor nodes about the topology changes of network. Each DSDV node maintains a routing table which stores; destinations, next hop addresses and number of hops and sequence numbers as well. Routing table updates are sent periodically as incremental dumps limited to a size of 1 packet containing only new information [7]. DSDV does its route discovery using sequence numbers and routing table updates. If it receives a high sequence number route update, it will replace existing route and will reduce the chance of routing loops, when a major topology change is detected, a complete routing table update will be done.

II. RELATED WORK.

[15] discusses the fundamental principles of the AODV but does not provide real insight into possible directions the protocol could take in the future, the network simulation collects data on several important metrics i.e. dropped packets, delay, transmission and receiving throughput, send time vs. delay, round trip time and jitter. These metrics are important for QoS considerations and useful pointers of network performance. [6], in their work, evaluated and compared AODV and DSR routing algorithm using GLOMOSIM simulator. DSR outperforms AODV in terms of overhead with just 10% of overhead as compared to AODV. DSR also performs better than AODV in constraint conditions in terms of PDR which is 90.16 % as compared to 83 % of AODV. End to End delay of AODV is less than that of DSR. For both protocols, performance improves as pause time increases. [19], also did a comprehensive performance analysis of the routing protocols using NS2 simulator considering all the metrics as suggested by RFC 2501. Results indicate reactive routing protocols are more suitable for Adhoc networks.

Geetha and Ganapathy [8] in their study, compared the performance of two prominent on-demand routing protocols for mobile ad hoc network: Dynamic Source Routing (DSR), Ad Hoc On-demand Distance Vector Routing (AODV). A detailed simulation model with MAC and physical layer models is used to study the interlayer interactions and their performance implications. They demonstrate that even though DSR and AODV share similar on-demand behavior, the differences in the protocol mechanisms can lead to significant performance differentials. In their work, they examine two on-demand routing protocols AODV and DSR based on packet delivery ratio, normalized routing load, normalized MAC load, and average end to end delay. Birdar et al., [4] compared the performance of two on-demand routing protocols for mobile ad hoc networks, Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). They demonstrate that even though DSR and AODV both are on-demand protocol, the differences in the protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying mobility. They used Network Simulation (NS)-2 in their evaluation. They compared the two protocols based on packet delivery ratio, routing overhead, average end-to-end delay and normalized routing overhead. DSR performs better in high mobility, and average delay is better in a case of AODV for increased numbers of groups. DSR Protocol produces higher control traffic during high mobility, due to its aggressive caching.

Lego et al., [12] in their paper; Comparative Study of Adhoc Routing Protocol AODV, DSR, and DSDV in Mobile Adhoc Network compared the three routing protocols based on Packet Delivery Ratio, Average End to End Delay and throughout. They analyzed that when pause time set to 0 each of the routing protocols obtained around 97% to 99% for packet delivery ratio except DSDV which obtained 77%. DSR and AODV reached approximately 100% packet delivery ratio when pausing time equal to 200 while DSDV obtained only approximately 94% packet delivery ratio. DSR and DSDV have low and stable routing overhead as the comparison to AODV that varies a lot. Avg. End to End delay of DSDV is very high for pause time 0 but it starts decreasing as pause time increases. DSR performs well as having low end to end delay. When they compare the three protocols in the analyzed scenario we found that overall performance of DSR is better than other two routing protocols.

III. SIMULATION BASED ANALYSIS USING NETWORK SIMULATOR (NS-2)

In this paper, NS2 was used as a simulation tool which is the most preferred tool for simulating MANET. NS is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks [14]. NS2 is an object oriented simulator, written in C++, with an OTcl interpreter as a frontend. This means that most of the simulation scripts are created in Tcl (Tool Command Language). If the components have to be developed for ns2, then both tcl and C++ have to be used. Even today, it remains the most widely used network simulator for TCP research. Over the period of time, it gained wide acceptance in industry, and now supports simulation of latest networking paradigms such as MANETs, VANETs, etc. At the simulation layer NS2 uses OTcl (Object oriented Tool Command Language) programming language to interpret user simulation scripts. OTcl language is in fact an object oriented extension of the Tcl Language.

A. Simulation Setup and Parameters

The performance analysis is done on LINUX (UBUNTU). NS2.35 was installed on the platform.

