Study and Comparison Performance of On-demand AODV and DSR, along with the traditional proactive DSDV Routing Protocols for MANET

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Abstract- In wireless research area, efficient routing algorithms can provide remarkable benefits in Ad-hoc networks, including higher throughput, lower average end-to-end delay, less number of dropped data packets and generally an ameliorated network performance. Many routing protocols for such networks have been proposed so far. My research work, an attempt has been made to compare the performance of three prominent on-demand reactive routing protocols for mobile ad hoc networks: DSR and AODV, along with the traditional proactive DSDV protocol. A simulation analysis with MAC and physical layer models is used to study interlayer communication and their performance implications. Experimental results obtained, showed that the On-demand protocols, AODV and DSR perform much better than the table-driven DSDV protocol. Although DSR and AODV share similar On-demand behavior, the differences in the protocol mechanics can lead to significant performance differentials. For a variety of scenarios, as characterized by mobility, load and size of the ad-hoc network were simulated. The performance differentials are analyzed using varying network load, mobility pattern, and Network size.

***Index Terms*-** Ad Hoc Network, AODV, DSDV, DSR, NS2.

I. INTRODUCTION

In ad hoc networks, each mobile node operates not only as a host but also as a router, forwarding packets for other mobile nodes in the network that may not be within direct wireless transmission range of each other. Each node participates in an ad hoc routing protocol that allows it to discover “multi-hop” paths through the network to any other node. The idea of ad hoc networking is sometimes also called infrastructure less networking, since the mobile nodes in the network dynamically establish routing among themselves to form their own network “on the fly.”

A. Mobile Ad-Hoc Network

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any standalone infrastructure or centralized administration [13]. Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes [12]. Nodes in these networks utilize the same random access wireless channel, cooperating in a friendly manner to engaging themselves in multihop forwarding. The nodes in the network not only act as hosts but also as routers that route data to/from other nodes in network [10]. In mobile ad-hoc networks where there is no infrastructure support as is the case with wireless networks, and since a destination node might be out of range of a source node transmitting packets; a routing procedure is always needed to find a path so as to forward the packets appropriately between the source and the destination. Within a cell, a base station can reach all mobile nodes without routing via broadcast in common wireless networks. In the case of ad-hoc networks, each node must be able to forward data for other nodes. This creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes [11, 14].

B. Infrastructure Networks

Infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

C. Infrastructure less (Ad hoc) Networks

In ad-hoc networks [5] all nodes are mobile and can be connected dynamically in an arbitrary manner. As the range of each host’s wireless transmission is limited, so to communicate with hosts outside its transmission range, a host needs to enlist the aid of its nearby hosts in forwarding packets to the destination. So all nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. Ad hoc Networks are very useful in emergency search-and rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrain. This ad-hoc routing protocols can be divided into two categories:

1. *Table-Driven Routing Protocols:* In table driven routing protocols, consistent and up-t o-date routing information to all nodes is maintained at each n ode.
2. *On-Demand Routing Protocols:* In On-Demand routing protocols, the routes are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination.

D. Some of the differences between proactive (Table-driven) and reactive (On-demand) routing protocols are:

Parameters	Proactive-table driven	Reactive-on demand
Overhead	High	Low
Memory requirement	High	Low
Delay	Low	High
Routing philosophy	Flat	Flat
Availability of routing information	Always available regardless of need	Available when need it
Coping with mobility	Inform other nodes to achieve a consistent routing table	Use localized route discovery
Quality of service(QoS) support	Mainly shortest path as the QoS metric	Few can support QoS, although most support shortest path
Signaling traffic generated	Greater than that in on-demand routing	Grows with increasing mobility of active routes

E. Destination Sequenced Distance VECTOR (DSDV)

The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven.

Advantages of DSDV

a. DSDV protocol guarantees loop free paths [9].
b. Count to infinity problem is reduced in DSDV [9].
c. We can avoid extra traffic with incremental updates instead of full dump updates.
d. Path Selection: DSDV maintains only the best path instead of maintaining multiple paths to every destination. With this, the amount of space in routing table is reduced.

