Effects of Traffic Load and Mobility on AODV, DSR and DSDV Routing Protocols in MANET

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Abstract

Mobile Ad-hoc network is an infrastructure less multi hop wireless network without the aid of any centralized administration. MANET is a self configuring and self organizing collection of mobile nodes. As the nodes provided mobility, the routing is a very complex task in MANET. In MANET each node works as a host as well as a router to forward the packets from source to destination. As in MANET the network topology is dynamic and frequently changes, so routing protocols should be designed to meet the requirement of the MANET. There are various protocols available for the routing. This paper mainly compares the working of AODV with DSR and DSDV for various traffic load and different mobility. Also in future we can compare AODV with other routing protocols.

Keywords- MANET, NS-2, AODV. DSR, DSDV, ZRP, TORA throughput, PDR, End-to-end delay

I. INTRODUCTION

Basically there are two types of networks: Infrastructure based and Infrastructure less networks. Mobile Ad-hoc networks (MANETs) are infrastructure less networks as there is no existing infrastructure available. Currently Ad hoc networks are enjoying extraordinary research interest, and are expected to provide opportunities for utilization of network applications in new scenario in which today's internet-based communication paradigms are no longer applicable. Ad-hoc networks are formed in a situation where no infrastructure is available and having no central administration. For MANET no predetermined subnet structure is known. Ad hoc networks are considered to be composed of mobile wireless devices, so the interconnection pathways between the devices can change rapidly.

As in MANET each device is free to move independently, links between the devices may change frequently. Routing is the process of forwarding the packets from source to the destination with efficient performance. As in MANET devices are moving frequently, routing is the most complex process. There are basically two types of traditional routing protocols: Link-State routing and Distance Vector routing protocols. In either case, the routing protocols typically specify that each node makes periodic advertisements to supply current routing information to its neighbors. The neighbor is then able to determine routes to network nodes based on the received information. The node can also include the information it has received into its own advertisements, as essential according to the protocol. In the case of link-state protocols, the advertisements can have information about every known link between other routing agents in the network. On the other hand, Distance-vector protocols supply next-hop information about all destinations in the network. For Internet routing protocols, routing information is aggregated according to a well-defined subnet structure in order to reduce the size of the advertisements. Routes to all hosts on a particular subnet are represented by a single route entry to a routing prefix, and the addresses of all the hosts on the subnet are then required to use the routing prefix as the initial bits of their network-layer address. Subnets with longer prefixes (i.e., more specific addressing) are themselves typically aggregated into larger subnets with shorter prefixes. At the core (center) of the Internet, there is finally a requirement to advertise all of the routing prefixes with no further aggregation possible. The routers in the Internet (core and otherwise) are often considered to be the infrastructure of the Internet. Ad hoc network study has suggested that such periodic advertisements may be uneconomical because the presumptions about fixed relationships between hosts and subnets are not necessarily valid in these networks. There may not be any flat relationship between wireless, mobile devices and any distinguished routing node. There may not be any infrastructure, and hence ad hoc networks are often characterized to be infrastructure less networks. Since the communication medium of interest is often wireless, it is matter to capacity constraints, and is less appropriate for periodic advertisements containing volumes of routing data.

Two techniques for solving this problem are 1) to limit the amount of information advertised and 2) to establish routes only on demand so that periodic advertisements are no longer required. Though, such on-demand routing protocols have the disadvantage that routes are often unavailable at the time an application first needs them. This means that applications in networks using such routing protocols often experience initial delay during the time it takes to establish a route between the communication endpoints.

II. ROUTING PROTOCOLS

Mainly there are three types of routing protocols:

(1) Proactive (Table-Driven)
(2) Reactive (On-Demand)
(3) Hybrid

Proactive routing protocols find paths for all source-destination pairs in advance and stores in the routing tables. Each node periodically exchanges the routing information by broadcasting. The protocols are also known as table-driven routing protocol. Destination-Sequenced Distance-Vector Routing (DSDV) is a proactive routing protocol.

Reactive routing protocols discover a path when a packet needs to be transmitted and no known path exists between source and destination. So the protocol is known as on-demand routing protocol. In case of routing failure occurs the protocol discovers an alternate path. Dynamic Source Routing (DSR) and Ad-hoc On-demand Distance Vector (AODV) routing protocol are the most popular routing protocols.

Hybrid routing protocols are the combination of proactive and reactive routing protocols. Hybrid routing protocol use the proactive as well as reactive routing protocols for route finding. For the route finding between two networks hybrid protocols are used. To find a route in the network proactive routing protocols are used when to find a route between two different networks reactive routing protocols are used (i.e. for short distance proactive routing protocols are used and for long distance reactive routing protocols are used). Zone Routing Protocol (ZRP) is an example of hybrid routing protocol.