Table 1: Simulation setup

PARAMETERS	**VALUES**
Platform	Linux (UBUNTU V14.4)
Simulator	NS-2 (Ver. 2.35)
Simulation Time S	500 sec
Number of mobile nodes	10, 20, 30, 40, and 50
Simulation area	750 m X 750 m
Transmission range	250 m
Traffic Type	Constant Bit Rate (CBR)
Packet size	512bytes
Mobility model	Random Waypoint
Protocols	AODV, DSR AND DSDV

B. Simulation Results

This paper uses three metrics for the analysis of the routing protocols; Packet Delivery Ratio (PDR), Average end-to-end delay and Routing Overhead. PDR is defined as the ratio of the data packets received at the destination station compared to the total of data packets transmitted by the source node. The Average End-to-End Delay is defined as the average time employed for a data packet to be delivered from the source node to the destination node. Routing Overhead It is the number of packet generated by routing protocol during the simulation. Figure 1, 2 and 3 shows the graphical representation of the result obtained by comparing the three protocols based on the three metrics.

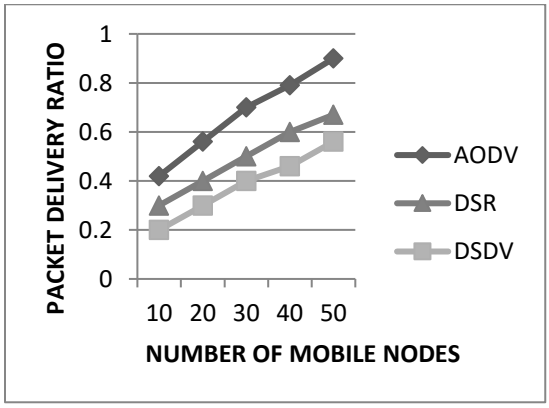

Figure 1: Packet Delivery Ratio VS No. of mobile nodes.

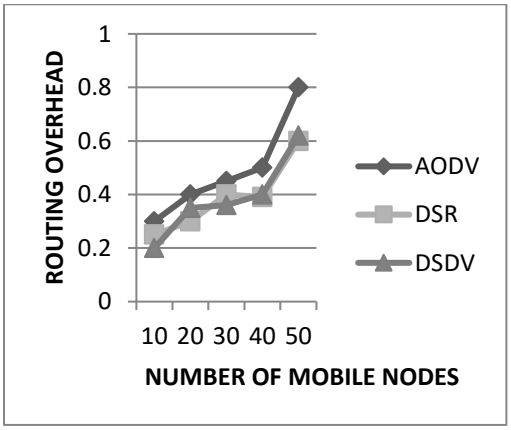

Figure 2: Routing overhead VS No. of mobile nodes.

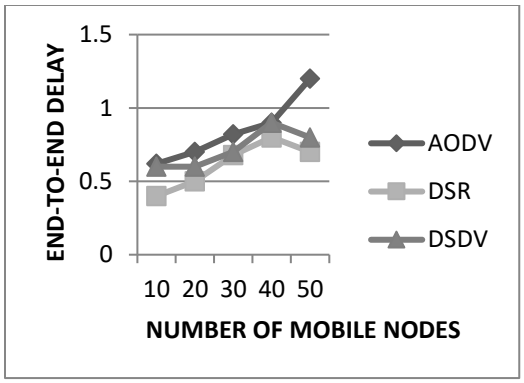

Figure 3: end-to-end delay VS No. of mobile nodes.

IV.CONCLUSION

In this paper, we reviewed and analyzed the performance of three MANET routing protocols; AODV, DSR, and DSDV. We provided some literature which can be useful for researchers, also the main aim of the comparison which is to provide an insight on the performance of some prominent MANET routing protocols for future and upcoming researchers in the field of MANET and its security. We performed the comparison by simulating the three protocols using NS2 in the same environment, using the same parameters. From figure 1 below, one can see that AODV has a better packet delivery ratio than both DSDV and DSR. In terms of overhead, DSDV and DSR are consistent with lower overhead than AODV as can be seen in figure 2. It can also be seen from figure 3 that DSR has lower end-to-end delay, followed by DSDV and then AODV. Therefore it can be concluded that DSR is better than AODV and DSDV in terms of general performance.