Limitations of DSDV

a. Wastage of bandwidth due to unnecessary advertising of routing information even if there is no change in the network topology [7].
b. DSDV doesn't support Multi path Routing.
c. It is difficult to determine a time delay for the advertisement of routes [3].
d. It is difficult to maintain the routing table's advertisement for larger network. Each and every host in the network should maintain a routing table for advertising. But for larger network this would lead to overhead, which consumes more bandwidth.

F. Ad Hoc On-Demand Distance Vector Routing (AODV)

Ad-hoc On-demand Distance Vector is essentially a combination of both DSR and DSDV. It borrows the basic on-demand mechanism of Route Discovery and Route Maintenance from DSR, plus the use of hop-by-hop routing, sequence numbers, and periodic beacons from DSDV. It uses destination sequence numbers to ensure loop freedom at all times and by avoiding the Bellman-Ford count-to-infinity problem offers quick convergence when the ad hoc network topology changes. In this research paper we attempt to present an overview of two main categories of mobile ad-hoc routing protocols and performance comparison of both the protocols by simulation of two routing protocols(DSDV and AODV) focusing on the differences in their dynamic behavior that can lead to performance differences.

Advanced uses of AODV

a. Because of its reactive nature, AODV can handle highly dynamic behavior of Vehicle Ad-hoc networks [2].
b. Used for both unicasts and multicasts using the 'J' (Join multicast group) flag in the packets [4].

Limitations/Disadvantages of AODV

a. Requirement on broadcast medium: The algorithm expects/requires that the nodes in the broadcast medium can detect each others' broadcasts.
b. No reuse of routing info: AODV lacks an efficient route maintenance technique.
c. The routing info is always obtained on demand, including for common case traffic [8].
d. It is vulnerable to misuse: The messages can be misused for insider attacks including route disruption, route invasion, node isolation, and resource consumption [6].
e. AODV lacks support for high throughput routing metrics: AODV is designed to support the shortest hop count metric. This metric favors long, low bandwidth links over short, high-bandwidth links [8].
f. High route discovery latency: AODV is a reactive routing protocol. This means that AODV does not discover a route until a flow is initiated. This route discovery latency result can be high in large-scale mesh networks

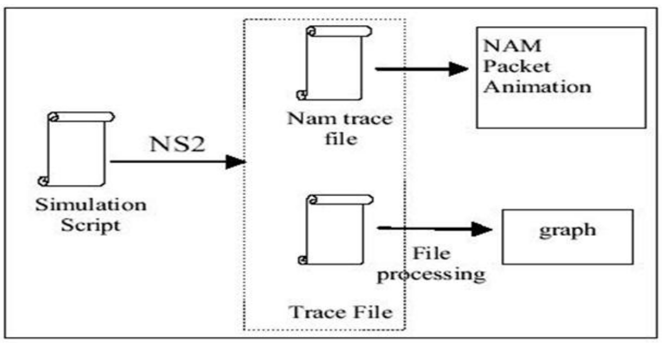
G. Dynamic Source Routing (DSR)

The key distinguishing feature of DSR is the use of source routing. Dynamic Source Routing (DSR) is a reactive protocol i.e. it doesn't use periodic advertisements. It computes the routes when necessary and then maintains them. Source routing is a routing technique in which the sender of a packet determines the complete sequence of nodes through which the packet has to pass; the sender explicitly lists this route in the packet's header, identifying each forwarding hop by the address of the next node to which to transmit the packet on its way to the destination host.

H. NS2 TOOLS DETAILS:

1. **Ns2:** Tool for virtual presentation of Network.
2. **Simulations:** The artificial flow of virtual network
3. **Working:** Nodes created by coding in TCL and given motion as in real network.

Ns-2 Simulation Process Flow:



I. EXPERIMENTS AND RESULTS:

1. **Throughput:** The packet delivered per unit time.
2. **Delay:** The time of delivery
3. **Packet delivery:** The volume and information sent network.

II. PERFORMANCE ANALYSIS

A. Simulation Environment

The simulation experiment is carried out in LINUX (Ubuntu 9.04). The detailed simulation model is based on network simulator-2 (ver-2.33), is used in the evaluation. The NS instructions can be used to define the topology structure of the network and the motion mode of the nodes, to configure the service source and the receiver, to create the statistical data track file and so on.