A. Ad-hoc On-Demand Distance-Vector

Ad-hoc On-demand Distance Vector (AODV) [1] routing protocol is the most popular reactive unicast routing protocol, essentially combination of DSDV and DSR. AODV uses mechanism of route maintenance from DSDV and route discovery from DSR. AODV was first proposed in an Internet engineering task force (IETF) Internet draft in fall of 1997. AODV was designed to meet the following goals: [2]

• Minimal control overhead.
• Minimal processing overhead.
• Multi-hop path routing capability.
• Dynamic topology maintenance.
• Loop prevention.

Route Requests (RREQs), Route Replies (RREPs), Route Errors (RERRs) and Route Reply Acknowledgement (RREP-ACK) are message types defined by AODV [3]. Due to simple AODV messages require little computations to minimize processing overhead. AODV allows mobile nodes to find routes quickly for new destination, and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to react to link breakages and changes in network topology in a timely manner. When links break, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. The operation of AODV is loop-free, and by avoiding the Bellman-Ford "counting to infinity" problem offers quick convergence when the adhoc network topology changes (typically, when a node moves in the network).

B. Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) [4] is a reactive routing protocol which is source-initiated rather than hop-by-hop and is based on the theory of source-based routing rather than table-based. Every node in the network maintains a route cache to store the complete and ordered list of nodes through which the packet must pass to reach to the destination. Since the hop sequence is known to the source, any loop in routing can be excluded, and the routing decision is determined when sending out data packets. Thus data packets are appended with the same complete hop sequence in the packet header; intermediate nodes just forward the packet to the next hop along the hop sequence. A node that desires to send a packet to other node first checks its entry in the route cache. If the route is available then it uses that path to transmit the packet and node also attaches its source address on the packet. If the route is not available in the cache or the entry in the cache is expired, the sender initiates route discovery process by broadcasting a new Route Request packet message tagged with a unique Request ID set by the source. The Request ID, with the source node address, helps to identify Route Requests uniquely and discards any duplicate Route Requests. While receiving a non-duplicate Route Request, if the node is neither the destination nor a node with a valid route to the destination, it appends its own address into the message and re-broadcasts it to its neighbors; otherwise, the node can send back a Route Reply with a complete and ordered list of intermediate nodes from the source to the destination. Throughout propagation of the Route Reply back to the source, any intermediate node and the source can get the hop sequence, the entire route to the destination, and record it in one's route cache. In DSR no periodic routing-update messages are used. The route is used till some link on that hop sequence breaks. The link breakage is detected by using a wireless MAC layer retransmission and acknowledgement mechanism or passive acknowledgements as described in

[5]. Once a link breakage occurs at an intermediate node, the node sends a Route Error message back to the source node. Along the traverse of the Route Error, the broken link and the links after it are removed from any route cache that contains this hop. Any route containing that broken link is also removed by the source. If the source still needs to send data packets to that destination, a new route discovery process is initiated; otherwise, there is no need to discover a new route. Several optimization options proposed by DSR are: (1) salvaging used for repairing a disconnected route locally; (2) promiscuous listening used for finding smaller hop-count route; and (3) piggybacking the bad link on its next Route Request, which can assist to remove the broken link in the caches of other nodes, and keep other nodes away from generating Route Replies containing the bad link.

C. Destination-Sequenced Distance-Vector Routing (DSDV)

Destination-Sequenced Distance-Vector Routing (DSDV) [6] is a distance vector routing protocol based on classical Bellman-Ford routing algorithm. It was developed by C. Perkins and P.Bhagwat in 1994. Each node in DSDV maintains next hop table, which it exchanges with its neighbor. Periodic full-table broadcast and event-driven incremental updating are two types of next-hop table exchange. It eliminates route looping, increases convergence speed, and reduces control message overhead, by having a monotonically increasing even sequence number for each node, which increments whenever a new routing-update message is sent out, thus letting other nodes know about which routing information is fresher. Routing table also contains the hop count to the destination, next hop to the destination and currently known largest sequence number of the destination in addition to the destination node address. Packets are routed using the information available in the routing table. The relative frequency of the full-table broadcast and incremental updating is determined by node mobility. The source node appends a sequence number to each data packet sent during a next-hop table broadcast or incremental updating. This sequence number is propagated by all nodes receiving the corresponding distance-vector updates, and is stored in the next-hop table entry of these nodes. A node updates its route to a destination, after receiving a new next-hop table from its neighbor, only if the new sequence number is the same as the recorded one, but the new route is shorter or if the new sequence number is larger than the recorded one. A settling time is estimated for each route in order to further reduce the control message overhead. A node updates to its neighbors with a new route only if the settling time of the route has expired and the route remains optimal [7].

