Performance Evaluation of AODV and DSR using Random Way Point Mobility Model

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ABSTRACT
An Ad hoc network is a short-live network in which two or more mobile devices connected to each other without the help of intervening infrastructure. The routing protocols designed for wired networks are different from Ad hoc networks protocols because wired network can't work efficiently in Ad hoc networks. This imposes different design constraints and requirement on routing protocols for MANET. There are some properties of Ad hoc networks that do not directly relate to performance, but they describe very nature of Ad hoc networks and formulate boundary conditions of Ad hoc networks. In this paper, we consider end-to-end delay as metric to measure external performance of a protocol, and to measure internal effectiveness of a protocol, we consider Packet Delivery Ratio, Routing overheads and Packet loss as the metrics.

Keywords
MANET, throughput, end-to-end delay, Packet Delivery Ratio, Routing overheads, Packet loss

1. INTRODUCTION
Mobile Ad hoc Network is a collection of self organized network of flexible wireless nodes without a centralized control or infrastructure. These mobile nodes are capable to communicate with each other directly or with the help of intermediate nodes without a central controller using wireless links or multi-hop wireless links as shown in Figure1. This type of networks have dynamic topology i.e. topology of the network is not fixed and all the nodes work as an access points without the need of any base stations. Battlefields, emergency services, moving vehicles, and conference rooms are some of the applications where Mobile Ad hoc Network is used.

The routing protocols for Ad hoc networks are broadly classified into three categories based upon the update mechanism of the routing information: Proactive, Reactive and Hybrid.

In proactive routing protocols, each node update and maintain the routing tables to keep track of all possible destinations for the immediate availability of the routes for future use. Destination Sequence Distance Vector and Wireless Routing Protocol are the examples of proactive protocols.

Reactive routing protocols establish routes only when routes are needed by a source node; each node maintains individual routing information to destinations, but does not have a full topological view of the network i.e. in reactive protocols, routes are discovered

on-demand i.e. for finding a route to destination a route request is initiated. Dynamic Source Routing and Ad hoc On Demand Distance Vector are the examples of reactive protocols.

Hybrid Protocols combines the best features of the above two categories. Nodes within a certain distance from the node concerned or within a particular geographical region are said to be within the routing zone of the given node. For routing within this zone, a table driven approach is used. For the nodes that are located beyond this zone, an on-demand approach is used. Zone Routing Protocol (ZRP) is an example of Hybrid Routing Protocol.

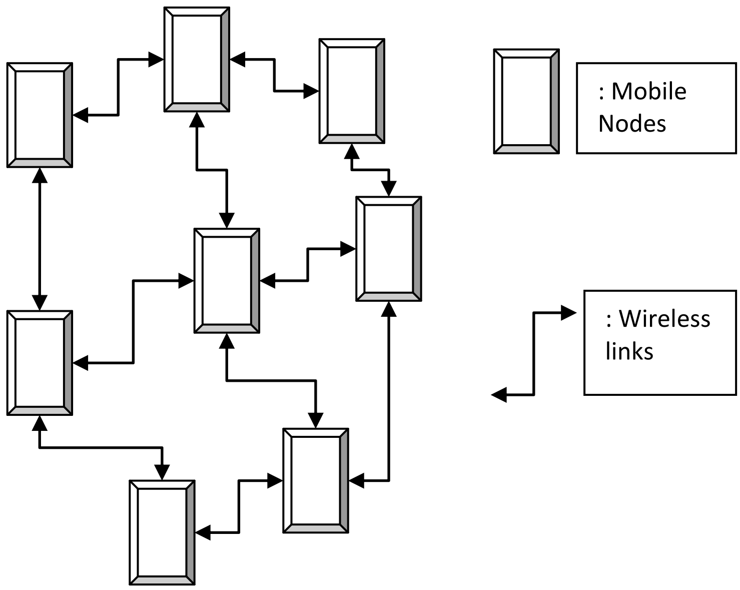

Figure1 Mobile Ad hoc Network

1.1 CHALLENGES FOR ROUTING PROTOCOLS
An Ad hoc wireless network consists of a set of mobile nodes (hosts) that are connected by wireless links. The network topology in such network may keep changing randomly.

The major challenges that a routing protocol designed for Ad hoc networks faces are mobility of nodes resource constraints, error prone channel state and hidden and exposed terminal problems.