B. Traffic Model

Continuous bit rate (CBR) traffic sources are used. The source-destination pairs are spread randomly over the network. Only 512-byte data packets are used. The number of source-destination pairs is varied to change the offered load in the network. The protocols maintain a send buffer of 64 packets. It contains all data packets waiting for a route, such as packets for which route discovery has started, but no reply has arrived yet. To prevent buffering of packets indefinitely, packets are dropped if they wait in the send buffer for more than 30 s. All packets (both data and routing) sent by the routing layer are queued at the interface queue until the MAC layer can transmit them. The interface queue has a maximum size of 50 packets and is maintained as a priority queue with two priorities each served in FIFO order. Routing packets get higher priority than data packets.

III. PERFORMANCE METRICS

The performance of the protocols depends on various inter-relating adhered metrics. The most important parameters End to End Delay, Packet Loss and Throughput have been considered herein to draw an analytical observation.

A. Average END to End Delay

Average end to end delay includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times of data packets.

B. Packet Loss

The protocols maintain a send buffer of 64 packets. It contains all data packets waiting for a route, such as packets for which route discovery has started, but no reply has arrived yet. To prevent buffering of packets indefinitely, packets are dropped if they wait in the send buffer for more than 30 s. All packets (both data and routing) sent by the routing layer are queued at the interface queue until the MAC layer can transmit them. The interface queue has a maximum size of 100 packets and is maintained as a priority queue with two priorities each served in FIFO order. Routing packets get higher priority than data packets.

C. Throughput

Also called packet delivery ratio, this is the ratio of the number packets received by the CBR sink to the number of packets sent by the CBR source, both at the application layer. Packets that are sent but not received are lost in the network due to malicious drops, route failures, congestion, and wireless channel losses. A higher throughput will directly impact the user's perception of the quality of service (QOS).

IV. PERFORMANCE RESULTS

A. Throughput vs. Node:

DSR performed poorly in our metrics (PDR and Throughput) in these "stressful" situations (higher mobility, more network load). The reason of these phenomena is the aggressive use of route caching in DSR. In our observation, such caching provides a significant benefit up to a certain extent. With higher loads the extent of caching is deemed too large to benefit performance. Often, stale routes are chosen since route length (and not any freshness criterion) is the only metric used to pick routes from the cache when faced with multiple choices. DSDV shows higher throughput than the DSR and AODV since its routing overhead is less than others. The rate of packet received for AODV is better than the DSDV.