III. COMPARISON OF AODV, DSR AND DSDV

For the comparison the simulation tool used is NS-2[8] which is highly preferred by research community.

TABLE 1: SIMULATION PARAMETERS

Serial No.	Parameters	Value
1	Number of nodes	50
2	Simulation Time	200sec.
3	Area	500*500m2
4	Max Speed	20 m/s
5	Traffic Source	CBR
6	Pause Time (sec)	0, 20, 10, 30 ,40, 100
7	Packet Size	512 Bytes
8	Packet Rate	4 Packets/s
9	Max. Number of connections	10,20,30,40
10	Bandwidth	10Mbps
11	Delay	10ms
12	Mobility model used	Random way point

The performance metrics that are taken into consideration for the comparison are:

1) Throughput 3) Packet Delivery Ratio (PDR)
2) Packets Dropped 4) End-to-end delay

A. Simulation Results : Effect of mobility

The number of nodes is taken as 50 and the maximum number of connection as 20. For the analysis of the effect of mobility, pause time was varied from 0 seconds (high mobility) to 100 seconds (low mobility). Graphs shown in Fig (1-4) show the effect of Mobility for AODV, DSR and DSDV protocols with respect to various performance metrics.

1) Pause Time Vs Throughput

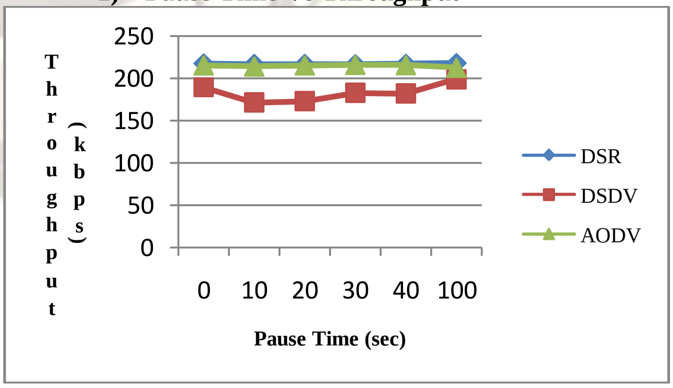

Fig. 1 Pause Time Vs Throughput

Throughput of DSDV is poor at lower pause times (high mobility), therefore performance of DSDV protocol decreases as mobility increases compared to on demand protocols DSR and AODV. AODV and DSR perform better at high mobility.

2) Pause Time Vs Packets Dropped

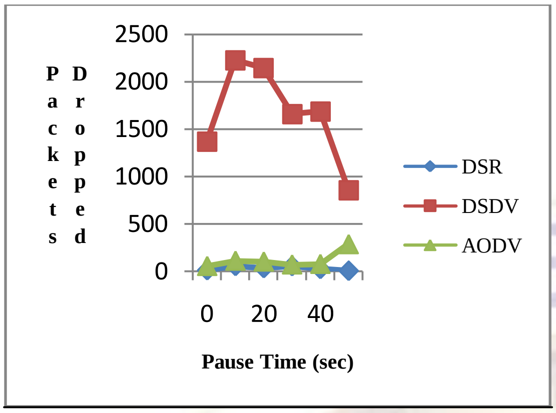

Fig. 2 Pause Time Vs Packets Dropped

DSDV performs poorly as it is dropping more number of packets at high mobility. This is attributed to only one route per destination maintained by DSDV. Each packet that the MAC layer is unable to deliver is dropped since there are no alternate routes. Both AODV and DSR allow packets to stay in the send buffer for 30 seconds for route discovery and once the route is discovered, on that route data packets are sent to be delivered at the destination. If route fails, both DSR and AODV find new path within 30 seconds thereby minimizing the possibility of packet drop.