1.2 DESIGN ISSUES FOR ROUTING PROTOCOL

Due to the issues in an Ad hoc wireless network environment, wired network routing protocols cannot be used in Ad hoc wireless networks. Hence Ad hoc wireless networks requires specialized routing protocols that address that challenges described above. A routing protocol for Ad hoc wireless networks should have the following characteristics:

- It must be fully distributed, as centralized routing involves high control overhead and hence is not scalable. Distributed routing is more fault-tolerant than centralized routing, which involves the risk of single point of failure.
- It must be adaptive to frequent topology changes caused by the mobility of nodes.
- Routing computation and maintenance must involve a minimum number of nodes. Each node in the network must have quick access to routes, i.e. minimum connection setup time is desired.
- It must be localized, as global state maintenance involves a huge state propagation control overhead.
- It must be loop-free and free from stale routes.
- The number of packet collision must be kept to a minimum by limiting the number of broadcasts made by each node. The transmission should be reliable to reduce message loss and to prevent the occurrence of stale routes.
- It must coverage to optimal routes once the network topology becomes stable. The convergence must be quick.
- It must be optimally use scarce resources such as bandwidth, computing power, memory, and battery power.

2. ROUTING PROTOCOLS PERFORMANCE ISSUES

Routing is defined as the process of finding a path from a source to some arbitrary destination on the network. Mobile Ad hoc networks, or MANET, are fundamentally different from traditional wired networks as wired networks are assumed to be stationary and static. So the routing protocols designed for wired networks can't work efficiently in Ad hoc networks. This imposes different design requirement and constraints on routing protocols for MANET. These properties do not directly relate to performance, but they describe very nature of Ad hoc networks and formulate boundary conditions of Ad hoc networks. To measure external performance of a protocol, we consider throughput and end-to-end delay as metrics and to measure internal effectiveness of a protocol; we consider Packet Delivery Ratio, Average e-e delay, Routing overheads and Packet loss as the metrics.

Packet Delivery Ratio: Packet Delivery Ratio is the delivery ratio of the data packets which are generated by the CBR sources to the destination.

Average e-e delay: Average e-e delay is the average amount of delay taken by the packets when they are moving from source to the destination. Delay can be occurred due to the following reasons: buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC and propagation and transfer times.

Packet Loss: Due to many reasons packets will be dropped while moving from source to the destination. Packet Loss is used to measure of the number of packets dropped by the routers.

Routing Overhead: Routing Overhead is the ratio of the routing packets (that is extra data bits are added to user-transmitted data, for carrying routing information) to the data packets.

3. RELATED WORK

Chang J et. al. [1] and Stojmenovic I et. al. [2] have proposed power aware Ad hoc routing protocol in which main focus on minimizing the total power needed to route packets or maximizing the lifetime of all nodes. Research focus was based on individual nodes in the system instead of the system as a whole

Sesay S et.al. [3] have proposed a combine Adaptive load energy balancing and hotspot mitigation scheme that aims at evenly distributing network traffic load and energy, mitigate against any possible occurrence of hotspot and provide some form of security to the network. This combine approach is expected to yield high reliability, availability and robustness, that best suits any dynamic and scalable Ad hoc network environment .

Bouhorma M et.al. [6] performs the comparison of AODV and DSR. Their simulated results show that DSR performs well in small networks with low node speeds and AODV performs better if mobility increases. If we want to get the optimize results then we should have to use combination of both the protocols .

Lin-zhu WANG et. al. [7]. Min have compared two routing protocols. In which DSR outperforms AODV in less "stressful" situations, i.e., smaller number of nodes and lower load and/or mobility. AODV, however, outperforms DSR in more stressful situations, with widening performance gaps with increasing stress.

Emmanouil S et. al. [5] have used DSR to route packets in Mobile Ad hoc Network. They study the management of routing data stored in nodes' route caches by optimizing the cached route lifetime using a route Time-To-Live (TTL) parameter. The idea is to purge cache entries after some Time-to-Live (TTL) interval. If the TTL is small, valid routes are likely to be discarded prematurely, on the other hand if the TTL value is large, invalid route-caches are likely to be used, and in both cases additional routing delay and traffic overhead may result before a broken route is discovered. But there is a drawback as the transmission range becomes higher the throughput improvement drops significantly.