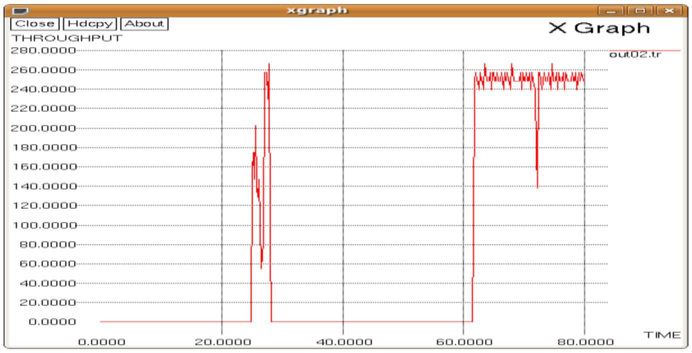


Fig. 1: THROUGHPUT Agent 1, Sink 1 DSDV

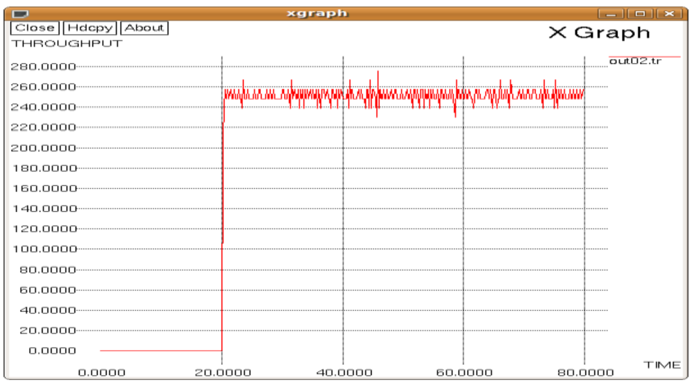


Fig. 2: THROUGHPUT Agent 1, Sink1 AODV

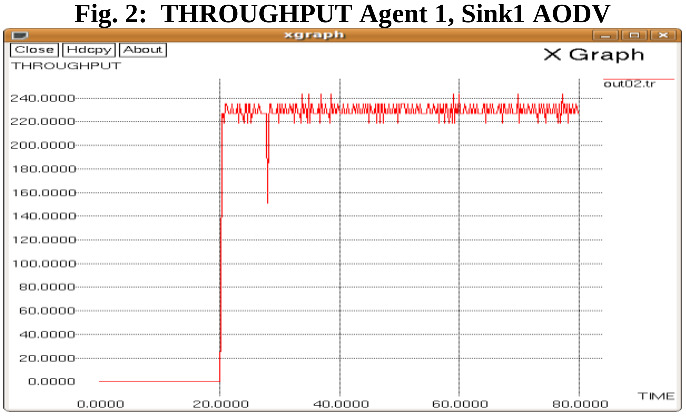


Fig. 3: THROUGHPUT Agent 1, Sink1 DSR

B. Packet Dropped vs. Nod:

Mainly Packet drop occurs due to the end of TTL (Time to Live). If a protocol takes much time to decide destination path, then the packets having short life time, fall into victim to drop. Efficient protocols can wisely find out routing direction thus packets dropping rate reduces for them. The dropped packet for DSR is less than that of DSDV; AODV has no periodic updates exist in DSR.