3) Pause Time Vs Packet Delivery Ratio (PDR*)*

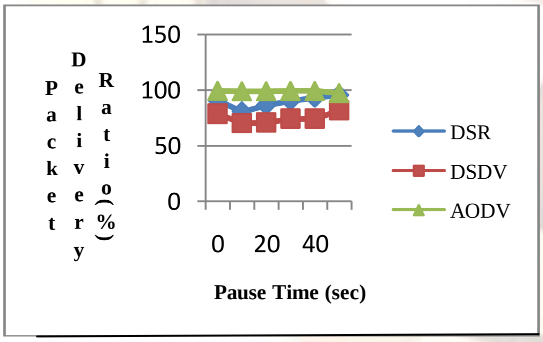

Fig. 3 Pause Time Vs PDR

Packet delivery ratio of DSDV is very less as compared to on demand protocols DSR and AODV at lower pause time (high mobility). AODV and DSR perform best among all at high mobility because both allow packets to stay in the send buffer for 30 seconds for route discovery and once the route is discovered, on that route data packets are sent to be delivered at the destination. Using AODV 99.38% PDR is obtained.

4) Pause Time Vs End-to-end Delay

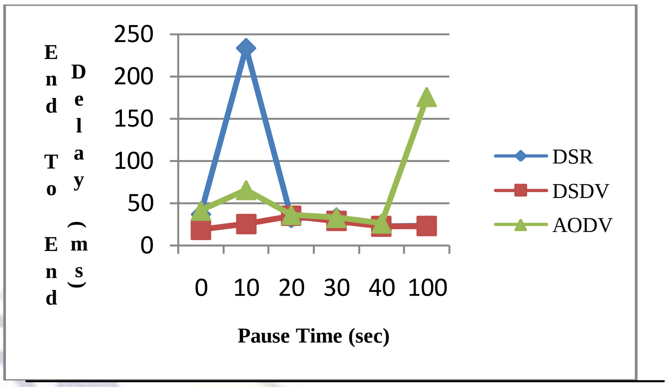

Fig. 4 Pause Time Vs End-to-end Delay

As DSDV always holds optimal paths to all other destinations in their routing tables, delay involved in sending data packets at highest mobility is very less. Mobility decrease end-to-end delay increase in DSDV. As mobility increases AODV performs better as it adopts hop-by-hop routing. DSR performs better at lower and moderate traffic load as it uses source routing.

B. Simulation Results: The effect of traffic load

The network was simulated for high mobility scenario keeping the pause time 0 seconds. The number of connections was varied as 10, 20, 30 and 40 connections to study the effect of traffic load on the network. Graphs in Fig (5-8) show the effect Traffic Load for AODV, DSR and DSDV protocols with respect to various performance metrics.

1) Max. Number of Connections Vs Throughput

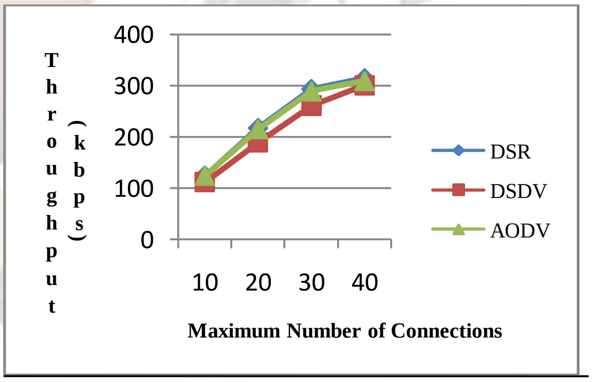

Fig. 5 Maximum Number of Connections Vs Throughput

As the traffic load increases both on-demand protocols work better compared to DSDV.

2) Max. Number of Connections Vs Packets Dropped

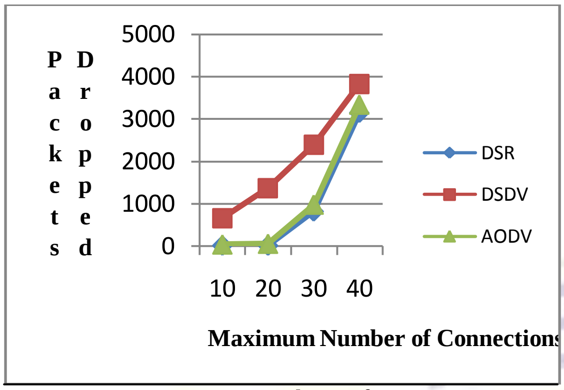

Fig. 6 Maximum Number of Connections Vs Packets Dropped

As the traffic load increases packets dropped will also increase. The reason is bandwidth requirement increases as load increases. Each packet that the MAC layer is unable to deliver is dropped in DSDV since there are no alternate routes. DSR and AODV drops less packets compared to DSDV.