Biradar S.R et.al. [8] analyzed the MANET popular routing protocols DSR and AODV. The DSR performs better in high mobility, and average delay is better in case of AODV for increased numbers of groups. DSR Protocol produces higher control traffic during high mobility, due to its aggressive caching [8].

Huang Tsung-Chuan et.al. [10] proposed backup routing scheme which utilized 2-hop neighbor knowledge to establish backup paths. These backup paths are geographically close to the primary path in order to provide efficient recovery from route failure and reduce the number of route discovery procedure. But there is a problem, they propose backup routing scheme which utilized 2-hop neighbor knowledge to establish backup paths only for single link breakup. They do not propose any backup path for multiple link breakups .

Mohseni M et. al. [4] propose a new algorithm in which they uses the information location of intermediate nodes to forward the route request packets. The frequency of route breaking increased at high speeds, overhead reduction is more visible.

Mittal S et. al. [9] perform the comparison of AODV, DSR and ZRP Routing Protocols in MANET. Their results AODV is better than the other two and delivers almost 90 percent of packets.

Barakovic Sabina. et. al. [11] do the comparative performance evaluation of MANET routing protocols. Their result shows DSR is better in high mobility.

Agrawal R et. al. [12] also performance the evaluation and comparison of AODV and DSR under adversarial environment. Simulation result shows that performance of AODV is better for small number of nodes but performance degrades if number of nodes increases.

In the last years, lots of people are pushed to study the performance in wireless networks because of the increasingly use of wireless networks. Some researcher's advices to change routing protocols to dynamic protocols or source routing protocol. But there are some researcher's make a difference of the cause of packets lost or they can change the congestion control protocol of TCP.

We have analysed two protocols, and we will show how they can improve the performance on wireless network. We have used NS-2 for comparing different routing protocols .This simulator will give the results for different protocols' throughput, overhead, etc. that we have compared. Our results will fit in with those researches and consequently they demonstrate and verify the assumptions of these researches.

We have done the simulation based comparison and performance analysis on different parameters like PDF, Average e-e delay, Routing Overheads and Packet Loss. The comparison is done for two main protocols DSR, AODV (Reactive).

4. PERFORMANCE EVALUATION

We have evaluated the performance based on end-to-end delay, routing overhead, packet delivery ratio and packet loss as the metrics. These matrices describe nature of Ad hoc networks and formulate boundary conditions of Ad hoc networks but these properties do not directly related to performance. To measure external performance of a protocol, we consider end-to-end delay as metrics and to measure internal effectiveness of a protocol; we consider routing overhead, packet delivery ratio and packet loss as the metrics. All these metrics are most widely used for representing performance of routing protocols because higher data delivery, lower control overhead and lower delay are always desirable.

4.1. SIMULATION SETUP

We conducted the extensive simulation using NS-2 simulator and compared DSR, AODV and DSDV protocols. In simulation, we first generate scenario files considering the area of 1500mx300m as under the Scenario files for varying Pause Time and keeping No. of Nodes(50), Speed (20 m/s) and simulation Time (500 sec) constant.

TABLE 1: SIMULATION PARAMETERS

S.NO.	SIMULATION PARAMETERS	VALUES
1	Protocols	AODV,DSR
2	Simulation Area	1500x300
3	Simulation Time	500sec
4	No. of nodes	50
5	Mobility model	Random Way Point
6	Speed	20 m/sec
7	Varying pause time	(0-500) sec
8	Type of Traffic	CBR
9	Varying maximum connections	15,25,35,45

After generating the scenario files we generated traffic files using cbrgen utility of NS-2. The no. of maximum connections were mentioned as no of nodes for a particular file 8 traffic files were generated for the varying pause time ranging from 0 ms to 500 ms. Before starting the simulation it was ensured that the computer system was having a good processing speed and large storage capacity as 88 trace files were generated. Tcl script was run over to generate the trace files for various protocols DSR and AODV. After analysing these 88 file trace files with awk script we concluded the results for various parameters to be calculated and plotted the graph as in the next section. Every simulation was done for 500 seconds.

4.2. CREATION OF TRAFFIC FILE

We generated the traffic files using cbrgen utility of NS-2. We have generated 8 traffic files for the varying maximum connections (15, 25, 35, 45) for 50 no. of nodes. Before starting the simulation it was ensured that the computer system was having a good processing speed and large storage capacity.