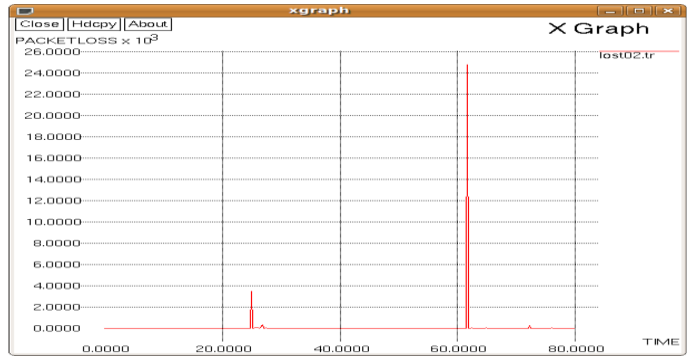


Fig. 4: PACKET LOSS Agent 1, Sink 1 DSDV

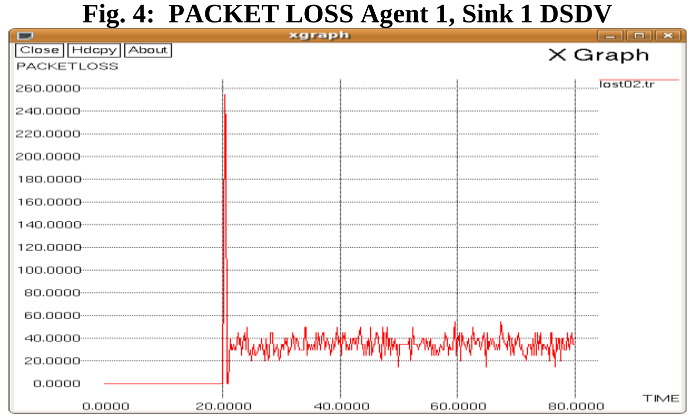


Fig. 5: PACKET LOSS Agent 1, Sink 1 AODV

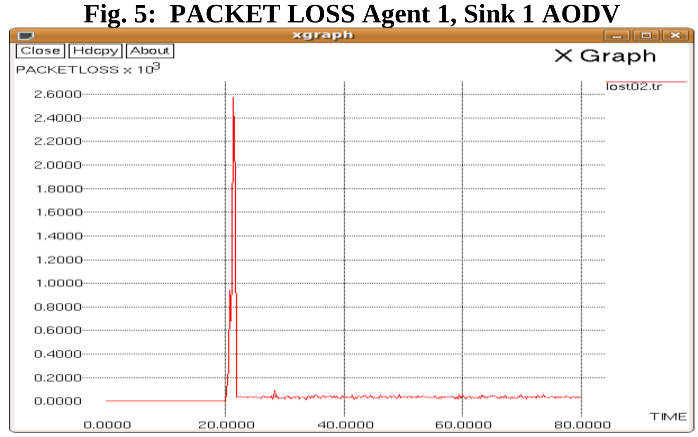


Fig. 6: PACKET LOSS Agent 1, Sink 1 DSR

C. END to End Delay

DSDV which is a table driven proactive routing protocol completely wins over the on demand reactive routing protocols AODV and DSR .Since DSDV proactively keeps the routes to all destination in its table it does not have to initiate the route request process as frequently as in AODV and DSR while sending packets. Hence on average DSDV clearly has less delay. Now we can easily observe that DSR is the worst protocol in terms of delay. At high mobility and more networks load (512 byte packets at 3 packets/sec) aggressive route caching strategy of DSR fails. In these stressful condition links break very often leading to invalidation of routes cached.

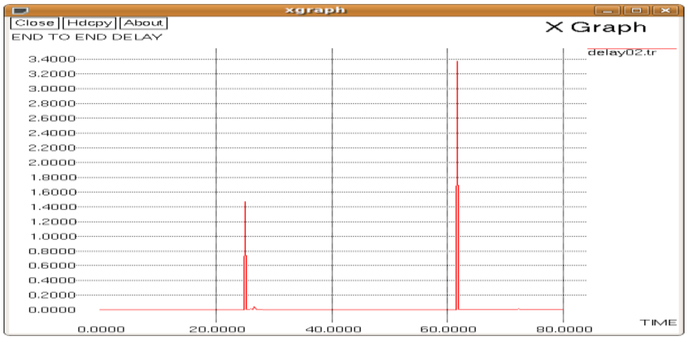


Fig. 7: DELAY Agent 1, Sink 1 DSDV

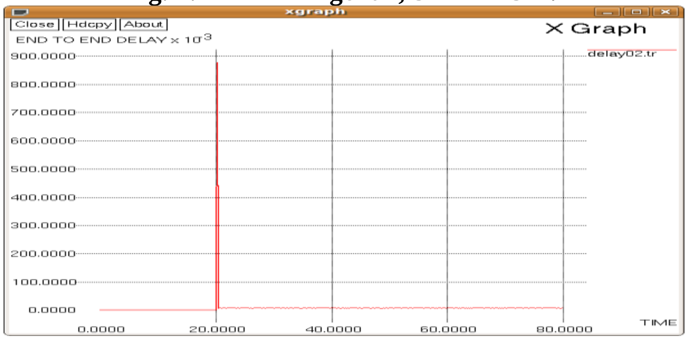


Fig. 8: DELAY Agent 1, Sink 1 AODV

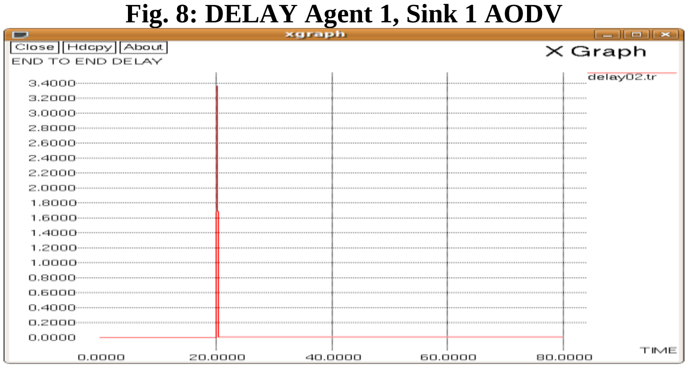


Fig. 9: DELAY Agent 1, Sink 1 DSR

1. *Comparison for 20 and 30 NODES (DSDV):*

Throughput (kbps)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	DSDV		DSDV		DSDV	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	0.0	496.800	0.0	496.800	248.400	506.0
2 Agent, 2 Sink	138.0	156.400	193.199	46.0	239.199	285.199
3 Agent, 3 Sink	73.599	147.199	0	73.599	147.199	248.400
4 Agent, 4 Sink	36.799	101.2	73.599	27.600	82.799	220.800

Packet Loss (No. of Packets)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	DSDV		DSDV		DSDV	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	0	0	0	0	35	0
2 Agent, 2 Sink	75	50	110	65	60	115
3 Agent, 3 Sink	100	60	120	40	105	90
4 Agent, 4 Sink	45	155	160	65	70	20