3) Max. Number of Connections Vs Packet Delivery Ratio (PDR)

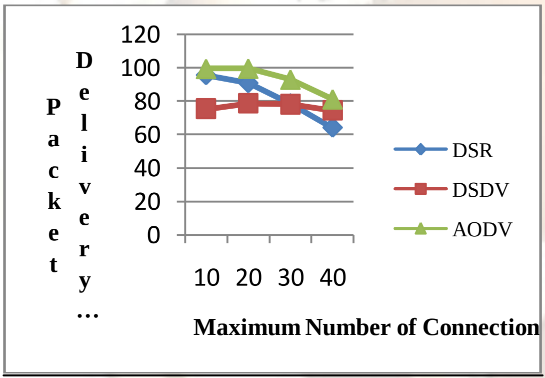

Fig. 7 Max. Number of Connections Vs PDR

AODV and DSR to build the routing information as and when they are required to send data, which makes them more adaptive and results in better performance with respective to high packet delivery fraction. AODV delivers more packets at high traffic load compared to DSR.

4) Max. Number of Connections Vs End-to-end delay

As DSDV always holds optimal paths to all other destinations in their routing tables, delay involved in sending data packets at lower traffic load is very less. As traffic load increases AODV performs better as it adopts hop-by-hop routing. DSR performs better at lower and moderate traffic load as it uses source routing.

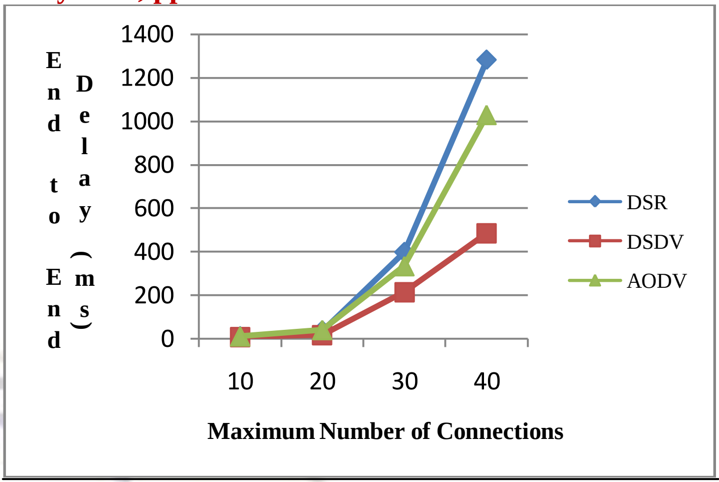

Fig. 8 Maximum Number of Connections Vs End-to-End Delay

IV. CONCLUSIONS AND FUTURE WORK

The analysis of adhoc routing protocols indicate that DSDV is more preferable for a network with low mobility and less number of nodes. The performance of DSR which uses source routings is preferable for the normal network of general nature with moderate traffic and moderate mobility. Investigation also suggests that AODV performs better for the robust scenario where high mobility, nodes are dense, the amount of traffic is more, area is large, and network pattern sustains for longer period.

In future AODV can be compared with other routing protocols like TORA and ZRP for various traffic loads and different mobility.

REFERENCES

[1] Perkins, C. E. and Royer, E. M.; "Ad-hoc On-Demand Distance Vector Routing", Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA.99), New Orleans, LA, USA, February 1999, pages 90-100.

[2] "Evolution and future directions of the ad hoc on-demand distance-vector routing protocol", Elizabeth M. Belding-Royer, Charles E. Perkins, 2003 Elsevier B.V, doi:10.1016/S1570-8705(03)00016-7.

[3] Mobile Ad Hoc Networking Working Group – AODV, http://www.ietf.org/rfc/rfc3561.txt.

[4] D. B. Johnson, D. A. Maltz and Y.C. Hu, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", IETF Draft, http://www.ietf.org, April 2003.

[5] Maltz, D. A.; Broch, J.; Jetcheva, J. and Johnson, D. B.; .The Effects of On-Demand Behavior in Routing Protocols for Multihop Wireless Ad Hoc Networks., IEEE Journal on Selected Areas in Communications Special Issue on Mobile and Wireless

Networks, August 1999, Vol. 17, No. 8, pages 1439-1453.
[6] Perkins, C. E. and Bhagwat, P.; "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers", Proceedings of the ACM SIGCOMM.94 Conference on Communications Architectures, Protocols and Applications, London, UK, August 1994, pages 234-244.
[7] "Wireless Ad Hoc Networks" Zygmunt J. Haas, Jing Deng, Ben Liang, Panagiotis Papadimitratos, and S. Sajama Cornell University School of Electrical and Computer Engineering.
[8] Tutorial for Simulation-based Performance Analysis of MANET Routing Protocols in ns-2By Karthik sadasivam ISSN