Random traffic connections of TCP and CBR can be setup between mobile nodes using a traffic-scenario generator script. This traffic generator script is available under ~ns/indep-utils/cmu-scen-gen and is called cbrgen.tcl. It can be used to create CBR and TCP traffics connections between wireless mobile nodes. In order to create a traffic-connection file, we need to define the type of traffic connection (CBR or TCP), the number of nodes and maximum number of connections to be setup between them, a random seed and incase of CBR connections, a rate whose inverse value is used to compute the interval time between the CBR pkts. So the command line looks like the following:

ns cbrgen.tcl [-type cbr|tcp] [-nn nodes] [-seed seed] [-mc connections][-rate rate] >traffic_file_name

4.3. CREATION OF SCENARIO FILE

Scenario file is used to depict the physical organization of the nodes , how they are moving with what speed etc. Setdest tool is used to generate the positions of nodes and their moving speed and moving directions. The syntax is:

./setdest -v <1> -n <nodes> -p <pause time> -M <maximum speed> -t <Simulation time> -x <maximum x> -y <maximum y> > scenario_file_name

In simulation, we generate scenario files considering the area of 1500mx300m .We have generated the Scenario files for constant number of nodes (50) and varying Pause time (2 sec), Max Speed(20m/s) and Simulation Time (500 sec) constant. We have generated total of 88 files.

5. ANALYSIS OF RESULTS

END TO END DELAY: Average end-to-end delay is an average end-to-end delay of data packets. This delay can be caused by many reasons, like, latching during route discovery latency, queuing at interface queue, and retransmission delays at the MAC.

End to end delay can be calculated by dividing the time difference between every CBR packets sent and received, to the total number of CBR packets received. For the better performance of the protocol end to end delay must be as lower as possible. From the graphs it is very clear that AODV out performs DSR for the scenarios of varying pause time. In case of DSR delay time increases very sharply with the increasing pause time while AODV is consistent with the increasing pause time as shown in Figure2.

PACKET DELIVERY FRACTION: Packet Delivery Ratio is the delivery ratio of the data packets which are generated by the CBR sources to the destination. Performance of the protocol is better if PDF value is higher which implies that how successfully the packets have been delivered. In our simulation it has been noticed that AODV outperforms DSR as shown in Figure3.

ROUTING OVERHEAD: Routing overhead is the ratio of total number of routing packets to data packets which are calculated at the MAC layer. In our results we have calculated routing overheads at Network layer as well as MAC layer. In comparison of AODV, DSR has performed well in most of the cases when the pause time is around 100 for the particular scenario but AODV outperforms DSR when the pause times are above 100. Since AODV is having more routing control packets than DSR, routing overhead of AODV is always higher even in stressful environment as shown in Figure4 and Figure5.

PACKET LOSS: Due to many reasons packets will be dropped while moving from source to the destination. Packet Loss is used to measure of the number of packets dropped by the routers It is defined as the difference between the number of packets sent by the source and received by the destination. The packets are forwarded to the destination only if the valid route is known otherwise it is stored in buffer until a route is available. If buffer is full than the packets is dropped, this cause the packet loss. Performance of the protocol will increases if the packet loss is minimal. In case of DSR packet loss is minimum in all the cases as compared to AODV shown in Figure6.