Delay (sec)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	DSDV		DSDV		DSDV	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	0.0	0.00369	0.0	0.00370	0.00755	0.00364
2 Agent, 2 Sink	0.01319	0.01155	0.00951	0.03724	0.00805	0.00637
3 Agent, 3 Sink	0.01953	0.01351	0.0	0.02318	0.01204	0.00735
4 Agent, 4 Sink	0.08927	0.01809	0.02019	0.06490	0.01645	0.00839

2. *Comparison for 20 and 30 NODES (AODV):*

Throughput (kbps)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	AODV		AODV		AODV	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	257.600	506.0	248.400	496.800	248.400	506.0
2 Agent, 2 Sink	110.400	230.0	128.800	82.799	128.800	55.200
3 Agent, 3 Sink	18.399	257.600	64.400	46.0	128.800	73.599
4 Agent, 4 Sink	0	82.799	73.599	110.400	55.200	147.199

Packet Loss (No. of packets)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	AODV		AODV		AODV	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	35	0	15	0	35	0
2 Agent, 2 Sink	110	90	85	50	75	85
3 Agent, 3 Sink	180	35	100	5	140	120
4 Agent, 4 Sink	5135	135	140	110	70	145

Delay (sec)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	AODV		AODV		AODV	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	0.00696	0.00364	0.00735	0.00365	0.00755	0.00367
2 Agent, 2 Sink	0.01743	0.00747	0.01535	0.02213	0.01401	0.03059
3 Agent, 3 Sink	0.12409	0.00713	0.02705	0.03874	0.01446	0.02508
4 Agent, 4 Sink	0.0	0.02247	0.02949	0.01674	0.03063	0.01227

3. *Comparison For 20 and 30 NODES (DSR):*

Throughput (Kbps)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	DSR		DSR		DSR	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	235.199	453.600	235.199	453.600	218.4	462.0
2 Agent, 2 Sink	126.0	193.199	168.0	58.799	126.0	260.399
3 Agent, 3 Sink	16.8	126.0	42.0	50.399	92.4	134.400
4 Agent, 4 Sink	16.8	75.599	0.0	25.199	16.8	142.800

Packet Loss (No. of Packets)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	DSR		DSR		DSR	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	20	0	35	0	35	0
2 Agent, 2 Sink	75	70	100	100	85	35
3 Agent, 3 Sink	30	95	90	240	140	10
4 Agent, 4 Sink	70	45	0	20	45	10

Delay (sec)	Time T1(30 sec)		Time T2 (50 sec)		Time T3 (70 sec)	
Protocol	DSR		DSR		DSR	
Number of Nodes	20	30	20	30	20	30
1 Agent, 1 Sink	0.00708	0.00367	0.00716	0.00368	0.00745	0.00367
2 Agent, 2 Sink	0.01288	0.00884	0.01097	0.02001	0.01270	0.00645
3 Agent, 3 Sink	0.02497	0.01331	0.03333	0.03088	0.01828	0.01251
4 Agent, 4 Sink	0.01331	0.02006	0.0	0.08587	0.04322	0.01043

4. *Comparison based on QOS Parameters 20 nodes:*

Throughput (kbps)	Time T1(30 sec)			Time T2 (50 sec)			Time T3 (70 sec)		
Protocol	DSDV	DSR	AODV	DSDV	DSR	AODV	DSDV	DSR	AODV
1 Agent, 1 Sink	0.0	235.199	257.600	0.0	235.199	248.400	248.400	218.4	248.400
2 Agent, 2 Sink	138.0	126.0	110.400	193.199	168.0	128.800	239.199	126.0	128.800
3 Agent, 3 Sink	73.599	16.8	18.399	0	42.0	64.400	147.199	92.4	128.800
4 Agent, 4 Sink	36.799	16.8	0	73.599	0.0	73.599	82.799	16.8	55.200

Packet Loss (Number of packets)	Time T1(30 sec)			Time T2 (50 sec)			Time T3 (70 sec)		
Protocol	DSDV	DSR	AODV	DSDV	DSR	AODV	DSDV	DSR	AODV
1 Agent, 1 Sink	0	20	35	0	35	15	35	35	35
2 Agent, 2 Sink	75	75	110	110	100	85	60	85	75
3 Agent, 3 Sink	100	30	180	120	90	100	105	140	140
4 Agent, 4 Sink	45	70	5315	160	0	140	70	45	70