REFERENCES

[1] Awerbuch B., Curtmola R., Holmer D., Nita-Rotaru C., Rubens H. "Mitigating Byzantine Attacks in Ad Hoc Wireless Networks", ACM MobiCom,2000

[2] Abbas L., Iqbal M., Shafiq M, Rasool S. and Irshad A. "A Comprehensive Review of some well-known routing protocols for MANETS" International Journal of Advanced Technology &Engineering Research (IJATER), Volume 3, Issue 6, ISSN No: 2250- 3536.

[3] Bakht, H. (2011). Survey of Routing Protocols for Mobile Ad-hoc Network. International Journal of Basagni, S., Chlamtac, I., Syrotiuk, V. R., & Woodward, B.

[4] Birdar, S. R., Sarma, H. H. D., Sharma, K., Sarkar, S. K., & Puttamadappa, C. (2009). "Performance Comparison of Reactive Routing Protocols of MANETs using Group Mobility Model". International Conference on Signal Processing Systems.

[5] Bakht H. (2003), "Computing Unplugged, Wireless infrastructure, Some Applications of Mobileadhocnetworks"http://www.computingunplugged.com/issues/issue200410/00001395001.

[6] Chaba Y., Singh Y., Joon M., (2010) "Simulation-Based Performance Analysis of On-Demand Routing Protocols in MANETs" Second International Conference on Computer Modeling and Simulation.

[7] Divecha B., Abraham A, Grosan C., & Sanyal S.M., (2007) "Analysis of Dynamic Source Routing and Destination-Sequenced Distance-Vector Protocols for Different Mobility models". Proc. of First Asi International Conference on Modeling Simulation, Phuket Thailand, 27-30.

[8] Geetha, J. and Ganapathy, G "Performance Comparison of Two On-demand Routing Protocols for Ad-hoc Networks based on Random Way Point Mobility Model" American Journal of Applied Sciences. DOI: 10.3844/ajassp.2008.659.664,2008

[9] Jakhade Y. A and Gavai N.R (2015) "Comparative Study of AODV, DSR and AOMDV Routing Protocols in MANET" International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 10.

[10] Joa-Ng M. (1999), "A Peer-to-Peer Zone- Based Two-Level Link State Routing for Mobile Ad Hoc Networks", IEEE Journal on selected areas in communications, Vol. 17, No. 8.

[11] Johnson, D. B. and Maltz, D. A. "Dynamic Source Routing in Ad Hoc Wireless Networks, Mobile Computing", Chapter 5, pp.153181, Kluwer Academic Publishers, 1996

[12] Lego, K., Singh, P. K., & Sutradhar, D. (2011). Comparative Study of Adhoc Routing Protocol AODV, DSR, and DSDV in Mobile Adhoc network. Indian Journal of Computer Science and Engineering.

[13] Mahmoud T.M. Aly A.A. & Makram O.., (2015) "Avoiding Black Hole attack of AODV routing protocol in MANET (IASAODV)" Int. J. on Network Security, Vol.6.

[14] Nsnam web http://www.isi.edu/nsnam/ns/

[15] Morshed, Md. M., Rahman, Md. H., Mazumder, Md. R. R., & Lutfullah, K. A. M. (2009). "Simulation and Analysis of Ad-hoc On-demand Distance Vector Routing Protocol". ICIS, November24-26, Seoul, Korea.

[16] Makkar, A., Bhushan, B., Shelja, & Taneja, S. (2011) "Behavioral Study of MANET Routing Protocols". International Journal of Innovation. Management and Technology, Vol. 2, No. 3

[17] Perkins C. E. & Bhagwat P. (1994) "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers". In Proceedings of the ACM Conference on Communications Architectures, Protocols and Applications (SIGCOMM), pages 234244.

[18] Royer E. M. (1999). "A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks". University of California, Santa Barbara, Georgia, Institute of Technology.

[19] Reddy, P. C. (2006). "Performance Analysis of Adhoc Network Routing Protocols". ISAUHC '06, International Symposium on Ad Hoc and Ubiquitous Computing.

[20] Shrivastava, A., Shanmogavel A. R., Mistry A., Chander, N., Patlolla P., & Yadlapalli, V. (2005). "Overview of Routing Protocols in MANET's and Enhancements in Reactive Protocols". Department of Computer Science, Lamar University.