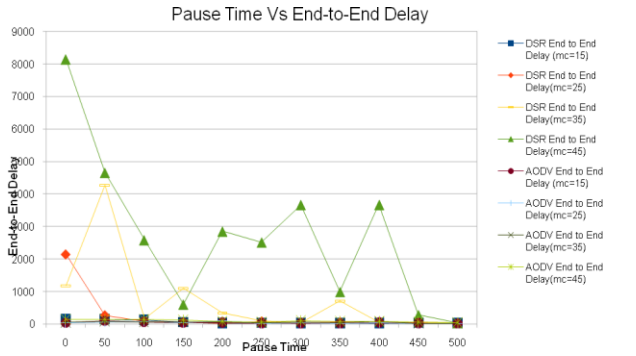

Figure2 Pause time Vs End-to-End Delay

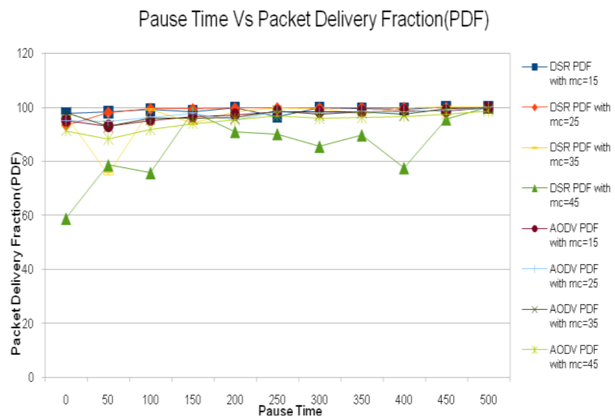

Figure3 Pause time Vs PDF

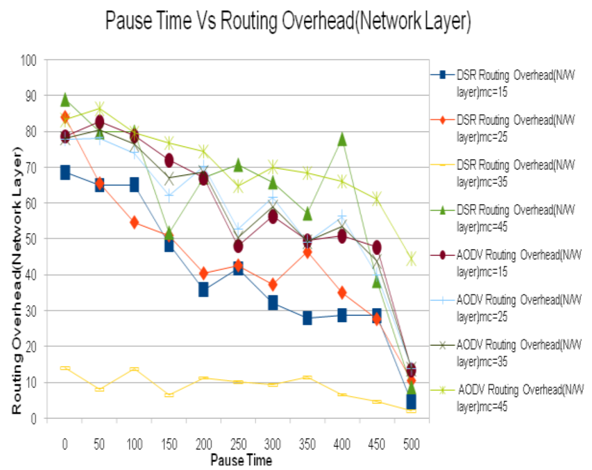

Figure4 Pause time Vs Routing Overhead (Network Layer)

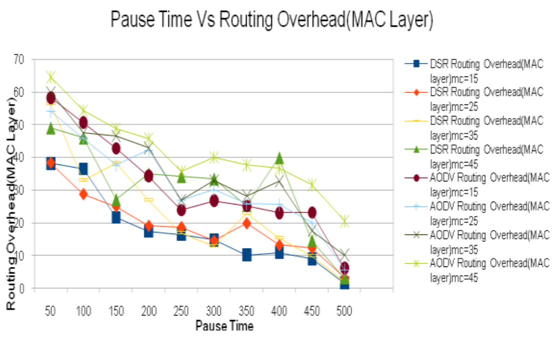

Figure5 Pause time Vs Routing Overhead (MAC Layer)

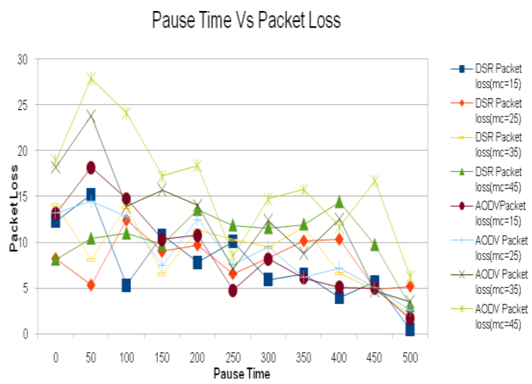

Figure6 Pause time Vs Packet Loss

6. CONCLUSION

From the analysis of the graphs obtained from the simulation of the two prominent protocols, AODV and DSR using NS-2 shows that AODV is better than DSR. AODV and DSR are the representative of reactive routing protocols. From the graphs it is very clear that AODV out performs DSR for the scenarios of varying pause time. In case of DSR delay time increases very sharply with the increasing pause time while AODV is consistent with the increasing pause time. Performance of the protocol is better if PDF value is higher which implies that how successfully the packets have been delivered. In our simulation it has been noticed that AODV outperforms DSR

In comparison of AODV, DSR has performed well in most of the cases when the pause time is around 100 for the particular scenario but AODV outperforms DSR when the pause times are above 100. Since AODV is having more routing control packets than DSR, routing overhead of AODV is always higher even in stressful environment.

Performance of the protocol will increase if the packet loss is minimal. In case of DSR packet loss is minimum in all the cases as compared to AODV. As AODV is designed for up to thousands of nodes while DSR is designed up to two hundred nodes. AODV performed better in dense environment.

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