Delay (sec)	Time T1(30 sec)			Time T2 (50 sec)			Time T3 (70 sec)		
Protocol	DSDV	DSR	AODV	DSDV	DSR	AODV	DSDV	DSR	AODV
1 Agent, 1 Sink	0.0	0.00708	0.00696	0.0	0.00716	0.00735	0.00755	0.00745	0.00755
2 Agent, 2 Sink	0.01319	0.01288	0.01743	0.00951	0.01097	0.01535	0.00805	0.01270	0.01401
3 Agent, 3 Sink	0.01953	0.02497	0.12409	0.0	0.03333	0.02705	0.01204	0.01828	0.01446
4 Agent, 4 Sink	0.08927	0.01331	0.0	0.02019	0.0	0.02949	0.01645	0.04322	0.03063

5. Comparison based on QOS Parameters 30 nodes:

Throughput (kbps)	Time T1(30 sec)			Time T2 (50 sec)			Time T3 (70 sec)		
Protocol	DSDV	DSR	AODV	DSDV	DSR	AODV	DSDV	DSR	AODV
1 Agent, 1 Sink	496.800	453.600	506.0	496.800	453.600	496.800	506.0	462.0	506.0
2 Agent, 2 Sink	156.400	193.199	230.0	46.0	58.799	82.799	285.199	260.399	55.200
3 Agent, 3 Sink	147.199	126.0	257.600	73.599	50.399	46.0	248.400	134.400	73.599
4 Agent, 4 Sink	101.2	75.599	82.799	27.600	25.199	110.400	220.800	142.800	147.199

Packet Loss (Number of packets)	Time T1(30 sec)			Time T2 (50 sec)			Time T3 (70 sec)		
Protocol	DSDV	DSR	AODV	DSDV	DSR	AODV	DSDV	DSR	AODV
1 Agent, 1 Sink	0	0	0	0	0	0	0	0	0
2 Agent, 2 Sink	50	70	90	65	100	50	115	35	85
3 Agent, 3 Sink	60	95	35	40	240	5	90	10	120
4 Agent, 4 Sink	155	45	135	65	20	110	20	10	145

Delay (sec)	Time T1(30 sec)			Time T2 (50 sec)			Time T3 (70 sec)		
Protocol	DSDV	DSR	AODV	DSDV	DSR	AODV	DSDV	DSR	AODV
1 Agent, 1 Sink	0.00369	0.00367	0.00364	0.00370	0.00368	0.00365	0.00364	0.00367	0.00367
2 Agent, 2 Sink	0.01155	0.00884	0.00747	0.03724	0.02001	0.02213	0.00637	0.00645	0.03059
3 Agent, 3 Sink	0.01351	0.01331	0.00713	0.02318	0.03088	0.03874	0.00735	0.01251	0.02508
4 Agent, 4 Sink	0.01809	0.02006	0.02247	0.06490	0.08587	0.01674	0.00839	0.01043	0.01227

V. CONCLUSION

The study reveals that, DSDV shows higher throughput than the DSR and AODV since its routing overhead is less than others. The rate of packet received for AODV is better than the DSDV. The dropped packet for DSR is less than that of DSDV; AODV has no periodic updates exist in DSR. DSDV routing protocol consumes more bandwidth, because of the frequent broadcasting of routing updates. While the AODV is better than DSDV as it doesn't maintain any routing tables at nodes which results in less overhead and more bandwidth. It can be assumed that DSDV routing protocols works better for smaller networks but not for larger networks. In END to End Delay, DSDV which is a table driven proactive routing protocol completely wins over the on demand reactive routing protocols AODV and DSR .Since DSDV proactively keeps the routes to all destination in its table it does not have to initiate the route request process as frequently as in AODV and DSR while sending packets. Hence on average DSDV clearly has less delay. It can be observed that DSR is the worst protocol in terms of delay.

So, my conclusion is that, a combination of DSR and DSDV would result in a protocol with better performance than either of the two.

VI. FUTURE SCOPE

In the future, extensive complex simulations could be carried out using the project code, in order to gain a more in-depth performance analysis of the ad hoc routing protocols. Other new protocol performance could be studied too.

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